

**GIDR WORKING PAPER SERIES**

**No. 248 : February 2018**

**Technological Disruptions and  
the Indian IT Industry:  
Employment Concerns and Beyond**

**Hastimal Sagara  
Keshab Das**



**Gujarat  
Institute of  
Development  
Research**

**Working Paper No. 248**

**Technological Disruptions and  
the Indian IT Industry:  
Employment Concerns and Beyond**

**Hastimal Sagara  
Keshab Das**

**February 2018**

**Gujarat Institute of Development Research**  
Gota, Ahmedabad 380 060

Abstracts of all GIDR Working Papers are available on the Institute's website. Working Paper No 121 onwards can be downloaded from the site.

All rights are reserved. This publication may be used with proper citation and due acknowledgement to the author(s) and the Gujarat Institute of Development Research, Ahmedabad.

© **Gujarat Institute of Development Research**

First Published    February 2018

Price                Rs. 100.00

## Abstract

The information technology (IT) industry is one of the most dynamic sectors in India. This US\$ 150 billion-strong industry employs 3.8 million people and contributes more than 9 per cent to Indian GDP. However, this largest private sector employer has been experiencing stress due to fast changing business models, increased competition from other countries, restrictive visa policies, upsurge in anti-outsourcing sentiments and, most importantly, technological disruptions. These disruptive technologies - captured in a moment in history of technological transformations as the Fourth Industrial Revolution or *Industrie 4.0* - principally include such developments as cloud computing, big data and analytics, Internet of Things (IoTs), automation, robotics and blockchain. While *Industrie 4.0* has rendered conventional engineering expertise and low-end IT services redundant it has the potential of creating new employment opportunities in a host of sectors including administration, banks, retail trade and online marketing. Disruptive technologies have a strong chance of transforming the nature and composition of the Indian IT industry in a big way including endangering India's position as the software superpower in the world. Albeit, the Indian IT industry has historically proved itself to be extraordinarily resilient and fortified during turbulent shocks of dotcom bubble, subprime crisis and US visa restrictions. Based on secondary data, this paper aims at mapping the changing nature and composition of the Indian IT industry during recent years. It tries to identify contemporary challenges to employment and business opportunities in the Indian IT industry. The paper includes policy suggestions for enhancement of relevant technological and skill capabilities in the country.

**Keywords** : IT Industry, Fourth Industrial Revolution, Technological Disruptions, Internet of Things, Robotics, Automation, India

**JEL Classification** : F14, J23, J24, L86, O33

## **Acknowledgements**

We express our sincere gratitude to Dibyendu Maiti (Delhi School of Economics, Delhi) for the opportunity, encouragement and comments in writing this paper. Towards improving the quality of the paper useful comments, suggestions and technical help were received from Pratap C. Mohanty (Indian Institute of Technology, Roorkee), Jaya Prakash Pradhan (Central University of Gujarat, Gandhinagar), Itishree Pattnaik (GIDR, Ahmedabad), Tara Nair (GIDR, Ahmedabad), Fulvio Castellacci (Centre for Technology, Innovation and Culture - TIK, University of Oslo, Norway) and Grace Kite (School of Oriental and African Studies, London). Detailed comments from Pralok Gupta (Centre for WTO Studies, IIFT, New Delhi) on an earlier draft contributed to improving the content and readability of the paper. We also appreciate observations made by participants at the Workshop on 'Economics of ICTs: Transformation, Digital Divides and Development', organised by the DSE, Norwegian Institute of International Affairs (NUPI), Oslo, Norway and TIK. We are grateful to all of them.

## Contents

Abstracts	i
Acknowledgements	ii
Contents	iii
List of Tables/List of Figures	iii
The Context	1
Growth of the Indian IT Industry	3
Employment Implications	11
Emerging IT Services and New Technologies	13
Opportunities and Challenges	21
Threat of Technological Disruptions	23
Concluding Observations	26
References	29

### List of Tables

1: Major Factors Responsible for the Growth of the IT Industry in India	4
2: Aspects of Growth of the IT Industry in India, 1999-2017	11
3: Description and Measurement of Variables	13
4: Determinants of Employment in the Indian IT Industry	13
5: Correlation Coefficient between Exports and Employment by Major IT Segments, 1999-2016	14

