‘Future of Work’ in India’s IT/IT-eS Sector

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Introduction

The Centre for Internet and Society has recently undertaken research into the impact of Industry 4.0 on work in India. Industry 4.0, for the purposes of the research, is conceptualised as the technical integration of cyber physical systems (CPS) into production and logistics and the use of the 'internet of things' (connection between everyday objects) and services in (industrial) processes. By undertaking this research, CIS seeks to complement and contribute to the discourse and debates in India around the impact of Industry 4.0. In furtherance of the same, this report seeks to explore several key themes underpinning the impact of Industry 4.0 specifically in the IT/IT-es sector and broadly on the nature of work itself.

Scholarship that has emerged globally has sought to address the challenges of technological forecasting as it relates to work in varied forms. For instance, the Frey-Osborne methods examine characteristic tasks of each occupation and suggest that almost half of all jobs in the United States and other advanced countries are at risk of being substituted by computers or algorithms within the next 10 to 20 years.[1] On the other hand, scholars such as Autor and Handel as well as research produced by OECD on this subject argue that occupations as a whole are unlikely to be automated as there is great variability in the tasks within each occupation.[2] Existing literature on the impact on jobs in the IT sector in India too have arrived at mixed conclusions. Reports have raised concerns about job loss in the sector as a result of automation[3] whilst it has also been reported that employment from the IT sector reached 3.86 million in 2016-17 and an addition of around 105,000 was witnessed in FY18 itself.[4]

In this context, it is crucial to start by developing an understanding of which technologies are at the forefront of bringing in Industry 4.0. Such an understanding will further help understand which jobs, and more specifically, job functions are at the greatest risk of being replaced by automation technologies. To further contextualise the impact, it is imperative to develop a comprehensive understanding of how job functions are organised within the sector itself. This becomes especially relevant with the emphasis Industry 4.0 places on the horizontal and vertical integration of the various technologies constituting Industry 4.0.[5]

It is anticipated that to stay ahead of the curve of 'technological unemployment' there will be significant skilling and re-skilling challenges to enable new talent addition around emerging job roles.[6] The skilling challenge gains enhanced importance in the broader context of nurturing an inclusive digital economy.[7] This is particularly relevant in the context of female labour force participation, since it has been predicted that job creation will be concentrated in sectors where females are underrepresented and difficult to retain, while sectors with higher female participation, such as secretarial work, will undergo job loss.[8]

However, it is not clear how these trends will play out in the future, particularly because other structural changes are taking place simultaneously (such as globalisation and protectionism, demographic change, policymaking, technological adoption etc.).

Objective and Scope

This research seeks to contribute to existing studies and dialogue on the impact and effect of industry 4.0 on work in the Information Technology services (IT) sector in India. Though the research focuses on the impact of technologies that comprise Industry 4.0, such technologies are frequently interchanged with the words 'automation' and 'digitisation'. Thus, the desk research also examines the impact of 'automation' and 'digitisation' on the IT sector in India. The case study looks at the IT sector broadly and where applicable, calls out information specific to sub-sectors such as IT enabled services (IT-eS) or Business Process Management (IT-BPM). The IT sector in India is uniquely placed; it is producing the technologies that are disrupting work in other industries as well as implementing them internally. This report focuses on the latter, but brings into context the former when relevant to work in the sector.

By drawing out trends and providing an analysis of contextual, quantitative and qualitative data on changes to work and labour markets in India as a result of technological uptake, it is anticipated that comparative research can be enabled by creating a framework that can be replicated in other, particularly developing, contexts.

Methodology

This research looks at the impact of technological adoption on work in the IT sector in India through desk research and empirical research.

Empirical Research: Empirical research in the project sought to generate primary data through a mixed methods approach which included qualitative interviews and quantitative surveys with selected groups of stakeholders.

In total, we conducted 7 semi-structured, qualitative interviews with stakeholders, including trade unions, industry bodies and companies. Though we had reached out to HR services, trade bodies, training/skilling services, and media - we were unable to obtain interviews with these stakeholders.

We also undertook a survey with IT companies to generate quantitative data. For the survey, employees at varying hierarchical levels - at the entry, middle and higher management levels - were surveyed in person. We received 182 responses in total: with 135 responses from entry level workers and 47 responses from middle and higher level workers. The survey questionnaires are provided as Annexure 2.

Further, at the mid-stage of the research, a roundtable was held on June 29, 2018, that brought together representatives from several stakeholder groups to have thematic discussions on the role of Industry 4.0 in the Indian IT industry.[9]

Desk Research: Desk research analysed industry reports, news items, academic reports, companies' sustainability reports and annual reports, interviews, national employment data,

questions to the Parliament, job descriptions from online job portals, surveys, and roundtable inputs. The desk research studied the narrative around the impact of industry 4.0 and work in the sector. As part of the desk research, we focused on sixteen companies in the sector. These were shortlisted based on their contribution to employment in the sector (and the specific sub-sector they operate in) as well as the revenue generated. It should be noted that the two were synonymous for a significant part of the sector's growth in India. The former metric was chosen as the impact of technological change on employment would be most stark in large employment bases while revenue would indicate the capital wherewithal to implement technological adoption. It is further anticipated that market leaders, as evidenced by this shortlist, would pioneer technological change with the rest of the market following suit.

IT sector overview

According to the "Make in India" website, the IT sector is comprised of four main segments - IT services, BPM industry exports, Engineering, Research & Development (ER&D), and Software Product Development. The Indian IT sector is said to currently employ 3.86 million people directly and 13 million indirectly.[10] As pointed out in a release by the Ministry of Electronics and IT, following the consolidation of secondary data from NASSCOM and staffing agencies operating in the sector, the outlook on job creation in the sector is positive in the short to medium term despite global employment challenges that the sector faces.[11] It is important to contextualise these sectoral numbers to the larger projected Indian labour market. India is expected to grow from 1.352 billion people in 2018 to 1.461 billion[12] with over 68%[13] in the productive age group of 15-64 years by 2025. The total job market in the IT sector is expected to grow to about 6.5 million by 2025[14]. Taken within the context of the Indian labour market, the IT sector would still constitute only 0.65% of the total productive workforce in India by 2025.

Identified drivers of growth for the sector include the emergence of new platforms, products, and automation.[15] Of the four main segments, the IT-BPM sector in India expanded at a compounded annual growth rate (CAGR) of 13.7% over 2010–16. This is 3 - 4 times higher than the global IT-BPM growth, and is estimated to expand at a CAGR of 9.1%to USD 350 billion by 2025.[16] According to NASSCOM, the growth of India's IT Services industry for 2017-18 is projected at 7.8%, with an expected growth rate of 7-9% in the next financial year. While the software export revenue is projected to grow to 7 -9 % to $135-137 billion; the domestic revenue is likely to grow 10-12% to $28-29 billion.[17] India's ER&D Globalization and Services market reached USD 22.3 billion in 2016 and is set to rise to US$ 38 billion by 2020.[18] The Indian Software industry is also said to be poised for tremendous growth, where the present additional digital revenue coming from new business has crossed 20%, when compared to 14% in 2016. The value of the Indian Software Industry is expected to go to 38-40% in 2025.[19] India is a prominent sourcing destination across the world, accounting for approximately 55% market share of the US$ 185-190 billion global services sourcing business in 2017-18.[20] However, it should be noted that nearly 90% of these exports are to the US, UK and Europe.[21]

India's IT-BPM sector includes 670 offshore development centres around 78 countries.[22] India's IT sector has further been cited as one of the fastest growing tech markets in APAC with the sector displaying over 11% growth (in INR) in 2016-17.[23] The sector has also contributed over USD 11 bn in revenue,[24] with a 7% share of the total FDI inflows.[25]

Specifically with respect to the IT sector, the IT and IT-eS sub-sectors, in 2016, added 1.7 lakh jobs, according to NASSCOM.[26] However, this fell short of its projection to add over 2 lakh new jobs in the same year. This is in comparison to 5 years ago when the sector was adding nearly 4 lakh new jobs. Additionally, while it remains outside the category of direct employment in technical jobs, the IT/IT-eS industry would have also employed another 2.5 lakh indirectly in the form of logistics, catering, security and other allied industries.[27]

The fact that it is the third largest start up base, supporting over 4,200 new startups in 2016 means that new jobs are also being created in the sector.[28] At the same time, there is anxiety over the impact of automation on jobs in the sector.[29] The Government of India has been questioned about the impact of automation and AI in parliament with three questions being asked in 2018.[30] These were with respect to the impact of jobs due to AI and automation and job losses in the IT sector. While acknowledging that there has been unprecedented technological changes that have led to changes in skill requirements, in its response the Government held that the IT sector is a net recruiter but is in need of significant reskilling efforts. With respect to the concerns around retrenchment of IT employees, the government response denied receiving any complaints in this regard.

Framing Industry 4.0 Technologies in the IT sector

According to the 2017 NASSCOM IT-BPM Annual Guidance report, growth areas for the sector include software as a service, cloud platforms, BI, and cognitive embedded analytics.[31] FICCI and NASSCOM also reported Internet of things, machine learning/artificial intelligence, big data and cloud, and robotics and automation as key technologies in the sector.[32] These reports have demonstrated that the IT sector has actively been adopting into processes:

Cloud Computing

Cloud computing has resulted in a transformation of traditional business models of IT firms. For example, Cloud vendors now handle several aspects of the IT ecosystem, like marketing, sales, productivity, workflow, CRM, and analytics.[33] Cloud hosting has resulted in industry moving from a small number of large expensive deals to numerous low-cost cloud hosting deals.[34] This new landscape has increased in complexity due to increased competition and the need to evolve brand new market strategies.[35] Cloud allows software product vendors to shift to more regular annuity based revenue stream.[36] The could also enable a shift from traditional BPO models where customers pay based on number of seats to one based on usage.[37] Cloud solutions can provide scanning, indexing, managing, and archiving electronic documents. Cloud can also catalyze a shift away from IT assets.[38] Cloud computing has also enabled “edge computing”, a concept brought forth by GE digital, where computing happens closer to the source of data on the “cloud edge”, also leveraging analytics, and artificial intelligence technology.[39]

While IT infrastructure is now taken care of by companies like Amazon, Google, and Microsoft, other aspects of the ecosystem, like marketing, sales, productivity, workflow, CRM, and analytics are now handled by cloud vendors. The industry is now more likely to have numerous low-cost (sub-$1 million) cloud hosting deals, in contrast to the previously prevalent expensive $200 million deals with large companies.[40] However, though the size and cost of these deals have reduced, the new landscape has become much more complex due to the increased competition and redundancy of many existing market strategies. In 2016, Gartner predicts that more than $1 trillion in IT spending will be influenced by the shift to cloud during the next five years. However, data collected by HfS shows that out of 121 cloud deals in 2016 that had a total contract value of over $8 billion, TCS was the only Indian company in the top five with 5% of the market share.[41]

Big Data and Analytics

Big Data and Analytics have been a part of the IT sector's offerings for a few years now. Since 2014, the 'SMAC' (Social, Mobile, Analytics and Big Data, and Cloud) stack has formed a crucial component of companies' IT strategies across disparate industries and commensurately forming an increasingly significant part of Indian IT services companies' revenue as well.[42] The current phase of big data analytics is said to have been revolutionised due to the incorporation of cloud based platforms by decoupling storage and processing and allowing for on-demand processing with dynamic access to data becoming possible.[43] Some of the advantages of leveraging Big Data capabilities have been pegged as enabling insights into effective use of resources for efficient business and operational processes and enhancing the customer experience and communication. However, challenges relating to the effective utilisation of big data analytics in the Indian context remain with data format and management being a primary one; the absence of clean and consistent data before applying modelling techniques to the data is said to be a major impediment.[44]

NASSCOM, acknowledging the importance of Big Data and Analytics, has identified areas of specialisation which are expected to emerge and are emerging within the domain: business analysts, solution architects, data integrators, data architects, data analysts and data scientists.[45] It further estimates that the total demand for roles in the domains of AI and Big Data Analytics put together, in 2018 will be 511,000 and will increase to 786,000 by 2021. Within these, it is anticipated that the demand for data scientists is going to be significantly higher than that for traditional Big Data roles.[46] It has been further reported in the media that in India, currently, there are over 50,000 open data analytics jobs on the market with the figure expected to have grown to 100,000 in 2018.[47]

Internet of Things (IoT)

The IoT market in India is projected to grow to reach $15 billion USD by 2020.[48] Further, a Deloitte-NASSCOM report highlights that the largest uptake of these technologies will be seen in the manufacturing, automotive, agriculture, retail, and transportation and logistics industries.[49] Specifically in the Indian context, the Government of India planning to invest close to $1 billion towards its Smart Cities Mission is also a potential enabler for the uptake of IoT based use-cases in the aforementioned industries.[50] Consequently, it is anticipated that the demand for IoT based solutions will be catered to by "the technology services industry across IT Services, Business Process Management (BPM) and Engineering, Research & Development (ER&D)".[51] This will require these sub-sectors to expand their portfolios and devise new architectures in their existing areas of domain expertise.

The uptake of IoT in business process management, is expected to drive the next phase of growth in the Indian IT-BPM sector with newer clients emerging and existing clients requiring solutions to aid their transitional and innovative models predicated on the usage of IoT coupled with other Industry 4.0 technologies.[52] Some of the IoT based offerings that BPM

vendors are offering have been outlined as enabling dynamic case management with the conversion of unstructured business process into structured ones and providing real time business activity monitoring coupled with predictive analysis and automated report generation. Further, other use-cases of integration of IoT are said to be in the domains of customer service processes and the incorporation of BPM into IoT to enable centralised data monitoring and processing.[53] However, modelling the integration of device communication and process is expected to be the biggest challenge in the uptake of IoT in BPM. The associated challenges of managing the disparate protocols and of retrofitting are seen as possible reasons for the slower than anticipated uptake of IoT so far.[54]

The Indian IT services firms have established themselves providing IoT based solutions with around 44% of the global outsourced IoT market in 2017.[55] The opportunities for growth for the IT sector lie in providing services that cater to requirements that will emerge in the domains of data analysis, cybersecurity, sensor technologies and data storage.[56] This is being accompanied by newer revenue models of leveraging IoT capabilities. Platform-as-a-Service is one, as is evidenced by a lot of other technologies outlined here. Microsoft's IoT Central[57] is a case in point. While PaaS models centralise the software component of IoT solutions, it is anticipated that newer models leveraging the layer of sensors and the network itself will see uptake in the shape of Everything as a Service (XaaS) or IoT-as-a-Service.[58]

What is also being anticipated is the impact on jobs that is going to be felt due to the introduction of IoT based solutions. On one hand, it is estimated that in the five-year period from 2016-2012, around 94,000 jobs will be lost due to IoT uptake, with the accompanying creation of around 25,000. The loss of jobs is expected to be in low-skill jobs such as office administration and maintenance, while the newer job roles that are expected to emerge will be those of IoT product managers, robot co-ordinators, industrial programmers and network engineers.[59] On the other hand, a senior official from the Department of Telecom has reportedly stated that the impact of IoT uptake will be seen in the creation of 10-15 million jobs, mostly by start-ups and not big IT companies.[60]

Cyber Security

The European Parliament, in a recent report, outlined the various cybersecurity risks associated with Industry 4.0 and in doing so highlighted how traditional cybersecurity frameworks need a re-look in the context of the industrial setting.[61] Further, within the industry, a Deloitte report calls for re-looking of cybersecurity as a new form of operational risk in the Industry 4.0 paradigm.[62] This is unsurprising considering the technology underpinning Industry 4.0 depends on enormous amounts of data. Thus, commensurate risks associated with data sharing in digital supply chains, pitfalls of increased production and challenges to systems update emerge.[63] To address these challenges, it is anticipated that supply side participants such as IT services firms in India have a vast market to tap into with the global cybersecurity market estimated to grow at a CAGR of 8.2% till 2025, as per a NASSCOM-DSCI report.[64] With the cybersecurity value chain quite analogous to that of IT

product development, it further represents an opportunity for the Indian IT sector to enter a market currently dominated by countries in North America and Europe.[65]

Systems Integration

The foundational block of Industry 4.0 is characterised by each of the aforementioned technologies as its constitutive components coming together to bring about overarching change in work processes.[66] This signals a potentially emerging area for engineers to work in - the integration of the systems that will be reliant on these diverse technologies working together seamlessly. As one IBEF report points out, the requirement for system integration is already recognised by large players and is being seen in their move away from being "simple maintenance providers to full service players, offering infrastructure, system integration and consulting".[67] For example, the data and analytics company GlobalData has found that 48% of IT services deals during 2017 were focused on systems integration.[68] For some companies , such as WIPRO, the shift to systems integration began in 2007 alongside a shift to software solutions and services.[69] As several other anecdotes by systems integrators highlight, their role is growing in coping with the challenges posed by Industry 4.0 with capabilities being required spanning domain areas such as automation, data analytics as well as cybersecurity along with non-technical areas such as business and project management.[70]

Artificial Intelligence

Surveys of upper management conducted within the Indian IT sector suggest that along with IoT, AI is projected to be the biggest technological trends that will impact the future of jobs in the sector.[71] This has been attributed to the expectation of AI based solutions to generate $100-120 billion by 2025 in productivity led gains for the global IT service providers, particularly in areas of consulting, engineering services, application development and others.[72] A survey commissioned by Infosys across 7 countries (Australia, China, France, Germany, India, the United Kingdom and the United States) further suggested that the uptake of AI is increasingly being seen in verticals within organisations other than just IT, such as operations, R&D and customer service.[73]

Additionally, it is also expected that the falling costs of AI based technologies will drive their uptake in economically advanced countries which will further drive IT firms in India to develop competencies in the domain.[74] Moreover, in the Indian context, the acknowledgement of the economic potential that AI holds is being recognised through the development of a policy framework by the government.[75] Challenges to the adoption of AI, however, exist with data underpinning AI technologies being suggested as the major one.[76] Commensurately, organisations in the aforementioned Infosys survey reported widespread investment in data management, particularly in India and the United States.[77]

AI is also expected to drive newer outsourcing models within the BPM sector such as BPaaS (Business Process as a Service)[78] which will allow firms within the sector to move past transactional business process outsourcing to deliver a more mature end-to-end strategic solutions for companies to implement. These models also represent cost-savings by eliminating the need for large upfront capital outlays and reductions in total ownership costs.[79] The disruptive potential of AI on jobs has been said to potentially redefine what the traditional notions of back, mid and core office jobs look like. This is being rendered possible due to evolving robotic process automation models now being utilised not just for traditional rule-based tasks but also knowledge-intensive ones.[80] With advancements in technologies subsuming AI such as natural language processing, the BPM sector is seeing a transformation of the voice business to a customer interaction service with the introduction of voice bots, email solutions, and mobile apps clubbed together as a consolidated service.[81] Similarly, within the IT services sector, the impact of AI can be anticipated owing to the potential it holds in the disruption of existing software development practices.[82]

Legal Backdrop to Labour in India

The different political and economic climates in which India's labour law framework and IT sector emerged, have led to a piecemeal application of labour protections to the sector. A key reason can be attributed to the argument made by industry players vis-a-vis the white-collar nature of workers in the sector. Simultaneously, relaxation from labour law applicability has been instrumentalized by various state governments to incentivise the growth of the sector endemically.[83] As a result, the applicability of labour laws to the IT sector have been at times ambiguous, leaving gaps with respect to worker protection. For example:

Legal status of 'workers'

Job protection regulations in India protect jobs by prescribing rules for termination of employment. While these regulations are clear for factory workers in the country, the applicability for the IT industry has been less clear largely due to the "white-collar" heavy composition of the labour force engaged in the sector.[84] The uncertainty arises primarily with respect to coverage of the sector within the Industrial Disputes Act, 1947, as it is intended to provide legal protections to "workmen". A workman is defined as "as any person who does any manual, unskilled, skilled, technical, operational, clerical or supervisory work for hire [...]" and excludes persons "in a managerial or administrative capacity or a supervisor drawing wages in excess of Rs. 10,000/-". Courts have rarely adopted a plain reading of the definition and interpreted the interpretation of workmen to not include "duties which require the imaginative and creative mind" under the criterion of manual, skilled, unskilled or clerical.[85] Resultantly, there has been uncertainty over the coverage of IT sector employees' determination as workmen. This doubt was further compounded by blanket

exemptions that were granted to the sector in Karnataka from the Industrial Employment (Standing Orders) Act, 1946.[86] In two cases of employee terminations of IT workers which were reported in the media, the courts stayed the terminations citing impropriety with the retrenchment procedure envisioned under the Industrial Disputes Act [87]. At the heart of the issue is the classification of employees who perform technical labour and thus, can be classified as "workmen" under the Industrial Disputes Act.[88]

Legal status of trade unions

Trade unions are formed for the purpose of collective bargaining. Owing to the 'white-collar' nature of the sector in India, trade unions have historically been unable to establish themselves in the IT sector.[89] Contemporarily though, trade union formation in the sector is picking up.[90] In December 2017, the Forum for IT Employees (FITE) became the first registered trade union operating in the IT/ITeS space.[91] Karnataka State IT/ITeS Employees Union (KITU) was formed on August 20, 2017[92] and is affiliated with the Centre of Indian Trade Unions (CITU). Another early initiative was the formation of the Union for Information Technology & Enabled Services (UNITES).[93] This was set-up under the aegis of Union Network International - a global trade union. The National Democratic Labour Front-IT and West Bengal Information Technology Services Association (backed by CITU)[94] are other trade unions in the sector. Even though a few unions have been registered, they have not been recognised by the management and invited to take part in collective bargaining[95]. This is a consequence of union recognition being mandated by law in a select few states. While industry associations like NASSCOM have claimed that the employees are not interested in unionising, studies have contested this claim[96].

These unions are currently supporting IT employees in legal fights against their employers in the case of termination. Some key issues concerning unions working in the IT sector are: (a) long working hours, (b) workload, (c) compensation related issues, (d) appraisal and promotions issues, (e) job insecurity, (f) high stress levels, (g) denial of annual leaves, (h) no recognition for extra efforts and (i) lack of transparency and equity. These findings indicate that IT employees look to unions not only for termination related issues but on a host of other issues.[97]

Consolidation of India's labour law framework

The labour law framework in India has been criticised widely for being fragmented due to the multiplicity of laws.. This follows in the wake of employer demands for deregulation of labour laws since product market liberalization in India, so as to allow employers to be more agile in responding to market forces.[98] Consequently, the labor law framework is currently undergoing a major consolidation. The underlying premise of these is supported by studies promoting the notion that pro-worker laws contribute to increasing unemployment and informality,[99] while ignoring the widespread criticism of these estimations[100].

Consequently, the proposed labour law reforms are likely to usher in a more flexible labour force with the aim of furthering objectives within the "Make in India" and the "Ease of Doing business" ideals.[101] Some of these labour code 'reforms', we anticipate, will lead to an imbalance in bargaining power in favour of employers. These include the scrapping of the labour court, liberalisation of inspection and labour administration, notice periods prior to striking, increasing the employee threshold for factories that are required to seek state sanction before shutting down, provisions for fixed term employment etc. While these moves may prima facie placate employers by making hiring and firing easier, these 'reforms' do not adequately strike a balance with the interests of the protection of rights traditionally accorded to workers in an already fragmented labour market and in the context of retrenchments being seen in the IT sector. Broadly, the labour law 'reform', then, does not anticipate some of the pitfalls for workers in the changing world of work including newer contractual arrangement, increasing precarity and lack of social security protections and associated labour market transitions that can be anticipated vis-a-vis the eccentricities of the Indian labour market.[102]

Impact of minimum wage

Minimum wage regulations specify a wage floor to ensure that wages provide the basic means of livelihood for employees. This has been predominantly used for according protection to blue collar workers.[103] Minimum wages in India are implemented through the Minimum Wages Act, 1948 and is applicable to "employment specified in the schedule appended to the Minimum Wages Act or any process or branch of work forming part of such employment"[104]. Compared to the IT/It-eS services sector, the domestic call centre is anticipated to be impacted more as workers can be included under the 'date entry operator' scheduled employment under the Minimum Wages Act.[105] With increasing competition and lowering wages[106], at least in the case of entry level staff in IT/IT-eS sector, these regulations are expected to hurt companies operating in the BPO sector owing to the significant costs incurred linked to manpower requirements.[107]

Contextualising Methodologies

Labour markets are complex and are impacted by a wide variety of contextual factors such as national and global policy, informal sectors, demographics, migration and immigration. The impact of technological adoption is also complicated and is increasingly a key factor influencing companies, labour markets, work and tasks. To put forth a comprehensive view of the impact of automation on work, it is important to qualify the impact technology has on a range of aspects relating to work. This includes aspects at the individual level such as motivation, productivity and communication, value of education, and entrepreneurship. It also includes the direct or indirect impact of technology on welfare, human capital and GDP. It is also important to address questions such as whether the technology is augmenting the

job, automating the job/parts of the job, digitising the job/part of the job and the potential resulting job loss or a change and/or re-shuffling of tasks.[108] For example, declining labour participation as captured by national statistics in India need not necessarily equate to unemployment and could mean instead more people are staying in education, or the work has yet to be adequately captured by national metrics etc .[109]

International studies on the impact of industry 4.0 in developing countries have reached differing conclusions. For example, some have concluded that jobs in developing countries will be more at risk to the impact of automation than those in developed countries because of a larger workforce employed in routine jobs. [110] Other studies, however, anticipate that the impact of technology will be slower in developing countries because of a slower rate of technological adoption and because of a high percentage of manual non-routine jobs.[111]

For example, Frey and Osborne in their seminal work, "The Future of Employment: How susceptible are jobs to computerisation"[112] argue that it is possible to automate any task. They also qualify four bottlenecks: (a) sufficient data is available and can be used for pattern recognition, (b) creative intelligence tasks, (c) social intelligence tasks, and (d) perception and manipulation. While this methodology predicted that upto 47% of all jobs could be automated in the US and upto 35% in the UK by 2030, other studies have projected widely varying numbers.[113]

In another study, McKinsey analyzed the impact of automation across 54 countries covering 78% of the global labor market to assess the percentage of time spent on activities with the technical potential for automation by adapting currently demonstrated technology[114]. In this study, they found the automation potential for the "Information" sector in India at 59% of the workforce affecting approximately 7,68,800 employees and in the "Professional, Scientific and Technical Services" sector, the impact was stated to be 46% representing 1.9 million employees.

Yet, it is unclear how these studies have accounted for content and local labour market structures and risk importing methodologies and framings developed for western markets into developing contexts.[115] Yet, it is also hard to qualify with any granularity how technology is affecting work from the above mentioned studies. Also, while these studies theorise potential impacts of automation, these numbers do not completely reflect the realities that affect the potential rate of adoption of technologies. Various constraints operating at the macro and micro levels of policy, economics, technology and society[116] and the interplay between them has the ability to significantly impact the eventual adoption and consequently the implications for work. For example, a policy level constraint could be statutorily banning the adoption of a technology or a class of technologies. Take the example of conversations regarding a ban on driverless vehicles in India[117] and the government's view of potential job losses that this technology could engender. That said, the borderless nature of the knowledge economy compels competitive development of these technologies and companies might still devote resources to developing these technologies,[118] irrespective of the potential for policy moves that would prevent adoption at the national level.

Thus, as research into the impact of emerging technologies on work continues to progress, there is a need to consider quantitative changes in employment in response to technological adoption, eg. number of jobs lost or created in particular segment More importantly, there is a need to address qualitative changes whereby change hurts some workers while benefiting others or varying impacts on different groups of workers and the emergence of newer models of workforce such as the gig economy, crowdsourced workers etc. in order to inform the policy response to Industry 4.0. This is where this research situates itself in relation to understanding the future of work in the IT/IT-eS sector.

For a more realistic assessment of the impact of Industry 4.0 on labour markets, the structural factors relevant to each market such as demographics impacted by technology, firm-level frictions, issues of migration etc. as well as a holistic impact on the work must be examined closely.

Drivers of Change in Work

Technological change is merely one of the many forces that will impact the future of work. It has been argued that the future of jobs is not deterministic and is heavily influenced by the dynamics of social, political, and economic transformation processes.[119] A 2017 FICCI and NASSCOM report identified twelve trends that impact the future of jobs across various key sectors in India. These include: level of exports of Indian companies, rapid adoption of industry 4.0 in advanced markets and impact on offshoring, changing overseas job market for Indian workforce, level of FDI flow into India, launch of smart products and services, creation of highly optimized supply chains, business innovations, demand for resourceful planet and sustainability, new work arrangements, rising middle class, high proportion of young population including millennials, and increasing urbanisation.[120]

It should be noted that these trends do not operate in isolation, rather they often reinforce each other or work in opposing directions. This makes the task of anticipating the exact magnitude of their impact potentially challenging, requiring more forward-looking and prudent policy measures to anticipate their impact on labour systems.[121] Most of these trends can be subsumed within broader 'mega trends' around globalisation, changing demographic profiles and rising urbanisation. Some such processes within these mega trends are highlighted below.

Globalisation

Globalisation has led to the integration of disparate economies into global markets through trade. For example, OECD data shows that trade as a proportion of GDP is rising both in developed and developing economies.[122] This integration has taken the shape of not just integration of products and services but also technological dissemination.[123] This is evidenced by the rapid adoption of ICT leading to trade in tasks, termed as the "great

unbundling" by greater fragmentation of the production process and rising global outsourcing.[124] It was this integration into global value chains that worked well for emerging economies in Asia as they adopted an export-driven development model.[125] In the context of the Indian IT sector, it becomes especially important to contextualise the integration into these global value chains due to the high participation of the sector and the impact it is anticipated to have as a potential driver for employment.[126]

Over the last few years though, a countermovement - reshoring, is being seen in developed economies.[127] The ILO explains reshoring as "the 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)."[128] The term re-shoring comprises two components:

1. Near-shoring: i.e. if production is relocated to a location near the home country (e.g. to Canada instead of the United States or to Eastern Europe instead of Germany). This represents a major challenge for the Indian IT sector as the cost-advantage for offshoring to India is dwindling and near-shoring becomes a more cost-effective way of outsourcing MNE IT requirements.[129]

2. Back-shoring: i.e. if the production is relocated to the same country."[130] In a political climate where there is a populist dissonance with globalisation and its impact on jobs and the quality of jobs, as well as in the wake of protectionist policies being adopted in developed economies, it can be anticipated that backshoring will be exacerbated. For instance, the 'reform' of the H1B visa regime is expected to put further pressure on the margins of Indian IT companies by having a significant impact on the landed/onshore costs.[131] This is already being evidenced as firms such as Infosys and Cognizant have publicly stated that they seek to substantially increase their workforce headcount in the US.[132]

Increased trade liberalisation and globalisation are also touted to be one of the fundamental factors behind emerging economies undergoing a premature deindustrialisation[133], i.e. the increasing capital and skill intensity of manufacturing.[134] In emerging countries, the manufacturing share of employment is peaking well below the levels experienced by advanced economies in their early stages of industrial development, which leaves them in a middle-income trap.[135] This has been documented in the specific Indian context as well.[136] Consequently, manufacturing which is a predominant site of job-creation in developing countries' contexts cannot accommodate the growing demands of the labour market, thus leaving industries within the service sector to absorb the pressure. The duality of forces at play here - that of back-shoring and premature deindustrialisation, could have conflicting impacts on industries such as the IT services sector, owing to their reliance on production work being outsourced from developed economies.

Emerging economies that have utilised their comparative labour advantage, need to be wary, especially in light of the potential impact of technological adoption of Industry 4.0 technologies in 'advanced' markets. For example, it is argued that "the adoption of these

exponential technologies by the Indian IT industry would be a factor of the rate of diffusion of these technologies from the advanced markets to India."[137] A need may thus arise to develop tools to combat the consequences of reduced foreign direct investment in such a scenario, especially after structuring the economy around gradual liberalisation of FDI entering the country.

Demographic shifts

The dependency ratio in the Indian demographic i.e. dependents (aged under 15 and over 60) in relation to the share of working-age population (aged 15 to 59) has been declining in India.[138] A similar fall in dependency ratio has been credited with the success stories of East Asia economies[139] and has been more broadly established to be a pathway to economic growth given adequate policy reforms tapping into this transition.[140] In India, this transition started about 40 years ago and will likely last another 20 years.[141] The working-age ratio in the country is set to rise from about 64 percent currently to 69 percent in 2040, reflecting the addition of over 300 million working-age adults. It is projected that this will make India the single greatest contributor to the global workforce, by at least an order of magnitude.[142] This shift in the demographic profile of workers, it can be anticipated, comes with the added pressure of creating employment opportunities along with ensuring skill development for the increasing number of workers slated to be entering the workforce, to be able to maximise the potential for gainful employment that the demographic dividend holds.

The IT sector then holds the potential to provide for this demographic transition by laying the foundation deepening technological capabilities in other sectors that have traditionally held the potential to generate large scale employment such as manufacturing. This role for the IT sector in the wake of India's demographic dividend has been emphasised upon by the erstwhile Planning Commission in the 12th Five Year Plan[143] and more recently, the Finance Minister.[144]

Additionally, this demographic transition is associated with an expansion in the middle class and accompanied by increasing urbanisation.[145] The rising middle class has been attributed as a key reason behind the economic success stories of China, India, and the ASEAN region.[146] In India, a study by Krishnan and Hatekar using National Sample Survey (NSS) Consumer Expenditure Survey (CES) data finds that the size of the Indian middle class expanded significantly between 2004–05 and 2011–12.[147] However, it is important to add that they further find that this was mostly driven by growth in the lower middle class. The occupational structures then become important to contextualise: the lower middle class is seen to be engaged in occupations synonymous with the poor while the upper middle class is associated with engagement in knowledge-based service industries. The consumption patterns and the commensurate growth that is typically associated with the expansion of the middle class[148] is increasingly being targeted by global firms looking to expand into developing and heavily populated markets such as India.[149]

Further, this has important implications for the demand of jobs in service industries like the IT industry. As education within the middle class increases, it is expected to create a demand for higher paying jobs such as those found typically within the services industry in contrast to jobs found in industries like manufacturing, for instance.[150] It also becomes imperative to further disaggregate this phenomenon to understand how it may be dissimilar in the Indian context. For instance, research[151] shows a continuing of systemic income inequality between classes (as is being evidenced globally), and these considerations need to be factored in while accounting for the impact of an expanding middle class and its implications for fostering inclusive job growth across sectors - including the IT sector.

Urbanisation

Work and urbanisation have traditionally been associated with each other - with companies headquartered in urban centers to find talent and people moving to urban centers to find work. This pattern has been confirmed with the global rise in urbanisation over the last two centuries; the UN in 2009 estimated that urban population outnumbered the rural population globally.[152] Similarly, in India, the twentieth century witnessed rapid urban population growth peaking in 1981. Since then, however, there has been a steady decline in urbanisation growth rates.[153] This could be pegged to the capital-intensive industrialisation of the manufacturing sector coupled with the growth of predominantly white-collar sectors such as finance, insurance, IT - ITeS etc. in the urban cities.[154] Having said that, the absolute number of urban population in India is still enormous with an additional 300 million new urban residents projected by 2050.[155] This has seen spiralling land prices especially in the Tier I cities, with several government initiatives like the Jawaharlal Nehru National Urban Renewal Mission. Additionally, allowing 100% FDI in the real estate sector, introduced to increase the supply of land to combat the increasing urban land prices, had a limited effect. Bangalore, for instance, registered the second highest land appreciation amongst Asian cities, according to consultancy firm Knight Frank's Prime Asia Development Land, with the increase in the prices in Bangalore being attributed to the saturating presence of the IT sector.[156]

Consequently, firms in the IT sector may be required to look at relocating to Tier II and III cities to cut down on operational costs. In fact, such a strategy was earlier recommended by Assocham for the IT sector to counteract the impact of weakening rupee[157] and is increasingly being evidenced in the growth of IT services clusters in Tier II and III cities.[158] In a growing trend, some companies like Zapier and WordPress have leveraged technology to enable remote work for the company, making location a moot point.[159] Firms in the Indian IT sector are developing products to enable this change in work, though it is less clear if they themselves are adopting it.[160]

Contextualising Work in the IT Sector

This section seeks to arrive at a conceptual framing for understanding the way in which work is structured in the ITS and BPO sub-sector. The objective here is to be able to use the framing to then be able to better understand the production processes underpinning these sub-sectors to then pinpoint the points at which technological implementation is underway.

Occupational Mapping

Utilising the occupational mapping done as a prerequisite to setting up occupational standards - as required for the functioning of Sector Skill Councils (SSCs)[161] - offers a useful framework for understanding the manner in which work within the various sub-sectors of the IT sector is structured. Occupations can be understood to be a set of job roles which perform a similar/related set of functions in an industry.[162] These occupations are then seen across the different hierarchical levels: entry-level, middle management, and leadership with the job role-component of the occupation varying across hierarchies. Job roles can also be understood as unique positions that can be held in a company within a sub-sector. Further, entry level is understood as requiring 0-2 years of experience, the middle-management as 2-10 years, and the leadership as greater than 10 years of experience.

ITS sub-sector[163]

Currently, the ITS sub-sector comprises the highest portion of the overall IT-BPM exports and domestic industry. In 2013, the ITS sector contributed 59% to a total of USD 75.8 billion of export revenue, and 64% to a total of USD 19.32 billion of domestic revenue. Consequently, this magnitude is reflected in the growth of the directly and indirectly ITS employed workforce. Occupational mapping highlights directly employed workers engaged in producing and managing information for businesses. Services provided range from consultation, systems integration, IT outsourcing, hosting, training, and support maintenance. In contrast to the sub-sector's history of resourcing companies with a cost-effective extended workforce, changing economic environments and export led growth have warranted the value-added services offered today.

Recommendations and trends for continued growth include expanding delivery channels (e.g. cloud computing), maintaining attractiveness of skill availability in India, penetrating other industries (e.g. healthcare) and offering new services (e.g. information security). Despite fears of increasing volatility in a globally interconnected world, positive predicted growth yields and trends create the conditions for an increased demand of a variety of skills to optimise efficiency.

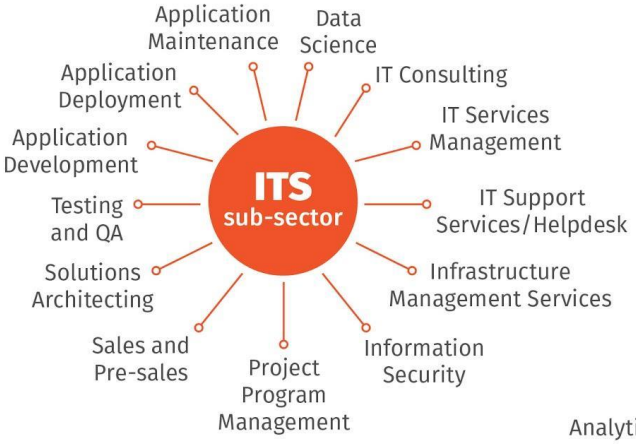
BPM sub-sector[164]

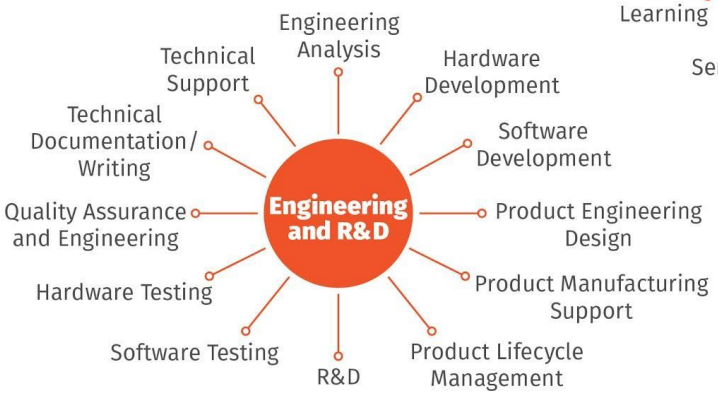
In 2013, the BPM sub-sector contributed 22% to the IT-BPM industry's export revenues and 16% to domestic revenues. Emerging from the advancement of ICT and a shift in delivering business processes from high-cost to low-cost destinations, the BPM sub-sector is characterized by externally managing, owning, and evaluating business processes. Business processes range from finance, HR, supply chain management, knowledge/research work, or legal services. Deemed as the helm of India's knowledge-based economy, BPM is moving away from labour arbitrage to analysis-informed solutions that will streamline business objectives and cater to customer expectations.

Expected to grow 9% and increase the total workforce to 30 million, channels of growth include harnessing big data outsourcing opportunities, specialising further in knowledge services, and increasing the use of social media communication to manage customer relations.

Notwithstanding the various drivers of change in work, understanding the intensive growth both sub-sectors are experiencing via mapping occupations becomes necessary. Cross-cutting job levels and required skills pictorifies a career trajectory and incorporates constant variables into an evolving occupational field. Moreover, through primary and secondary research, occupational mapping further contextualizes labour laws, attrition and the need for substantive skilling and re-skilling programmes. Formalised by the NASSCOM IT/IT-eS Sector Skills Council and the National Skill Development Corporation (NSDC) after consultations with various industry representatives in 2013, the occupational mapping for the various IT sub-sectors includes:

Occupational Mapping for IT Sub-Sectors





These broad occupations are then further disaggregated into several job roles. For instance, the occupation “Analytics” within the BPM sub-sector comprises of job roles : (a) at the entry level - associate for analytics (b) at the middle management level - manager, team leader, and senior associate for reporting; manager, team leader, senior associate, process lead, and process expert for modelling and analysis; (c) at the leadership level - business manager/AVP/VP for reporting as well as for modelling and analysis, and head of analytics. An exhaustive job-role level disaggregation for each occupation can similarly be found in the mentioned reports.

In terms of aggregate findings, we found that across each sector there was a significantly greater concentration of job roles at the middle management level. The distribution was as follows:

1. ITS sub-sector - 19, 91 and 25;
2. BPM sub-sector - 16, 11 and 30;
3. ER&D sub-sector - 16, 48 and 54;
4. SPD sub-sector - 18, 63 and 21

The concentration in the middle management level is unsurprising given the experience level bracket is more prolonged for the middle management. The implication of this distribution then needs to be related to news reports that have cited the middle management as being hit hardest by automation and the introduction of technology into business processes, as discussed later in this report. Tasks such as monitoring and supervision that were earlier the domain of the middle management are now being performed by technological tools.[165] As one report highlights, “Capgemini is using IBM's cognitive consulting tool Watson to assign people to projects, while Infosys is building a machine-learning platform that will help project managers take decisions to make better trade-offs between the number of people needed for a project and the timeline for completion.”[166]

In our desk-review of publicly available information regarding the adoption of Industry 4.0 technologies being adopted or implemented by companies, we found that all of the 16 companies studied had made inroads. These took the shape of platforms that were implemented to organise work internally at the company and/or were created as customer-facing service offerings and have been captured in the diagram below:

Table 1: Documenting Information on Adoption and Implementation of Industry 4.0 Technologies in Sample IT Firms

Company	Platform/Technology	Description
Tata Consultancy Services	- Digitate launched Ignio	- Root cause detection, automation of tasks, predictive impact analysis[167]
Infosys	- Mana and Aikido leverage the Infosys Automation Platform, Infosys Information Platform, and Infosys Knowledge Platform[168] - AssistEdge - Nia - Cloud Based Human Capital Management	- Automation of maintenance of tasks for physical and digital assets - Robotic Process Automation - AI Platform forecasting, understanding customer behaviour, and compliance and fraud.[169]
Wipro	- HOLMES - HOLMES Cloud Bot	- Algorithmic intelligence and cognitive computing - Chat interface, analysis of firm's technology application architecture, risk management and compliance[170]
IBM	- Cloud	- Use heaps of data collected into quality insights and transform businesses[171]
Cognizant	- Automation	- Cybersecurity, Talent migration, re-platforming to the cloud[172]

Capgemini India	- AI - Advanced Analytics	- Process automation, Machine to machine communication, 3D printing[173]
Mindtree	- Auditing AI	- The machine should be able to explain its decisions[174]
HCL Technologies	- Augmented Intelligence	- Human-machine partnership. It's not human or the machine. It's human and the machine[175]
Mphasis	- Automation	- Intelligent automation, optimize IT costs, drastically enhance efficiencies of their IT and provide better customer service and satisfaction overall[176]
Tech Mahindra	- AI	- Simpler solutions for higher adoption[177]
Genpact	- Genpact Cora	- Reducing risks around errant robots and misapplied AI spinning out of control[178]
Intelenet Global Service	- AI	- indigenous solutions that are specifically wired to address the niche challenges of aviation industry[179]
Hinduja Global Solutions	- AI - Automation	- AI-powered messaging technology to transform customer experiences driven by digital innovations and key design principles[180]

CSC India	- Industrial Machine Learning (IML)	- Improves the return-on-investment clients see from their information - facilitate tangible benefits, such as reduction in patient readmissions or lowering manufacturing material consumption rates[181]
CGI	- AI - IoT - Advanced analytics	- RPA, optical character recognition, neural networks, computer vision[182]
WNS Global Services	- WNS SocioSEER™[183]	- Advanced AI and deep learning modules[184]

To understand the interaction of the occupational categories with Industry 4.0 technologies, we used the framing previously constructed and mentioned above by the NASSCOM IT/IT-eS Sector Skills Council and the NSDC. These occupational categories formed the bedrock of our survey questionnaire and responses were sought regarding the impact being felt across each occupational category along the lines of technological implementation, skilling challenges etc. Further, we granulated the adoption and implementation of these technologies to specific occupational hierarchical brackets: the entry, mid and higher levels.

To answer the pressing question of trends currently being observed in terms of occupations being impacted most, respondents were asked to indicate the level of implementation of Industry 4.0 technologies on a five point scale. The lowest number in the scale indicated that the degree of implementation of Industry 4.0 in job roles comprising a particular occupation, on average, was currently negligible. A number higher up the scale similarly indicated a greater incidence of engagement of workers involved in performing job roles comprising a particular occupation. As the tables below indicate, all occupations at the entry level are seeing some degree of automation through Industry 4.0 technologies. This observation only negligibly changes for occupations at the middle and higher levels.

Table 2.1: Degree of Technological Implementation in Sample IT Firms - Entry Level

Sl No.	Activity	Entry Level						
		0 (No Impact)	1	2	3	4 (Most Impact)	N/A	Total
1	Systems Integration	0.0	27.4	35.6	9.6	4.4	23.0	100
2	Custom Application Development	1.0	31.7	44.2	12.5	10.6	0.0	100
3	Software Deployment and Support	0.0	8.7	63.5	13.5	14.4	0.0	100
4	Infrastructure Management, Consulting and Integration	1.9	42.3	37.5	10.6	7.7	0.0	100
5	Infrastructure Management Operations	1.9	43.3	37.5	10.6	6.7	0.0	100
6	Software Testing	1.0	6.7	67.3	14.4	9.6	1.0	100
7	Services Oriented Architecture (SOA)	1.0	53.8	26.0	5.8	13.5	0.0	100
8	Application Management	0.0	2.9	67.0	20.4	9.7	0.0	100

9	Information System Outsourcing	2.9	11.5	69.2	10.6	5.8	0.0	100
10	Hardware Deployment and Support	1.0	33.7	47.1	11.5	6.7	0.0	100
11	Web Services	0.0	9.6	58.7	21.2	10.6	0.0	100
	Total	**0.9**	**24.8**	**49.9**	**12.7**	**8.9**	**2.7**	**100**

Table 2.2: Degree of Technological Implementation in Sample IT Firms - Mid Level

Sl No.	**Activity**	**Mid Level**						
		0 (No Impact)	**1**	**2**	**3**	**4 (Most Impact)**	**N/A**	**Total**
1	Systems Integration	0.0	14.1	45.2	8.9	8.9	23.0	100
2	Custom Application Development	2.9	7.7	51.0	26.9	11.5	0.0	100
3	Software Deployment and Support	3.8	2.9	41.3	44.2	7.7	0.0	100
4	Infrastructure Management, Consulting and Integration	1.0	11.5	60.6	19.2	7.7	0.0	100

5	Infrastructure Management Operations	5.8	20.2	51.0	18.3	3.8	1.0	100
6	Software Testing	1.0	4.8	39.4	44.2	8.7	1.9	100
7	Services Oriented Architecture (SOA)	0.0	14.4	59.6	15.4	10.6	0.0	100
8	Application Management	0.0	1.9	35.9	51.5	10.7	0.0	100
9	Information System Outsourcing	3.8	4.8	26.9	57.7	6.7	0.0	100
10	Hardware Deployment and Support	1.0	1.9	62.5	28.8	5.8	0.0	100
11	Web Services	2.9	1.9	12.5	65.4	16.3	1.0	100
	Total	**2.0**	**8.0**	**44.2**	**33.9**	**8.9**	**3.0**	**100**

Table 2.3: Degree of Technological Implementation for Sample IT Firms - Higher Level

Sl No.	**Activity**	**Higher Level**						
		0 (No Impact)	**1**	**2**	**3**	**4 (Most Impact)**	**N/A**	**Total**

1	Systems Integration	1.9	6.7	44.2	35.6	11.5	0.0	100
2	Custom Application Development	0.0	8.7	30.8	51.0	9.6	0.0	100
3	Software Deployment and Support	2.9	2.9	17.3	62.5	13.5	1.0	100
4	Infrastructure Management, Consulting and Integration	2.9	0.0	36.5	48.1	9.6	2.9	100
5	Infrastructure Management Operations	1.9	6.7	45.2	35.6	8.7	1.9	100
6	Software Testing	1.0	4.8	11.5	67.3	14.4	1.0	100
7	Services Oriented Architecture (SOA)	1.0	1.9	36.5	48.1	11.5	1.0	100
8	Application Management	0.0	4.9	7.8	63.1	23.3	1.0	100
9	Information System Outsourcing	1.9	2.9	13.5	55.8	26.0	0.0	100
10	Hardware Deployment and Support	1.9	3.8	30.8	49.0	12.5	1.9	100

11	Web Services	1.9	5.8	8.7	32.7	50.0	1.0	100
	Total	**1.6**	**4.5**	**25.7**	**49.9**	**17.3**	**1.0**	**100**

Another key finding from the data below is that while occupational categories across hierarchies are having to contend with the uptake of these technologies, on average, those at the highest levels in the hierarchy are experiencing the involvement of Industry 4.0 in job roles within occupations. This further indicates that basic support work, called L0 work in the sector, is currently not seeing any significant levels of automation. As industry analysts have observed, any significant impact aggregated to the level of the sector will only be visible once L0 work sees significant automation.[185] It is important to note that the responses for each hierarchy were provided by individuals irrespective of their hierarchical position in the firm.

Chart 1 – Degree of technological implementation by hierarchical buckets (as reported by entry level respondents)

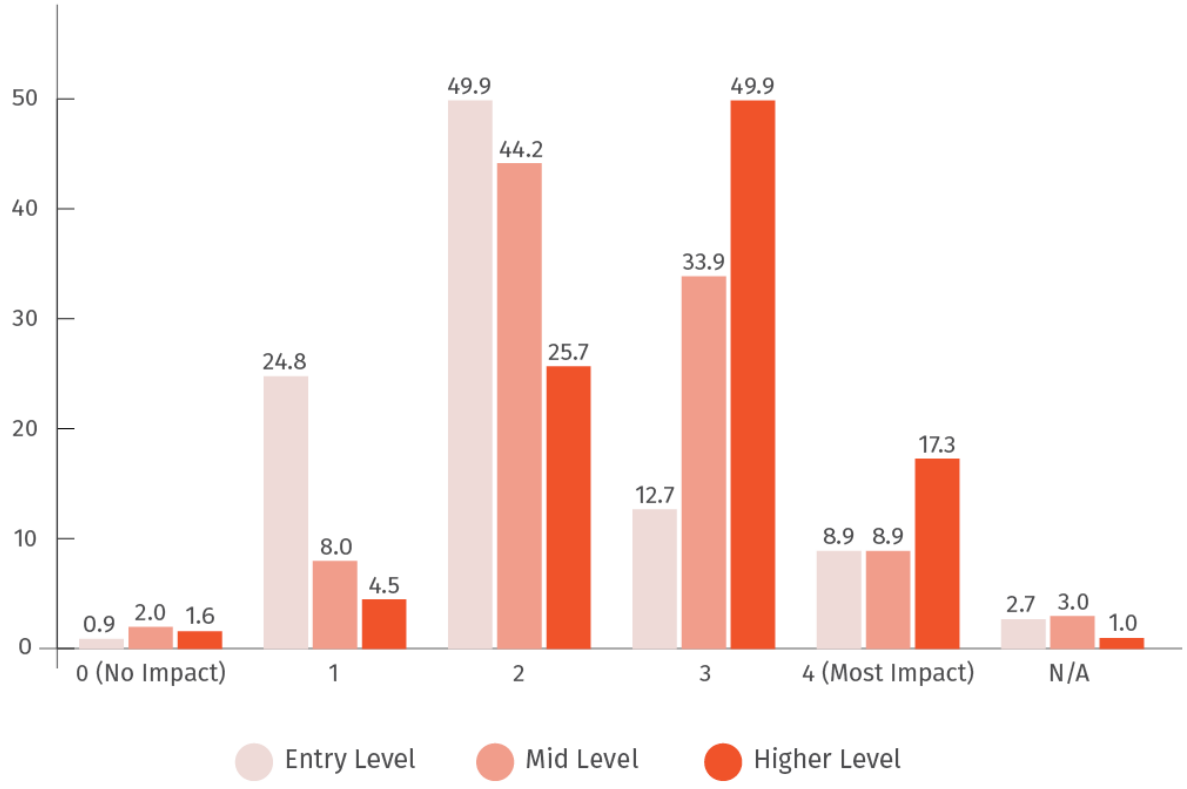
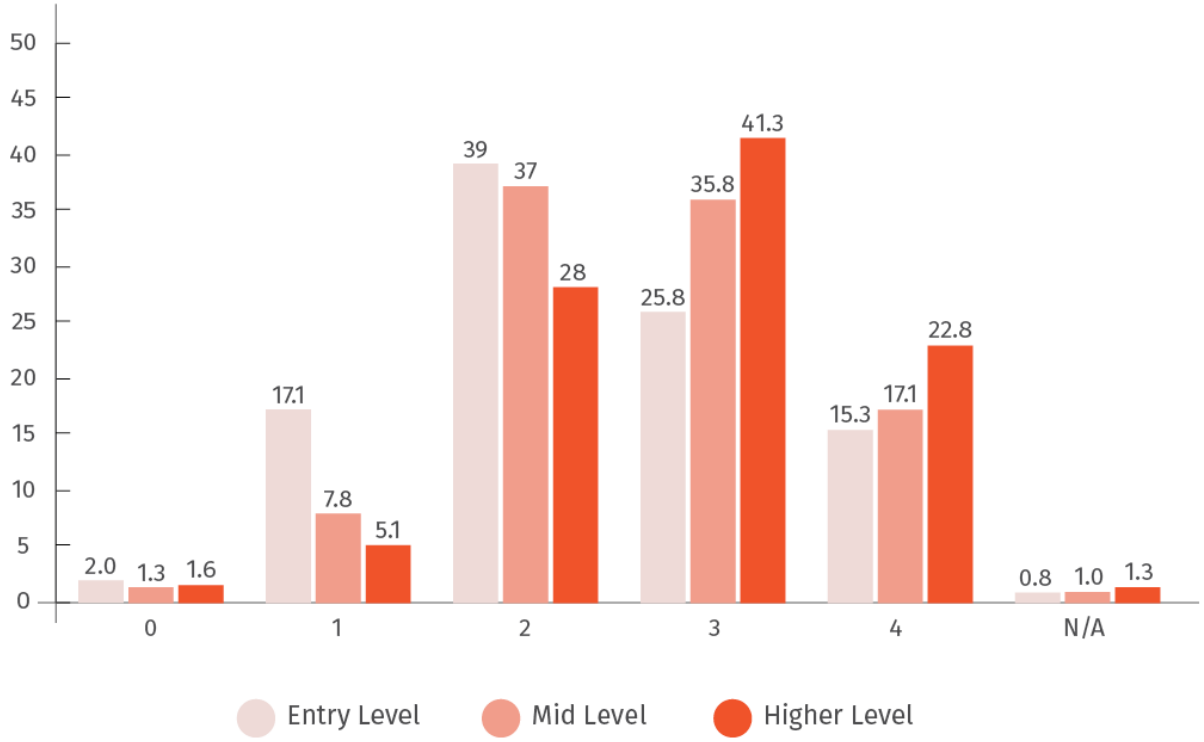


Chart 2 – Degree of technological implementation by hierarchical buckets (as reported by mid and high level respondents)



Impact on the BPO Sector

There is growing consensus around how the uptake of Industry 4.0 is going to be differential across the various sub-sectors subsumed within the larger ambit of IT/IT-eS.[186] Within the sub-sectors, there is growing evidence around the BPM sub-sector being the predominant site of automation owing to the repetitive nature of the tasks that jobs in the industry comprise of.[187] However, the nature of automation, at present in the sub-sector, is more commonly in the shape of robotic process automation, which is useful for automating rule-based tasks.[188] As one report explains, "Typical examples of RPA are transaction processing, data entry in high volume, repeatable and computer-centric processes such as claim processing for the insurance sector and reward processing for the telecom sector." Having said that, cognitive automation as understood in the context of Industry 4.0, is seeing gradual but increased adoption.[189] Several tasks of various complexities such as damage assessment for insurance companies, e-KYC verification and risk assessment for credit scoring have already been fully automated through offerings by firms in the IT-BPM industry.[190]

The uptake of technologies associated with Industry 4.0, along with the proliferation of online work, are predicted to play a big part in the expansion of the industry.[191] The BPM sector had also adopted the linear growth model that was characteristic of IT services companies as discussed above.[192] In the same manner that IT services companies felt the need to evolve newer models of revenue growth to keep up with changing customer demands, the BPM industry is said to be on the cusp of developing similar non-linear models of revenue growth that decouple revenue and headcount.[193] Cost models that charge on the basis of outcome(s) achieved instead of man-hours expended are already being seen.[194] One report estimates that 70% -75% of the jobs in the IT sector broadly would require skill sets different from those required currently. For the BPM sector, this is anecdotally corroborated by Genpact's Vice President Mohit Gujral acknowledging a change in hiring practices with the greater recruitment of "design engineers, data scientists, digital engineers" with the aim of better leveraging the opportunities of technologies typically associated with Industry 4.0. This requirement is further corroborated by data on the last quarter released by NASSCOM that suggests that "employee growth during the quarter remained negative, as BPM firms concentrate on improving their digital and analytical capabilities by hiring for skill and not scale."[195]

Research by HfS Research, in what it terms the "HfS Future Workforce Impact Model", categorised the workforce in the IT and BPO sector on the basis of skill levels - low skilled, medium skilled and high skilled - to then ascertain the impact on automation on jobs.[196] They categorise "low skilled workers as conducting simple entry level, process driven tasks that require little abstract thinking or autonomy and higher skilled workers as undertaking complicated tasks that require experience, expertise, abstract thinking and autonomy." Their findings indicate that 640,000 low-skilled service jobs in the IT sector in India are at risk of automation while only 160,000 mid to high-skilled positions will be created in the Indian IT

and BPO service sector. Further, the findings indicate that, 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.

However, it is unclear which occupational categories within the BPO sub-sector are being impacted, if any, by the adoption of Industry 4.0 technologies. In order to build this understanding, we mirrored the above mentioned approach used for the IT services sub-sector. Here too, the degree of implementation judged on a five point scale was used as a proxy for the impact on the average content of job roles within occupational categories. This was further granulated hierarchically.

As the tables below indicate, unlike the ITS sub-sector, there is a clear indication that some occupational categories are only seeing the early stages of the adoption of Industry 4 technologies at the stage of entry-level job roles: namely human resources management and legal process outsourcing. Interestingly, however, these occupations are experiencing greater uptake of Industry 4.0 technologies in job roles performed by middle and high level workers at firms.

This also lends to another key finding around the job roles having a higher propensity to be subject to interaction with Industry 4.0 technologies is more pronounced for occupational roles involving customer interaction and support, when compared to more specialised service lines such as supply chain management and research occupations. This can be said to be a reflection of the manner in which the BPO sector in India is structured, with a heavy composition of customer interaction and support than the other specialised roles.[197]

Table 3.1: Degree of Technological implementation – BPO Sector Entry Level

Activity	**Entry Level**						
	0	**1**	**2**	**3**	**4**	**N/A**	**Total**
Customer Interaction and Support	0.0	0.0	33.3	38.9	27.8	0.0	100
Finance and Accounting	9.5	14.3	42.9	14.3	14.3	4.8	100
Research and Analytics	4.8	19.0	66.7	9.5	0.0	0.0	100

Human Resource Management	14.3	38.1	9.5	19.0	19.0	0.0	100
Supply Chain Management	4.8	4.8	33.3	38.1	19.0	0.0	100
Knowledge Process Outsourcing	0.0	0.0	47.6	28.6	14.3	9.5	100
Legal Process Outsourcing	25.0	15.0	10.0	25.0	20.0	5.0	100
Total	**8.3**	**13.0**	**34.8**	**24.8**	**16.3**	**2.8**	**100**

Table 3.2: Degree of Technological implementation – BPO Sector Mid Level

Activity	**Mid Level**						
	0	**1**	**2**	**3**	**4**	**N/A**	**Total**
Customer Interaction and Support	0.0	0.0	38.1	33.3	28.6	0.0	100
Finance and Accounting	0.0	23.8	33.3	33.3	9.5	0.0	100
Research and Analytics	4.8	4.8	42.9	42.9	4.8	0.0	100
Human Resource Management	4.8	23.8	33.3	28.6	9.5	0.0	100
Supply Chain Management	4.8	14.3	28.6	47.6	4.8	0.0	100

Knowledge Process Outsourcing	0.0	4.8	33.3	42.9	14.3	4.8	100
Legal Process Outsourcing	0.0	20.0	50.0	20.0	5.0	5.0	100
Total	**2.0**	**13.1**	**37.1**	**35.5**	**10.9**	**1.4**	**100**

Table 3.3:Degree of Technological implementation – BPO Sector Higher Level

Activity	Higher Level						
	0	1	2	3	4	N/A	Total
Customer Interaction and Support	4.8	4.8	23.8	28.6	28.6	9.5	100
Finance and Accounting	0.0	9.5	19.0	52.4	19.0	0.0	100
Research and Analytics	4.8	0.0	19.0	47.6	23.8	4.8	100
Human Resource Management	0.0	4.8	28.6	42.9	23.8	0.0	100
Supply Chain Management	0.0	0.0	47.6	33.3	14.3	4.8	100
Knowledge Process Outsourcing	0.0	0.0	19.0	47.6	33.3	0.0	100
Legal Process Outsourcing	4.8	14.3	33.3	19.0	19.0	9.5	100
Total	**2.0**	**4.8**	**27.2**	**38.8**	**23.1**	**4.1**	**100**

The Business Case

Productivity in the IT Sector

The importance of measuring productivity in the services sector becomes key in the wake of the sector broadly forming increasingly larger shares in national economies in terms of both output and employment. Paradoxically though, there is a lack of uniformity in measuring productivity by applying traditional measures of productivity that have originated in the context of manufacturing industries.[198] This becomes uniquely important in the IT sector with leveraging intangible assets i.e. intellectual property gaining more importance than physical assets.[199]

This multiplicity of measurements has been reflected in literature attempting to document the productivity of the services sector in India, but concluding that the services sector in India has been the site of greater labour productivity than any other sector in the Indian economy post the 1980s.[200] Labour productivity can be understood as the value added per employee.[201] Using total factor productivity as a metric, it was found that the services sector outperformed agriculture and manufacturing.[202] A disaggregated analysis using cross-country data from the EU KLEMS showed that productivity growth was highest in the 'modern' services such as software services and business processes. It should be noted that these analyses suffer from the NSS EUS data being unavailable after 2011-12 as highlighted earlier in this case study.[203]

Within the Indian IT sector, the internal metric for assessing productivity internally appears to be that of revenue per employee (RPE).[204] Where legacy models of service delivery (and commensurately revenue generation) within the sector were linked to the headcount in a linear relationship, this does appear to be a simplistic yet useful metric especially given the challenges faced with quantifying a process such as software production.[205] The utility of the adoption of Industry 4.0 technologies then has been to enhance productivity, thereby resulting in rising revenues per employee - an extension of the decoupling of revenue and headcount that has been underway within the sector[206].