### List of Figures

1: Revenue from the IT Industry in India	5
2: Employment in the IT Industry in India	5
3: Number of Firms in the IT Industry	6
4: Share of the IT Industry in Indian GDP	6
5: Share of the IT Industry in Indian Services Exports	7
6: Export Revenue from Sub-sectors of the IT Industry (2012-13)	8
7: Export Revenue from Sub-sectors of the IT Industry (2017-18)	9
8: Segment-wise Export Revenue Trends in the IT Industry	10
9: CAGR of Revenue of IT Industry in India, 2013-18 (per cent)	10
10: Direct Employment in the IT Sector in India	20
11: IT Firms in India: Landscape	21
12: IT Firms in India: Verticals	21
13: Employment in Major IT-ITES Companies in India	24
14: Impact of Automation on Jobs in Select Indian IT-ITES Companies	24
15: Risk of Job Losses due to New Technologies at Different Work Hierarchy	26

# Technological Disruptions and the Indian IT Industry: Employment Concerns and Beyond

Hastimal Sagara  
Keshab Das

## The Context

Developing economies, including India, had been deeply influenced by the post-World War II industrialisation strategies that relied mostly on state-led approaches and, in order to promote import-substitution strategies, undermined the potential of export markets; this was the case at least till the early 1980s. The importance of participating in global markets – as could be facilitated through a lowering of tariffs and relaxing (or, getting rid of) domestic trade and industrial laws – towards promoting a competitive industrial system had come to dominate policy discourse by mid-1980s. During the subsequent years - till the early 2000s - “Governments still mattered but market forces were also critical and exports were central to achieving scale. Import-competition was critical to ensuring market discipline” (Baldwin, 2011: 2).

Experiences with global trade of some of the dynamic emerging economies, including India, appeared in line with what the new trade theory (based on monopolistic firm strategies to product differentiation to remain competitive), attributed to Dixit-Stiglitz model that was perfected in Krugman (1979) had envisaged (Ahmed, 2012). However, the later approaches of the developing economies in dealing with ‘liberalised’ trade were increasingly focused on firm level differences, especially when ‘outsourcing’ as an activity dominated trade clearly by the turn of the century (Melitz, 2003; Antràs and Helpman, 2004). The Indian IT sector rise may be best understood through the rise of what has come to be known as the ‘new’ new trade theory (NNTT) where the individual firm’s strategic responses to challenges and opportunities of global market assume greater significance than the sector *per se*.

---

Hastimal Sagara (hastimalsagara@gmail.com) is Assistant Professor, GLS University, Ahmedabad and PhD Scholar at the Gujarat Institute of Development Research, Ahmedabad.

Keshab Das (keshabdas@gmail.com) is Professor at the Gujarat Institute of Development Research, Ahmedabad.

The information technology (IT) industry is one of the most accomplished and dynamic sectors in India that has been globally recognised. The industry's phenomenal and historic rise at the turn of the millennium following its unmatched solution to sort out what is termed the 'dotcom bubble' or 'millennium bug' remains a high point in India's technological supremacy in the sphere of the software. India is in the forefront of the rapidly evolving global IT-Business Process Outsourcing (BPO) or, as now known as the Business Process Management (BPM) market and is well established as a 'destination of choice'. It has grown into an over US\$ 150 billion industry accounting for two-thirds of the total export of software in the world and it has created direct employment to the tune of about 3.8 million and indirect employment around 10 million (NASSCOM, 2017). Even as the industry could weather a steep fall during the sub-prime crisis in 2008-09, this sector is under stress as during recent times, due to a host of unforeseen obstacles like changing business models, increased competition from other countries, restrictive US and UK visa policies and technological disruptions. However, the most formidable of these clearly is the technological disruptions which is impacting the industry in a big way.

The Fourth Industrial Revolution - also known as *Industrie 4.0* - includes developments in previously disjointed fields such as artificial intelligence and machine-learning, robotics, nanotechnology, 3-D printing, and genetics and biotechnology (WEF, 2016:3). The inevitable acceleration of technology will 'disrupt', radically and fundamentally, global employment and the nature of work. For instance, robots have the ability to work continuously, as they become more flexible and easier to train for new tasks, they will become an increasingly attractive alternative to human workers, even when wages are low (Ford, 2015: 9). Digital platforms and improvements in communication technologies have been squeezing transaction costs and information asymmetries (Productivity Commission, 2016: 25). For instance, innovations in power storage battery and metering would disrupt the traditional models of power generation, transmission and monitoring.<sup>1</sup> Digital

---

<sup>1</sup> An impression about the nature and impact of such technological disruption may be had from the following example. "The Tesla Power wall home battery is a household technology enabled by Li-on battery storage and has the potential to be highly disruptive. The Power wall is a battery module that enables large amounts of electricity to be stored at the user's home. The battery can be charged using electricity from solar panels, or from the grid during non-peak energy use periods when rates are low. This stored electricity can then be used to power the home during peak hours" (Productivity Commission, 2016: 208).



technologies offer greater scope for the market use of household assets, including labour (Productivity Commission, 2016: 19). E-commerce has set in fierce competition in the retail business (Kaur, 2015). *Industrie 4.0* will transform labour markets in the next five years, leading to a net loss of over 5 million jobs in 15 major developed and emerging economies<sup>2</sup>.