Analysis done on major companies within the IT sector such as Wipro, Infosys, TCS show a marginal rise in revenue over the last 3 quarters of the financial year 2017-18 with Cognizant showing a strong increase in RPE over the entire reporting period of 2017.[207] This has been a result of increasing revenue with a contraction of headcount numbers. However, another news report using a different methodology where the RPE is calculated on just the digital revenue shows a fall in RPE of Infosys, Wipro and TCS.[208] The article notes that digital revenue itself is not necessarily an accurate metric to use and suggests using the growth and revenue generated from data analytics.[209]

Key policies and initiatives in the IT sector can also be expected to influence the uptake of these technologies to increase productivity. The National Policy on Information Technology 2012, the establishment of software technology parks of India, the special economic zones policy, the national task force on IT and Software development, the national e-governance plan, and the national cyber security policy 2013, all have implications for productivity in the sector. The national policy on IT calls for fiscal incentives to increase the presence in tier II and tier III regions. The reasoning was that cost is in the denominator of any productivity calculation. Consequently, any reduction in cost will lead to an increase in productivity. The general discourse has been focused on increasing the output. Productivity can be increased by either reducing the resources required for producing the service, or by increasing the services produced with the available resources. It is also important to note that 90% of the exports from Indian IT industry are generated from Bangalore, Chennai, Hyderabad, Mumbai, Pune and NCR.[210] With these regions achieving near saturation with respect to human resources and infrastructure, expanding to tier II and III cities the industry will be able to attract a much larger pool of human resources. This might have the potential to reduce the cost of human resources and thereby reduce the cost of employees and infrastructure. Historically, an increase in the lowest wage levels have led to increased automation leading to an increase in productivity[211]. While this will not stop the impact of automation, it might reduce or delay it to some extent.

Business and Revenue Models

The IT/IT-eS sector has traditionally been a site of job-creation owing to a revenue model that was highly people-dependent. In what has been termed a linear growth model, revenues were directly reliant on the billable hours - a measure of time put in by employees working on a project. Commensurately, an increase in employee headcount represented a proportional increase in revenues[212]; indeed, revenue per employee was an important metric in assessing the performance of companies in the sector.

In what has been described as an inflection point for the industry[213], a shift away from the linear growth model is being witnessed with the decoupling of workforce expansion and revenue growth.[214] A KPMG report on the need for newer non-linear growth models in the IT sector states:

“Market conditions have become tougher due to heightened competition among vendors, the emergence of other low-cost destinations and increasing maturity of clients now demanding more accountability. Technological disruption is shaking up the vendor landscape, where players are racing against time to respond to change. But the most important challenge of all is perhaps the employee conundrum.”[215]

The emergence of varied non-linear models of revenue growth then becomes important to contextualise in light of recent layoffs that are being reported in the IT sector as well as the simultaneous technological disruption taking place. The impact of technological disruption,

as per NASSCOM, is being reflected in revenue numbers from the sector being driven largely by an acceleration in digital adoption.[216]

In terms of the specific technological adoption, cloud computing has been acknowledged to have had an impact on carving out newer delivery models developed within the sector through the “as-a-service” paradigm.[217] Cloud Computing, with its ability to centralise computing resources, has created opportunities that entail massive savings on capital outlays, infrastructure spending, as well as software services through a rental “pay as you use” model.[218] It has thus posed an existential threat to IT companies by making dents into one of the most lucrative sources of revenue - infrastructure management.[219] This has led cloud to be described as the new infrastructure underlying the global economy with the disintermediation of firms in India being its very objective.[220] Additionally, the flexibility that Cloud technology provides, serves as another incentive for businesses to actively seek Cloud-based solutions. The three main models of cloud service (Software as a Service, Platform as a Service, and Infrastructure as a Service) provide a range of features and functionalities that organisations can tailor to suit their needs, be it cloud based storage, customised application development, or complete control of a remote infrastructure. In its recent quarterly report, the NASSCOM pegged “as-a-service” as a “key growth driver, growing by 40 percent, with IaaS reaching USD 4.6 billion of ACV, up 48 percent over last year, while SaaS ACV was USD 1.3billion, up 18 percent. Traditional outsourcing ACV recorded a decline of 6 percent versus a year ago, to USD 6.3 billion.”[221] Niti Ayog in their National Strategy for AI propose that India’s IT sector could evolve into offering AI as a service as well as focusing on key technologies solutions like natural language processing.[222]

News items have cited experts suggesting that the IT industry needs to pursue new forms of revenue and business models to stay relevant as outsourcing declines. Such changes include personalizing products to customers needs, looking across the organisation for innovative ideas, and strategically engaging in partnerships with startups to enable innovation. For example, Tech Mahindra is reported to have developed its platform DAVID to address consumers preferences, is emphasizing in-house development of solutions, exploring developing solutions through crowdsourcing, has engaged with start-ups, and conducted an in-house hackathon to spur new ideas and innovation.[223] Infosys also runs a hackathon to help identify talent for hiring,[224] and crowdsources new ideas for the company internally.[225] Other shifts have included a move to consulting, acquisitions, in house development of IP to serve a new set of clients[226], as well as expanding companies’ global footprint and capital allocation.[227]

IT Companies and Organisational Restructuring

Strategies of workforce restructuring have been recently documented in the United States in the case of IBM's systematic workforce reduction over the last 5 years the aim of correcting its "seniority mix".[228] Taking cognizance of the reported age-bias in IBM’s recruitment and lay-off practices, the U.S. Equal Employment Opportunity Commission has launched an

investigation into the alleged flouting of US laws prohibiting age-based discrimination in employment.[229] Furthermore, these layoffs are purported to be facilitators in accelerating IBM's push towards "several strategies such as the cloud, cognitive computing, Watson, mobile, social and security services."[230]

In order to assess whether a similar trend is underway in the Indian context, the below table documents the different ways companies have publicly announced restructuring around the digital. Several companies did indicate the importance of shifting attention to digital technologies or automation as a reason for undertaking restructuring activities. In a few instances, the rationale was couched in the language of meeting customer and market demands, which may also be construed to be linked to an observed demand for automation solutions. This is an important finding as it hints towards a potential link between the usage of automation tools for the production of automation solutions.

Table 4: Digital Restructuring Announcements from Sample IT Firms

Company	Restructuring Modalities
TCS	- Focus on digital technologies[231] - Lay off some mid-to-senior level employees[232]
Capgemini	- Re-build the corporate culture[233] - Integrating, mobilizing and aligning key resources - Installing effective internal communication - Reviewing the management model/decision-making process - Establishing clear leadership frameworks - Revising incentive models
IBM	- Aims to transform service and delivery model in 2018 with 30% of service and delivery technology (SD&T) to be redeployed in 2018[234] - Redeployment is concentrated on cloud computing, AI, and analytics – re-skill workforce to meet emerging client requirements[235] - Unclear whether or not redeployment will result in mass layoffs
Cognizant	- To trim top management to make room for juniors[236] - Focusing more on processes that are run on cloud-based platforms which use machine learning to help clients improve their business and engagement with customers. It realises that people-oriented processes are not going to fetch the margins that once propelled the company to be one of the largest IT outsourcing companies in the world. [237]
Mphasis	- Focus on building our orderbook and deal wins and from that perspective we are fairly satisfied with what we have achieved in Q4 - Restructuring of portfolio and operational efficiency helped the company to drive up the margins, Suryanarayanan (CFO). [238]

Mindtree	- Restructure business for a clearer focus that will help the firm achieve a billion-dollar topline in its "second phase" of growth. [239] - Realignments within product engineering services (PES) [240] - Identified potential leaders who will steer it to the next level.[241]
HCL	- Distribution has been growing via Telecom and non-telecom distribution to leading IT brands, Office automation, and consumer electronics spaces - Services business has increased due to large Managed Services and Break-fix services outsourcing deals Restructuring enables: - Attention on key growth engines: Distribution and Services - Flexibility to invest in capability building and rapid expansion across markets - Services business to explore growth in emerging technologies - The new Learning business to stand as its own subsidiary and meet large expansion goals [242]
Tech Mahindra	Restructuring of most of their network business [243]
CGI	- 2007: CEO Michael Roach claims growth enables meeting market and client demands[244] - 2017: After restructuring projects, namely acquiring Logica and expanding operations in India[245], CGI is cutting 2.3% of its global workforce to hire in other areas – responding to increasing demands for online services - Encouraging clientele to go digital to meet consumer needs while CGI continues to hire in-demand expertise and increase billable headcount[246]
WNS Limited	- Streamlined administrative operations, achieve operational and financial synergies, and reduced the costs and expenses relating to regulatory compliance. This restructuring involved the merger of the following seven Indian subsidiaries of WNS Global into WNS Global through a Scheme of Amalgamation approved by an order of the Bombay High Court passed in August 2009 pursuant to the Indian Companies Act, 1956.

	- In fiscal 2011 and 2012, restructured and rationalized UK and US group companies, wherein three UK-based non-operating subsidiaries, Chang Limited, Town & Country Assistance Limited and BizAps, were voluntarily dissolved. In the US, two subsidiaries, WNS Customer Solutions North America Inc. and Business Application Associates Inc. were merged with and into WNS North America Inc.[247]
Infosys	- Reorganized sector units to address cloud computing business trends - Adopted new Industry Sector Units (ISU) structure (Financial, energy and communications, manufacturing, retail/consumer goods/ logistics and life sciences) - To complement ISU, three service and innovation groups have been consolidated: consulting and systems integration, business operations services, products, platforms and solutions - Service and innovation groups will span across all units to drive technology services and meet the needs of clients[248] - To align better with complex industry 4.0 technologies, bottom-up approach of restructuring includes doubling the entry-level salary for those with advanced capabilities in the digital domain - Identify employees with an affinity for business management and consulting - Incentivising project managers to develop skills as technical architects[249]
Wipro	- Large modernising projects for the IT and operations landscape deploying Holmes (AI platform) for the entire operation[250] - In India and West Asia - moving away from low-end commoditised services business through high-end digital offers - Pivoting towards digital application and consulting led-business with higher profitability[251] - Digital transformation involves centering a consumer centric ecosystem and acknowledging dynamic nature - Going digital involves evolving rules of engagement , raising the level of experience and skill, and setting new standards in stakeholder empowerment[252]
Genpact	- Believe that superior customer experience defines success in the digital world - Continued investments in Genpact Cora makes the company more competitive – in 2018, advancements

	include data driven dashboards, seamless workflows, and patented technologies acquired in 2017[253] - In 2019, Genpact adopted pretrained AI accelerators to help companies more easily adopt and effectively implement AI – aims to address results of Genpact study showing general lack of clarity in adopting AI for most 500 executives across various companies[254]
Intelenet Global Solutions	- Emphasizing training programs and initiatives for employees – related to developments in technology and leadership – in 2018 – 41.9 million hours of training were completed for employees worldwide[255]
Hinduja Global Solutions	- Launching HGS Digital combining customer care with digital analytics, marketing technology, cloud, intelligent automation and AI - Builds on DigiCX to address industry specific challenges e.g. retailers convert more browsers to buyers - aims to create frictionless customer experiences[256]
CSC India	- By 2019, CSC India hopes to provide e-services through a single delivery platform (particularly G2C services) , localised help desk support, standardization of services and capacity building of stakeholders[257]

IT Companies' Acquisitions

The below table outlines acquisitions from the 16 companies between 2016 - 2018. Acquisitions could give us a reading on potential job and work task displacements between acquired and acquirer organisations, potential job growth areas, potential technological areas of ingress into organisational and project workplaces, etc.

Table 5: Sample IT Firms - Acquisitions from 2016-2018

Company	**Acquisitions in 2016 - 2018**[258]
Infosys	Skytree (2017): OCR, NLP, and infrastructure management services[259] Brilliant Basics (2017) : Product Design And customer experience[260] Wongdoody (2018) : Digital Marketing and Consumer Insights[261]
WIPRO Ventures	Avaamo Inc (2018) : AI based conversational computing platform[262] ; HeadSpin: app testing platform[263], Vectra Networks: cyber security[264] Altizon : big data startup[265] ; Vicarious: robotics startup[266] ; Emailage Corporation: fraud prevention ; Designit (2016)[267] : Strategic Design ; Appirio (2016)[268] : Cloud Tech Cooper (2017)[269] : Design Consultancy HealthPlan Services (2016)[270]: Business Process as a Service
TCS[271]	Citigroup Global Services (2016)[272]; Swedish Indian IT Resources AB (2017); Financial Network Services (2017) :
MindTree	Magnet 360(2016)[273] : Consulting
Cognizant	Frontica Business Solutions(2016)[274]: IT & BPO KBACE Technologies(2016)[275]: Cloud Netcentric(2017)[276]: Digital Agency BZone(2017): Digital marketing and experience SaaSfocus(2018)[277]: Salesforce cloud consulting Hedera Consulting(2018)[278]: Data analytics

	Bolder Healthcare Solutions (2018)[279]: Revenue cycle management for healthcare
Tech Mahindra	BIO(2016)[280]: Digital Design Target Group(2016)[281]: Business Process as a Service CJS Solutions(2017)[282]: Healthcare solutions consulting Inter - Informatics(2018)[283]: Engineering Services
HCL Technologies	Geometric Limited(2016)[284]: Engineering Services Butler America Aerospace(2016)[285]: Engineering Services Point to Point(2016): Cloud Solutions Datawave(2017)[286]: Data Automation Platform Urban Fulfilment Services(2017)[287]: BPO Services Actian(2018)[288]: Data Management C3i Solutions (2018): Lide Sciences & consumer services H&D International Group(2018): IT and Engineering Services
WNS (Holdings) Limited	Value Edge Research Services Pvt.[289] (2016) Denali Sourcing Services[290] (2017)
Capgemini	LiquidHub[291] (2018) - customer engagement Leidos Cyber[292] (2018) - commercial cybersecurity
Computer Sciences Corp.	Covansys[293] (2017)
Intelenet Global Service	N/A
Hinduja Global Solutions	Element Solutions LLC, USA (2018): digital consulting services[294] AxisPoint Health (2018): health management company[295]

CGI	N/A
IBM	Sanovi Technologies (2018): cloud services[296] Vivant Digital (2018): customer experiences[297]
Mphasis	N/A
Genpact	Barkawi Management Consultants (2018): Supply Chain Management[298]

Implications for Labour

Hiring and Jobs

While new jobs may be created, our research indicates that the rate of hiring in the IT sector is going down. The number of workers being hired incrementally has reduced year over year (YOY). This is driven by an increase in productivity of employees because of automation. As per data from the Ministry of IT, Government of India the Table 1 is constructed. This shows that the increase in the number of employees hired YoY is reducing. It has reduced from 2.18 lakh in 2014 to about 1.05 in 2017, which is less than half compared to 2014. So while there has been an overall increase in the number of hires, the rate of hiring is reducing at a very high pace. This trend has been reported in the news items as early as 2016 - with companies being quoted as noting improving productivity and decreasing hiring in the sector. This is linked to a move away from the traditional labour arbitrage model to one where increased revenue is not a result of increased manpower.[299]

A wave of recent layoffs in the Indian IT industry reflect its most significant period of churn since the IT boom two decades ago. While IT companies haven't necessarily attributed these layoffs to automation, they have consistently identified automation as the spark for huge changes in the industry, by rendering old skills redundant, recasting the idea of work, and making a smaller labour force seem likely. The loss of jobs in the IT sector is also claimed to be due to changes in demand for skills.[300] According to a December 2017 article in Quartz India, the IT sector laid off 56,000 employees in 2017 while entry level hiring dropped by 50%. The article pointed to a combination of automation ,a shift to remote and technology based solutions (video conferences, cloud, and AI), pressure on revenue growth, and detrimental policies from the US, including stalling the H-1B visa process, the Buy American, Hire American executive order, and closer monitoring by the USCIS.[301] A Mint report stated that at least 56,000 would be laid off in 2017-18 by the top seven IT firms in India.[302] Infosys announced, after its Summer AGM, that 11,000 of its 200,000 employees whose work involved

repetitive tasks would be replaced by automation and redeployed elsewhere within the company.[303]

In the Infosys Annual report for the year 2017, it has been mentioned that "the Cumulative impact of the journey of the past 12 months has been massive - "it (Nia- AI platform) has helped us eliminate around 11,000 full-time employees worth of effort and repurpose those people into more valuable and rewarding tasks."[304] Similarly Wipro in its annual report for the same year mentions that, "we generated productivity worth over 12,000 persons across 140+ customer engagements by leveraging next generation delivery practices and deploying over 1,800 cumulative instances of HOLMES bots in the areas of application development, maintenance and infrastructure services".[305] These numbers suggest that the impact of automation through Industry 4.0 technologies has been significant in terms of reducing the manpower requirement. From the information shared in the annual reports, it is unclear how employees have been repurposed or how productivity is being measured.

Contract Workforce and IT Companies

In terms of employment trends, an increase in contractualisation in the IT sector was observed as a trend by both entry-level respondents as well as by trade unions in our interviews. Specific trends observed included skills exchange with other organisations within the sector, and teams being created for specific projects. An example of this shift to contract workers and freelancers in the IT sector was given in a July 2018 news article that focused on the hiring firm Quess. The article notes that the company has found the hiring of software engineers to have reduced by almost 50%.[306] Yet, this drop has been accompanied by a shift in hiring patterns, with IT companies hiring on an augmentation basis - with individuals being hired for specific six to twelve month projects. The article posits that the reasons include efficiently recruiting, convenience in managing contracts, and enabling companies to focus on technology issues and not administrative issues.[307] It also notes that social media, analytics, and internet related applications, along with a shift of enterprise software to the cloud, has resulted in requiring fewer people to oversee the running of applications.[308]

To further study the growth of contract work in the IT sector, we studied the staffing firms in India which work towards fulfilling such requirements. According to a study commissioned by Indian Staffing Federation and conducted by KPMG, the Indian IT contractual staffing industry was worth $3.04 Bn in the year 2017[309]. About 0.26 million employees were associated through this mode and had 5.6% penetration in the IT workforce in India. In 2017, India was quoted as making up 28% of APAC and 4.8% of the global IT contractual staffing industry.[310] This is very low penetration considering the fact that as of 2017 India has been quoted as having a 55% market share in the global IT services market.[311] The share of contractual staffing is 6%, amounting to about 2.34 lakh staff in the IT/ITES segment[312]. For example, Quess corp the largest player in the flexi staffing industry in India had 159,000 associates in the year 2018, of which only 12,000 were in IT staffing.[313] Teamlease, which is another leading player in the

market, has about 150,000 associates and IT's share is 4.7%.[314] The present situation, then, suggests an inclination towards direct full time employment.

Since contractual workers may be hired from other sources, it is useful to asses the situation at the company level as well: in FY 2016-17, TCS spent $1,319 million (7.5% of revenue) on fees to external consultants, compared with $1,280 million (7.7% of revenue) in FY 2015-16."[315] With an expected growth rate of 15.8% per year in the IT segment, flexi staffing will see significant growth over the next few years, but will remain a very small percentage of the overall IT workforce.[316] From both employer and the employee details, IT makes up the largest segment of the freelancing industry. For example, Paypal Report shows the high amount of participation of Indians in freelance work predominantly in IT related work.[317]

Further, the contractual staffing industry in India appears to be driven by a demand for niche skills sets rather than for cutting costs. This is confirmed through two sources of data. A 2017 report by Indian staffing federation shows that 58% of the companies used flexi-staffing for niche skill sets compared to 21% for cost benefits.[318] The annual/sustainability reports of TCS also confirms this as a major driving factor by stating that "TCS also uses contractors, especially for assignments that are of a short-term nature, or which require skills not readily available internally."[319] Moreover, in one of our interviews, a respondent pointed out that the hiring workers on contract was especially true for projects dedicated to developing automation solutions for clients.[320]

The table below documents the percentage of contract workforces in companies based on publicly available information.

Table 6: Qualitative and Quantitative Information of Contract Workforces in Sample IT Firms

Company	Percentage Contract Workforce	Figures	Comment
Infosys	10-15% as of July 25th 2018[321]	200364 (as on 31st March 2017)[322] 16000 contract staff work in non-core activities such as housekeeping, security and maintenance service	"Most of our employees work as full-time permanent members. We have de minimis number of employees working on part time /fixed-term contract"[323]

TCS	TCS doesn't disclose the number of contract workers it takes on.[324]	Employee Benefit expense of Rs.61,621 Crores as per the 2016-17 annual report. In FY 2016-17, TCS spent $1,319 million (7.5% of revenue) on fees to external consultants, compared with $1,280 million (7.7% of revenue) in FY 2015-16.[325]	"TCS also uses contractors, especially for assignments that are of a short-term nature, or which require skills not available readily internally."[326]
Wipro	12%[327]	No. of employees was 165481 in 2017 (core employees in IT business. Does not include partner employees, retainers and support service workforce). The workforce includes more than 20,000 contract employees.	"A customized Partner Employee Engagement team (PEET) in our Global Infrastructure Service is responsible for building an engaged and motivated contract employee workforce"[328]
HCL	N/A	N/A	-

Tech Mahindra	1.6%[329]	73702 Total employee count as on 31st March 2017 1199 (Fixed term + Third party contract)	-
Mindtree	8%[330]	16470 as on 31st March 2017 Sub-contractor charges were Rs.3,071 Mn. which is about 5.9% of the revenue for the year 2016-17	-
IBM	-	Total employees: 130,000 as of 28th September 2017.	-

Gig work in the IT sector is possible due to the advancement in technology which have made reputation management and work monitoring much easier across the globe. The ability to break work into much smaller tasks which are outsourced through the online platform needs very high levels of process automation capabilities. As part of the 2017 FICCI-NASSCOM report, recommendations for the industry included using the gig economy approach to leverage the competencies of the laid off workforce, and using the gig economy resources as part of HR planning strategies.[331] This appears to be in line with government visions and policies at the national level as the platform economy has been identified by a number of governments as key to creating employment opportunities. The NITI Aayog Discussion Paper on AI stated that the hike in demand for jobs in India can be attributed to the increased adoption of technology; shift in market demographics and deceleration of globalisation. The paper also stated that the changing nature of the service sector internationally, could pose challenges for up-skilling and reskilling.[332]

Yet, it is important to understand the potential of the gig economy as well as the drawbacks to the gig framework. For example, the flexibility provided by this mode of employment has enabled more inclusiveness in job creation. There has been a larger participation of women in this mode of employment[333], while also further entrenching a gendered labour force[334]. This mode of hiring enables the flow of work in developing countries while potentially mitigating migration of skilled workers to developed countries. At the same time, those working in the 'gig economy' full time can face social stigma as it is not considered "work" and have issues in getting loans from banks. They can also face issues like power supply and internet connectivity.[335] At the industry structural level they can face issues in terms of entering the market as it is driven by ratings. Those without ratings may have to accept work at highly discounted wages. With the workers having to bid for every project, they fear a race to the bottom in terms of wages. With no industry organisation or collective bargaining rights, resolving these issues seems very tenuous[336]. Thus, though there is a real risk that these jobs will take over the "office" jobs that are currently available in the IT sector, at the same time, there are challenges and entry barriers to the freelancing market. While everyone talks about online freelancing as a solution, there will be a threshold beyond which it cannot employ people directly, but people who already have high ratings will in turn employ those freshers as there is a clear arbitrage in terms of ratings. This will act as an entry barrier for newcomers and calls into question the scalability of online freelancing. There is a need to identify the size and the impact of this mode of employment in the Indian job market across sectors. Policies that will help these workers need to be explored.

When looking at the rate of hiring as it relates to automation, it is important to take into account other factors that may be showing a decrease in hiring, including freelance work. Towards this, it is important to look at what work can and is being freelanced. While the number of software professionals in the IT companies are tracked, there is very little information on the Indian IT freelancers who are the largest suppliers of these services globally.

Wages

Almost all the IT companies have shown concern about the rise in labour wages in the Indian market and that this could be eroding the traditional labor arbitrage model that they worked in.[337] They report a huge demand for skills in the digital technologies which is leading to high salaries in that segment.[338] Automation is looked upon as a way of reducing this increase in wages. As the industry predominantly caters to the western markets, especially the US, the changes in technology landscape there directly affects the operations of these companies. The industry does not react to the growth of technology in India so they have very little leeway in terms of the time frame available to catch up with the emergence of new technologies.[339] Historically, the IT sector has been the site of higher incomes for its software professionals, about twenty times the national average., While still a fraction of what international counterparts have received—it is an important comparative advantage that India which has contributed to the exponential growth of the sector.[340]

Of late, there has been growing reportage around concerns relating to salaries, especially the increment component. The India Salary Increase Survey conducted by Aon Hewitt reported that average pay hikes in the IT sector in 2016-17 dropped from 15.4% to 10.6%, the lowest increment rate since 2011 with an even lower projection of 9.5% for 2018 being reported as well.[341] A KPMG report provides similar estimations with the IT-eS sector showing marginally higher numbers.[342] For example, a 2018 newspaper article around Capgemini handing out

minimal to no salary increments to a large chunk of its employees accompanied by cuts in variable pay despite registering impressive growth numbers.[343]

Reductions in wages can be credited to changes in revenue streams of IT sector companies from traditional software to robotics and automation, uptake of machine-learning and AI, maturity of the IT sector, and recruiting foreign labour.[344] There are also issues regarding a stagnancy in entry-level wages being reported, with former industry insiders allegedly voicing concerns around the cartelisation within the sector to keep fresher-pay low.[345] On the other hand, there is also growing anecdotal evidence around those equipped with the skill set and domain knowledge of technologies such as AI and machine learning receiving significant pay hikes to the tune of 40% and more.[346]

Gender

In interviews with 2 entry-level engineers, individuals noted that there was gender parity within their organisation; one even highlighted that while they didn't have exact numbers, it is possible that females may outnumber males in their organisation. One of them, though, anticipates that this is geography-specific and may not be true for organisations based outside of the Bangalore cluster. In our survey, the firms surveyed did have lower female participation in their workforce broadly matching that of work done looking at female participation in the IT sector previously.

Table 7: Age and Gender- wise distribution of employees for FY 2017-18 in Sample IT Firms

Age (years)	**Male**	**Female**	**Total**
18-30	61.6	38.4	100.0
31-55	66.2	33.8	100.0
56 and older	74.6	25.4	100.0
Average	**67.4**	**32.6**	**100**

These findings were in line with our review of research on the literature around participation of women in the IT sector revealed that the engagement of the female participation in STEM jobs was significantly lower. The NASSCOM report identified that 30% of the workforce were made up of women.[347] While interest in STEM is gradually increasing, women are less likely to pursue and remain in a STEM career[348]. Deep-rooted cultural and social barriers give rise to these trends. This includes gender roles and household responsibilities, limited resources to spend on education, and societal expectations[349]. In addition to these factors, the gendered nature of STEM education carries on into the workforce. Although enrolment is increasing, there is still a proportional disparity between male and female students. Often, this leads to women perceiving a gender bias in performance evaluation, ultimately impacting their career opportunities[350]. Moreover, efforts to improve education and technological literacy, such as targeted government programs, are heavily focused on provision of ICT technologies, increasing the number of consumers of technology, not necessarily creators[351].

In fact, private companies such as IBM have also rolled out educational programs focussed on augmenting women in Tech[352]. While providing degrees, diplomas, and AI operated mentees can increase exposure and expertise, work must also be done to limit the barriers to entry women face, and create opportunities for women to occupy a wide range of skill-level positions. To address these challenges, recommendations include establishing female-only colleges and vocational training close cities that are hubs for employment. Additionally, the training for STEM courses could be made more interdisciplinary to alleviate gender biases and build well-established networks for apprenticeships and employment[353].

Addressing the discrepancy in women occupying jobs at all skill-levels, literature about these sectors also revealed that a majority of women in these sectors were in the entry level positions and these numbers reduced as they went up senior management positions. A significant number of these women were employed in BPOs. However studies have shown that the tasks contained in the BPOs are at a high risk of being automated and seeing the effects of technological disruption in the near future.[354]

Qualitative Shifts in Work

Documented by the FICCI, shifts in job structure and workspace include employee mobility and job rotation, virtual workplace/flexible work arrangements, changes in existing processes, increase in part time work, reskilling of current employees, and cross industry collaboration.[355] The increased contractualisation was reported by most of our respondents as being a fundamental change in the way the firm itself is structured. Changes in the lifecycle of projects is also being experienced, leading to rethinking of employment strategies and leading to increased contractualisation. More granularly, there are critical changes happening in the nature of work in ways that are typically associated with the

uptake of automotive technologies—the miniaturisation of tasks, changes in task content, the intensification of work etc. The below table indicates the propensity of these changes being felt, as reported by the respondents in our survey.

Table 8: Observations Regarding Changes in the Nature of Work— Responses from Employees in Sample IT Firms

	Yes	**No**
Increased contractualisation of labour (people hired for short durations)	92.1	7.9
Miniaturisation of tasks and platformisation of these tasks	75.0	25.0
Changing tasks within existing job functions (designations have remained the same but the actions performed within the designation has changed)	80.0	20.0
Intensification of work (more activities are expected to be completed in a shorter time frame)	51.5	48.5
Change in lifetime and size of projects	75.7	24.3

IT Companies and HR Initiatives

Reflective of the changes underway, companies are adopting technology enabled human resource management as well. The below table outlines the use of Industry 4.0 in technology enabled HR initiatives in the 16 companies studied. It is interesting to note Industry 4.0

technologies are being used both exercising monitoring and surveillance over employees while also aiding them in career guidance and path selections.

Table 9: Use of Industry 4.0 Technology Enabled HR Initiatives in Sample IT Firms

Company	**Tech Enabled HR Initiatives**
HCL	1) Career Connect 2.0 or Intelligent Career Maps[356], which is prescriptive and predictive platform leveraging Artificial intelligence and big data algorithms to provide a personalized digital career concierge service to employees, suggesting career paths, learning maps, mentors & jobs at HCL relevant to the employee's profile: - At HCL, the value is to power up the intelligence of 100 thousand employees and codify it to predictive analytics insight for the employee. - The career-connect 2.0 not only helps employees to choose career paths as a prescriptive analytics engine but also suggests shortlisted internal jobs basis their profile, instead of looking from a whole list of jobs available. - The platform pulls data for the employee through internal systems, profile and feeds it to them giving details about suggested career paths & internal job most suitable for them. 2) Smart Survey[357] Smart Survey is a platform for collating effective, constructive and integrated feedback from the employees. This is crucial to the ongoing development and growth of the individual, managers and the organisation at large. Through our self-assessment tool, Smart Survey, we identify our employees' passion indicators and the individual factors that drive them to excel at work. 3) MEME[358] This first-of-a-kind social networking platform leverages the collective power of the organisation through micro-blogging, social networking, content and knowledge sharing and open forums. The purpose of the MEME is to socialize the business, enable single point access for employees, and improve productivity and collaboration. Some of MEME's key features include content viralling; its ability to integrate seamlessly with other knowledge repositories, making it a sustainable social learning platform;

Infosys	1) Infosys Learning Platform The Infosys Learning Platform provides the entry level employees, training in a minimum of three different languages. Employees are also given the opportunity to explore internal job profiles through an App within the system which gives workers more control over their work. The other upcoming projects include digital tutor on cloud and next-generation knowledge management platform. Infosys should plan to focus on increasing the skills in design thinking and digital technologies. As of 2015, Infosys had trained 39,000 employees under its design thinking program.[359] 2) Digital Tutor
TCS	1) CareerHub Is a platform that provides TCS employees with mentoring services.[360] 2) Inspire Provides a specialised program that provides fast-track career progression to high-potential employees.[361]
Mindtree	1) Exuberance Is a training and mentoring program for 100 women identified to have the highest potential to advance.[362] 2) Mindtree has built a training campus in Bhubaneswar to train 2,500 software engineers on cutting edge technologies.[363] 3) Launched a self-paced Learning Management System consisting of audio learning modules–ShotClasses to client stories with the sales force, live training workshops, and social-selling coaching sessions.[364]
Genpact	1) Genpact partnered with NIIT to create the NIIT Institute of Process Excellence (NIPE Uniqua), which offers training programs in Business Process Services to create a talent pool for the business and technology services industry.[365]

	2) Genpact launched its Education@Work initiative by partnering with premier business schools like IIMs, NMIMS, XLRI, IMT and other prominent educational bodies,to offer employees courses to develop their career skills while working with the firm.[366]
Wipro	1) Wipro BPOs SEED academic program - The SEED academic program helps employees enhance their academic capability.The program offers a large spectrum of courses across a range of subjects in the field of Management and Information Technology.Since 2004, SEED has enabled over 6000 WBPO employees shape and transform their careers.[367] 2) Manager Excellence Framework The framework includes a set of resources available to managers to boost team performance, build process capability and chart out self-learning & developmental plan. Managers have access to a self-development feedback survey, workshops, online courses & mentors.[368]
IBM	Talent and Change solutions - help organisations prepare for the transformational change required to build a smarter, more connected workforce.[369]
Cognizant	Cognizant Academy - the firm's in-house learning center[370]
Intelenet Global Service[371]	1) SEED (Skill Enhancement for Employee Development) 2) GROW (Getting Ready for Opportunities at Work) 3) FLAME (Foundations for Leadership and Managerial Excellence) 4) Pinacle
Mphasis	Learning Week - 5-day virtual conference with parallel tracks running on technical, domain and leadership areas[372]
Hinduja Global Solutions	-

Tech Mahindra	1) Intrapreneurship Program, you even have the opportunity to pursue your ideas and commercialize them with support from mentors and resources from Tech Mahindra 2) Facial recognition attendance software[373]
CSC	-
WNS (Holdings) Limited	WiNCUBATE to recognize entrepreneurs within the organisation.[374]
Consultants to Government and Industries	-
Capgemini	MyLearning, is open to all employees for informal, just-in-time learning and for structured learning events.[375]

Labour law implications

Over the last half a decade or so, retrenchment of employees has been a frequent source of criticism levied at organisations in the IT sector.[376] The concerns around the retrenchments have been about them being "forced" and "illegal" as were surfaced in S.Paul Raj vs Tata Consultancy Services Ltd, a widely cited case where the Madras High Court issued an injunction staying the retrenchment of a TCS software analyst.[377] The reasons accorded for these retrenchments in the media have popularly been United States' protectionist changes in visa policy[378] and the uptake of automation within the sector,[379] leading to changing organisational structures and revenue models[380].

To clarify, in Indian legalese, the terms "layoff" and "retrenchment" are distinct. Broadly speaking, layoff can be understood to mean the temporary dismissal of employees due to market conditions with the aim of re-hiring the laid off workers once business picks up or commences again[381]; layoffs are usually accompanied by a layoff compensation[382]. Retrenchment is distinct in that it refers to the permanent termination of employment, for reasons other than disciplinary action, and has a specified processes, and conditions precedent and subsequent[383] for retrenching employees.[384,385]

This spate of retrenchments in the IT sector was also discussed in the Maharashtra state assembly.[386] This led several states to clarify that the IT sector did fall within the ambit of the Industrial Disputes Act, 1945.[387] Employee organisations working in the IT sector that we interviewed also suggested that these retrenchments had made it easier for them to collectivise employees in the IT sector and overcome the earlier lack of unionisation in the

sector. These have allowed unions to file petitions seeking relief for the retrenched employees to state labour departments.[388]

The movement to a knowledge based economy has historically led to an increase in the inequality in the society. However in countries which have strong labor market institutions like coordinated wage setting, strict employment protection legislation, and high bargaining coverage were able to mitigate these issues. Surprisingly the trade union presence in the IT sector does not seem to have any significant impact with respect to the reduction of inequalities[389].

Though issues that have been raised with unions can potentially be associated with automation, in our research we did not find publicly available complaints or demands directly linked to the detrimental impact of industry 4.0. In part because the unions are focusing on 'employability' and combating illegal retrenchments. If these concerns do exist, this points to a need for these to be clearly articulated in the public domain. As our survey indicated, the biggest cause for attrition within firms is the working conditions i.e. questions around wages, workload etc. The obsolement of skills due to technological change was a big concern, too, but still articulated lesser than the challenges with working conditions.

Table 10: Reasons for Workforce Attrition in Sample IT Firms

Reason for attrition	Yes	No	Total
Wage and salary conditions	83.8	16.2	100
Work environment (workload, cleanliness, noise, etc.)	87.0	13.0	100
Lack of inclination towards traditional long-term employment	77.8	22.2	100
Commute time between home and work	64.5	35.5	100
Relationships at work, communication	31.6	68.4	100

Extensive overtime work	35.7	64.3	100
Emerging technologies making skills obsolete	73.3	26.7	100

Skills, Roles, and Job Mobility

Industry 4.0 is impacting the skills individual workers need, the roles that they can or need to play in a company, and their ability to move horizontally and vertically in a company or between companies.

Trends such as increasing demand for connected services, growing digital penetration, demand for smart factories in other sectors, e-governance infrastructure and platforms, and development of smart cities are increasing business for IT firms and leading to new job roles.[390] According to the 2017 NASSCOM Annual Guidance for the IT/BPM sector, the industry is now in demand for individuals with a combination of skills—domain, technology, and soft skills. New roles emerging include cybersecurity, mobile app development, new user interfaces, social media, data science, and platform engineering. New skills include big data analytics, cloud & cyber security services, IoT, service delivery automation, robotics, AI/machine learning and natural language processing.[391] According to the Make in India website, 0.15 million employees have been trained in social, mobile, analytics, and cloud skills. Towards this, the government has invested 1.6 billion USD annually on workforce training.[392] According to the report, new job roles that will be created in the IT/BPM sector include VFX Artist, Computer Vision Engineer, Wireless Network Specialist, Embedded System Programmer, Data Scientist, Data Architect, AI Research Scientist, RPA Developer, Language Processing Specialist, Deployment Engineer, 3D Modeling Engineer, 3D Designer, Cloud Architect, Migration Engineer, Android/iOS App developer, Digital Marketing.[393]

The report goes on to predict that by 2022, 10%-20% will see deployment in new jobs that do not exist today, 60%-65% will be deployed in jobs that require new skill sets and 20%-35% will see a threat to their job.[394] The report analyses the transformations jobs will undergo by 2022, a few illustrative examples provided include the job of data administrator being modified to become a database service analyst, the job of software developers changes to UX Designers, the employees working on data mining/warehousing will shift to working as data analysts and marketing professionals will start working in the field of digital media and marketing.[395]

The impact of automation seems to be concentrated on specific profiles. For example, the software development value chain is comprised of business analysis, architecture and design, coding and testing, and integration. Within this, the current target for automation include call center agents, data entry operators, document processing, accounts payable,

system administration and testing[396], support, and coding.[397] A report published by FICCI makes the following predictions for the Indian job landscape in 2022[398]:

- 9% would be deployed in new jobs that do not exist today
- 37% would be deployed in jobs that have radically changed skill sets
- 54% of the workforce will fall under unchanged job category.

While the findings of this report acknowledge the importance of differential skilling/re-skilling of the workforce, the findings also predict that more than half of the workforce in 2022 will be required to do jobs whose nature, and demands will remain unchanged.[399] The skills that were highlighted by our higher level respondents as crucial to work in the IT sector can be found below.

It is evident that a tremendous amount of primacy is placed on having high levels of adaptability and comfort with new technologies. Simultaneously, what also emerges is the emphasis currently being placed on being able to do repetitive, structured work. This is a hierarchy-neutral finding, too. Tellingly, these are the tasks that stand to be impacted the most by the uptake of automation technologies.

Table 11.1: Degree of Importance Assigned to the Following Skills and Competencies in Sample IT Firms—Entry Level

Skill	Entry Level						
	0	1	2	3	4	N/A	Total
Analyzing data/information	0.0	7.7	61.5	12.8	15.4	2.6	100
Thinking creatively	0.0	6.4	25.5	51.1	17.0	0.0	100
Interpreting information for others	2.1	2.1	42.6	21.3	31.9	0.0	100

Establishing and maintaining relations	0.0	12.8	31.9	29.8	25.5	0.0	100
Guiding, directing & motivating subordinates	8.5	19.1	34.0	25.5	12.8	0.0	100
Repeating the same task without error	0.0	0.0	29.8	51.1	19.1	0.0	100
Ability to work remotely	2.1	0.0	44.7	31.9	21.3	0.0	100
Doing structured rather than unstructured work	8.7	8.7	43.5	26.1	13.0	0.0	100
Controlling machine and processes	2.1	6.4	17.0	61.7	12.8	0.0	100
Familiarity with emerging technologies	0.0	4.3	38.3	42.6	14.9	0.0	100
Ability to adapt to changes in technology	0.0	4.3	27.7	51.1	17.0	0.0	100
Others	5.6	11.1	16.7	27.8	38.9	0.0	100
Total	**2.4**	**6.9**	**34.4**	**36.1**	**20.0**	**0.2**	**100.0**

Table 11.2: Degree of Importance Assigned to the Following Skills and Competencies in Sample IT Firms—Mid Level

Skill	Mid Level						
	0	1	2	3	4	N/A	Total
Analyzing data/information	0.0	6.4	40.4	40.4	12.8	0.0	100
Thinking creatively	0.0	0.0	27.7	59.6	12.8	0.0	100
Interpreting information for others	0.0	4.3	51.1	27.7	17.0	0.0	100
Establishing and maintaining relations	0.0	4.3	38.3	38.3	19.1	0.0	100
Guiding, directing & motivating subordinates	0.0	6.4	36.2	46.8	8.5	2.1	100
Repeating the same task without error	0.0	4.3	25.5	55.3	14.9	0.0	100
Ability to work remotely	0.0	6.4	40.4	36.2	17.0	0.0	100

Doing structured rather than unstructured work	0.0	2.1	72.3	21.3	4.3	0.0	100
Controlling machine and processes	0.0	6.4	42.6	29.8	19.1	2.1	100
Familiarity with emerging technologies	0.0	2.1	23.4	61.7	12.8	0.0	100
Ability to adapt to changes in technology	0.0	4.3	17.0	31.9	46.8	0.0	100
Others	11.1	11.1	55.6	11.1	11.1	0.0	100
Total	**0.9**	**4.8**	**39.2**	**38.3**	**16.4**	**0.4**	**100.0**

Table 11.3: Degree of Importance Assigned to the Following Skills and Competencies in Sample IT Firms—High Level

Skill	**Higher Level**						
	0	**1**	**2**	**3**	**4**	**N/A**	**Total**
Analyzing data/information	0.0	2.1	25.5	48.9	23.4	0.0	100
Thinking creatively	0.0	2.1	12.8	25.5	59.6	0.0	100

Interpreting information for others	0.0	2.2	41.3	43.5	13.0	0.0	100
Establishing and maintaining relations	2.1	2.1	23.4	46.8	23.4	2.1	100
Guiding, directing & motivating subordinates	0.0	2.1	12.8	36.2	46.8	2.1	100
Repeating the same task without error	0.0	4.3	40.4	42.6	12.8	0.0	100
Ability to work remotely	0.0	6.7	22.2	62.2	4.4	4.4	100
Doing structured rather than unstructured work	0.0	6.4	36.2	40.4	17.0	0.0	100
Controlling machine and processes	0.0	2.2	37.0	41.3	19.6	0.0	100
Familiarity with emerging technologies	2.1	4.3	12.8	36.2	44.7	0.0	100
Ability to adapt to changes in technology	0.0	2.1	6.4	31.9	55.3	4.3	100
Others	11.1	11.1	33.3	22.2	22.2	0.0	100
Total	**1.3**	**4.0**	**25.3**	**39.8**	**28.5**	**1.1**	**100.0**

While there is a lot of focus put on the importance of Indian IT companies to build AI-related skills and capabilities, and on the need to train Indian IT workers with AI skills there is not

nearly the same amount of focus put on the impact of AI on jobs in the "middle-skill category", i.e., assembly line workers, clerical workers, etc.[400]

In 2018, NASSCOM also launched the FutureSkills platform with a focus on skill development in the nine technologies comprising industry 4.0. It envisions training in 66+ job roles and 155+ skills with a focus on AI and Big Data Analytics as they are the areas expected to have the most demand. Companies that are leveraging the platform include Wipro, Tech Mahindra, Cyient, Genpact & WNS, CGI, Purpletalk, and Dev-IT and Kellton.[401] As a note, the 2013 occupational standards document does not reflect the above jobs or skills.

Additionally, the IT/IT-es Sector Skills Council (SSC) is also run by the NASSCOM[402], and was one of the first SSCs to be set-up from across various sectors (there are 40 in existence currently). SSCs are industry led and industry governed bodies which have been mandated with the aim of executing a demand-driven skills programme. The mandate for the creation of the SSC is delegated from the National Skills Development Corporation (NSDC). The Report on the Committee for Rationalization & Optimisation of SSCs describes the role of SSC as: "the main interface between employers, trade unions, governments and various components of Vocational Education and Training (VET) system. The need for setting up these employer-led and employer governed bodies arose as manufacturing processes and technologies became more complex and the VET systems of the country were not able to deliver the skilled manpower which could help in improving productivity, quality and gross value addition to the industry."[403] As of 2016, the industry contribution to the SSC was INR 5.67 crore and had a placement rate of 12.6% from within the Pradhan Mantri Kaushal Vikas Yojana (PMKVY).[404]

In line with its mandate of ensuring skill development efforts in accordance with the actual needs of the industry, the IT/IT-es Sector Skills Council (SSC) has also launched a Basic Learning for Future Technologies platform which has self-explanatory courses on the following technologies: (a) Big Data, (b) Cybersecurity, (c) Internet of Things, (d) Cloud Computing, and (e) Machine Learning.[405]

Multidisciplinary education, creativity, and entrepreneurship are aspects that are increasingly being valued by IT companies and recognized as essential to stay relevant in the changing work landscape. The commodification of expertise has also been discussed—education in its traditional sense holds less significance because of the amount of and sources of knowledge that are available. This also reflects a shift to emphasis on self learning.[406] For example, NASSCOM and PwC have noted that this is reflected in a change that the industry itself is going through—shifting from an offshoring sector to one that develops knowledge based solutions.[407] This can be evidenced in strategic partnerships that companies are undertaking. For example, in 2018 Infosys entered into a partnership with Trinity College for the purpose of bridging the liberal arts and digital technology for the co-development of content and discovery of learning opportunities.[408] The importance and demand for knowledge workers and creativity has also been emphasized by WIPRO.[409]

Government Initiated Skilling Programs

The table below documents different government initiated skilling programmes predominantly targeting students including youth, undergraduates, postgraduates, and PhDs. Yet, there seems to be an absence of re-skilling programmes for individuals within the industry or those who have been laid off. It is also unclear if skilling is approached comprehensively and in a coordinated fashion by the government, or if different departments develop and implement programmes.

Table 12: Describing Government Initiated Skilling Programmes

Pradhan Mantri Kaushal Vikas Yojana – PMKVY[410]	Aims to train about 24 lakh Indian youth to be industry relevant, skill based and to prepare them for the global market
National Program on Technology Enhanced Learning (NPTEL)[411]	Engineering and physical science undergraduate/postgraduate
Centre of Excellence for Data Science and Artificial Intelligence	NASSCOM in collaboration with the Karnataka government opened the centre with an aim to nurture innovation in emerging disruptive technologies such as AI and to leverage the power of data science. The centre aims to support small and mid-sized businesses by fast-tracking their product development and providing market access. It will work with governments, and universities to provide the emerging businesses with required mentorship, talent and skills. The centre will create a platform for industry to academia to co-create digital solutions for Industry 4.0.[412]
Rashtriya Madhyamik Shiksha Abhiyan (RMSA)	Students undergoing vocational IT-ITes education in secondary and higher secondary levels.[413]
Maulana Azad National Academy for Skills	Works towards meeting all skill up-

(MANAS)	gradation/development needs of Minority Communities.The training programme is aimed at providing meaningful and sustainable livelihood options in terms of self-employment/wage employment opportunities to all its trainees, with primary focus on self-employment.[414]
Modified Special Incentive Package Scheme (M-SIPS)	The M-SIPS scheme, developed to boost manufacturing and attract investments in the electronic sector, was modified in August 2015 by extending the scheme for 5 more years to 2020, and adding 15 new product categories like smart cards, liquid crystal modules, consumer appliances, Internet of Things products, multi-functional electronic devices and optical fibre etc. [415]
Digital Saksharta Abhiyan (DISHA)	Under Digital Saksharta Abhiyan and National Digital Literacy Mission, around 99.56 lakh candidates have been enrolled for training, 82.74 lakh candidates have been trained and more than 47.13 lakh candidates have been certified so far.[416]
Visvesvaraya PhD Scheme for Electronics & IT	Launched by MeitY in March 2014, the scheme was revised in November 2015 and the budget outlay increased to Rs 466 crores for a period of 9 years with an objective to enhance the number of PhDs in Electronics System Design and Manufacturing (ESDM) and IT/IT Enabled Services (IT/ITES) sectors in the country.[417]
India BPO Promotion Scheme (IBPS)	48,300 seats have been approved under India BPO scheme and over 5000 seats have been approved for BPOs in North East.[418]

Company Initiated Skill Programs

Interestingly, along with the existence of a number of government skilling initiatives, all the companies studied have a plan for retraining employees in digital technologies. The retraining is predominantly done through online courses and setting up of internal learning frameworks. Companies have followed different structures and learning systems as shown in the figure below. The stakeholders for their skilling programs spread across the broad spectrum from freshers to specialists including the mid and senior management and CXOs.

Table 13: Structure of Firm Initiated Skill Programs

Structure	**Learning Systems**
Traditional (Classroom + Instructor Led)	In-house expertise
Mobile (Apps)/Web (Cloud)	Peer Learning
MOOCs	CoEs/Labs/Innovation Centres
Seminars/Workshops	Mentorship Programs
Hackathons, Gamification, Techtalks	Training Partners
Collaborative Learning	E-Learning Platforms

This points to a demand for multi skilled employees with strong skills in the domain of digital and analytics from within companies. As per company and industry reports, the number of people reskilled shows a huge effort on behalf of the IT companies. For example, Tech Mahindra has trained about 60,000 employees in various digital technologies. A 2017 NASSCOM annual guidance report for the IT/BPO sector notes that less than 50% of top firms already have employees trained in the digital though this number has increased 12x since 2010. According to the report—the focus of skills has been on analytics (37%), mobility (26%), cloud (24%), and other (13%).[419]

In our survey, respondents indicated that skilling programs are in place most companies. 65% of our respondents said that internal skill development programs were running at their company. Further, 40% of our entry-level respondents also stated that they had availed of external skill development programs. Moreover, another finding was that respondents

availing of external programs often enrolled in several programs. These were usually offered by: government bodies (14.9%); corporate run training institutes (77.8%); private education institutes (80%); and those run by industry bodies (73.1%).

The table below documents the different company initiated skilling programmes. This demonstrates an emphasis that is being placed by companies on skilling. These programs take different shapes and sizes and can include applications, platforms, centres of excellence, and partnerships with third parties.

Table 14: Skilling Programmes Initiated by Sample IT Firms

Company	**Skilling Programme**
Wipro	Mission10x[420] Newton's Cradle[274]
Infosys	Infosys-Udacity FastTrack Program[421] Design Thinking platform[422]
TCS	Learning and Assessment platform of TCS iON[423]
Mindtree	Yorbit, the company's online enterprise learning platform[424] Automation Center of Excellence (CoE)[425]
HCL Technologies	Edge Networks[273]
IBM	New Collar' curriculum[426]
Cognizant	CasKade[427]
Hinduja Global Solutions	Quality Professional Excellence Program (QPEP) and Kaleidoscope 360° (KL 360°)[428]
Intelenet Global Service	

Genpact	"Reach Higher," a vocational skill-building program [429]
Tech Mahindra	Skills-for-Market Training (SMART) program[430]
Mphasis	Skilltrain mobile app[431]
Capgemini India	In partnership with NIIT[432]
Consultants to Government and Industries	-
CSC	-
WNS (Holdings) Limited:	-

Companies have used innovative methods to structure their skill development program. For example, HCL Technologies has internalised the usage of AI technologies in the planning processes for training. They have implemented "Intelligent Career Maps" which is a "prescriptive and predictive platform leveraging Artificial Intelligence and big data algorithms to provide a personalised digital career concierge service to employees, suggesting career paths, learning maps, mentors & jobs".[433]

Robust identification of skill deficits and structuring reskilling and upskilling programmes aimed at existing employees is another approach being utilised. Mindtree, for instance, in what is self-identified by the company as a "humane approach to skilling" has designed its internal reskilling curriculum by identifying skills 'adjacent' to those skills comprising job roles that are being replaced.[434] Moreover, granulating skills to every job role has allowed Mindtree to undertake a dynamic re-skilling approach catering to individual project requirements.[435]

Interestingly, in 2018 Infosys also initiated a skilling programme and opened tech and innovation hubs in the U.S in part in response to the changes in the narrative around global mobility that seeks to train and hire 10,000 workers.[436] Infosys launched its "next-generation" learning platform for employees, as part of its broader competency development programs. This platform incorporates both classroom, and digital learning with the digital platform offering services that are accessible at all times, on multiple devices. The learning tools also utilise social learning techniques and gamification, in the form of telemetry, statistics, progress reports, and daily learning goals to incentivise learning. Some of these tools include

a work environment simulator, chatbots, machine learning based adaptive learning models, and documentation of employee learning, as well as application of these learnings by each employee. Infosys has also rolled out an immersive training program to sensitize employees on pluralist perspectives, aimed at giving them a better appreciation of multilingual skills and cultural sensitivity to appreciate diverse perspectives and collaborate with clients through culture based interventions. [437]

Policy Recommendations

Diversify export target countries: The Indian IT sector's heavy reliance on the United States, United Kingdom and the EU has adversely impacted the potential to make inroads in other major markets such as Japan. Moreover, this reliance has stymied both India moving up the value chain and counteracting confining the areas of the IT sector specialisation to services and the BPO sector.[438] Such a heavy reliance on an export oriented model to a select few countries is not a pragmatic business model which was evidenced by the impact on the sector during the recession,[439] and is being evidenced by 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.[440]

Enabling lifelong learning capabilities: In a labour market that can be expected to undergo rapid changes, it becomes expeditious for the government to develop dynamic high-quality lifelong learning programs. Such programs would enable re-skilling and up-skilling in the wake of a quickly changing technological environment and would ease workforce (such as moving from manufacturing to services or informal to formal etc.)[441]. This could help mitigate impact felt by middle management in the IT sector as highlighted earlier in this document. This would require a focus on employability in addition to the ongoing focus on employment as was highlighted in interviews we have had with trade unions engaged in the IT sector.

The problem becomes trickier given the design of the Indian education system along with a cultural proclivity towards undertaking formal education no later than 20-25 years of age.[442] Moreover, as the OECD 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."[443]

Incentivising industry involvement in skilling: While the companies that we have looked at incorporate skilling programmes, a need for incentivising demand-driven skilling programmes within the larger ambit of government skilling programmes is being felt[444]. 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.[445]

Platforms that allow for 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.[446] While one way to incentivise participation could be through purely financial perks: inclusion of participation in government skilling programs being included under permissible CSR activities and even tax breaks. Other incentive models, such as firm-level incentives for quality upgradation and training,[447] need to be looked at as well to determine the extent of private and public contributions towards these measures.[448]

Another financing model that is receiving consideration is a 'Reimbursable Industry Contribution,' a common pool of industry contributions utilised towards training.[449] Subsequently, firms could seek reimbursement for training costs from the fund. This could potentially address the financial reservations that prevent companies from undertaking rigorous skilling initiatives while also ensuring that there is financial gain for firms.[450]

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 occur alongside existing forms of employment that enjoy little 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).[451] Building from the assumption that social security is a fundamental part of the implicit social contract of modern societies and a basic human right,[452] 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 focusing on the individual will likely acquire heightened importance. This decoupling would ensure portability of entitlements across jobs while also not acting as an impediment in terms of labour mobility.[453] 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 recommends understanding working arrangements based on 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[454] manifests.[455]

While implementing such a policy measure, it is important to anticipate ways to sustainably finance a stronger social protection system. There are two possibilities : contributions and taxes. Entirely decoupling entitlements from jobs is not desirable as contributory forms of financing require regular sources of income to work sustainably. One way to solve this could be to make social security accounts multi-employer, similar to the United States[456].

Framing Future Research

Adopting a task-based approach

In the wake of globally rising wage inequality between skilled and unskilled workers in the 1980s—in the context of developed economies—a significant amount of literature emerged from these geographies pegging the rising wage inequality to the adoption of ICT.[457] Also called the skill-biased technological change (SBTC), this theory argues that it is low-skilled workers who bear the brunt of adjustment costs associated with occupational shifts brought about by digitalisation.[458] While the theory of SBTC enjoyed significant agreement for its ability to explain the wage gaps, it started receiving criticism for its inability to sufficiently explain job polarisation that was being evidenced in terms of hollowing out of the middle-skilled jobs as well as for its failure to explain the relationship between technology and the demand for skills—instead treating it as black box.[459] Consequently, this led to the development of more refined versions of the SBTC hypothesis and led to the creation of a task-based model looking to understand the skill requirements of different jobs as opposed to a mere demarcation between skilled and unskilled labour in the original conception of the SBTC hypothesis. Task-based models then categorise jobs into two broad task-based categories—routine and non-routine with further demarcation within each for manual and cognitive tasks.[460]

These newer models of SBTC then have led to the determination that automation is routine-biased in that it impacts jobs with primarily routine tasks across a range of skill levels.[461] 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 other factors such as demographic shifts, labour law legislation, migration patterns etc.[462] Yet, this line of reasoning does not play out the same way in a context like India. Work done utilising the methodology of the task-content model in the Indian labour context suggests 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) being evidenced.[463] This is similar to what has been observed in the developed economy context 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.[464] To then understand the impact within the Indian IT sector, it becomes imperative to understand the nature of the knowledge based economy, for example software production, by undertaking a granular assessment of the tasks comprised within it.

Skill intensity of tasks in software production

It is also pertinent to look at individual tasks owing to the nature of the production processes inherent in the IT sector. W. Wayt Gibbs, in the September 1994 Scientific American, famously wrote about the artisanal, labour-intensive nature of software production by juxtaposing it against the massified, capital-intensive nature of hardware production. Using this juxtaposition to bring out issues regarding productivity and consistency of quality in software production, he says:

> "[...] the industry has heard tell many times before of "silver bullets" supposedly able to slay werewolf projects. Since the 1960s developers have peddled dozens of technological innovations intended to boost productivity- many have even presented demonstration projects to "prove" the verity of their boasts. Advocates of object-oriented analysis and programming, a buzzword du jour, claim their approach represents a paradigm shift that will deliver "a 14-to-1 improvement in productivity," along with higher quality and easier maintenance, all at reduced cost."[465]

To overcome this problem of a resulting "software bottleneck"—a result of software production lagging behind hardware production—several approaches to managing the software development process were created ranging from conceptual methodologies to industry wide certification norms. A quintessential example of the former is the waterfall model, as popularly accredited to Winston Royce, where the software development process was broken down into six sequential and iterative components: requirement analysis (system as well as software), analysis, design, coding, testing and operations.[466] Examples of industry certifications for the IT sector include the ISO-9001/9000-3 standards prescribed by the International Standards Organisation[467], the Software Engineering Institute's five-level Capability Maturity Model (SEI-CMM)[468], and several other IEEE/ANSI standards. In fact, the Indian government even took to incentivising IT firms for obtaining these quality certifications to enable harmonisation of software production processes and address the issue of bottlenecks in software production.[469]

The waterfall model is a useful starting point to ascertain the labour-intensity of software production and understand it within the automation framework. As Balaji Parthasarathy points out -

> "Although the last three stages of the waterfall model have been amenable to automation with computer-aided software engineering tools, such automation demands tediously clear and detailed specifications. Consequently, much coding, testing and implementing is still done manually and the division of

> labour in software production is better seen as a division between more and less skilled labour, but skilled nevertheless."[470]

Coupled with the labour-intensity of the maintenance and re-engineering of older software, he argues, lead to US firms looking to outsource skill-cost combination with India as the preferred outsourcing destination[471]; especially since India has an institutional compatibility with the US in terms of sharing similar legal and accounting systems[472]

It then becomes necessary to place this skill and labour intensive quirk of software development, a predominant component of the value chain that the IT sector in India has tapped into, within the larger discourse on interplay between skill and technological change.

Research and Data Challenges

In our research we found that there are inconsistencies in frameworks and terminology, a number of gaps in terms of availability of data and challenges in metrics that make it difficult to research the impact of technology on work in the IT sector in India. These are outlined below:

Inconsistencies in Frameworks and Terminology

- Sectoral Conceptualisation: Traditionally, the IT sector in India is comprised of four sub-sectors—IT Services, Business Process Management, Software Products and Engineering Research and Development[473]. Yet distinguishing between the sectors can be challenging especially as many IT companies offer services and house segments that fall into multiple sub sectors. For example, Infosys provides business consulting, information technology, and outsourcing and would fall under the category of both IT-eS and BPO. Furthermore, reports on the IT sector often conflate and interchange sectors—making it difficult to examine the sectors individually. The IT sector can also employ people in different countries for a project, thus employment in the sector may not be fully captured through an analysis specific to one jurisdiction. At the same time, comparative research across jurisdictions across sectors can be challenging because sectors are conceptualised differently from country to country, with varied legal-regulatory frameworks dictating information made publicly available.
- Framing the Technology: The initial focus of this research was technologies that fall within the ambit of Industry 4.0. As mentioned in our methodology—we found that the words digital, automation, and industry 4.0 were often interchanged and all used to describe specific technologies that fall into the definition of industry 4.0.

Data Gaps

- Employment Data: Employment data on the IT sector in India is either outdated or only available from an industry body. The contemporary estimates on employment in the sector in India are from NASSCOM. On the other hand, the National Sample Survey Organisation's Employment-Unemployment Survey (NSS EUS) as carried out by the Ministry of Statistics and Programme Implementation, is regarded as the gold standard for employment data in India. However, the NSS-EUS provides data only from it's most recent 68th round which was released in 2011-12[474]. The NSS EUS was thereafter temporarily suspended for its next scheduled quinquennial round and was expected to provide data from the 69th round in late 2018 instead[475]. The idea behind the suspension was to create a more robust system with a higher frequency as 5 years was considered to be too long a period. The fact that the Government is depending on an industry body for employment data without any independent statistical verification highlights both a capacity and a potential data gap that exists. It also makes it difficult to cross verify data from multiple sources. Companies, the government, and industry bodies opening up and publishing the data they have on employment, work, and technology will go a long way in enabling evidence based policy making.

- Task Data: Presently, there is a data gap in researching the future of work in India because of a lack of task level data. Meaningful conclusions about what is driving industry 4.0 and the impact of the same on work in the sector could be carried out by identifying drivers across economy and labour, correlating data on what kind of tasks each industry 4.0 technology can carry out, and research into what is driving changes in specific tasks.

- Cost of Technologies: A significant factor that is driving and will drive the uptake of technology is the cost-effectiveness of such uptake. While the cost-effectiveness to the customer is one factor, another is the organisational capital outlay. The latter would entail various factors such as the up-front cost, regular maintenance costs, costs of transition of infrastructure as well as the cost it would represent vis-a-vis manual labour for similar tasks. The last being of particular importance in the Indian IT sector as a major factor behind them flourishing was the labour cost advantage they enjoyed in comparison to developed economies. These would then also need to be contextualised to the commensurate gains in productivity and efficiency—a key driver in the adoption of technology in production processes.[476] However, data indicating the cost of the uptake of technology (as opposed to just the cost of the technology) is absent, posing a critical challenge for both research purposes as well as decision making within policy framers and industry participants.

Challenges in Standards and Metrics:

- Productivity: Input and output measurement in the software industry is complex. Some of the methods like function point metrics[477], number of lines of code, etc. have several subjective assumptions such as quality and project type. If the revenue per employee is measured, then productivity depends heavily on the type of projects undertaken and not simply on the employee. Number of lines of code can be an indicator of productivity as that is an output that does not have much relation to other factors. However this is problematic as there is a quality dimension where the same functionality can be coded in few or many lines based on the skill levels. In software development, there are many different inputs and outputs. The importance of the different parameters also vary with the level of the worker. A previous study has attempted to estimate these factors[478]. Many of the parameters driving the productivity may not be in the hands of the programmer eg. the type of client is a factor (which no programmer determines as they are assigned to projects by the managers), the output factor (varies based on industry company is engaged in), and the demand for the product. So if a company is creating a product that is highly valued the productivity automatically increases by virtue of high output value but attributing this to programmer level is complicated as they have no influence in determining the product or its features. Clarity on what is actually being used will help in driving the expected behaviour amongst the employees. A clear idea of how productivity is measured will provide an idea of the direction automation will take.

- Contractualisation: Contractualisation of blue-collar work in the IT sector is anecdotally supported and came through in our interviews with trade unions and entry-level engineers engaged in the sector. Contractualisation took myriad shapes such as the recruiting of personnel only for specific projects and body shopping—or ‘staff augmentation’. Further, the emergence of the gig economy is seeing IT tasks being outsourced to freelance workers operating on gig platforms. However, empirical data explaining the dynamics of these work arrangements was a data gap we observed, though a cursory analysis from the limited data available is presented below.

In the Indian IT/BPO sector one of the indicators is the quarterly report on employment. The 7th round was the latest one that has been released[479]. In the IT/BPO sector there has been an increase in the usage of Contract and Casual labor. But this represents only the freelancers hired by the organisation and not all freelancers in India. Estimates by the Oxford Internet Institute show that India has the largest number of freelancers on the online platforms (25%). Half of this workforce is doing work on software development projects.[480] Thus, 12% of the global freelance workforce on online platforms are software developers from India. With 75% of the global freelance work getting sourced from US, it will not show up in any survey of indian industries. According to this study, the number of freelancers working in the IT sector are about fifty thousand only. This is a negligible amount compared to the overall workforce engaged in this industry. However, as indicated earlier, an industry survey will not be the appropriate source of data.