With this backdrop, this paper attempts to identify the emerging services in the IT industry and tries to map new opportunities and challenges of the transformation from traditional low-end IT services of back office and other repetitive tasks to high-end technical skilled-based ones. It tries to map the impact of technological disruptions on the IT industry in India. It is important to note that due to paucity of relevant database on several dimensions of the impact of new technology, arguments and concluding statements have generally been drawn upon reports and newspaper articles published by responsible institutions. The remaining part of the paper is divided into four sections. Section I discusses the growth and composition of the IT industry in India in recent decades. Section II deals with the present phase of transformation in the IT services through technological innovations like mobile applications, cloud computing and automation. Section III attempts to identify opportunities and challenges for the IT industry in India. Concluding observations and policy suggestions have been presented in Section IV.

## **Section I**

### **Growth of the Indian IT Industry**

Reasons behind the growth of the IT industry in India have varied over time. As summarised in Table 1, the 1980s witnessed cost arbitrage through software development and time and material (T and M) pricing as the prime reason behind the growth of the IT industry in India. During the 1990s through greater collaborative efforts Indian IT firms contributed notably towards improving standards and productivity of western buyers even through non-critical functions. The period 2000-10 experienced value addition through a non-linear growth, end-to-end services and partnerships in the IT industry. In the current period, automation platforms, smart technology and innovations have emerged as dominant features.

---

<sup>2</sup> [Chttps://www.weforum.org/press/2016/01/five-million-jobs-by-2020-the-real-challenge-of-the-fourth-industrial-revolution/](https://www.weforum.org/press/2016/01/five-million-jobs-by-2020-the-real-challenge-of-the-fourth-industrial-revolution/) (Accessed June 5, 2018)

**Table 1: Major Factors Responsible for the Growth of the IT Industry in India**

Time	Major Reason	Factors
1980-90	Cost arbitrage	Software development, T and M pricing
1990-2000	Collaboration	Improving standards and productivity through non-critical functions, project based, fixed cost, T and M pricing
2000-10	Value addition	End-to-end services, non-linear growth, strategic partnerships, pay-as-you-use
2010-15	Enabling smart enterprise	Bimodel IT, digital BUs, automation platforms, IoT, smart tech, innovation, outcome-based risk reward, start-up eco-system

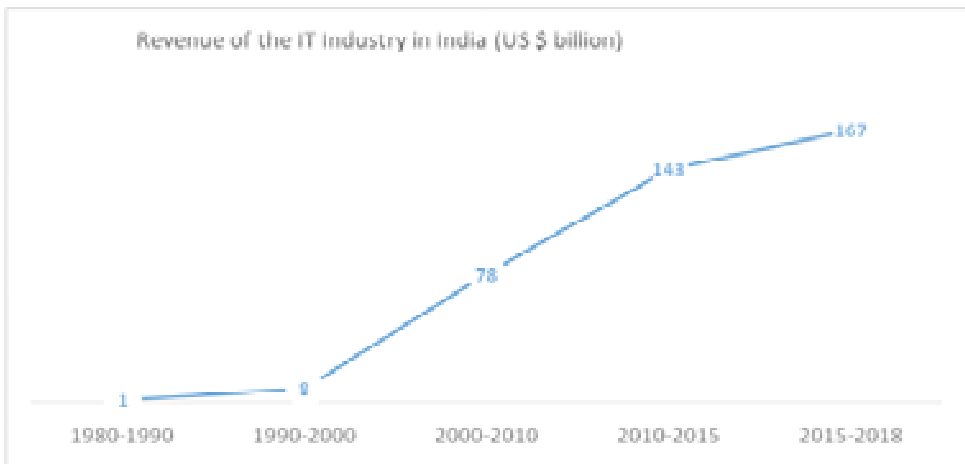
Source: <http://www.nasscom.in/impact-indias-growth>