- Quality of Skilling Programmes: In our research, most firms in the IT sector had developed skill development and training mechanisms for their employees with industry reports estimating close to 2% of the industry revenue being expended on employee training,[481] with a growing focus towards training in digital technologies[482]. Additionally, a diversity of approaches was evidenced.[483] However, what was not clear was the quality of these programs and the metrics utilised for their assessment, if any. For instance, in our interview with an entry-level engineer, it was pointed out the programs instituted at their workplace was sufficient only as broad primers on various domains and was not sufficient to develop industry-readiness. Moreover, it was unclear what the frequency of these programs were. Frequency being key to monitoring their efficacy in keeping up with constantly evolving domains that technologies under the Industry 4.0 conception fall under.

- Measuring short term and long term rates of technology diffusion and adoption: The rate of technological diffusion within a company will differ from unit to unit. This makes it difficult to qualify comprehensively the extent of adoption of a technology in a company and its subsequent impact. It is also not clear what the best way to measure the rate of diffusion and adoption is. For example, though it is possible to count the number of machines or software used in a company, associate cost to adoption, or call out competition and legitimation as forces driving adoption—these methods do not capture how intensely a technology is used within a company.[484] Measuring diffusion and adoption becomes even more complicated when a set of technologies are looked at together as opposed to focusing on one single technology, in part because the means of measuring adoption and use will vary (ie Cloud vs. Robot) . Without clarity on the adoption and intensity of use of a technology, it is difficult to accurately quantify the actual impact that a specific technology is having on productivity. Other aspects such as capacity and skills to use the technology, culture, and policies impact adoption of technology but are difficult to statistically link back to diffusion and adoption rates.

- Occupational Standards: There have been several issues with the functioning of the IT/IT-eS Sector Skill Council (SSC) which has led to its limited efficacy in providing for the skills required in the labourforce. Despite being one of the first SSCs to be established, it still does not have courses in the level 1 to level 3 category of the National Skills Qualification Framework (NSQF).[485] Broadly speaking, the various levels can be understood as increasing in cognitive skill intensity as the levels increase.[486] Further, the occupational standards defined by the IT/IT-eS Sector Skill Council are too narrow, with an average of just 393 hours of training being provided across the courses. While this is higher than the overall average of SSCs, it still represents a meagre time outlay for making prospective entrants into the labour market industry-ready, given the relatively low pre-existing educational-levels of those that the SSC targets. This has resulted in a meagre placement rate of 12.5%[487] from the IT/IT-eS SSC, despite industry consultations in setting up the occupational standards.

- Measuring quantitative impact of technology on work: It is difficult to measure the impact that technology has on work. Determining causality as opposed to correlation is a challenge as is accounting for direct and indirect changes. Impact itself is difficult to qualify and can mean intensity, directness, scope, stage, time frame, and characterization.[488]

Learnings and Conclusions

- Though there are trade unions in the IT sector, they are not directly taking up issues linked to automation. This could result in the entrenchment of new and existing inequalities as India shifts to a knowledge based economy, a shift that is driven predominantly within and by the IT sector.
- In India, legal categorisation of IT workers is ambiguous with few safety nets. In view of this, there is the possibility of severe socio-economic distress for IT workers if there is a contraction in the employment marketplace.
- Potential for extemporary policies that can affect work and employment are seen. A formal policy of timed incorporation of technological innovation in the sector is not currently in place.
- There is a disconnect between individual perception and literature regarding gender ratios and parity with companies in the IT sector—specifically in STEM jobs.
- There is a disconnect between the skills identified in the 2013 Occupational Standards for the sector and skills identified by NASSCOM as key in their FutureSkills Platform. This highlights the need for Occupational Standards to be brought up to date and for further coordination across all relevant aspects of skilling efforts.
- It is unclear how government level, industry level, and company level skilling efforts interact with each other or if they are standardised.
- Of all four sub-sectors in the IT Industry in India, the BPM sector has seen the greatest amount of impact. New business models and shifts in an attempt to address this are already being seen.
- Many news reports document the stress experienced by IT workers about the threat of losing their job and the reality of having lost their job . This points to the need for a greater emphasis placed on transitioning workers from one job to another by companies, sectoral skill councils, and governments.
- Organisational restructuring occurring as a result of shifting to the 'digital' (incorporating industry 4.0 technologies) spans across almost all aspects of an organisation.
- Adoption of industry 4.0 into the HR process was seen across almost all 16 companies. Many of these include 'learning platforms", internal social networking platforms, and career path platforms—potentially indicating a higher technological ingress into areas involving workers, such as HR.

- Unionisation in IT is rising. Unionisation could potentially give workers bargaining power but could have consequences for the competitiveness of indian companies in the global market.
- A consolidated labour law that bridges issues underlying calls for unionisation with that of market needs, could have a significant bearing on the productivity and competitiveness of indian companies.
- Instead of minimum wage, a need for sector specific unemployment benefits or insurance scheme (like the ESI act) is observed.
- Industry 4.0 is changing the way in which workers communicate, are motivated, and engaged at work. This shift is being pushed by both the need to enable changes, such as remote work and skill adaptation, and is being pushed by preferences of workers who are more accustomed and engaged through platforms and experiences facilitated by industry 4.0 technologies.
- 'Trust' in technologies associated with industry 4.0 is generally not associated with adoption, though with some technologies like AI - trust is closely associated with adoption.
- The IT sector in India needs to and is changing its business model to adapt to the changes brought about by industry 4.0. Such shifts should incorporate ways to enable new jobs, skilling, or transitioning for workers. Though companies are undertaking skilling programs, there needs to be a way to link the effectiveness of the skilling program to the retention of jobs.
- The impact of technology on work is complicated. It can impact structures such as supply chains or tasks, and is also shaping workplace structures, communication etc. The changes are driven by multiple factors associated with technology from opportunity cost to efficiency, consumer preferences, and worker preferences.
- There is a need to develop metrics around the success and effectiveness of skilling programmes. Beyond an individual is being hired to fulfill a position—how long are they in that position for, salary changes etc?
- The impacts of technology on work can be direct and indirect. One country's policy response to technology and its impact on work can have an impact on work in another country. This would be an indirect impact of technology. Transitions of countries to knowledge based economies is driving the age of conceptual workers that are focused on creation, invention, innovation and increased entrepreneurship.
- Studies have looked at 'industry 4.0', 'automation', and 'digital' separately, yet at the same time these terms are often conflated. In researching the impact of technology on work and the future of work—it is important to take a broad approach to the conceptualization and framework of emerging technologies.

- Cost of adopting technology vs. human labour is unclear. Towards understanding this relationship—job and employment data with granularity of task function should be generated.
- Standardisation of terms should be taken up by industry bodies with respect to framing the sector, work, and technology. This will go a long way in facilitating sectoral, national, and regional research.
- Productivity and efficiency metrics are not easily accessible. If productivity and efficiency metrics were made available by companies, this data can also be made available for research.
- Contract workers and freelancers labour markets and skills and hiring information need to be tracked to further understand the impact on the IT sector at a national and regional level.
- Qualitative information about skilling—areas, topics, depth and the demographic, needs to be collected to make informed decisions about the shape, scope, and direction of skilling programmes.
- Adoption and diffusion rates of technology related to tasks would allow for a more quantitative measurement of the changing nature of work.

Annexure 1

1. **Tata Consultancy Services:** TCS is India's first publicly listed IT company to reach the $100 billion market capitalisation mark.[489] TCS provides IT services, consulting and business solutions organisation with, through consulting, BPO, infrastructure, engineering and assurance services. TCS operates in 45 countries and has more than 208 offices around the world, which employs over 4,00,875 people worldwide.[490]

2. **Infosys:** Infosys is a leader of digital services and consulting, with clients in over 45 countries.[491] Infosys aims to leverage AI to provide services to their clients. Their recent undertaking, "Infosys Nia" is an intelligent automation platform.[492] They also believe in preparing and reskilling their employees to be able to work with new technologies. With a total number of employees being more than 2,00,000 worldwide.[493]

3. **Wipro:** Wipro limited is a global IT, consulting and business process services company, leveraging technologies such as cognitive computing, hyper-automation, robotics, cloud, analytics and other emerging technologies to help their clients. They have offices in six continents and employ over 1,60,000 employees globally.[494]

4. **Capgemini:** Capgemini is also a global technological and consulting company that uses technology to provide digital services, business services, and cyber security risk detection and mitigation. It has offices in 40 countries and employs close to 2,00,000 employees globally.[495]

5. **IBM:** International Business Machines Corporation (IBM) is a technology company that provides technology services, business services, software, Systems Hardware and Global Financing. IBM's software segment includes WebSphere, Information Management, Tivoli, Workforce Solutions, Rational, Watson, Watson Health and Watson Internet of Things (IoT). IBM has over 1,30,000 employees in India.[496]

6. **Cognizant:** Cognizant is a leading provider of information technology, consulting and business process outsourcing services. Cognizant's current employee strength in India is around 1,80,000.[497]

7. **Mphasis:** Mphasis is an Indian IT services company which provides infrastructure technology and applications outsourcing services, and architecture guidance, application development and integration, along with application management services. Mphasis' clients are mostly financial services, telecom entities, logistics service providers, and technology companies. Mphasis has a strength of 22,239 employees globally as of March 2018.[498]

8. **Genpact:** Genpact is a global professional services firm that provides digital-led innovation and digitally-enabled intelligent operations. Genpact has an employee strength of 77,000.[499]

9. **Intelenet Global Service:** Intelenet Global Service is a global business process solutions company. The services provided are customer management services, providing industry specific solutions, knowledge services and shared services set-up for various companies across sectors such as banking & financial services, travel & hospitality, logistics, healthcare, retail & e-commerce to name a few. The company has over 55,000 employees distributed over 40 Global Delivery Centers in 8 locations across the Americas, UK, Europe, Middle East, India and the Philippines.[500]

10. **Hinduja Global Solutions:** Hinduja Global Solutions is a business and service provider based in India, with offices in 12 countries and employs 45,900 people globally.[501]

11. **Consultants to Government and Industries:** CGI is a global information technology (IT) consulting, systems integration, outsourcing, and solutions company. The services it provides includes application, business consulting, infrastructure, IT and outsourcing and system integration. While it is headquartered in Canada, it has over 13,500 professionals working out of eight offices in major Indian cities.[502]

12. **WNS (Holdings) Limited:** WNS is a global business process management company providing services and solutions in sectors such as travel, insurance, banking and financial services, manufacturing, retail and consumer packaged goods, shipping and logistics, healthcare and utilities. WNS has over 34,789 employees in India and 24,484 globally. [503]

13. **Mindtree:** Mindtree is a global technology consulting and services company, helping corporations achieve competitive advantage. Mindtree has offices in 17 countries and employs 17,723 people globally[504]

14. **HCL:** HCL Technologies is a global technology company that helps enterprises by providing technology products and services. HCL offers a large portfolio of products, solutions, services, and IP some of which are digital, IoT, cloud, automation, cybersecurity, analytics, infrastructure management and engineering services. HCL employs 1,24,121 in over 41 countries[505]

15. **Tech Mahindra:** Tech Mahindra Limited provides services in the field of consulting and business solutions. Tech Mahindra is a part of the USD 21 billion Mahindra Group that employs more than 2,00,000 people in over 100 countries.[506]

16. **CSC:** CSC Is an American multinational corporation that provided information technology (IT) services and professional services. CSC employs about 23,000 people in India.[507]

Annexure 2

QUESTIONNAIRE FOR SURVEY OF INDUSTRY 4.0 IN THE IT/IT-es SECTOR

This is the questionnaire for entry-level respondents

SECTION 1: FIRM AND RESPONDENT PROFILE

1. Please indicate

    1. Name of the firm:

    2. Physical address of workplace:

    3. Name of the respondent:

    4. Designation of the respondent:

    5. Duration of contract of the respondent:

    6. Educational qualification(s) of the respondent:

2. What are the main tasks you perform in your job?

SECTION 2: ADOPTION OF INDUSTRY 4.0 TECHNOLOGIES

1. Please indicate the level of information and readiness you possess to implement these Industry 4.0 technologies (0 – No information/implementation, 4 – Full information/implementation)

S. No.	Technology	Information						Readiness to Implement					
I.	Big Data and Analytics	0	1	2	3	4	N/A	0	1	2	3	4	N/A
II.	Autonomous Robots	0	1	2	3	4	N/A	0	1	2	3	4	N/A
III.	Simulation (allows operators to test and optimize the machine settings for the next product in line in the virtual world before the physical changeover)	0	1	2	3	4	N/A	0	1	2	3	4	N/A
IV.	Horizontal and vertical system integration (cross-firm, universal data-integration networks)	0	1	2	3	4	N/A	0	1	2	3	4	N/A
V.	Internet of Things	0	1	2	3	4	N/A	0	1	2	3	4	N/A
VI.	Cybersecurity	0	1	2	3	4	N/A	0	1	2	3	4	N/A
VII.	Cloud	0	1	2	3	4	N/A	0	1	2	3	4	N/A
VIII.	Cyber-physical systems (Augmented reality, wearables)	0	1	2	3	4	N/A	0	1	2	3	4	N/A

IX.	Artificial intelligence and autonomous systems (Machine learning, semantics technology)	0	1	2	3	4	N/A	0	1	2	3	4	N/A
X.	Digital to physical transfer (3D printing)	0	1	2	3	4	N/A	0	1	2	3	4	N/A

2. Please indicate where the Industry 4.0 technologies mentioned above in Q.1 are being or have been introduced in the below activities, if at all (0-No impact; 4 – Most impact; For the Technology column use the serial numbers from Q1 above):

S. No.	**Activity**	**Implementation Extent**						**Technology (ies)**
I.	Systems Integration	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
II.	Custom Application Development (CAD)	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
III.	Software Deployment and Support	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.

		0	1	2	3	4	N/A	3.
IV.	Infrastructure Management, Consulting and Integration	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
V.	Infrastructure Management Operations	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
VI.	Software Testing	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
VII.	Services Oriented Architecture (SOA)	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
VIII.	Application Management	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.

		0	1	2	3	4	N/A	3.
IX.	Information System Outsourcing	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
X.	Hardware deployment and support	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
XI.	Web Services	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.

For BPO sector:

S. No.	**Activity**	**Implementation Extent**						**Technology(ies)**
I.	Customer Interaction and Support	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.

		0	1	2	3	4	N/A	3.
II.	Finance and Accounting	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
III.	Research and Analytics	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
IV.	Human Resource Management	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
V.	Supply Chain Management	0	1	2	3	4	N/A	1.

		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
VI.	Knowledge Process Outsourcing	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
VII.	Legal Process Outsourcing	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.

3. What is the degree of implementation, if at all, of Industry 4.0 technologies at the various levels within your team or your firm within the following activities (0-No implementation; 4-Fully implemented; NA - Not important for implementation):

S. No.	**Activity**	**Entry level**	**Mid level** **(0/1/2/3/4/NA)**	**Higher level** **(0/1/2/3/4/NA)**

		(0/1/2/3/4/NA)		
I.	Systems Integration			
II.	Custom Application Development			
III.	Software Deployment and Support			
IV.	Infrastructure Management, Consulting and Integration			
V.	Infrastructure Management Operations			
VI.	Software Testing			
VII.	Services Oriented Architecture (SOA)			
VIII.	Application Management			
IX.	Information System Outsourcing			

X.	Hardware Deployment and Support			
XI.	Web Services			

For BPO sector:

S. No.	**Activity**	**Entry level (0/1/2/3/4/NA)**	**Mid level (0/1/2/3/4/NA)**	**Higher level (0/1/2/3/4/NA)**
I.	Customer Interaction and Support			
II.	Finance and Accounting			
III.	Research and Analytics			
IV.	Human Resource Management			
V.	Supply Chain Management			
VI..	Knowledge Process Outsourcing			

VII.	Legal Process Outsourcing			

4. What are the impediments you anticipate for the uptake of the Industry 4.0 technologies mentioned in Q.1 above?

S. No.	**Impediment**	**Yes/No**
I.	Lack of benefits or Rate of return on the implementation of technology	
II.	Regulatory concerns	
III.	Clear use-case for new technology	
IV.	Lack of skills in the workforce	
V.	Lack of underlying infrastructure for implementation	
V.	Others (please specify)	

SECTION 3: CHANGING NATURE OF WORK

1. According to you what, if any, are newer job roles your team is looking for?

S. No.	**Job Profile**	**Yes/No**

I.	Data scientist	
II.	Cybersecurity architect	
III.	User experience designer	
IV.	Robotics engineer	
V.	Artificial Intelligence/ Machine Learning Engineer	
VI.	Platform engineer	
VII.	Others (please specify)	

2. Please indicate which of the following trends in the changes, if any, in the nature of work are being observed in your team:

S. No.	**Trend**	**Yes/No**
I.	Increased contractualisation of labour (people hired for short durations)	
II.	Miniaturisation of tasks and platformisation of these tasks	
III.	Changing tasks within existing job functions (designations have remained the same but the actions performed within the designation has changed)	

IV.	Intensification of work (more activities are expected to be completed in a shorter time frame)	
V.	Change in lifetime and size of projects	
VI.	Others (please specify)	

3. If option III in Q.2 is marked as Yes: Are new skills being required to perform the same job? If yes, what are these new skills?
4. What are the main reasons for attrition, if at all, within your team?

S. No.	**Reason**	**Yes/No**
I.	Wage and salary conditions	
II.	Work environment (workload, cleanliness, noise, etc.)	
III.	Lack of inclination towards traditional long-term employment	
IV.	Commute time between home and work	
V.	Relationships at work, communication	
VI.	Extensive overtime work	
VII.	Emerging technologies making skills obsolete	

VIII.	Others (please specify)	

5. What are the any key technological trends and projections in the below processes within the sector? Where possible, please mention any relevant tools underlying the trend/projection as well:

For IT sector:

S. No.	**Process**	**Technological Trend(s)**	**Tools(s)**
I.	Human Resources		
II.	Technology support to customer		
III.	Software Testing		
IV.	Project management		
V.	Training and Skilling		
VI.	Employee performance monitoring		

For BPO sector:

S. No.	**Process**	**Technological Trend(s)**	**Tool(s)**

I.	Customer Interaction and Support		
II.	Human Resources		
III.	Skilling and Training		
IV.	Employee performance monitoring		

6. Which of these scenarios is the most likely in the next 2-5 years within the industry?

S. No.	**Scenario**	**Likeliest**
I.	New technologies will result in large job losses, and few of those will be replaced by new ones	
II.	New technologies will result in large job losses, and most of those will be replaced by new ones	
III.	New technologies will not result in large job losses, and instead most jobs will gradually evolve over time	
IV.	New technologies will not result in large job losses, but most jobs will be significantly transformed	
V.	Job losses will happen but for reasons other than introduction of new technologies	

VI.	New technologies will result in job creation	
VII.	Don't know	
VIII.	Other (please specify)	

SECTION 4: SKILLS AND EDUCATION

1. What skills do you consider necessary for the successful use of technology in the following activities:

S. No.	**Activity**	**Skills**
I.	Systems Integration	
II.	Custom Application Development	
III.	Software Deployment and Support	
IV.	Infrastructure Management, Consulting and Integration	
V.	Infrastructure Management Operations	

VI.	Software Testing	
VII.	Services Oriented Architecture (SOA)	
VIII.	Application Management	
IX.	Information System Outsourcing	
X.	Hardware Deployment and Support	
XI.	Web Services	

For BPO sector:

S. No.	**Activity**	**Skills**
I.	Customer Interaction and Support	
II.	Finance and Accounting	
III.	Research and Analytics	

IV.	Human Resource Management	
V.	Supply Chain Management	
VI..	Knowledge Process Outsourcing	
VII.	Legal Process Outsourcing	

2. Do you consider the availability and quality of a skilled talent pool to be an issue in your team?

3. How long did it take you to achieve the desired technical/professional performance or skill set for your current job role?

4. Do you have any internal skill development programmes running at your firm?
    1. If yes, how large (in terms of employee coverage) is the programme?
    2. Is it targeted at new recruits or existing employees or both?
    3. How is the program financed?
    4. How long does it take to re-skill and/or upskill using these programs?
    5. Is the program conducted and administered in-house?
    6. When did you undertake the program? (Upon joining/regularly after joining/some other point after joining)

5. Have you utilised any external skill development platforms? If yes, please indicate.

S. No.	Organizations	Yes/No (Tick wherever applicable)	Organisation Name(s)
1.	Govt. Bodies		
2.	Corporate Run Training Institutes		
3.	Pvt. Education Institutes		
4.	Govt. Education Institutes		
5.	Industry Bodies		
6.	NGOs		
7.	Sector Skill Council		
8.	Others (Specify)		

6. What is the degree of importance assigned to the following skills and competencies in your team? (0 – Not important, 4 – Most important)

S. No.	Skill	Entry-level (0/1/2/3/4/NA)	Mid-level (0/1/2/3/4/NA)	Higher-level (0/1/2/3/4/NA)
1.	Analysing data/information			

2.	Thinking creatively			
3.	Interpreting information for others			
4.	Establishing and maintaining relations			
5.	Guiding, directing & motivating subordinates			
6.	Repeating the same task without error			
7.	Ability to work remotely			
8.	Doing structured rather than unstructured work			
9.	Controlling machine and processes			
10.	Familiarity with emerging technologies			

11.	Ability to adapt to changes in technology			
12.	Others (please specify)			

SECTION 5: INDUSTRY IMPACT PERCEPTION

1. To which extent do you think your firm's existing IT infrastructure is appropriate for the switch to Industry 4.0?
2. What jobs/tasks, if any, are seeing lower human involvement owing to increased involvement of automation technologies?
3. Were you industry-ready right after graduation? If not, what changes would you recommend in the education framework to allow graduates to be better prepared for their roles?
4. Are you engaged with, or have you previously engaged with, an employee organisation such as a trade union? If yes, please provide information about the reasons behind such interaction and how your experience of it was.

QUESTIONNAIRE FOR SURVEY OF INDUSTRY 4.0 IN THE IT/IT-es SECTOR

This is the questionnaire for higher-level/managerial respondents

SECTION 1: FIRM AND RESPONDENT PROFILE

1. Please indicate

    1. Name of the firm:

    2. Physical address:

3. Name of the respondent:

4. Designation of the respondent:

2. What are the firm's main activities?

1. Please indicate the sub-sector that best describes the main industrial/business activity of the firm:

SECTION 2: EMPLOYEE CONFIGURATION

1. Please furnish the age-wise distribution of employees for FY 2017-18 :

Age (years)	**Male**	**Female**	**Total**
18-30			
31-55			
56 and older			

2. Please indicate the hierarchical distribution of employees (in percentage) vis-a-vis their age for FY 2017-18:

	Male (%)	**Female (%)**	**Total**
Entry-level	18-30 years: 31-55 years: 56 years and older:	18-30 years: 31-55 years: 56 years and older:	
Mid-level	18-30 years: 31-55 years: 56 years and older:	18-30 years: 31-55 years: 56 years and older:	
Higher-level	18-30 years: 31-55 years: 56 years and older:	18-30 years: 31-55 years: 56 years and older:	

3. Please indicate the position-wise educational qualification of your employees (in percentages) for FY 2017-18:

Educational qualification	**Entry-level**	**Mid-level**	**Higher-level**	**18-30 years**	**31-55 years**	**56 years and older**
Secondary	Male:	Male:	Male:	Male:	Male:	Male:

	Female:	Female:	Female:	Female:	Female:	Female:
Higher Secondary	Male: Female:	Male: Female:	Male: Female:	Male: Female:	Male: Female:	Male: Female:
Diploma	Male: Female:	Male: Female:	Male: Female:	Male: Female:	Male: Female:	Male: Female:
Graduate	Male: Female:	Male: Female:	Male: Female:	Male: Female:	Male: Female:	Male: Female:
Post Graduate	Male: Female:	Male: Female:	Male: Female:	Male: Female:	Male: Female:	Male: Female:
Others (please specify)	Male: Female:	Male: Female:	Male: Female:	Male: Female:	Male: Female:	Male: Female:

SECTION 3: ADOPTION OF INDUSTRY 4.0 TECHNOLOGIES

1. Please indicate the level of information and readiness of your firm to implement these Industry 4.0 technologies (0 – No information/implementation, 4 – Full information/implementation)

S. No.	Technology	Information						Readiness to Implement					
I.	Big Data and Analytics	0	1	2	3	4	N/A	0	1	2	3	4	N/A
II.	Autonomous Robots	0	1	2	3	4	N/A	0	1	2	3	4	N/A
III.	Simulation (allows operators to test and optimize the machine settings for the next product in line in the virtual world before the physical changeover)	0	1	2	3	4	N/A	0	1	2	3	4	N/A
IV.	Horizontal and vertical system integration (cross-firm, universal data-integration networks)	0	1	2	3	4	N/A	0	1	2	3	4	N/A
V.	Internet of Things	0	1	2	3	4	N/A	0	1	2	3	4	N/A
VI.	Cybersecurity	0	1	2	3	4	N/A	0	1	2	3	4	N/A
VII.	Cloud	0	1	2	3	4	N/A	0	1	2	3	4	N/A
VIII.	Cyber-physical systems (Augmented reality, wearables)	0	1	2	3	4	N/A	0	1	2	3	4	N/A
IX.	Artificial intelligence and autonomous systems (Machine learning, semantics technology)	0	1	2	3	4	N/A	0	1	2	3	4	N/A

X.	Digital to physical transfer (3D printing)	0	1	2	3	4	N/A	0	1	2	3	4	N/A

2. Please indicate the investment, if any, being made by your firm in the last 2 years in the Industry 4.0 technologies mentioned in Q.1 above:

3. Please indicate where the Industry 4.0 technologies mentioned above in Q.1 are being or have been introduced in the below activities, if at all (0-No impact; 4 – Most impact; For the Technology column use the serial numbers from Q1 above):[508]

S. No.	**Activity**	**Implementation Extent**						**Technology (ies)**
I.	Systems Integration	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
II.	Custom Application Development (CAD)	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
III.	Software Deployment and Support	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.

		0	1	2	3	4	N/A	3.
IV.	Infrastructure Management, Consulting and Integration	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
V.	Infrastructure Management Operations	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
VI.	Software Testing	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
VII.	Services Oriented Architecture (SOA)	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
VIII.	Application Management	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.

IX.	Information System Outsourcing	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
X.	Hardware deployment and support	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
XI.	Web Services	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.

For BPO sector:

S. No.	**Activity**	**Implementation Extent**						**Technology (ies)**
I.	Customer Interaction and Support	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
II.	Finance and Accounting	0	1	2	3	4	N/A	1.

		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
III.	Research and Analytics	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
IV.	Human Resource Management	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
V.	Supply Chain Management	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
VI.	Knowledge Process Outsourcing	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.
		0	1	2	3	4	N/A	3.
VII.	Legal Process Outsourcing	0	1	2	3	4	N/A	1.
		0	1	2	3	4	N/A	2.

		0	1	2	3	4	N/A	3.

-

4. What is the degree of implementation, if at all, of Industry 4.0 technologies at the various levels within your firm within the following activities (0-No implementation; 4-Fully implemented; NA - Not important for implementation):

S. No.	**Activity**	**Entry level (0/1/2/3/4/NA)**	**Mid level (0/1/2/3/4/NA)**	**Higher level (0/1/2/3/4/NA)**
I.	Systems Integration			
II.	Custom Application Development			
III.	Software Deployment and Support			
IV.	Infrastructure Management, Consulting and Integration			
V.	Infrastructure Management Operations			
VI.	Software Testing			
VII.	Services Oriented Architecture (SOA)			
VIII.	Application Management			

IX.	Information System Outsourcing			
X.	Hardware Deployment and Support			
XI.	Web Services			

For BPO sector:

S. No.	**Activity**	**Entry level (0/1/2/3/4/NA)**	**Mid level (0/1/2/3/4/NA)**	**Higher level (0/1/2/3/4/NA)**
I.	Customer Interaction and Support			
II.	Finance and Accounting			
III.	Research and Analytics			
IV.	Human Resource Management			
V.	Supply Chain Management			
VI..	Knowledge Process Outsourcing			
VII.	Legal Process Outsourcing			

5. What are the impediments felt by your firm to the uptake of the Industry 4.0 technologies mentioned in Q.1 above?

S. No.	Impediment	Yes/No
I.	Lack of benefits or Rate of return on the implementation of technology	
II.	Regulatory concerns	
III.	Clear use-case for new technology	
IV.	Lack of skills in the workforce	
V.	Lack of underlying infrastructure for implementation	
V.	Others (please specify)	

SECTION 4: CHANGING NATURE OF WORK

1. According to you what, if any, are newer job roles your firm is looking for?

S. No.	Job Profile	Yes/No
I.	Data scientist	
II.	Cybersecurity architect	
III.	User experience designer	
IV.	Robotics engineer	
V.	Artificial Intelligence/ Machine Learning Engineer	
VI.	Platform engineer	
VII.	Others (please specify)	

2. Please indicate which of the following trends in the changes, if any, in the nature of work are being observed in your firm:

S. No.	Trend	Yes/No
I.	Increased contractualisation of labour (people hired for short durations)	
II.	Miniaturisation of tasks and platformisation of these tasks	
III.	Changing tasks within existing job functions (designations have remained the same but the actions performed within the designation has changed)	
IV.	Intensification of work (more activities are expected to be completed in a shorter time frame)	
V.	Change in lifetime and size of projects	
VI.	Others (please specify)	

3. If option III in Q.2 is marked as Yes: Are new skills being required to perform the same job? If yes, what are these new skills?

4. What are the main reasons for attrition within your firm?

S. No.	Reason	Yes/No
I.	Wage and salary conditions	
II.	Work environment (workload, cleanliness, noise, etc.)	
III.	Lack of inclination towards traditional long-term employment	
IV.	Commute time between home and work	
V.	Relationships at work, communication	
VI.	Extensive overtime work	
VII.	Emerging technologies making skills obsolete	

VIII.	Others (please specify)	

5. What are the any key technological trends and projections in the below processes within the sector. Where possible, please mention any relevant tools underlying the trend/projection as well:

For IT sector:

S. No.	**Process**	**Technological Trend(s)**	**Tools(s)**
I.	Human Resources		
II.	Technology support to customer		
III.	Software Testing		
IV.	Project management		
V.	Training and Skilling		
VI.	Employee performance monitoring		

For BPO sector:

S. No.	**Process**	**Technological Trend(s)**	**Tool(s)**
I.	Customer Interaction and Support		
II.	Human Resources		

III.	Skilling and Training		
IV.	Employee performance monitoring		

6. Which of these scenarios is the most likely in the next 2-5 years within the industry?

S. No.	**Scenario**	**Likeliest**
I.	New technologies will result in large job losses, and few of those will be replaced by new ones	
II.	New technologies will result in large job losses, and most of those will be replaced by new ones	
III.	New technologies will not result in large job losses, and instead most jobs will gradually evolve over time	
IV.	New technologies will not result in large job losses, but most jobs will be significantly transformed	
V.	Job losses will happen but for reasons other than introduction of new technologies	
VI.	New technologies will result in job creation	
VII.	Don't know	
VIII.	Other (please specify)	

SECTION 5: SKILLS AND EDUCATION

1. What skills do you consider necessary for the successful use of technology in the following activities:

S. No.	Activity	At entry level	At mid level	At higher level
I.	Systems Integration			
II.	Custom Application Development			
III.	Software Deployment and Support			
IV.	Infrastructure Management, Consulting and Integration			
V.	Infrastructure Management Operations			
VI.	Software Testing			
VII.	Services Oriented Architecture (SOA)			
VIII.	Application Management			
IX.	Information System Outsourcing			
X.	Hardware Deployment and Support			
XI.	Web Services			

For BPO sector:

S. No.	Activity	At entry level	At mid level	At higher level
I.	Customer Interaction and Support			
II.	Finance and Accounting			
III.	Research and Analytics			
IV.	Human Resource Management			
V.	Supply Chain Management			
VI..	Knowledge Process Outsourcing			
VII.	Legal Process Outsourcing			

2. Do you consider the availability and quality of a skilled talent pool for hiring to be an issue at your firm?

3. How long does it take your new employees to achieve the required technical/professional performance or skill set?

4. Please indicate the skilling challenges faced by your firm (Not challenging – 0; Most challenging - 4):

S. No.	Challenge	Difficulty
I.	Continuous demand for skilled workforce	

II.	Inability to innovate in skill development	
III.	Increased share of other business verticals	
IV.	Evolution of newer pricing models	
V.	Evolution of emerging technologies	
VI.	Others (Please specify)	

5. Do you have any internal skill development programmes running at the firm?
    1. If yes, how large (in terms of employee coverage) is the programme?
    2. Is it targeted at new recruits or existing employees or both?
    3. How is the program financed?
    4. How long does it take to re-skill and/or upskill existing employees?
    5. Is the program conducted and administered in-house?
6. Does your firm have any skill development partners? If yes, please indicate.

S. No.	**Organizations**	**Yes/No (Tick wherever applicable)**	**Organisation Name(s)**
1.	Govt. Bodies		
2.	Corporate Run Training Institutes		
3.	Pvt. Education Institutes		
4.	Govt. Education Institutes		
5.	Industry Bodies		

6.	NGOs		
7.	Sector Skill Council		
8.	Others (Specify)		

7. What is (and will be) the degree of importance assigned to the following skills and competencies in your firm? (0 – Not important, 4 – Most important)

S. No.	**Skill**	**Entry-level (0/1/2/3/4/NA)**	**Mid-level (0/1/2/3/4/NA)**	**Higher-level (0/1/2/3/4/NA)**
1.	Analysing data/information			
2.	Thinking creatively			
3.	Interpreting information for others			
4.	Establishing and maintaining relations			
5.	Guiding, directing & motivating subordinates			
6.	Repeating the same task without error			

7.	Ability to work remotely			
8.	Doing structured rather than unstructured work			
9.	Controlling machine and processes			
10.	Familiarity with emerging technologies			
11.	Ability to adapt to changes in technology			
12.	Others (please specify)			

SECTION 6: INDUSTRY IMPACT PERCEPTION

1. To which extent do you think your firm's actual IT infrastructure is appropriate for the switch to Industry 4.0?
2. What jobs/tasks, if any, are seeing lower human involvement owing to increased involvement of automation technologies?
3. How does your company plan to assess the digital fitness of the workforce to identify the strengths and gaps?
4. Is it anticipated that the uptake of these technologies will impact the gender diversity of your employees? Are you taking any measures to make your firm more gender diverse over the next 5 years?
5. Have organizational HR policies/practices changed as a result of the adoption of automation technologies? Or do you anticipate that a change will be required once your firm adopts Industry 4.0 technologies?

Endnotes

1. Carl Benedikt Frey and Michael A. Osborne, 2013. The future of employment: How susceptible are jobs to computerisation?, Oxford Martin School, September.
2. *See* David H. Autor & Michael J. Handel, 2013. "Putting Tasks to the Test: Human Capital, Job Tasks, and Wages," Journal of Labor Economics, University of Chicago Press, Vol. 31(S1), pages S59 - S96. *See also* Future of Work and Skills, The Organisation for Economic Co-operation and Development, February 2017.
3. Business Today, AI, automation will cost 7 lakh IT jobs by 2022, says report. (November 7, 2017) Retrieved https://www.businesstoday.in/sectors/it/ai-and-automation-to-cost-7-lakh-it-jobs-by-2022-says-report/story/259880.html
4. Advantage India, India Brand Equity Foundation. Retrieved https://www.ibef.org/download/IT-ITeS-Report-Apr-2018.pdf
5. Embracing Industry 4.0 - and Rediscovering Growth, Boston Consulting Group. Retrieved https://www.bcg.com/capabilities/operations/embracing-industry-4.0-rediscovering-growth.aspx
6. India's Readiness for Industry 4.0 - A Focus on Automotive Sector, Grant Thorton and Confederation of Indian Industry. Retrieved http://www.nasscom.in/sites/default/files/NASSCOM_Annual_Guidance_Final_22062017.pdf
7. G20 Insights, Bridging the digital divide: Skills for the new age., Retrieved http://www.g20-insights.org/policy_briefs/bridging-digital-divide-skills-new-age/
8. World Economic Forum, The Future of Jobs - Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution, (January 2016).
9. Centre for Internet and Society, Future of Work : Report of the 'Workshop: IT/IT-es Sector and the Future of Work in India' (16 August 2018). Retrieved https://cis-india.org/internet-governance/blog/future-of-work-report-of-the-workshop-on-the-it-it-es-sector-and-the-future-of-work-in-india
10. *Future of Jobs in India- A 2022 Perspective.* Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
11. *Employment Prospects in India's IT Sector: Robust Outlook* (2017, May 23), PIB Government of India. Retrieved http://pib.nic.in/newsite/PrintRelease.aspx?relid=162046
12. Population Pyramids of the World from 1950 to 2100. Retrieved https://www.populationpyramid.net/india/2025/
13. Mari Bhat, P.N, Demographic Scenario. Retrieved http://www.planningcommission.nic.in/reports/sereport/ser/vision2025/demogra.pdf
14. *Jobs and Skills: The Imperative to Reinvent and Disrupt* (2017), NASSCOM, Retrieved https://www.nasscom.in/sites/default/files/Jobs_and_Skills.pdf
15. *IT and BPM*, Make in India. Retrieved http://www.makeinindia.com/sector/it-and-bpm
16. *IT-BPM Industry in India: Sustaining Growth and Investing for the Future*, NASSCOM. Retrieved http://www.nasscom.in/sites/default/files/NASSCOM_Annual_Guidance_Final_22062017.pdf
17. Pramanik, A (2018, February 20) *The Economic Times*. Retrieved https://economictimes.indiatimes.com/tech/ites/indian-software-services-sector-to-grow-7-9-in-fy19-nasscom/articleshow/62995685.cms
18. *Research and Development in India* (2017, August). India Brand Equity Foundation. Retrieved https://www.ibef.org/industry/research-development-india.aspx

19. Bhan, S, (2018, June 27). Indian software industry poised for tremendous growth, says Nasscom head. *CNBC TV18*. Retrieved https://www.cnbctv18.com/information-technology/indian-software-industry-poised-for-tremendous-growth-says-nasscom-head-207691.htm
20. *IT and ITeS Industry in India* (2019, October). India Brand Equity Foundation. Retrieved https://www.ibef.org/industry/information-technology-india.aspx
21. Export Destinations. Retrieved http://meity.gov.in/content/export-destinations
22. *IT & ITeS* (2017, January). India Brand Equity Foundation: IT & ITeS. Retrieved March 23, 2018, from https://www.ibef.org/download/IT-and-ITeS-January-2017.pdf
23. *IT-BPM Industry in India: Sustaining Growth and Investing for the Future* (2017, June 22). NASSCOM. Retrieved http://www.nasscom.in/sites/default/files/NASSCOM_Annual_Guidance_Final_22062017.pdf
24. *Ibid.*
25. *Ibid.*
26. *Ibid.*
27. Dubey R., (June 7, 2017). IT sector job cuts: Are Infosys, Wipro, TCS really cutting jobs, or is it just fear-mongering? *Business Today*. Retrieved https://www.businesstoday.in/opinion/business-wise/the-great-jobs-fear-mongering-are-job-cuts-really-happening/story/253668.html
28. *IT & ITeS* (2017, January). India Brand Equity Foundation: IT & ITeS. Retrieved https://www.ibef.org/download/IT-and-ITeS-January-2017.pdf
29. Ganesh, V (2019, March 13). Another round of job loss looms for mid-level IT employees. The Hindu BusinessLine, Info-tech. Retrieved https://www.thehindubusinessline.com/info-tech/another-round-of-job-loss-looms-for-mid-level-it-employees/article26514653.ece
30. *See* Government Of India Ministry Of Labour And Employment Lok Sabha Unstarred Question No. 3805 To Be Answered On 19th March, 2018; Government Of India Ministry Of Labour And Employment Lok Sabha Unstarred Question No. 5561 To Be Answered On 02nd April, 2018; Government Of India Ministry Of Electronics & Information Technology Lok Sabha Unstarred Question No. 2734 To Be Answered On: 03.01.2018.
31. *IT-BPM Industry in India: Sustaining Growth and Investing for the Future*, NASSCOM, 10. Retrieved http://www.nasscom.in/sites/default/files/NASSCOM_Annual_Guidance_Final_22062017.pdf
32. *Future of Jobs in India-A 2022 Perspective*. Retrieved Future of Jobs in India- A 2022 Perspective. Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
33. Rao, R (2017, July 14). The cloud impact on outsourcing to India. *ZD Net*. Retrieved https://www.zdnet.com/article/the-cloud-impact-on-outsourcing-to-india/
34. *Ibid.*
35. *Ibid.*
36. TCS, Infosys Betting Big on Cloud Computing (2010, January 28). *The Economic Times*. Retrieved https://economictimes.indiatimes.com/tech/ites/tcs-infosys-betting-big-on-cloud-computing/articleshow/5506654.cms
37. *Ibid.*
38. *Ibid.*
39. Challenges and opportunities abound for Indian IT services industry at Nasscom 25 - Part 2. Retreived from https://community.nasscom.in/api/core/v3/contents/13187/data?v=5
40. Rao, R, (2017, July 14). The cloud impact on outsourcing to India. *ZD Net*. Retrieved https://www.zdnet.com/article/the-cloud-impact-on-outsourcing-to-india/
41. Fersht, P, Snowden, J and Reuner T (2016, July 4). Automation Will Trim 1.4 million Global Services Jobs by 2021. *HFS Research*. Retrieved https://www.hfsresearch.com/pointsofview/automation-will-trim-14-million-global-services-jobs-2021
42. D'Monte, L, (2014, February 13). SMAC is the New Flavour of IT Services Company. *Livemint*. Retrieved https://www.livemint.com/Industry/FXPE2yjjVrknGT3uJr33HP/SMAC-is-the-new-flavour-of-IT-services-companies.html

43. Big data analytics: How Decision Moments is leading the charge (2017, June 28). *Zinnov*. Retrieved https://zinnov.com/big-data-analytics-how-decision-moments-is-leading-the-charge/
44. Ahmed, M, (2015, August 22). Trends in India- Interview with Leading Data Scientist Navin Manaswi. *Big Data Made Simple*. Retrieved http://bigdata-madesimple.com/top-big-data-trends-in-india-interview-with-a-data-scientist/
45. *NASSCOM Hosts 6th Edition of Big Data and Analytics Summit*. Retrieved https://www.nasscom.in/sites/default/files/media_pdf/Big-Data-and-Analytics-Summit-2018-FINAL.pdf
46. *AI and Big Data Analytics are Changing the Jobs Ecosystem Across the Spectrum; Nasscom Showcases the Roadmap for Futureskills Initiative*. Retrieved https://www.nasscom.in/sites/default/files/media_pdf/NASSCOM-press-release-HR-Summit-2018.pdf
47. Raja Simhan, TE (2018, January 9). Big data, machine learning, AI to shape job market in 2018. *The Hindu BusinessLine*. Retrieved https://www.thehindubusinessline.com/info-tech/big-data-machine-learning-ai-to-shape-job-market-in-2018/article10006991.ece
48. *Industrial IoT to Surpass Consumer Space in India by 2020: Report* (2018, July 25). The Economic Times, telecom. Retrieved https://telecom.economictimes.indiatimes.com/news/industrial-iot-to-surpass-consumer-space-in-india-by-2020-report/65135150
49. *The Internet of Things: Revolution in the making* (2017, November). Retrieved https://www.nasscom.in/natc2017/images/white-papers/internet-of-things.pdf
50. Future of Jobs in India: A 2022 Perspective. Retrieved https://www.ey.com/Publication/vwLUAssets/ey-future-of-jobs-in-india/$FILE/ey-future-of-jobs-in-india.pdf
51. *Ibid.*
52. Internet of Things, Cloud Tech to Bring Next Phase of Growth for BPO sector: WNS (2015, May 10). The Economic Times. Retrieved https://economictimes.indiatimes.com/tech/ites/internet-of-things-cloud-tech-to-bring-next-phase-of-growth-for-bpo-sector-wns/articleshow/47221875.cms
53. Pearson, S. *The Role of Business Process Management (BPM) within the Internet of Things (IoT).* Retrieved https://tallyfy.com/bpm-internet-of-things-iot/
54. Vaid, K. (2017, August 21). IoT as a Service – A Game Changer? Retrieved https://zinnov.com/iot-as-a-service-a-game-changer/
55. *Zinnov Zones 2017 for IoT Technology* Services (2017, August 3). Retrieved https://zinnov.com/zinnov-zones-2017-for-iot-technology-services/
56. *Spotlight on the Internet of Things* (2016). Retrieved https://www.bdo.com/insights/industries/tech-life-sciences/technology-life-sciences-alert-june-2016
57. Azure IoT Central. Retrieved https://azure.microsoft.com/en-in/services/iot-central/
58. Vaid, K. (2017, August 21). IoT as a Service – A Game Changer? Retrieved/zinnov.com/iot-as-a-service-a-game-changer/
59. Mendonca J. (2016, August 19). IoT will impact 120,000 jobs in India by 2021: Report. *The Economic Times*. Retrieved https://tech.economictimes.indiatimes.com/news/internet/iot-will-impact-120000-jobs-in-india-by-2021-report/53764996
60. Christopher N. (2017, September 15). IoT alone will create 15 million jobs: Aruna Sundararajan. *The Economic Times*. Retrieved https://economictimes.indiatimes.com/small-biz/policy-trends/iot-alone-will-create-15-million-jobs-aruna-sundararajan/articleshow/60522804.cms
61. *Digitising Industry (Industry 4.0) and Cybersecurity.* Retrieved http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/607361/IPOL_BRI(2017)607361_EN.pdf
62. Waslo, R et al. (2017). *Industry 4.0 and Cybersecurity Managing Risk in an Age of Connected Production*. Retrieved https://www2.deloitte.com/content/dam/insights/us/articles/3749_Industry4-0_cybersecurity/DUP_Industry4-0_cybersecurity.pdf

63. *Ibid.*
64. *Growing Cyber Security Industry, Roadmap for India*. DSCI and NASSCOM. Retrieved https://www.dsci.in/sites/default/files/DSCI-Growing-Cyber-Security-Industry-Roadmap-for-India-Exec-Summary.pdf
65. *Ibid.*
66. *India's Readiness for Industry 4.0- A Focus on Automotive Sector*. Retrieved https://www.gita.org.in/Attachments/Reports/India%E2%80%99s%20Readiness%20for%20Industry%204.0.pdf
67. *IT & ITeS* (2018, April). India Brand Equity Foundation: IT & ITeS. Retrieved https://www.ibef.org/download/IT-_ITeS-Report-Apr-20181.pdf
68. *Systems Integration Contracts Dominate IT Services Deals in India, says GlobalData* (2018, February 20). Retrieved https://www.globaldata.com/systems-integration-contracts-dominate-services-deals-india-says-globaldata/
69. Kulkarni, V. (2007, December, 12). Wipro Moves Focus to System Integration Biz. *Livemint.* Retrieved https://www.livemint.com/Companies/m2VHYXjdaXYvaLVOUnu60I/Wipro-moves-focus-to-system-integration-biz.html
70. Vaccaro, M. (2018, April 23). *The System Integrator's Role in Industry 4.0.* Retrieved https://www.automationworld.com/system-integrators-role-industry-40; Brown, A. (2015, February 6). *What is the impact of Industry 4.0 for system integration engineers?* Retrieved https://blog.schneider-electric.com/machine-and-process-management/2015/02/06/impact-industry-4-0-system-integration-engineers/; Gurney, M. (2016, June 9). *System integration enables Industrial Internet of Things, Industrie 4.0 platforms*. Retrieved https://www.controleng.com/single-article/system-integration-enables-industrial-internet-of-things-industrie-40-platforms/873915e8b62ceb3f060cefde62ef71d0.html
71. *Future of Jobs in India- A 2022 Perspective. Retrieved* http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
72. AI to generate $100-120 billion for IT-BPM service providers: Report (2017, March 15). *The Economic Times*. Retrieved https://tech.economictimes.indiatimes.com/news/technology/ai-to-generate-100-120-billion-for-it-bpm-service-providers-report/57642998
73. Infosys. (2018). Leadership in the Age of AI - Adapting, Investing and Reskilling to Work Alongside AI. Retrieved https://www.infosys.com/age-of-ai/Documents/age-of-ai-infosys-research-report.pdf
74. FICCI, NASSCOM and EY. Future of Jobs in India- A 2022 Perspective. Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
75. *National Strategy for Artificial Intelligence* (2018, July). Retrieved http://www.niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-AI-Discussion-Paper.pdf; *NITI Aayog, Intel and TIFR collaborate to set up a Model International Center for Transformative AI (ICTAI)* (2018, September, 2011). Retrieved http://pib.nic.in/newsite/PrintRelease.aspx?relid=183377
76. *Leadership in the Age of AI - Adapting, Investing and Reskilling to Work Alongside AI* (2018). Retrieved https://www.infosys.com/age-of-ai/Documents/age-of-ai-infosys-research-report.pdf
77. *Ibid.*
78. *Key Elements of NASSCOM's Predictions till 2020* (2017, January). Retrieved https://www.avendus.com/crypted_pdf_path/img_5b0bfe7d610063.65835597_key_elements_of_nasscoms_predictions_till_2020.pdf
79. *Roy, M.* (2019, November). *The Future of BPS-Moving from BPO to BPS to BPaa.* Retrieved https://www.wipro.com/cloud/the-future-of-bps---moving-from-bpo-to-bps-to-bpaas/
80. FICCI, NASSCOM and EY. Future of Jobs in India- A 2022 Perspective. Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
81. Alawadhi, N. (2018, June 20). *Automation has growing-yet-specific role in IT-BPM business: WNS Global Services CEO*. Retrieved https://www.moneycontrol.com/news/business/automation-has-growing-yet-specific-role-in-it-bpm-business-wns-global-services-ceo-2611231.html

82. Lo Giudice, D. (2016, October 13). *How AI will Change Software Development and Applications.* Retrieved https://www.nhaustralia.com.au/documents/AI_report.pdf
83. Srivatsa, S.S. (2019, June 1). IT sector gets five more years of exemption from Standing Orders. *The Hindu.* Retrieved https://www.thehindu.com/news/national/karnataka/it-sector-gets-five-more-years-of-exemption-from-standing-orders/article27402107.ece
84. Nandkumar, I & Prasad, A. (2012, July 23). Archaic Labour Law returns to haunt IT Sector. *The Economic Times*. Retrieved https://economictimes.indiatimes.com/tech/ites/archaic-labour-law-returns-to-haunt-indian-it-sector/articleshow/15097849.cms
85. *T.P. Srivastava v. National Tobacco Co. of India Ltd.* [1991 AIR 2294].
86. *Information Technology Sector in Karnataka exempted from Standing Orders Act*. Retrieved https://www.nasscom.in/sites/default/files/policy_update/IT%20Sector%20in%20Karnataka%20exempted%20from%20Standing%20Orders%20Act.pdf
87. Cognizant layoff plea closed in favour of sacked staff: Govt (2017, May 28), *The Hindu BusinessLine*, Info-tech. Retrieved https://www.thehindubusinessline.com/info-tech/cognizant-layoff-plea-closed-in-favour-of-sacked-staff-govt/article9714320.ece
88. See “Sectoral Labour Market Institutions” for a detailed discussion.
89. Srivastava, M. (2018, March 26). Are trade unions gaining a foothold in the IT sector? *Livemint.* Retrieved https://www.livemint.com/Industry/niEiLE4J9rb53vz3FVAQFP/Are-trade-unions-gaining-a-foothold-in-IT-sector.html
90. Christopher, N. (2018, March 26), IT employees get nod to set up trade union in Karnataka. *Economic Times*. Retrieved https://economictimes.indiatimes.com/tech/ites/it-employees-get-nod-to-set-up-trade-union-in-karnataka/articleshow/61568071.cms
91. Biswas, P. (2018, January 14). India’s First IT Trade Union Registered in Pune, Aims to Fight ‘Illegal Layoffs. *The Indian Express*. Retrieved https://indianexpress.com/article/cities/pune/indias-first-it-trade-union-registered-in-pune-aims-to-fight-illegal-layoffs-5023587/
92. Patil, K. (2017, September 14). India's Technology Workers Look to Unions to Stem Job Losses. *Nikkei Asian Review, Economy*. Retrieved https://asia.nikkei.com/Economy/India-s-technology-workers-look-to-unions-to-stem-job-losses2
93. Christopher, N. (2018, March 26), IT employees get nod to set up trade union in Karnataka. *Economic Times*. Retrieved https://economictimes.indiatimes.com/tech/ites/it-employees-get-nod-to-set-up-trade-union-in-karnataka/articleshow/61568071.cms
94. IT Staff Union Set Up in Bengal (2011, August 23). *The Hindu BusinessLine*, Info-tech. Retrieved https://www.thehindubusinessline.com/todays-paper/tp-info-tech/IT-staff-union-set-up-in-Bengal/article20227510.ece
95. Abidi, A. (2016, July 17). IT Industry Unionisation: Don't Panic – Unions Don't Mean Strikes, They Offer a Collective Voice. *Scroll.in*, Workers’ Rights. Retrieved https://scroll.in/article/811635/it-industry-unionisation-dont-panic-unions-dont-mean-strikes-they-offer-a-collective-voice
96. Bisht, Nidhi S. (2010). “Trade Unions in Indian IT Industry? An Employees' Perspective.” Indian Journal of Industrial Relations, 46 (2), 220–228.
97. Kurmanath, KV. (2017, December 29). As layoff threat hits them, lateral IT staff begin to upgrade skills. *The Hindu BusinessLine*, Info-tech. Retrieved https://www.thehindubusinessline.com/info-tech/as-layoff-threat-hits-them-lateral-it-staff-begin-to-upgrade-skills/article10004996.ece
98. Shyam Sunder, K.R & Sapkal R.S. (2017, September 23). *Are They Legitimate? Labour Law, Governance Reforms, and Protests*. Retrieved https://www.epw.in/journal/2017/38/special-articles/labour-law-governance-reforms-and-protests.html
99. Besley, T & Burgess, R. *Can Labor Regulation Hinder Economic Performance? Evidence from India*. Retrieved http://econ.lse.ac.uk/staff/rburgess/wp/indreg.pdf

100. Deakin, S., & Sarkar, P. (2011). Indian labour law and its impact on unemployment, 1970-2006: a leximetric study. Cambridge: Centre for Business Research, University of Cambridge. Retrieved https://mpra.ub.uni-muenchen.de/35553/; *See also* Papola, T. S. (2013). Role of labour regulation and reforms in India. ILO Employment Working Paper, 147. Retrieved www.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_232497.pdf
101. Mamkoottam, K. (2017). Changing Labour Market and Industrial Relations, Changing Times: Make in India and Ensuing Labour Reforms. *Management and Labour Studies*, *42*(1), 59-67.
102. *Ibid*.
103. Papola, T.S & Kannan, K.P. (2017, October). *Towards an India Wage Report.* Retrieved https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---sro-new_delhi/documents/publication/wcms_597270.pdf
104. Labour Bureau. FAQs. Government of India. Retrieved http://labourbureau.nic.in/FAQ_Wages_Section_New.pdf <accessed on July 26th, 2018>
105. *Employment in Electronics Industries, Notification No. KAE 13 LMW 2015* (2010, September 16). Retrieved http://labour.kar.nic.in/labour/29.%20%20Employment%20in%20Electronics%20Industries.pdf
106. *Average Software Engineer Salary in India*. Retrieved https://www.payscale.com/research/IN/Job=Software_Engineer/Salary
107. Irrational, populist minimum wage hikes are hurting the BPO industry and will lead to job losses (2018, May 14), *The Economic Times*. Retrieved https://economictimes.indiatimes.com/tech/ites/irrational-populist-minimum-wage-hikes-are-hurting-the-bpo-industry-and-will-lead-to-job-losses/articleshow/64150748.cms
108. *The Automation Advantage*. Retrieved http://www.alphabeta.com/wp-content/uploads/2017/08/The-Automation-Advantage.pdf
109. Mckinsey, (2017, June). *India's Labour Markets: A new emphasis on gainful employment*. Retrieved https://www.mckinsey.com/global-themes/employment-and-growth/a-new-emphasis-on-gainful- employment-in-india
110. *Impact of technology on labour market outcomes* (2017). Retrieved https://www.wto.org/english/res_e/booksp_e/wtr17-3_e.pdf
111. Millington, A. K. (2017). How changes in technology and automation will affect the labour market in Africa.
112. Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation?. *Technological forecasting and social change*, *114*, 254-280.
113. Wallace-Stephens, F. (2017, August 2). *How Many Jobs Will Robots Replace? And Why Does Everyone Disagree?* Retrieved https://www.thersa.org/discover/publications-and-articles/rsa-blogs/2017/08/how-many-jobs-will-robots-replace-and-why-does-everyone-disagree
114. Chui, M., Manyika, J., & Miremadi, M. (2016). Where machines could replace humans—and where they can't (yet). *McKinsey Quarterly*, *30*(2), 1-9.
115. Foster, A. D., & Rosenzweig, M. R. (2010). Microeconomics of technology adoption. Annu. Rev. Econ., 2(1), 395-424.
116. Wallace-Stephens, F. (2017, August 2). *How Many Jobs Will Robots Replace? And Why Does Everyone Disagree?* Retrieved https://www.thersa.org/discover/publications-and-articles/rsa-blogs/2017/08/how-many-jobs-will-robots-replace-and-why-does-everyone-disagree
117. India says no to driverless cars to protect jobs (2017, July 25 July). *BBC*, Technology. Retrieved https://www.bbc.com/news/technology-40716296
118. Ghoshal, A. (2018, January 10 January) India's Uber rival Ola is reportedly working on assisted driving tech for its cabs. *The Next Web*. Retrieved https://thenextweb.com/cars/2018/01/10/indias-uber-rival-ola-is-reportedly-working-on-assisted-driving-tech-for-its-cabs/; Microsoft Is Helping This Uber-Rival With Self-Driving Car (2017, November 7). *Fortune,* Tech. Retrieved https://fortune.com/2017/11/07/microsoft-is-helping-this-uber-rival-with-self-driving-car-tech/

119. Nübler, I (2016, November). *New technologies: A jobless future or a golden age of job creation?* Retrieved https://www.ilo.org/wcmsp5/groups/public/---dgreports/---inst/documents/publication/wcms_544189.pdf
120. FICCI, NASSCOM and EY. *Future of Jobs in India- A 2022 Perspective.* Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
121. *Future of Work and Skills* (2017, February). Retrieved https://www.oecd.org/els/emp/wcms_556984.pdf
122. *Ibid.*
123. *Ibid.*
124. *Globalisation, Jobs and Wages* (2007, June). Retrieved https://www.oecd.org/els/emp/Globalisation-Jobs-and-Wages-2007.pdf
125. Saxer, M. (2017, February 1). *The Future of Work in India*. Retrieved https://medium.com/@marc_saxer/the-future-of-work-in-india-7a5717ed78e0
126. Grundke, R., et al. (2017), "Skills and global value chains: A characterisation", *OECD Science, Technology and Industry Working Papers*, No. 2017/05, OECD Publishing, Paris, https://doi.org/10.1787/cdb5de9b-en.
127. *Re-shoring in Europe: Trends and Policy Issues* (2015, September 23). Retrieved https://www.ilo.org/wcmsp5/groups/public/---europe/---ro-geneva/---ilo-brussels/documents/genericdocument/wcms_409031.pdf
128. *Ibid.*
129. Mitra ,S. (2017, May 6). The Death of Indian Outsourcing Is Imminent. *HuffPost.* Retrieved https://www.huffingtonpost.com/entry/the-death-of-indian-outsourcing-is-imminent_us_59357886e4b06c4693fb770a
130. *Re-shoring in Europe: Trends and Policy Issues* (2015, September 23). Retrieved https://www.ilo.org/wcmsp5/groups/public/---europe/---ro-geneva/---ilo-brussels/documents/genericdocument/wcms_409031.pdf
131. Sachitanand, R. (2017, January 15). India's $150 billion outsourcing industry stares at an uncertain future. *The Economic Times.* Retrieved https://economictimes.indiatimes.com/tech/ites/indias-technology-vendors-paddling-shaky-boats/articleshow/56543653.cms
132. Mendonca, J. (2018, February 9). Cognizant earns more per person as IT sector moves to tech-based digital model. *The Economic Times.* Retrieved https://economictimes.indiatimes.com/tech/ites/cognizant-earns-more-per-person-as-it-sector-moves-to-tech-based-digital-model/articleshow/62845933.cms
133. *Future of Work and Skills* (2017, February). Retrieved https://www.oecd.org/els/emp/wcms_556984.pdf
134. Kapoor, R. (2016). Technology, jobs and inequality: evidence from India's manufacturing sector.
135. Rodrik, D. (2017). Premature deindustrialisation in the developing world. *Frontiers of Economics in China*, *12*(1), 1-7.
136. Polaski, S. (2015, October 7). *The current reality and future of work, in India and beyond*. Retrieved https://www.ilo.org/newdelhi/info/public/sp/WCMS_412430/lang--en/index.htm
137. FICCI, NASSCOM and EY. *Future of Jobs in India- A 2022 Perspective.* Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
138. Mehdi, A & Chaudhry, D. (2015, September). *Human capital potential of India's future workforce*. Retrieved http://icrier.org/pdf/Working_Paper_308.pdf
139. Bloom, D.E, Cannind, D & Fiink, G. (2008, April), *Population Aging and Economic Growth*. Retrieved https://cdn1.sph.harvard.edu/wp-content/uploads/sites/1288/2013/10/PGDA_WP_31.pdf
140. Ronald Lee and Andrew Mason, "Fertility, Human Capital, and Economic Growth over the Demographic Transition," European Journal of Population 26, no. 2 (2010): 159–182, DOI 10.1007/s10680-009-9186-x.
141. Mody, M. A., & Aiyar, M. S. (2011). *The demographic dividend: Evidence from the Indian states* (No. 11-38). International Monetary Fund.
142. *Ibid.*

143. Sector Chapter on Skill Development, 12th Five Year Plan. Retrieved http://planningcommission.nic.in/hackathon/Skill%20Development.pdf
144. FM: Role of IT Sector is Crucial in Order to Promote E-Governance for Empowering Citizens; to Promote the Inclusive and Sustainable Growth of the Electronics, IT and ITeS Industries and Enhancing India's Role in Internet Governance, Press Information Bureau, Ministry of Finance, Government of India. (14 Jan 2015) Retrieved http://pib.nic.in/newsite/PrintRelease.aspx?relid=114638
145. (2017, February 17). *Paper presented at the 2nd Meeting of the G20 Employment Working Group*. Retrieved https://www.oecd.org/els/emp/wcms_556984.pdf
146. Chang, J. H., Rynhart, G., & Phu, H. (2016). ASEAN in transformation: How technology is changing jobs and enterprises.
147. Krishnan, S., & Hatekar, N. (2017). Rise of the new middle class in India and its changing structure. *Economic and Political Weekly*, *52*(22), 40-48.
148. Kant, A., and ors., Livemint (23 Jan 2018). India's burgeoning middle class. Retrieved https://www.livemint.com/Opinion/TvcFydQcN6KEFkvdW7BprM/Indias-burgeoning-middle-class.html
149. Court, D., & Narasimhan, L. (2010). Capturing the world's emerging middle class. *McKinsey Quarterly*, *3*, 12-17.
150. Bain and Company Press Release, (26 Jan 2018). China pushes towards a consumption-driven growth model as the country renews its commitment to quality of growth and technology. Retrieved https://www.bain.com/about/media-center/press-releases/2018/china-pushes-towards-a-consumption-driven-growth-model/
151. Lucas Chancel & Thomas Piketty, (2017). Indian income inequality, 1922-2014: From British Raj to Billionaire Raj? Retrieved http://wid.world/wp-content/uploads/2017/12/ChancelPiketty2017WIDworld.pdf
152. United Nations (2019). World Urbanization Prospects 2018: Highlights (ST/ESA/SER.A/421) Retrieved https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf
153. Amitabh Kundu, Infrastructure Financing and Emerging Pattern of Urbanisation: A Perspective,. Retrieved http://planningcommission.gov.in/reports/genrep/bkpap2020/9_bg2020.pdf
154. Lalit Batra, (April 2009). A Review of Urbanisation and Urban Policy in Post-Independent India. Retrieved https://www.jnu.ac.in/sites/default/files/u63/12-A%20Review%20of%20Urban%20%28Lalit%20Batra%29.pdf
155. Habitat, U. N. (2016). Urbanization and development: emerging futures. *World cities report*, *3*(4), 4-51.
156. Times News Network, (May 31 2014). Bangalore is second in land price appreciation. Retrieved https://timesofindia.indiatimes.com/business/india-business/Bangalore-is-second-in-land-price-appreciation/articleshow/35811716.cms
157. Livemint, (17 Sept 2007). ITES counters ₹ appreciation by moving to Tier II/III cities. Retrieved https://www.livemint.com/Industry/qmoNyECHCekPePm2DNhggM/ITES-counters-Rs-appreciation-by-moving-to-Tier-IIIII-citie.html
158. Rao, P. M., & Balasubrahmanya, M. H. (2017). The rise of IT services clusters in India: A case of growth by replication. *Telecommunications policy*, *41*(2), 90-105.
159. Kasriel S., (18 Jan 2018). Cities Are Killing The Future Of Work (And The American Dream). Retrieved https://www.fastcompany.com/40517126/cities-are-killing-the-future-of-work-and-the-american-dream
160. Infosys poster. Retrieved https://www.infosys.com/infrastructure-services/features-opinions/Documents/five-trends.pdf
161. Concept Note: Occupational Standards (OS) (2012). Retrieved https://www.nasscom.in/sites/default/files/uploads/Initiatives/Education/Docs/Occupational_Standards_Concept_Note_08June2012.pdf
162. NSDC. Occupational Analysis: IT Services. Retrieved https://s3-ap-southeast-1.amazonaws.com/pursuite-production/media/OA_Reports/ITS+OA+Report.pdf
163. *Ibid.*