The Indian IT industry grew at a snail's pace till the end of the previous century but, thereafter, a major shift upward was observed during 2000-15. The revenue shot up from around US\$ 1 billion during 1980-90 to US\$ 167 billion during 2015-18 (Figure 1). The Indian IT industry was in a nascent stage during the 1980s with about 1000 firms providing employment to a mere 0.06 million people. However, during 2010-15, there were more than 16000 IT firms employing about four million people (Figures 2 and 3). That the future of employment in the IT industry is quite uncertain may take exceptional turns have been a matter of emerging concerns. For instance, it is estimated that in the period up to 2022, around 75 million jobs across industries may be displaced by a shift in the division of labour between humans and machines, while 133 million new roles may emerge that are more adapted to the new division of labour between humans, machines and algorithms (WEF, 2018: 10). For instance, around 20-33 per cent out of the 1.5 million engineering graduates every year run the risk of not getting a job at all in India due to sharp fall in the demand for IT related jobs in India due to nonlinear growth models of IT companies and a lesser number of men required to handle the same jobs as before due to a higher degree of automation<sup>3</sup>. This industry enjoys the distinction of being the single largest private sector contributor to the GDP at 9.3 per cent (Figure 4). Even, IT exports rose at a compound annual growth rate (CAGR) of 12.9 per cent from US\$ 26 billion in 2010s to US\$ 117 billion in 2017 and its share was over 56 per cent in total services exports from India (Figure 5).

<sup>3</sup> <https://dazeinfo.com/2014/10/28/1-5-million-engineering-pass-outs-india-every-year-fewer-getting-hired-trends/> (Accessed June 10, 2018)

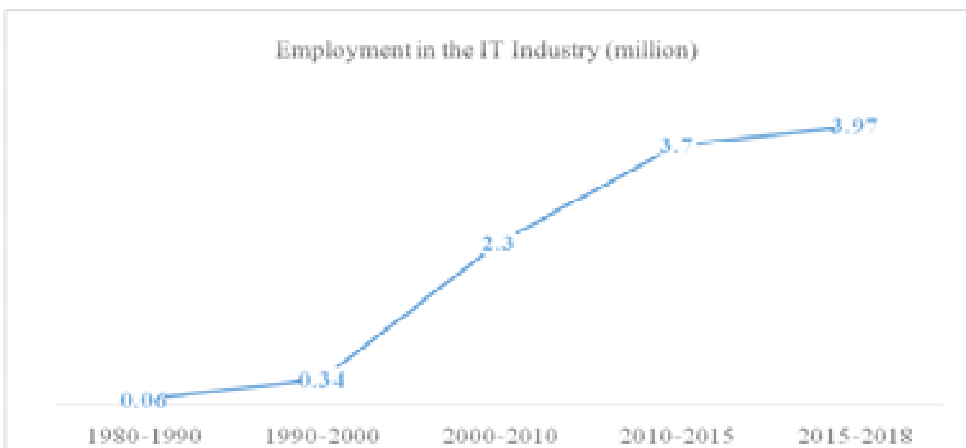
According to NASSCOM, the IT-BPM sector had generated revenue of US\$ 150 billion and had made exports worth US\$ 100 billion in 2017. Indian IT companies have set up over 600 delivery centres across the world and are engaged in providing services with their presence in over 200 cities across 78 countries and India continues to maintain a leadership position in the global sourcing arena accounting for almost 56 per cent of the global market share in 2017.

**Figure 1: Revenue from the IT Industry in India**



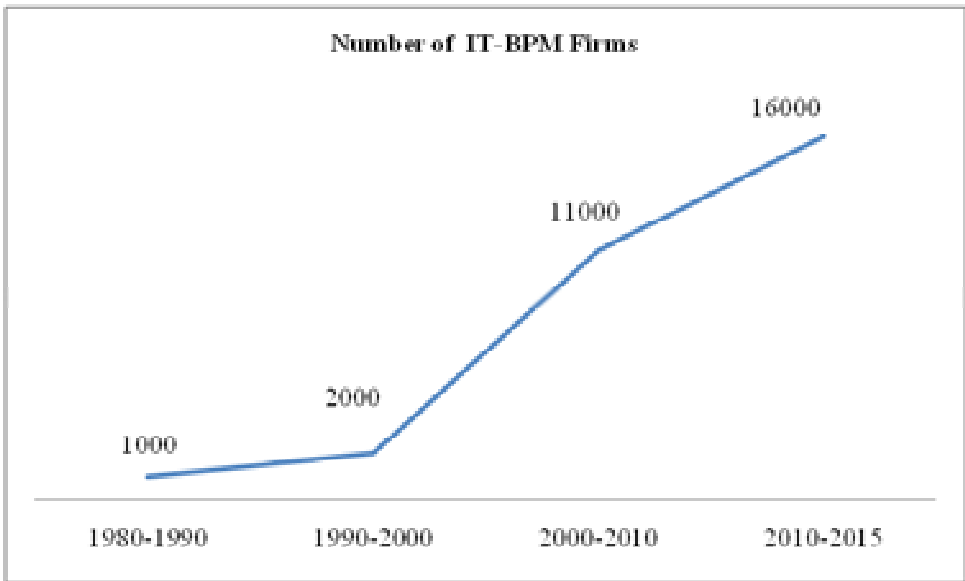
Source: Drawn on data obtained from <http://www.nasscom.in/impact-indias-growth>