164. NASSCOM. Business Process Management. Retrieved https://pursuite-production.s3.amazonaws.com/media/cms_page_media/155/BPM%20OA%20Report.pdf
165. Gratton, L. (2011). The end of the middle manager. Harvard Business Review. Retrieved https://hbr.org/2011/01/column-the-end-of-the-middle-manager
166. Alawadhi N., and Mendonca J., (07 Mar 2017). Mid-level IT employees face an uncertain future as IT sector modernizes. Retrieved https://tech.economictimes.indiatimes.com/news/corporate/mid-level-it-employees-face-an-uncertain-future-as-it-sector-modernizes/57506478
167. TCS Launches ignio™ Cheetah to Accelerate Transformation of Enterprise IT Operations. Retrieved https://www.tcs.com/tcs-launches-ignio-cheetah-accelerate-transformation-of-enterprise-it-operations
168. Infosys Launches Mana™ – a Knowledge-based Artificial Intelligence Platform. Retrieved https://www.infosys.com/newsroom/press-releases/2016/launch-mana-artificial-intelligence-platform.html, Infosys Announces Aikido - Next-Generation Services in Design Thinking, Platforms and Knowledge-Based IT. Retrieved https://www.infosys.com/newsroom/press-releases/2015/aikido-next-generation-design-thinking.html
169. Baruah A., (5 Apr 2019). Artificial Intelligence Initiatives at India's Top IT Services Firms. Retrieved https://emerj.com/ai-sector-overviews/artificial-intelligence-initiatives-indias-top-services-firms/
170. Wipro. (n.d.) Holmes for Business. Retrieved https://www.wipro.com/en-IN/holmes/
171. IBM. (n.d.). IBM Cloud-India. Retrieved https://www.ibm.com/in-en/cloud
172. Cognizant. (n.d.). Cognizant Automation Center. Retrieved https://www.cognizant.com/automation-center
173. Capgemini. (n.d.). Perform AI. Retrieved https://www.capgemini.com/service/perform-ai/, Capgemini. (n.d.). Unlock Value Through INtelligent Automation. Retrieved https://www.capgemini.com/in-en/service/business-services/unlock-value-through-intelligent-automation/unlock-value-through-intelligent-automation/
174. Mindtree. (2018). Mindtree Uses Artificial Intelligence and Machine Learning to Help Banks Across the Globe Reduce Risk and Improve Compliance. Retrieved https://www.mindtree.com/news/mindtree-uses-artificial-intelligence-and-machine-learning-help-banks-across-globe-reduce-risk
175. Krishnan V. (2017). The Rise of Augmented Intelligence: How Human Cognition is Joining Hands with AI for a Profound Impact. HCL Blogs. Retrieved https://www.hcltech.com/blogs/rise-augmented-intelligence-how-human-cognition-joining-hands-ai-profound-impact
176. *Ibid*
177. Tech Mahindra. (n.d.). AI for Quality Engineering. Retrieved https://www.techmahindra.com/en-in/testing-services/ai-for-quality-engineering/
178. Genpact. (n.d.). Genpact Cora. Retrieved https://www.genpact.com/cora
179. Rishi, S. (2017). Intelenet Global Services 'taps' into AI. CIO&Leader. Retrieved https://www.cioandleader.com/article/2017/07/20/intelenet-global-services-%E2%80%98taps%E2%80%99-ai
180. Hinduja Global Solutions. (2018). HGS Partners with Inbenta to Enhance Customer Experience Solutions with AI Enablement of Bots & Brains™. Retrieved https://www.teamhgs.com/news-resources/news/hgs-partners-inbenta-enhance-customer-experience-solutions-ai-enablement-bots
181. Ahaskar, A. (2019). CSC to use AI, data analytics to improve services in rural areas. Livemint. Retrieved https://www.livemint.com/news/india/csc-to-use-ai-data-analytics-to-improve-services-in-rural-areas-1557908039064.html
182. CGI. (n.d.). Intelligent Automation. Retrieved https://www.cgi.com/en/intelligent-automation
183. Business Wire India., (23 June 2017). WNS Launches Enhanced Version of SocioSEER™. Retrieved https://www.businesswireindia.com/wns-launches-enhanced-version-socioseer-53915.html

184. WNS. (n.d). Socio Seer - A Unique Social Media Analytics Platform to Decode Social Conversations into Powerful Business Insights. Retrieved https://www.wns.com/solutions/functional-solutions/analytics/socioseer
185. Sood V., (29 Apr 2016). TCS, Infosys, Wipro see decline in revenue per employee in FY16. Retrieved https://www.livemint.com/Industry/dU17UMnunpXFcKyaOlKBVP/TCS-Infosys-Wipro-see-decline-in-revenue-per-employee-in-F.html
186. Centre for Internet and Society, Future of Work : Report of the 'Workshop: IT/IT-es Sector and the Future of Work in India' (16 August 2018). Retrieved https://cis-india.org/internet-governance/blog/future-of-work-report-of-the-workshop-on-the-it-it-es-sector-and-the-future-of-work-in-india
187. *Ibid.*
188. Agara Labs. Retrieved https://factordaily.com/agara-labs/
189. *Ibid.*
190. Sen S., (12 Mar 2018). The machines check in at Indian BPO companies. Retrieved https://factordaily.com/automation-rpa-in-indian-bpo/
191. Future of Jobs in India: A 2022 Perspective. Retrieved https://www.ey.com/Publication/vwLUAssets/ey-future-of-jobs-in-india/$FILE/ey-future-of-jobs-in-india.pdf
192. See discussion under Changing Revenue Models
193. Sen S., (12 Mar 2018). The machines check in at Indian BPO companies. Retrieved https://factordaily.com/automation-rpa-in-indian-bpo/
194. *Ibid.*
195. NASSCOM. Quarterly Industry Review-June 2018. Retrieved https://www.nasscom.in/knowledge-center/publications/quarterly-industry-review-june-2018
196. Fersht, P, Snowden, J and Reuner T (2016, July 4). Automation Will Trim 1.4 million Global Services Jobs by 2021. *HFS Research*. Retrieved https://www.hfsresearch.com/pointsofview/automation-will-trim-14-million-global-services-jobs-2021
197. *Ibid.*
198. Report on the APO Symposium on Productivity Measurement in the Service Sector- Kuala Lumpur, Malaysia, 1-4 August 2000 Retrieved https://www.apo-tokyo.org/publications/wp-content/uploads/sites/5/ind-12-pm.pdf
199. *Ibid.*
200. Bosworth Barry, and Annemie Maertens (2010),"Economic Growth and Employment Generation: The Role of the Service Sector", in Ejaz Ghani (ed), The Service Revolution in South Asia, New Delhi: Oxford University Press.
201. Wachter, Till Von (2001),"Employment and Productivity Growth in Services and Manufacturing Sectors in France, Germany and the US", Working Paper No. 50,European Central Bank, March, 2001 http://www.ecb.int/pub/pdf/scpwps/ecbwp050.pdf
202. Eichengreen, Barry and Poonam Gupta (2010), "The Service Sector as India's Road to Economic Growth?"ICRIER Working Paper No. 249, April 2010.
203. *Ibid.*
204. Howindialives.com. (4 May 2015). Why Indian tech CEOs are worried about productivity. Livemint Retrieved https://www.livemint.com/Companies/lt8n75ddvj2SZm6UTAI13I/Why-Indian-tech-CEOs-are-worried-about-productivity.html
205. *See* discussion under 'Research Challenges'
206. *See* discussion under 'Business and Revenue Models'
207. Mendonca J., (9 Feb 2018). Cognizant earns more per person as IT sector moves to tech-based digital model. Retrieved https://economictimes.indiatimes.com/tech/ites/cognizant-earns-more-per-person-as-it-sector-moves-to-tech-based-digital-model/articleshow/62845933.cms
208. Sood V.,(22 May 2017). Indian IT firms struggle to generate revenue from digital businesses. Retrieved https://www.livemint.com/Industry/yDnnA5K5r9AyEcTczhskmJ/Indian-IT-firms-struggle-to-generate-revenue-from-digital-bu.html
209. *Ibid.*

210. Kurian V., (12 Mar 2018). GTech calls for strategy to drive IT benefits to small cities. Retrieved https://www.thehindubusinessline.com/news/gtech-calls-for-strategy-to-drive-it-benefits-to-small-cities/article20792628.ece1
211. Ferenstein G., (27 Aug 2017). New Study Suggests Minimum Wage Leads To Automation Of Low-Skill Workers. Retrieved https://www.forbes.com/sites/gregoryferenstein/2017/08/27/new-study-suggests-minimum-wage-leads-to-automation-of-low-skill-workers/#6f6d89a76ffa ; Ozimek A., (29 June 2018). Not All Automation Is The Same. Retrieved https://www.forbes.com/sites/modeledbehavior/2018/06/29/not-all-labor-saving-is-the-same/#748f55cc6829
212. Rastogi, G and B Pradhan (2011): Offshore: How India Got Back on the Global Business Map, New Delhi: Penguin Books India. p.112
213. Shenoy D., (3 Jan 2015). The Inflexion Point for the IT Service Industry. Retrieved https://www.capitalmind.in/2015/01/the-inflexion-point-for-the-it-service-industry-long/
214. Narayan, D. (2017). Lay-offs in the Software Industry Decoding Disruption. *Economic & Political Weekly*, 52(22).
215. KPMG (2011): "Non-linear Growth Model—Driving Profitability, Bolstering the Indian IT Industry, Retrieved https://www.scribd.com/document/88303313/KPMG-CII-Non-Linear-Models-IT-Driving-the-Next-Phase-of-Growth-for-the-Indian-IT-Industry .
216. NASSCOM. Quarterly Industry Review-June 2018. Retrieved https://www.nasscom.in/knowledge-center/publications/quarterly-industry-review-june-2018
217. KPMG's The Cloud: Changing the Business Ecosystem, 2011.
218. 218. IBEF. Cloud : The Way Forward. Retrieved https://www.ibef.org/download/Cloud_The_way_forward.pdf
219. Narayan, D. (2017). Lay-offs in the Software Industry Decoding Disruption. *Economic & Political Weekly*, 52(22).
220. Shroff, G (2010): Enterprise Cloud Computing: Technology, Architecture, Applications, New Delhi:Cambridge University Press.
221. NASSCOM. Quarterly Industry Review-June 2018. Retrieved https://www.nasscom.in/knowledge-center/publications/quarterly-industry-review-june-2018
222. *National Strategy for Artificial Intelligence* (2018, July). Retrieved http://www.niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-AI-Discussion-Paper.pdf
223. Sachitanand R., (15 Jan 2017). India's $150 billion outsourcing industry stares at an uncertain future. Retrieved https://economictimes.indiatimes.com/articleshow/56543653.cms
224. Infosys. (n.d). #Hackwithinfy. Retrieved https://www.infosys.com/careers/Pages/hackwithinfy.aspx
225. Sood V., (28 Nov 2014). Crowdsourcing: IT companies engage with staff to get innovative ideas, lift morale. Retrieved https://economictimes.indiatimes.com/news/company/corporate-trends/crowdsourcing-it-companies-engage-with-staff-to-get-innovative-ideas-lift-morale/articleshow/45302032.cms
226. Rao R., (14 July 2017). The cloud impact on outsourcing to India. Retrieved https://www.zdnet.com/article/the-cloud-impact-on-outsourcing-to-india/
227. 227. Mendonca J., (7 June 2018). How Indian IT companies are trying to survive as outsourcing business declines. Retrieved https://economictimes.indiatimes.com/tech/ites/how-indian-it-companies-trying-to-survive-as-outsourcing-business-decline/articleshow/64499542.cms
228. Gosselin, P., and Ariana T., (2018). "Cutting 'Old Heads' at IBM." Retrieved https://features.propublica.org/ibm/ibm-age-discrimination-american-workers/
229. Vogeler, E.W., IBM Under Scrutiny for Age Bias in Layoffs. (25 May 2018). Retrieved https://blogs.findlaw.com/in_house/2018/05/ibm-under-scruinty-for-age-bias-in-layoffs.html
230. Utermohlen K., (30 Mar 2018). IBM Layoffs 2018: What We Know About the Job Cuts. Retrieved https://investorplace.com/2018/03/ibm-layoffs/
231. Aggaral V., (15 Jan 2018). TCS begins restructuring to focus on digital technologies. Retrieved https://www.thehindubusinessline.com/info-tech/tcs-begins-restructuring-to-focus-on-digital-technologies/article9650624.ece

232. Firstpost, (11 Dec 2014). Restructuring: TCS may lay off some mid-to-senior level employees. Retrieved https://www.firstpost.com/corporate-business/restructuring-tcs-may-lay-off-some-mid-to-senior-level-employees-1999483.html
233. Capgemini, (2017). Successful restructuring. Retrieved https://www.capgemini.com/wp-content/uploads/2017/07/Successful_Restructuring.pdf
234. Kunert P., (11 Jan 2018). Black & Blue: IBM hires Bain to cut costs, up productivity. Retrieved https://www.theregister.co.uk/2018/01/11/ibm_gts_2018_consult/
235. Miller, R. (2018, January 12). IBM may be prepping for massive changes at Global Technology Services group. Retrieved https://techcrunch.com/2018/01/12/ibm-may-be-prepping-for-massive-changes-at-global-technology-services-group/
236. Cognizant to trim top management to make room for juniors - Latest News: Gadgets Now. (n.d.). Retrieved https://www.gadgetsnow.com/tech-news/cognizant-to-trim-top-management-to-make-room-for-juniors/articleshow/65251999.cms
237. Cognizant close to firing 1,000 senior managers. (n.d.). Retrieved https://yourstory.com/2017/05/cognizant/
238. Focus is to continue building order book, says Mphasis. (n.d.). Retrieved https://www.moneycontrol.com/news/business/earnings/focus-is-to-continue-building-order-book-says-mphasis-2290001.html
239. ET Bureau. (2011, April 2). MindTree to restructure business, target $1 bn topline. Retrieved https://economictimes.indiatimes.com/tech/ites/mindtree-to-restructure-business-target-1-bn-topline/articleshow/7847583.cms
240. *Ibid*
241. Punit, I. S. (2013, December 16). Mindtree says completed 70% of planned restructuring. Retrieved https://www.business-standard.com/article/companies/mindtree-says-completed-70-of-planned-restructuring-113121600440_1.html
242. HCL Infosystems Scheme of Arrangement comes into effect: Three New Subsidiaries become Operational. (2017, March 10). Retrieved https://www.hclinfosystems.in/hcl-infosystems-scheme-arrangement-comes-effect-three-new-subsidiaries-become-operational/
243. ET Bureau. (2017, August 1). We have been able to restructure most of our network business: CP Gurnani, Tech Mahindra Management. Retrieved https://economictimes.indiatimes.com/markets/expert-view/we-have-been-able-to-restructure-most-of-our-network-business-cp-gurnani-tech-mahindra-management/articleshow/59858477.cms
244. Marowits, R. (2007, January 30). CGI seeks to double size after restructuring. Retrieved https://www.thestar.com/business/2007/01/30/cgi_seeks_to_double_size_after_restructuring.html
245. Phadnis, S. (2012, October 6). Logica India sees churn after acquisition by CGI - Times of India. Retrieved https://timesofindia.indiatimes.com/business/india-business/Logica-India-sees-churn-after-acquisition-by-CGI/articleshow/16693659.cms
246. CGI to cut 1,600 jobs, reshaping workforce as web dominates. (2017, August 2). Retrieved https://www.theglobeandmail.com/report-on-business/cgi-to-cut-1600-jobs-reshaping-workforce-as-web-dominates/article35862607/
247. Headspin.io. (n.d.). Introducing the HeadSpin Connected Intelligence Platform™. Retrieved https://www.headspin.io/platform/
248. Infosys Limited. (n.d.). Infosys Organization Change Aligns To Company's Vision Towards Building Tomorrow's Enterprise. Retrieved https://www.infosys.com/newsroom/press-releases/2011/organization-change-vision-bte.html
249. Consultancy.in. (2018, October 19). Infosys to offer double the salary to employees with digital skills. Retrieved https://www.consultancy.in/news/1605/infosys-to-offer-double-the-salary-to-employees-with-digital-skills
250. Sood, V. (2018, July 26). Wipro's turnaround strategy working well, says CEO Abidali Neemuchwala. Retrieved https://www.livemint.com/Companies/kkZuViwWgP5qfpzQyk6g4J/Wipros-turnaround-strategy-working-well-says-CEO-Abidali-N.html

251. Majumdar, R. (2018, July 23). Experts remain skeptical about Wipro's plan to restructure business. Retrieved https://www.business-standard.com/article/companies/experts-remain-skeptical-about-wipro-s-plan-to-restructure-business-118072300021_1.html
252. Pursuit of Digital to Pursuit of Happiness. (n.d.). Retrieved https://www.wipro.com/en-IN/blogs/ashok-tripathy/pursuit-of-digital-to-pursuit-of-happiness/
253. Ghoshal, A. (2018, June 15). Genpact adds new features to modular AI platform Cora. Retrieved https://www.techcircle.in/2018/06/15/genpact-adds-new-features-to-modular-ai-platform-cora
254. TechHerald Bureau. (2019, June 13). Genpact Cora platform gets pretrained AI engines to push AI adoption. Retrieved https://techherald.in/technology/genpact-cora-platform-gets-pretrained-ai-engines-to-push-ai-adoption/
255. Development Programs: Teleperformance. (n.d.). Retrieved https://intelenetglobal.com/en-us/sustainability/development-programs
256. Indiainfoline.com. (n.d.). Hinduja Global Solutions launches HGS Digital. Retrieved https://www.indiainfoline.com/article/news-sector-information-technology/hinduja-global-solutions-launches-hgs-digital-119091600178_1.html
257. Welcome to CSC E-Governance Services India Limited. (n.d.). Retrieved https://csc.gov.in/scheme
258. Acquisitions. (n.d.). Retrieved https://www.crunchbase.com/search/acquisitions
259. Infosys is reaching for the sky with holistic automation strategy. (2017, April 27). Retrieved https://www.horsesforsources.com/blog/tom-reuner/Infosys-reaching-sky-holistic-automation-strategy_042117
260. Infosys Limited. (n.d.). Infosys Completes Acquisition of Brilliant Basics - Digital Innovation and Customer Experience Studio. Retrieved https://www.infosys.com/newsroom/press-releases/Pages/completed-acquisition-brilliant-basics.aspx
261. PTI. (2018, May 30). Infosys completes $75 million acquisition of WongDoody. Retrieved https://www.livemint.com/Companies/apU5xKmecz1kdSaYuLEsgN/Infosys-completes-75-million-acquisition-of-WongDoody.html
262. Team VCC. (2018, March 15). Wipro picks up minority stake in US-based startup Avaamo. Retrieved https://www.vccircle.com/wipro-picks-up-minority-stake-in-us-based-startup-avaamo/
263. Sood, V. (2017, November 2). Wipro Ventures invests in app-testing firm Headspin. Retrieved https://www.livemint.com/Companies/IdUKVz5HyuBulnIOUP41PN/Wipro-Ventures-invests-in-apptesting-firm-Headspin.html
264. Vectra.ai. (2016). Wipro and Vectra Networks Partner to Deliver Automated 'Threat Hunting-as-a-Service'. Retrieved https://www.vectra.ai/news/wipro-and-vectra-networks-partner-to-deliver-automated-threat-hunting-as-a-service
265. Business Standard Reporter. (2016, February 1). Wipro picks stake in Pune startup Altizon Systems. Retrieved https://www.business-standard.com/article/companies/wipro-picks-stake-in-pune-startup-altizon-systems-116020101195_1.html
266. SN, Vikas. (2015, July 23). Wipro backs AI startup Vicarious and big data firm Talena - ETtech. Retrieved https://tech.economictimes.indiatimes.com/news/startups/wipro-ventures-ai-vicarious-talena/48191742
267. SN, Vikas. (2015, July 9). Wipro Digital acquires Denmark-based design firm Designit for around $94.3M - ETtech. Retrieved https://tech.economictimes.indiatimes.com/news/corporate/Wipro-Digital-buys-designit/48004531
268. Appirio. (2018, September 5). Wipro to acquire Appirio, A Global Cloud Services Company. Retrieved https://hub.appirio.com/news/wipro-to-acquire-appirio-a-global-cloud-services-company
269. Mendonca, J. (2017, October 5). Wipro buys US-design consultancy Cooper for $8.5 million. Retrieved https://economictimes.indiatimes.com/tech/ites/wipro-buys-us-design-consultancy-cooper-for-8-5-million/articleshow/60950272.cms

270. Wipro Acquires BPaaS for Healthcare With Healthplan Services. (2016, November 16). Retrieved https://www.hfsresearch.com/pointsofview/wipro-acquires-bpaas-healthcare-healthplan-services
271. Tata Consultancy Services acquires Swedish Indian IT Resources AB - 2005-05-01. (n.d.). Retrieved https://www.crunchbase.com/acquisition/tata-consultancy-services-acquires-swedish-indian-it-resources-ab--bebc 1524#section-overview; *See also* Tata Consultancy Services acquires Citigroup Global Services - 2008-10-08. (n.d.). Retrieved https://www.crunchbase.com/acquisition/tata-consultancy-services-acquires-citigroup-global-services--cb38bccf ; *See also* Tata Consultancy Services acquires Financial Network Services - 2005-10-01. (n.d.). Retrieved https://www.crunchbase.com/acquisition/tata-consultancy-services-acquires-financial-network-services--fad7d174.
272. TCS To Acquire Citigroup Global Services. (n.d.). Retrieved https://www.tcs.com/tcs-to-acquire-citigroup-global-services.
273. Mindtree. (2019, March 5). Mindtree to Acquire Magnet 360, a Salesforce Platinum Consulting Partner. Retrieved https://www.mindtree.com/news/mindtree-acquire-magnet-360-salesforce-platinum-consulting-partner
274. Mendonca, J. (2016, October 3). Cognizant buys Norwegian IT services company Frontica Business Solutions for about $128 million. Retrieved https://economictimes.indiatimes.com/tech/ites/cognizant-buys-norwegian-it-services-company-frontica-business-solutions-for-about-128-million/articleshow/54662526.cms
275. Cognizant Acquires KBACE Technologies to Enable Clients to Accelerate Journey to Cloud and Improve Business Agility - Jan 27, 2016. (n.d.). Retrieved https://news.cognizant.com/2016-01-27-Cognizant-Acquires-KBACE-Technologies-to-Enable-Clients-to-Accelerate-Journey-to-Cloud-and-Improve-Business-Agility
276. Netcentric. (n.d.). Netcentric Is Now a Cognizant Digital Business. Retrieved https://www.netcentric.biz/blog/netcentric-cognizant-digital-business.html
277. *Ibid.*
278. Cognizant Acquires Hedera Consulting, a Belgian Advisory and Analytics Company - May 2, 2018. (n.d.). Retrieved https://news.cognizant.com/2018-05-02-Cognizant-Acquires-Hedera-Consulting-a-Belgian-Advisory-and-Analytics-Company
279. Cognizant Completes Acquisition Of Bolder Healthcare Solutions - Apr 19, 2018. (n.d.). Retrieved https://news.cognizant.com/2018-04-19-Cognizant-Completes-Acquisition-Of-Bolder-Healthcare-Solutions
280. Kalavalapalli, Y. (2016, June 22). Tech Mahindra acquires UK-based digital player The BIO Agency. Retrieved https://www.livemint.com/Companies/yNfXA521XtQxyiuKfmxS2K/Tech-Mahindra-buys-UKs-BIO-Agency-in-allcash-deal.html
281. Target Group to be acquired by Tech Mahindra. (n.d.). Retrieved https://www.targetgroup.com/latest-thinking/articles/target-group-to-be-acquired-by-tech-mahindra
282. Dhanjal, S. S. (2017, March 6). Tech Mahindra to buy CJS Solutions Group for $110 million. Retrieved https://www.livemint.com/Companies/beUxLfSmMlZBYBWpEKInjL/Tech-Mahindra-to-buy-CJS-Solutions-Group-for-110-million.html
283. Press Trust of India. (2018, August 22). Tech Mahindra to acquire Czech-based firm Inter-Informatics for Rs 80 mn. Retrieved https://www.business-standard.com/article/companies/tech-mahindra-to-acquire-czech-based-firm-inter-informatics-for-rs-80-mn-118082200562_1.html
284. Geometric Global. (n.d.). Geometric is HCL Technologies. Retrieved https://geometricglobal.com/
285. HCL Acquires Aerospace & Defense Engineering Services Provider Butler America Aerospace, LLC. (n.d.). Retrieved https://www.hcltech.com/press-releases/press-releases-corporate/hcl-acquires-aerospace-defense-engineering-services-provider
286. HCL acquires Datawave– automation driven Data platform. (n.d.). Retrieved https://www.hcltech.com/press-releases/press-releases-business/hcl-acquires-automation-driven-data-management-platform-help

287. HCL to Acquire Mortgage BPO Provider Urban Fulfillment Services, LLC. (n.d.). Retrieved https://www.hcltech.com/press-releases/business-process-services/hcl-acquire-mortgage-bpo-provider-urban-fulfillment
288. HCL Technologies and Sumeru Equity Partners to Acquire Actian Corporation. (n.d.). Retrieved https://www.actian.com/company/news-and-events/press-releases/hcl-technologies-and-sumeru-equity-partners-acquire-actian-corporation/
289. Mendonca, J. (2016, March 11). WNS buys Value Edge Research for about $17.5 million. Retrieved https://economictimes.indiatimes.com/tech/ites/wns-buys-value-edge-research-for-about-17-5-million/articleshow/51361487.cms
290. WNS (Holdings) Ltd acquires Denali Sourcing Services - 2017-01-10. (n.d.). Retrieved https://www.crunchbase.com/acquisition/wns-holdings-ltd-acquires-denali-sourcing-services--8ceaab58
291. Capgemini reinforces its global leadership in digital with the acquisition of customer engagement firm LiquidHub. (2018, February 19). Retrieved https://www.capgemini.com/news/capgemini-reinforces-its-global-leadership-in-digital-with-the-acquisition-of-customer-engagement-firm-liquidhub/
292. Capgemini to acquire Leidos Cyber, the commercial cybersecurity division of Leidos. (2018, June 7). Retrieved https://www.capgemini.com/news/capgemini-to-acquire-leidos-cyber/
293. The Hindu. (2016, September 28). CSC to acquire Covansys. Retrieved https://www.thehindu.com/todays-paper/tp-business/CSC-to-acquire-Covansys/article14755475.ece
294. HGS Completes Acquisition Of Majority Stake In Element Solutions. (n.d.). Retrieved https://www.teamhgs.com/news-resources/news/hgs-completes-acquisition-majority-stake-element-solutions
295. HGS closes acquisition of AxisPoint Health. (n.d.). Retrieved https://www.teamhgs.com/news-resources/news/hgs-closes-acquisition-axispoint-health
296. IBM. (n.d.). Recent Mergers and Acquisitions IBM Is Excited About. IBM Community. Retrieved https://www.ibm.com/developerworks/community/blogs/d162913c-1ba3-42b0-98fd-88ea50820e64/entry/5_Recent_Mergers_and_Acquisitions_IBM_Is_Excited_About?lang=en
297. IBM Acquires Vivant Digital Business in Australia. Retrieved https://www-03.ibm.com/press/us/en/pressrelease/53189.wss
298. Genpact to Acquire Barkawi Management Consultants. (n.d.). Retrieved http://www.genpact.com/about-us/media/press-releases/2018-genpact-to-expand-global-supply-chain-management-transformation-expertise-with-the-acquisition-of-barkawi-management-consultants
299. Sen, A. (2016, April 29). Automation raises Indian IT industry's productivity; firms like Infosys, TCS likely to see lower hiring. Retrieved https://economictimes.indiatimes.com/tech/ites/automation-raises-indian-it-industrys-productivity-firms-like-infosys-tcs-likely-to-see-lower-hiring/articleshow/52032913.cms
300. Mazzina, A., Popper, B., Reynolds, S. C., & Goldstein, R. (2017, December 5). Developer Hiring Trends in 2017. Retrieved https://stackoverflow.blog/2017/03/09/developer-hiring-trends-2017/ ; Ganesh, V., & Giriprakash, K. (2018, June 3). 'IT industry's hierarchy will change as skills matter over scale'. Retrieved https://www.thehindubusinessline.com/info-tech/it-industrys-hierarchy-will-change-as-skills-matter-over-scale/article24073453.ece.
301. Bhattacharya, A. (2018, January 13). 56,000 layoffs: India's IT bloodbath this year may just be the start. Retrieved https://qz.com/1152683/indian-it-layoffs-in-2017-top-56000-led-by-tcs-infosys-cognizant/
302. Sood, V. (2017, May 11). Top 7 IT firms including Infosys, Wipro to lay off at least 56,000 employees this year. Retrieved https://www.livemint.com/Industry/4CXsLIIZXf8uVQLs6uFQvK/Top-7-IT-firms-including-Infosys-Wipro-to-lay-off-at-least.html
303. Subramanian, S. (2017, November 22). India's grasp on IT jobs is loosening up. Is artificial intelligence to blame? Retrieved https://www.technologyreview.com/s/609118/india-warily-eyes-ai/

304. Infosys. (n.d.). Infosys Annual Report 2016-17.
305. Wipro. (n.d.). Wipro Annual Report 2016-17, CEO's letter to the stakeholder. 15.
306. Shankar, J. (2018, July 11). 'Hiring of techies slumps 50% from 2011 peak'. Retrieved https://www.thehindu.com/business/Industry/hiring-of-techies-slumps-50-from-2011-peak/article24392155.ece.
307. *Ibid*
308. *Ibid*
309. Indian IT Staffing Report 2017 - Current Overview & Future Roadmap, Indian Staffing Federation & Research Conducted by KPMG.
310. Indian IT flexi staffing industry worth $3.04 bn in FY17: ISF report. (n.d.). Retrieved https://www.moneycontrol.com/news/business/companies/indian-it-flexi-staffing-industry-worth-3-04-bn-in-fy17-isf-report-2432129.html
311. Brand India. (n.d.). Retrieved https://www.ibef.org/download/ITITeS-October-20171.pdf
312. Indian IT Staffing Report 2017 - Current Overview & Future Roadmap, Indian Staffing Federation & Research Conducted by KPMG.
313. Quess Corp Limited. (n.d). Annual Report 2017-18. Quess Corp. 32. Retrieved https://quesscorp.com/investor/Quess_Annual_Report_2017-18.pdf
314. Team.ease. (n.d.) 18th Annual report for FY 18. Teamlease.com. 9.
315. Tata Consultancy Services. TCS Corporate Sustainability Report 2016-17. TCS. 21. Retrieved https://www.tcs.com/content/dam/tcs/pdf/discover-tcs/investor-relations/corporate-sustainability/GRI-Sustainability-Report-2016-2017.pdf
316. PTI. (2017, November 7). 'Indian IT flexi staffing industry to see significant growth'. Retrieved https://economictimes.indiatimes.com/tech/ites/indian-it-flexi-staffing-industry-to-see-significant-growth/articleshow/61545108.cms.
317. Chingakham, D. (2018, January 15). PayPal's Narsi Subramanian On Digital Payments And Indian Freelancers. Retrieved https://inc42.com/features/paypal-freelancers-digital-payments/)
318. Indian IT Staffing Report 2017 - Current Overview & Future Roadmap, Indian Staffing Federation & Research Conducted by KPMG.
319. Tata Consultancy Services. TCS Corporate Sustainability Report 2017-18. TCS. Retrieved https://www.tcs.com/content/dam/tcs/pdf/discover-tcs/investor-relations/corporate-sustainability/GRI-Sustainability-Report-2017-2018.pdf
320. From interviews
321. Chengappa, S. (2018, January 11). IBM losing its 'top employer' mojo in India. Retrieved https://www.thehindubusinessline.com/info-tech/ibm-losing-its-top-employer-mojo-in-india/article9788338.ece
322. IFRS-USD Press Release. Infosys (NYSE: INFY) announces results for the Quarter and Year ended March 31, 2018. Infosys. Retrieved https://www.infosys.com/investors/reports-filings/quarterly-results/2017-2018/q4/Documents/IFRS-USD-press-release.pdf
323. *Ibid*.
324. Sood, V. (2016, June 9). Why hire when you can deploy contract workers? Retrieved https://www.livemint.com/Industry/65me0Of1iIMqJV0tEgdNVM/Why-hire-when-you-can-deploy-contract-workers.html.
325. Tata Consultancy Services. TCS Corporate Sustainability Report 2017-18. TCS. Retrieved https://www.tcs.com/content/dam/tcs/pdf/discover-tcs/investor-relations/corporate-sustainability/GRI-Sustainability-Report-2017-2018.pdf
326. *Ibid*
327. Total number of employees: 1,65,481
328. Wipro. (n.d.). Wipro Sustainability Report 2014-15. Retrieved http://wiprosustainabilityreport.com/14-15/?q=responsible-people-supply-chain
329. Total number of employees: 73,702
330. Total number of employees: 16,470
331. FICCI, NASSCOM and EY. *Future of Jobs in India- A 2022 Perspective*. Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf

332. NITI Aayog. (2018). Discussion Paper: National Strategy for Artificial Intelligence. Retrieved http://niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-AI-Discussion-Paper.pdf
333. Future of Work in a Digital Era: The Potential and Challenges for Online Freelancing and Microwork in India, ICRIER, Dec, 2017
334. Tandon, A and Rathi A. (2018). A Gendered Future of Work? *The Centre for Internet and Society*. Retrieved https://cis-india.org/internet-governance/blog/ambika-tandon-and-aayush-rathi-december-19-2018-a-gendered-future-of-work
335. Online Freelancing in India: what current and Potential Workers Say, LIRNE Asia
336. Salve, P., & Paliath, S. (2019, June 10). India's Gig Workers: Overworked And Underpaid. Retrieved https://www.indiaspend.com/indias-gig-workers-overworked-and-underpaid/.
337. Rapoza, K. (2017, September 25). No, India's High Tech Labor Isn't Leaving The U.S. For Bangalore. Retrieved https://www.forbes.com/sites/kenrapoza/2017/09/25/no-indias-high-tech-labor-isnt-leaving-the-u-s-for-bangalore/#783d6c681768
338. Basu, S. (2018, April 3). India Salary Benchmark 2018 Report: India to see uptick in hiring. Retrieved https://economictimes.indiatimes.com/jobs/india-salary-benchmark-2018-report-india-to-see-uptick-in-hiring/articleshow/63586952.cms
339. Gent, E. (2017, May 19). Why automation could be a threat to India's growth. Retrieved http://www.bbc.com/future/story/20170510-why-automation-could-be-a-threat-to-indias-growth
340. Arora, Ashish & Athreye, Suma. (2002). The Software Industry and India's Economic Development. Information Economics and Policy. 14. 253-273. 10.1016/S0167-6245(01)00069-5.
341. Laha, R. (2017, June 15). The slowing salary hikes at Indian companies. Retrieved https://www.livemint.com/Industry/s6rhFwQZGbnjkgeBVTBLbL/The-slowing-salary-hikes-at-Indian-companies.html; Bhattacharya, S., & Bhattacharyya, R. (2018, May 1). IT sector banks on cash sops to ease pay hike pain. Retrieved https://economictimes.indiatimes.com/tech/ites/it-sector-banks-on-cash-sops-to-ease-pay-hike-pain/articleshow/63980472.cms.
342. KPMG. (2018). KPMG in India's Annual Compensation Trends Survey 2018-19. Retrieved https://assets.kpmg.com/content/dam/kpmg/in/pdf/2018/04/KPMG-India-Annual-Compensation-Trends-Survey.pdf
343. Exclusive: Capgemini's dismal salary hikes after strong start to year leave employees furious. (n.d.). Retrieved https://www.moneycontrol.com/news/technology/exclusive-capgeminis-dismal-salary-hikes-after-strong-start-to-year-leave-employees-furious-2559311.html
344. *Ibid*; Bhattacharya, S., & Bhattacharyya, R. (2018, May 1). IT sector banks on cash sops to ease pay hike pain. Retrieved https://economictimes.indiatimes.com/tech/ites/it-sector-banks-on-cash-sops-to-ease-pay-hike-pain/articleshow/63980472.cms; *See also* Ferrao, C. (2018, May 5). Are policy changes in the west to blame for low pay hikes in Indian IT companies? Retrieved https://www.thenewsminute.com/article/are-policy-changes-west-blame-low-pay-hikes-indian-it-companies-80734
345. Asthana, S. (2017.).Why entry level salaries for IT firms will remain low – with or without the 'cartel'. Moneycontrol. Retrieved https://www.moneycontrol.com/news/business/moneycontrol-research/why-entry-level-salaries-for-it-firms-will-remain-low-with-or-without-the-cartel-2471213.html
346. Basu, S. and Verma, P. (2019). 'Hot Skill' Artificial Intelligence commands huge premium in job market. The Economic Times. Retrieved https://economictimes.indiatimes.com/jobs/hot-skill-artificial-intelligence-commands-huge-premium-in-job-market/articleshow/67948682.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
347. P. Raghuram et al., 'Women and IT scorecard - India', *NASSCOM,* 2017.
348. Seth, & People Matters. (2019, March 7). Weakening roots of India's STEM talent. Retrieved https://www.peoplematters.in/article/career/weakening-roots-of-indias-stem-talent-17926
349. Gupta, N. (2019). Analysing gender gap in science: Government of India initiatives. *Current Science*. 116(11). Retrieved https://www.currentscience.ac.in/Volumes/116/11/1797.pdf

350. Seth, & People Matters. (2019, March 7). Weakening roots of India's STEM talent. Retrieved https://www.peoplematters.in/article/career/weakening-roots-of-indias-stem-talent-17926
351. Spotlight, E. T. (2019, March 28). Enabling 'Future India': Achieving holistic growth by upskilling women in STEM fields. Retrieved https://economictimes.indiatimes.com/enabling-future-india-achieving-holistic-growth-by-upskilling-women-in-stem-fields/articleshow/68614372.cms
352. *Ibid*
353. Tandon, A. and Rathi, A. (2018). A Gendered Future of Work? *The Centre for Internet and Society*. Retrieved https://cis-india.org/internet-governance/blog/ambika-tandon-and-aayush-rathi-december-19-2018-a-gendered-future-of-work
354. ENS Economic Bureau. (2018). 'IT-BPO Sector: Automation may eat away 35% low skilled jobs by 2022', The Indian Express. https://indianexpress.com/article/business/business-others/it-bpo-sector-automation-may-eat-away-35-low-skilled-jobs-by-2022-4833602/
355. FICCI, NASSCOM and EY. *Future of Jobs in India- A 2022 Perspective.* Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
356. HCL Technologies . Career Connect Login Page. Retrieved https://meme.hcl.com/careerconnect/
357. HCl Technologies. (2014). Discovering the Smart Survey initiative at HCL Technologies. Retrieved https://www.youtube.com/watch?v=RmdAJLmlICA
358. Baghel, V. "HCL MEME"- Of the Employees, by the Employees, for the Employees. HCL blogs. Retrieved https://www.hcltech.com/blogs/%E2%80%9Chcl-meme%E2%80%9D-employees-employees-employees
359. (2016, August 26). Infosys to focus on skill training, digital technology in 2016-17 fiscal. Retrieved https://www.ibtimes.co.in/infosys-focus-skill-training-digital-technology-2016-17-fiscal-691391
360. TCS. (n.d.). Employee training & development programs. Retrieved https://www.tcs.com/nurturing-human-capital
361. Ibid
362. Mindtree. (2017). Submission of Sustainability Report 2016-17. Retrieved https://www.mindtree.com/sites/default/files/2017-10/submission-of-sustainability-report.pdf
363. Mindtree. (2015). Mindtree Launches Global Learning & Software Delivery Center in Bhubaneswar. Retrieved https://www.mindtree.com/news/mindtree-launches-global-learning-software-delivery-center-bhubaneswar
364. Mindtree. (n.d.). Shotclasses: Mobile-first microlearning platform to help your employees outperform. Retrieved https://www.mindtree.com/products/microlearning-platform-mobile-first-shotclasses
365. Genpact. (2008). Genpact-NIIT JV to Create Skilled Talent Pool for Business & Technology Services Industry. Retrieved https://www.genpact.com/docs/pr/pr_genpact-niit_jv_launch_061008
366. Training Industry. (2018). Simplilearn and Genpact Partners to Help Employees Upskill in Digital Technologies. Retrieved https://webcache.googleusercontent.com/search?q=cache:bCBtiDTwF3sJ:https://trainingindustry.com/press-release/it-and-technical-training/simplilearn-and-genpact-partners-to-help-employees-upskill-in-digital-technologies/+&cd=10&hl=en&ct=clnk&gl=in
367. About Wipro Training. Retrieved https://teqipgoodgovernance.in/pdf/4.%20Wipro%20Supporting%20Learning%20and%20Development.pdf
368. *Ibid*
369. IBM Services. (n.d.). Retrieved https://www-935.ibm.com/services/in/gbs/organisation-and-people/
370. Meister, J. (2014). Cognizant Academy: Lessons From A 2020 Learning Organization. Forbes. Retrieved https://www.forbes.com/sites/jeannemeister/2014/09/10/cognizant-academy-lessons-from-a-2020-learning-organization/#78c297be3f83

371. DQI Bureau. (2011). 6-Intelenet Global Services: Focus on Training. Data Quest. Retrieved https://www.dqindia.com/6-intelenet-global-services-focus-on-training/
372. Bhirani, P. B. P. (2019, March 7). Driving Innovation – Learning at Mphasis. Retrieved https://www.peoplematters.in/article/get-set-learn/driving-innovation-learning-at-mphasis-14742?utm_source=peoplematters&utm_medium=interstitial&utm_campaign=learnings-of-the-day
373. Singh, K. (2018, August 7). Tech Mahindra adopts facial recognition to mark attendance. Retrieved https://economictimes.indiatimes.com/news/company/corporate-trends/tech-mahindra-adopts-facial-recognition-to-mark-attendance/articleshow/65300255.cms
374. Welcome to WNS Careers. (n.d.). Retrieved https://www.wnscareers.com/CareerGrowth.aspx
375. Learning at Capgemini. (2019, December 23). Retrieved https://www.capgemini.com/careers/learning-development/
376. Bhattacharya, A. (2018, January 13). 56,000 layoffs: India's IT bloodbath this year may just be the start. Retrieved https://qz.com/india/1152683/indian-it-layoffs-in-2017-top-56000-led-by-tcs-infosys-cognizant/
377. Sasirekha Thangavel Natarajan v. Labour Court-III W.P.No.1057 of 2015 (Madras High Court)
378. Layoffs in IT not ruled out; sector reeling under visa curbs, rising rupee: ASSOCHAM. (n.d.). Retrieved http://www.assocham.org/newsdetail.php?id=6260
379. How to answer Indian IT sector's retrenchment problem. (2015, April 30). Retrieved https://www.businessinsider.in/how-to-answer-indian-it-sectors-retrenchment-problem/articleshow/47114028.cms.
380. See discussion under “Changing revenue models” and “Impact on middle management”
381. Section 2(kkk), The Industrial Disputes Act, 1947
382. Section 25C, The Industrial Disputes Act, 1947
383. Rao, G. S. (2003, March 6). India: Re-Visiting Chapter VB Of ID Act With Special Reference To The Retrenchment and Approach. Retrieved http://www.mondaq.com/india/x/20169/employee rights labour relations/ReVisiting Chapter VB Of ID Act With Special Reference To The Retrenchment and Approach.
384. Section 2(oo), The Industrial. Disputes Act, 1947
385. Research and Articles. (n.d.). Retrieved http://www.nishithdesai.com/information/research-and-articles/nda-hotline/nda-hotline-single-view/article/employment-termination-in-india-high-court-injunction-against-it-sector-employer.html?no_cache=1&cHash=cb7e5d14e16b7a8496fbe047cdbe27d4.
386. Biswas, P. S. (2017, July 26). Retrenchment in IT sector: Issue raised in state assembly. Retrieved https://indianexpress.com/article/india/retrenchment-in-it-sector-issue-raised-in-state-assembly-4767392/
387. S., B. (2012, March 10). IT industry has to adhere to labour laws now. Retrieved https://www.thehindu.com/news/cities/bangalore/it-industry-has-to-adhere-to-labour-laws-now/article2978689.ece
388. FITE & Affected Wipro, Hewlett-Packard and J.P. Morgan Employees filed Petitions – Bengaluru. (2017, June 22). Retrieved http://fite.org.in/2017/06/22/fite-affected-wipro-hewlett-packard-and-j-p-morgan-employees-filed-petitions-bengaluru/
389. The Transition to the Knowledge Economy, Labour Market Institutions, and Income Inequality in Advanced Democracies with Angelo Martelli, LSE International Inequalities Institute Working Paper, No. 18, November 2017
390. Future of Jobs in India- A 2022 Perspective. Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
391. India’s Readiness for Industry 4.0 - A Focus on Automotive Sector, Grant Thorton and Confederation of Indian Industry. Retrieved http://www.nasscom.in/sites/default/files/NASSCOM_Annual_Guidance_Final_22062017.pdf
392. IT AND BPM. (n.d.). Retrieved http://www.makeinindia.com/sector/it-and-bpm
393. Future of Jobs in India- A 2022 Perspective. Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
394. *Ibid*

395. *Ibid*
396. Bundhun, R. (2017, November 11). Job losses on the way for Indian IT industry thanks to AI. Retrieved https://www.thenational.ae/business/technology/job-losses-on-the-way-for-indian-it-industry-thanks-to-ai-1.674855
397. Future of Jobs in India- A 2022 Perspective. Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
398. *Ibid*
399. *Ibid*
400. Vempati, S. S. (2016). India and the Artificial Intelligence Revolution. Carnegie Endowment for International Peace.
401. *AI and Big Data Analytics are Changing the Jobs Ecosystem Across the Spectrum; Nasscom Showcases the Roadmap for Futureskills Initiative*. Retrieved https://www.nasscom.in/sites/default/files/media_pdf/NASSCOM-press-release-HR-Summit-2018.pdf
402. SSC NASSCOM Video. (n.d.). Retrieved https://www.sscnasscom.com/
403. Mla. (1970, January 1). Report of the Committee for Rationalization and Optimization of the Functioning of the Sector Skill Councils. Retrieved https://www.voced.edu.au/content/ngv:78304.
404. Guidelines. (n.d.). Retrieved https://pmkvyofficial.org/Guidelines.aspx; Mla. (1970, January 1). Report of the Committee for Rationalization and Optimization of the Functioning of the Sector Skill Councils. Retrieved https://www.voced.edu.au/content/ngv:78304.
405. Basic Learning for Future Technologies & Skills (n.d.). Retrieved https://www.sscnasscom.com/basiclearning/.
406. Morgan J., (2016). Wipro's Chief Learning Officer On The Future Of Learning And Career Development. Retrieved https://www.forbes.com/sites/jacobmorgan/2016/01/19/wipros-chief-learning-officer-on-the-future-of-learning-and-career-development/#14f569ae6f7b
407. PwC Perspective, (2014). India –A destination for sourcing of services. Retrieved https://www.pwc.in/assets/pdfs/publications/2014/india-as-a-destination-for-sourcing-of-services.pdf
408. Infosys Limited. (n.d.). Infosys and Trinity College Launch Catalytic Partnership to Bridge the Liberal Arts and Digital Technology. Retrieved https://www.infosys.com/newsroom/press-releases/Pages/partnership-liberal-arts-digital-technology.aspx.
409. Automation: Workforce Of The Future. (n.d.). Retrieved https://www.wipro.com/business-process/the-future-workforce-turbocharged-by-humans-and-bots/
410. NSN, T. (2019, May 4). Top 10 organizations, missions and schemes for skill development, livelihoods and gainful employment. Retrieved https://www.nationalskillsnetwork.in/government-of-india/
411. Arun, M. (n.d.). Skill Development. Retrieved http://ficci.in/sector-details.asp?sectorid=74
412. IANS. (2018). Nasscom opens centre for data science, AI in Bengaluru. The Week. Retrieved https://www.theweek.in/news/sci-tech/2018/07/06/nasscom-opens-centre-for-data-science-ai-in-bengaluru.html
413. Mla. (1970, January 1). Report of the Committee for Rationalization and Optimization of the Functioning of the Sector Skill Councils. Retrieved https://www.voced.edu.au/content/ngv:78304.
414. Skill development for minorities. (n.d.). Retrieved http://vikaspedia.in/social-welfare/skill-development/schemes-for-skill-development/skill-development-for-minorities#section-4
415. Make In India. (n.d.). Electronics and T Sector Achievement Report. Retrieved http://www.makeinindia.com/documents/10281/114126/Electronics+%26+IT+Sector+-+Achievement+Report.pdf
416. *Ibid.*
417. *Ibid.*
418. *Ibid.*

419. India's Readiness for Industry 4.0 - A Focus on Automotive Sector, Grant Thorton and Confederation of Indian Industry. Retrieved http://www.nasscom.in/sites/default/files/NASSCOM_Annual_Guidance_Final_22062017.pdf
420. Wipro Mission 10X. (n.d.). Retrieved http://wipro.org/portfolio/wipro-mission-10x/
421. Infosys fortifies partnership with Udacity to improve skill training for new hires- Technology News, Firstpost. (2017, July 7). Retrieved https://www.firstpost.com/tech/news-analysis/infosys-fortifies-partnership-with-udacity-to-improve-skill-training-for-new-hires-3835773.html
422. IT reboot: How Infosys, TCS, Wipro & HCL are re-skilling employees to beat automation. (n.d.). Retrieved https://www.moneycontrol.com/news/trends/it/it-reboot-how-infosys-tcs-wipro-hcl-are-re-skilling-employees-to-beat-automation-2323469.html
423. Prep Test. (n.d.). Retrieved https://www.tcsion.com/dotcom/TCSSMB/education/product/preptest.html
424. Krishna, V. (2017, August 7). In a world where machines and AI rule, re-skilling is the only way out. Retrieved https://yourstory.com/2017/08/machines-ai-reskilling-skill-development/
425. Mitter, S. (2018, June 25). Inside Mindtree's workforce automation, 'bot' deployment and employee upskilling. Retrieved https://yourstory.com/2018/06/inside-mindtrees-workforce-automation-bot-deployment-employee-upskilling/
426. Ians. (2018, February 15). IBM, skill development ministry launch 'New Collar' curriculum at ITIs. Retrieved http://www.sify.com/finance/ibm-skill-development-ministry-launch-new-collar-curriculum-at-itis-news-finance-scprahdjdgfjc.html
427. Cognizant. (n.d.). Digital Solutions to Advance Your Business. Retrieved https://www.cognizant.com/CasKade
428. Hinduja Group. HGS recognised for innovative skills development. Retrieved http://www.hindujagroup.com/newsletter/july14/hgs-innovative-skills.html
429. Genpact. (n.d.). Building skills that build the nation. Retrieved http://www.genpact.com/insight/blog/building-skills-that-build-the-nation
430. Tech Mahindra Foundation. (n.d.). Skills for Market Training. Retrieved https://techmahindrafoundation.org/smart/
431. Mphasis. (n.d.). Leveraging tech-driven, market-based solutions to empower 2,500 youth with employable skills. Retrieved https://www.mphasis.com/home/corporate/community-social-responsibility/livelihood/skilltrain-mobile-app.html
432. Leading Corporate Training Company in India: IT, Digital Marketing, Data Analytics, BFSI Courses. (n.d.). Retrieved http://www.niit.com/india/training/personals/graduate/capgemini-programs
433. HCL Technologies. HCL Technologies Annual Report 2016-17.
434. Christopher, N. (2017, June 7). Mindtree finds humane fix to automation. Retrieved https://economictimes.indiatimes.com/tech/ites/mindtree-finds-humane-fix-to-automation/articleshow/59026423.cms
435. *Ibid.*
436. Moore, E. (2018, June 21). Why This Company Wants to Pay You to Learn Today's Most In-Demand Skills. Retrieved https://www.glassdoor.com/blog/infosys-rajesh-ahuja-interview/.
437. Infosys Limited. (n.d.). 'Learning' to Succeed in a Dynamic World. Retrieved https://www.infosys.com/insights/disruptions/Pages/dynamic-world.aspx?soc=smo_tw_Infosys-Insights_Disruptions_Brand_Link-Image_43321_dynamic-world_tw167171_lq
438. D'Costa, Anthony P (2011): "Geography, Uneven Development and Distributive Justice: The Political Economy of IT Growth in India," Cambridge Journal of Regions, Economy and Society,Vol 4, No 2, pp 237–51
439. Kathpalia, L., & Raman, R. (2014). The road ahead for the Indian IT and ITES: Industry considering its service offerings, domestic market and technology Trends. *Journal of Theoretical and Applied Information Technology*, *60*(2).
440. State and the IT Industry in India : An Overview. (2017, October 17). Retrieved https://www.epw.in/journal/2017/41/special-articles/state-and-it-industry-india.html

441. No.8 Skills policies and systems for a future workforce. (2018, February 20). Retrieved https://www.ilo.org/global/topics/future-of-work/publications/issue-briefs/WCMS_618170/lang--en/index.htm
442. FICCI, NASSCOM and EY. *Future of Jobs in India- A 2022 Perspective.* Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
443. *Ibid.*
444. *Ibid.*
445. Mla. (1970, January 1). Report of the Committee for Rationalization and Optimization of the Functioning of the Sector Skill Councils. Retrieved https://www.voced.edu.au/content/ngv:78304
446. FICCI, NASSCOM and EY. *Future of Jobs in India- A 2022 Perspective.* Retrieved http://ficci.in/spdocument/22951/FICCI-NASSCOM-EY-Report_Future-of-Jobs.pdf
447. Labour Market Deepening in India's IT : (2004, December 11). Retrieved https://www.epw.in/journal/2004/50/special-articles/labour-market-deepening-indias-it.html
448. No.8 Skills policies and systems for a future workforce. (2018, February 20). Retrieved https://www.ilo.org/global/topics/future-of-work/publications/issue-briefs/WCMS_618170/lang--en/index.htm
449. Mla. (1970, January 1). Report of the Committee for Rationalization and Optimization of the Functioning of the Sector Skill Councils. Retrieved https://www.voced.edu.au/content/ngv:78304
450. Why is India Inc Reluctant to Participate in the Skill India Campaign? (n.d.). Retrieved https://thewire.in/business/why-is-india-inc-reluctant-to-participate-in-the-skill-india-campaign
451. International Labour Office (ILO). (2016). Non- standard employment around the world: Understanding challenges, shaping prospects.
452. International Labour Standards on Social security. (n.d.). Retrieved https://www.ilo.org/global/standards/subjects-covered-by-international-labour-standards/social-security/lang--en/index.htm
453. *Future of Work and Skills* (2017, February). Retrieved https://www.oecd.org/els/emp/wcms_556984.pdf
454. Disguised employment / Dependent self-employment. (2016, November 11). Retrieved https://www.ilo.org/global/topics/non-standard-employment/WCMS_534833/lang--en/index.htm
455. R198 - Employment Relationship Recommendation, 2006 (No. 198). (n.d.). Retrieved https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_INSTRUMENT_ID:312535
456. *Future of Work and Skills* (2017, February). Retrieved https://www.oecd.org/els/emp/wcms_556984.pdf
457. Katz, Lawrence and Kevin M. Murphy (1992): "Changes in Relative Wages, 1963-1987: Supply and Demand Factors."Quarterly Journal of Economics Vol.107(1): 35-78. Bound, John and George Johnson (1992): "Changes in the Structure of Wages in the 1980s:An Evaluation of Alternative Explanations."American Economic Review Vol.83(3):371-392.
458. Arntz M, Gregory T and Zierahn U (2016) The Risk of Automation for Jobs in OECD Countries. OECD Social, Employment and Migration Working Papers. OECD: Paris.
459. Vashisht, P., & Dubey, J. D. (2018). Changing Task Contents of Jobs in India: Implications and Way Forward.
460. Acemoglu D and Autor D (2011) Skills, tasks and technologies: Implications for employment and earnings. In: Ashenfelter O and Card D (eds) Handbook of Labor Economics. Amsterdam: Elsevier,pp. 1043–1171.
461. Graetz G and Michaels G (2015) Robots at Work. IZA Discussion Paper, Institute for the Study of Labor(IZA). Bonn: IZA.

462. Hardy W, Keister R and Lewandowski P (2016) Technology or Upskilling? Trends in the Task Composition of Jobs in Central and Eastern Europe. IBS Working Paper. Warsaw: Institute for Structural Research (IBS); Salvatori A (2015) The Anatomy of Job Polarisation in the UK. IZA Discussion Paper. Bonn: IZA Institute of Labor Economics.
463. Vashisht, P., & Dubey, J. D. (2018). Changing Task Contents of Jobs in India: Implications and Way Forward.
464. *Ibid*.
465. Gibbs, W. W. (1994). Software's chronic crisis. *Scientific American*, *271*(3), 86-95.
466. Royce, W. W. (1987, March). Managing the development of large software systems: concepts and techniques. In *Proceedings of the 9th international conference on Software Engineering* (pp. 328-338). IEEE Computer Society Press.
467. ISO 9000-3:1997. (2004, February 11). Retrieved https://www.iso.org/standard/26364.html
468. McKay, V. (n.d.). What is the Capability Maturity Model? (CMM). Retrieved http://www.selectbs.com/process-maturity/what-is-the-capability-maturity-model
469. State and the IT Industry in India : An Overview. (2017, October 17). Retrieved https://www.epw.in/journal/2017/41/special-articles/state-and-it-industry-india.html
470. Parthasarathy, & Balaji. (1970, January 1). India's Silicon Valley or Silicon Valley's India? Socially Embedding the Computer Software Industry in Bangalore. Retrieved https://econpapers.repec.org/article/blaijurrs/v_3a28_3ay_3a2004_3ai_3a3_3ap_3a664-685.htm.
471. *Ibid*.
472. Haas School of Business. Research Report, Fall 2003. Retrieved http://www.haas.berkeley.edu/news/Research_Report_Fall_2003.pdf
473. IT-ITeS Sector Skills Council NASSCOM, Industry Sub-Sector, Retrieved https://www.sscnasscom.com/stakeholders/industry/industry-sub-sector/
474. Himanshu. (2018, February 26). When data becomes political. Retrieved https://www.livemint.com/Opinion/urew0fWTqPIgzDbcmwT2sN/When-data-becomes-political.html
475. Missing Reliable Employment Data. (2018, April 11). Retrieved https://blogs.timesofindia.indiatimes.com/red-button-day-light/missing-reliable-employment-data/
476. Gaur, S. (2017, July 10). Shaping the future of manufacturing in India. Retrieved https://www.livemint.com/Opinion/mQqYAAL52lvVUqdIkeLTON/Shaping-the-future-of-manufacturing-in-India.html
477. Thirty years of IFPUG Progress. Retrieved www.ifpug.org/wp-content/uploads/2017/04/IYSM.-Thirty-years-of-IFPUG.-Software-Economics-and-Function-Point-Metrics-Capers-Jones.pdf
478. Hernández-López, A., Colomo-Palacios, R., Soto-Acosta, P., & Lumberas, C. C. (2015). Productivity Measurement in Software Engineering: A Study of the Inputs and the Outputs. *International Journal of Information Technologies and Systems Approach (IJITSA), 8*(1), 46-68.
479. The Seventh Round Quarterly Employment Survey from Labor Bureau. Retrieved http://labourbureaunew.gov.in/QES_7th_round_Report_final_12032018.pdf
480. The Online Labour Index. (n.d.). Retrieved https://ilabour.oii.ox.ac.uk/online-labour-index/
481. *IT & ITeS* (2017, January). India Brand Equity Foundation: IT & ITeS. Retrieved https://www.ibef.org/download/IT-and-ITeS-January-2017.pdf
482. IT-BPM Industry in India: Sustaining Growth and Investing for the Future. (2017, July 26). Retrieved https://www.nasscom.in/press/it-bpm-industry-india-sustaining-growth-and-investing-future
483. *See* discussion under 'Company Initiated Skill Programs'
484. Comin, D., & Mestieri, M. (2014). Technology diffusion: Measurement, causes, and consequences. In *Handbook of economic growth* (Vol. 2, pp. 565-622). Elsevier.
485. India. Committee for Rationalization and Optimization of the Functioning of the Sector Skills Councils. (2016). Report of the Committee for Rationalization and Optimization of the Functioning of the Sector Skill Councils.

486. NSDA., NSQF Level Descriptors. Retrieved https://www.nsda.gov.in/assets/documents/nsqf/NSQF%20LEVEL%20DESCRIPTORS.pdf
487. Committee for Rationalization and Optimization of the Functioning of the Sector Skills Councils. (2016). Report of the Committee for Rationalization and Optimization of the Functioning of the Sector Skill Councils.
488. Peña-López, I. (2011). Measuring the Impacts of Information and Communication Technology for Development.
489. Times of India, (April 23 2018). TCS becomes first Indian company to breach $100 billion market capitalisation Retrieved https://timesofindia.indiatimes.com/business/india-business/tcs-becomes-first-indian-company-to-become-100-billion-company/articleshow/63876020.cms
490. TCS Worldwide. Retrieved https://www.tcs.com/worldwide
491. Infosys. (n.d.). About Us. Retrieved https://www.infosys.com/about/
492. Edgeverve. (n.d). Infosys NIA. Retrieved https://www.edgeverve.com/artificial-intelligence/nia/
493. Press Trust of India. (Mar 14 2017). Employee strength at Infosys soars from 300 in 1996 to 20,000. The Economic Times, Retrieved https://economictimes.indiatimes.com/tech/ites/employee-strength-at-infosys-soars-from-300-in-1996-to-20000/articleshow/57632487.cms
494. Wipro Careers. (n.d). About Wipro. Retrieved https://careers.wipro.com/about-wipro.aspx
495. Company Profile & Key Figures, Capgemini. Retrieved https://www.capgemini.com/company-profile-key-figures/
496. Gadgets 360, NDTV, (September 29 2017). IBM Has More Employees in India Than It Does in Its Home Nation, the US: Report. Retrieved https://gadgets.ndtv.com/others/news/ibm-has-more-employees-in-india-than-it-does-in-its-home-nation-the-us-report-1756817
497. Das A., Phadnis S., Times of India, (March 1 2018). Cognizant's India headcount down by 8,000 in 2017. Retrieved https://timesofindia.indiatimes.com/business/india-business/cognizants-india-headcount-down-by-8000-in-2017/articleshow/63120617.cms
498. Mphasis Group Financial Overview and Trends for the Quarter and Year ending 31 Mar 2018. Retrieved https://www.mphasis.com/content/dam/mphasis-com/global/en/investors/financial-results/2018/q4-Group%20Overview.pdf
499. Genpact. Company Overview. Retrieved http://www.genpact.com/about-us/company-overview
500. Intelenet Global. About Us. Retrieved https://www.intelenetglobal.com/en-us/who-we-are/about-us
501. HGS - Hinduja Global Solutions. Retrieved https://www.linkedin.com/company/hinduja-global-solutions-inc--/?originalSubdomain=in
502. CGI. Retrieved https://www.cgi.com/india/en
503. WNS Investors. Retrieved http://www.wns.com/investors.
504. Hindu Businessline. (April 18, 2018). Mindtree profit rises 36%. Retrieved https://www.thehindubusinessline.com/info-tech/mindtree-profit-rises-36/article23590043.ece
505. HCL Investor Relations. Retrieved https://www.hcltech.com/investors/fast-facts
506. Tech Mahindra. Retrieved https://www.techmahindra.com
507. Phadnis S., John S., Times of India (October 21 2016). CSC CEO: We'll hire thousands in India in the coming years. Retrieved https://timesofindia.indiatimes.com/business/india-business/CSC-CEO-Well-hire-thousands-in-India-in-the-coming-years/articleshow/54971190.cms
508. Concept Note on Occupational Standards, IT-ITES Sector Skills Council, NASSCOM.