**Figure 2: Employment in the IT Industry in India**



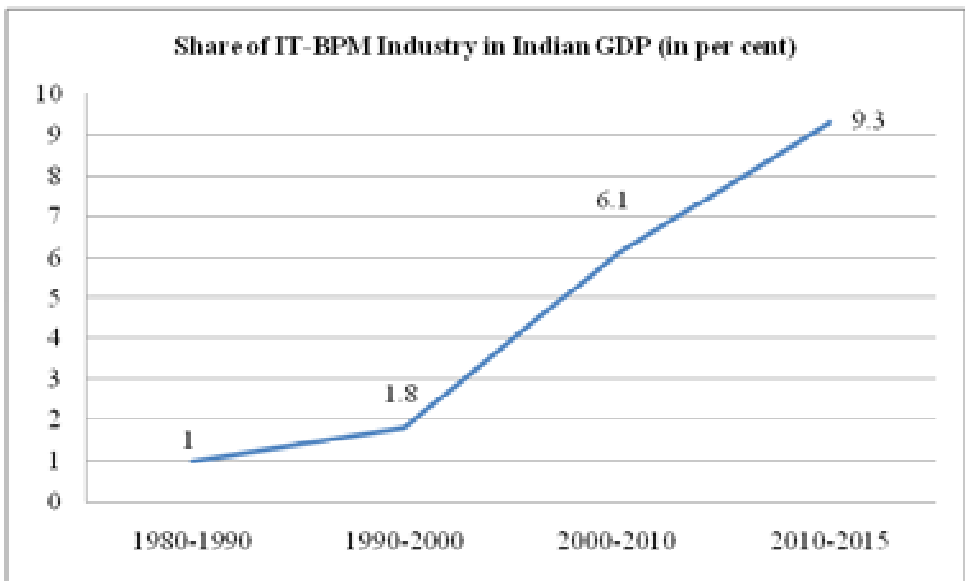
Source: Drawn on data obtained from <http://www.nasscom.in/impact-indias-growth>

**Figure 3: Number of Firms in the IT Industry**



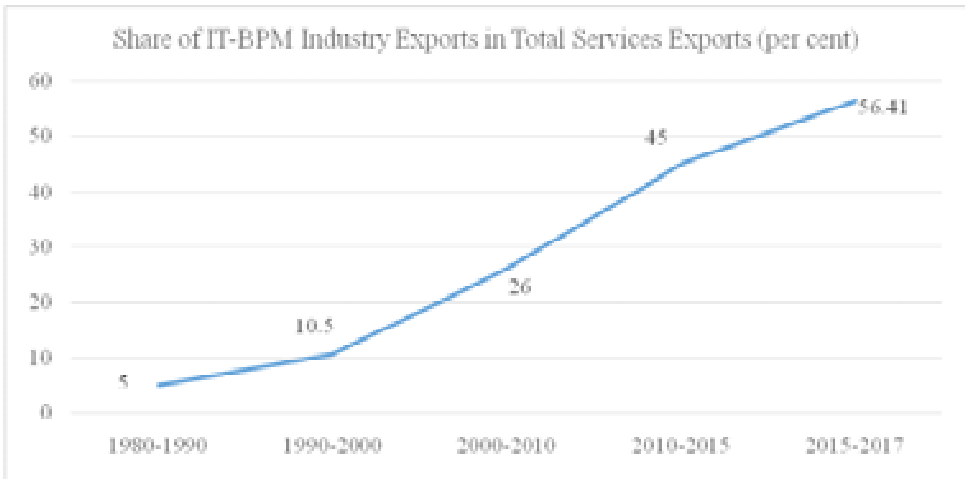
Source: Drawn on data obtained from <http://www.nasscom.in/impact-indias-growth>

**Figure 4: Share of the IT Industry in Indian GDP**



Source: Drawn on data obtained from <http://www.nasscom.in/impact-indias-growth>

**Figure 5: Share of the IT Industry in Indian Services Exports**



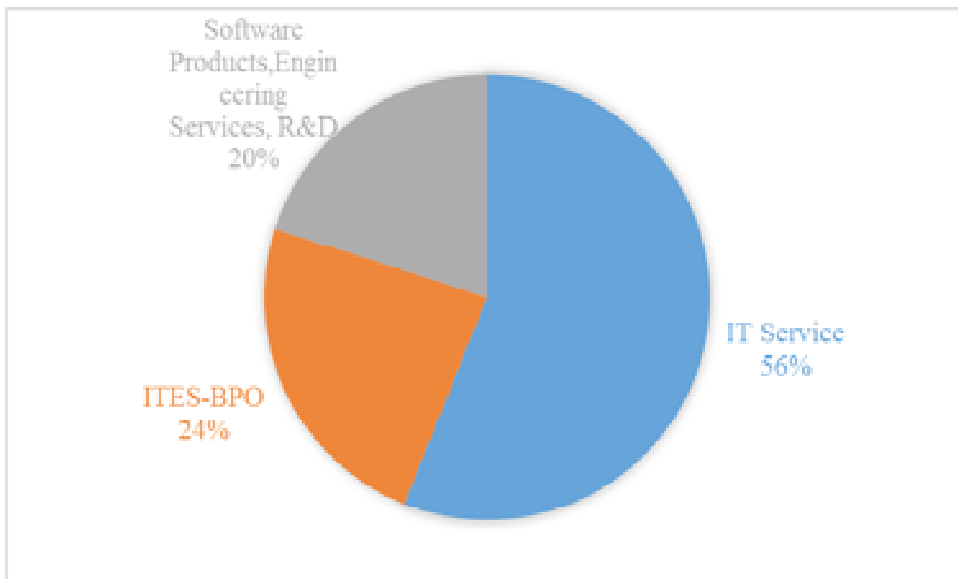
Source: Drawn on data obtained from <http://www.nasscom.in/impact-indias-growth>

Although India has had significant success in the IT services, it is yet to strike gold with IT products and intellectual property (Sadagopan, 2012). Given that TCS, Infosys, Wipro and Genpact are renowned brands from India there is no single IT product company yet like Microsoft, Facebook or Google. Bengaluru, Chennai, Mumbai and Hyderabad have definitely earned their names as IT hubs but the Silicon Valley of USA dominates in the field of IT innovations. Mani (2014) identifies three reasons for Indian IT firms not being able to break into the highly oligopolistic market of IT products. First, Indian IT firms did not have domain expertise to create products. Second, they did not want to take risks. Third, India was not a big market for IT products in the past. Majority of the Indian IT firms operate on business-to-business (B2B) models and not many have adopted the business-to-consumer (B2C) model.

Hailed as a global giant, paradoxically, the Indian IT industry predominantly provides low-end IT-services like BPO and IT software services. Figure 6 suggests that IT services and IT-BPO accounted for around 80 per cent of the export earnings from this industry in 2012-13. As per Figure 7, IT-Services exports accounted for the largest share of 57 per cent of about US\$ 86.0 billion, engineering R and D and software products has emerged as the second largest segment with 21.8 per cent share followed by BPO exports contributing 21.2 per cent. Interestingly, while there is a continuous

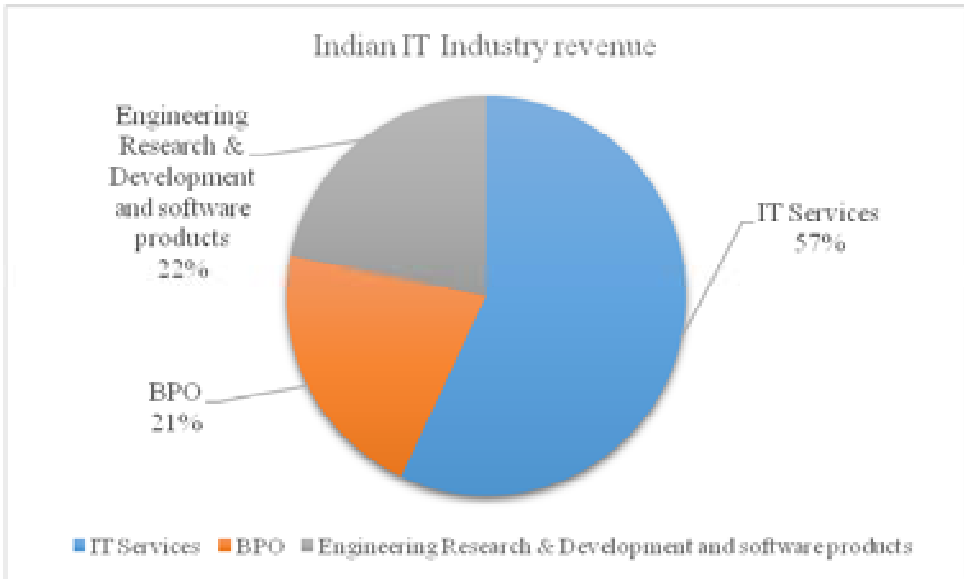
rise in the absolute value of the software product and engineering services, its relative share is just one fifth of the total exports of this industry. In fact, from both the figures it is clear that the software products, engineering services, R and D that are categorized as high-end IT-services had reported only a marginal rise from 20 to 22 per cent during the five years between 2012-13 and 2017-18.

**Figure 6: Export Revenue from Sub-sectors of the IT Industry (2012-13)**



Source: Drawn on data sourced from a report by India Brand Equity Foundation

**Figure 7: Export Revenue from Sub-sectors of the IT Industry (2017-18)**

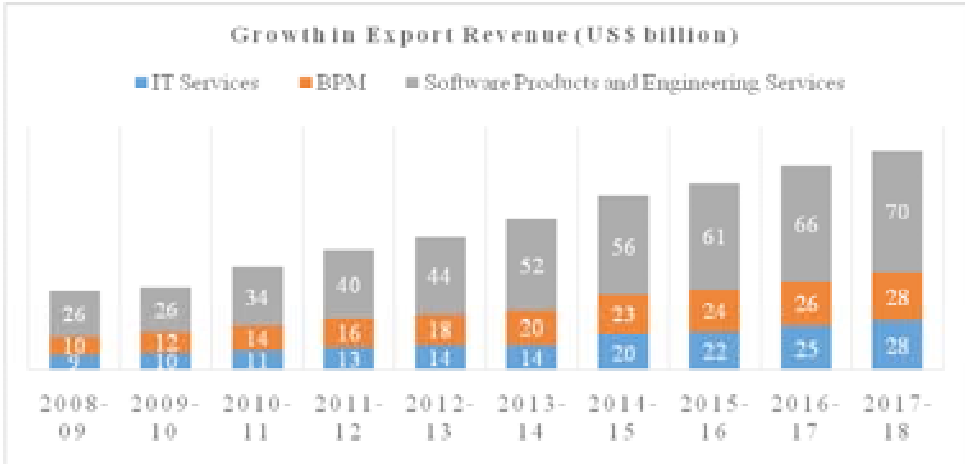


Source: Dawn on data sourced from <https://meity.gov.in/content/performance-contribution-towards-exports-it-ites-industry>

According to the *National Policy on Software Products*<sup>4</sup>, “The total revenue of software product industry in India was US\$ 6.1 billion, of which US\$ 2 billion was from exports. However, comparing the Indian software product industry with its Western counterparts, it is still in its infancy” (p. 4). The IT services, BPM and software product and engineering services have almost tripled between 2009-10 and 2018-19 (Figure 8) and the CAGR for the industry has been 12.26 per cent during the same period. The CAGR during 2013-18 for IT services, IT-BPO and software product and engineering services were recorded as 10.07 per cent, 9.19 per cent and 13.09 per cent respectively, and the CAGR for the entire industry was estimated to be 10.32 per cent during this period (Figure 9).

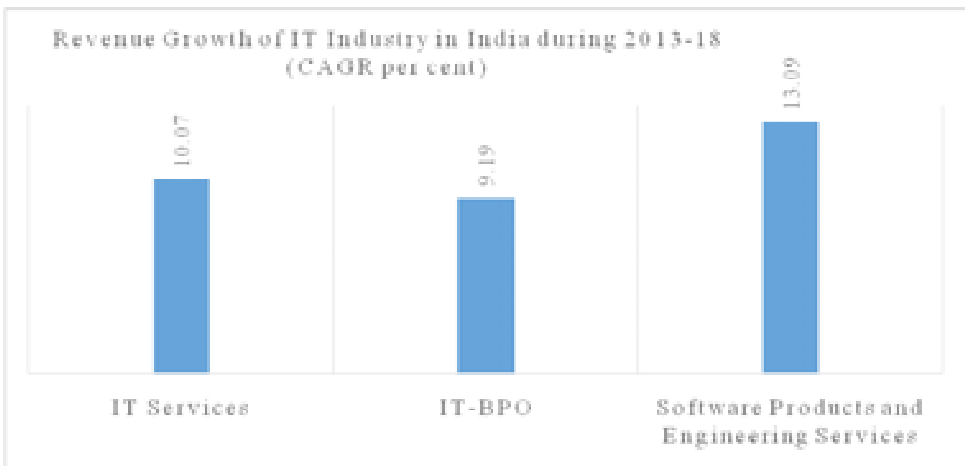
<sup>4</sup> <https://cis-india.org/internet-governance/files/national-policy-on-software-products.pdf> (accessed June 10, 2018)

**Figure 8: Segment-wise Export Revenue Trends in the IT Industry**



Source: Drawn on data from <https://www.ibef.org/uploads/industry/Infographics/large/it-and-ite-nov-2018.pdf>

**Figure 9: CAGR of Revenue of IT Industry in India, 2013-18 (per cent)**



Source: Drawn on data from <http://deity.gov.in/content/performance-contribution-towards-exports-it-ITES-industry>



## Employment Implications

### *Data and Methodology*

The empirical analyses relate to data on the IT sector and GDP Services for the years 1999 to 2017. As indicated earlier, the Indian IT industry had taken off since 1999 following the solution to the Y2K problem contributing significantly to the generation of employment, exports and GDP of India. Since the industry was typically dominated by low-end IT services, the introduction of 'disruptive' technologies like cloud, big data and analytics and automation in certain spheres has emerged as a challenge to the sustenance of existing jobs or creation of future jobs and obtaining orders from global buyers. Further, as IT-ITeS form an important component of the services sector, GDP-Services is likely to be affected by technological disruptions. Hence, as shown in Table 2, variables such as employment, market size, exports and GDP-Services have been included in the empirical analysis; all the values are in current prices.

**Table 2: Aspects of Growth of the IT Industry in India, 1999-2017**

Year	Employment in IT Industry (million)	Market size of IT Industry (US\$ billion)	Total IT Exports (US\$ billion)	GDP Services
1999-2000	0.66	7.63	3.71	11198.5
2000-01	1.86	11.94	6.54	11799.8
2001-02	0.53	13.12	7.93	12611.6
2002-03	0.68	15.42	9.86	13490.4
2003-04	0.84	20.79	12.97	14578.0
2004-05	1.06	28.18	18.05	15762.6
2005-06	1.31	38.67	25.69	17481.7
2006-07	1.62	49.58	33.22	19239.7
2007-08	2.01	70.70	47.02	21215.6
2008-09	2.21	73.40	50.41	23332.5
2009-10	2.30	73.70	49.7	25781.7
2010-11	2.54	74.00	59.0	28273.8
2011-12	2.77	88.00	68.8	30130.4
2012-13	2.77	101.00	76.5	32009.5
2013-14	3.29	108.00	87.3	34215.5
2014-15	3.52	118.00	97.8	37269.6
2015-16	3.69	147.00	107.8	40467.6
2016-17	3.86	143.00	117.0	43469.1

Source: For the IT sector data, NASSCOM and, for GDP Services data, *National Accounts Statistics*, Central Statistical Office. (Relevant years).

### *An Empirical Analysis*

An attempt has been made through econometric analyses to establish the relationship between employment and growth of the IT industry, especially, in terms of rise market demand, domestic as well as foreign. The massive rise in jobs in the IT sector in the country has often been cited as a high point in this sector's contribution to economic progress of the country and also an acknowledgement of quality of Indian IT-ITES personnel. The demand for labour in each industry is a derived demand. The size of the demand for final product produced by the industry, hence, is a critical factor affecting the industry employment level. In the case of Indian IT industry, the size of the market can be taken to be consisting of two components, namely, domestic market (DM) and export market (EM). The growth of the Indian IT industry is historically driven by exports while the size of domestic IT market has been comparatively small. It is predicted that both these components of the IT market will favourably affect employment generation in the Indian IT industry.

In addition to the size of the market for IT, employment level in the Indian IT industry can be expected to be related to the size of the services sector (SS). The growth of different areas of the services sector like finance, ecommerce, marketing, etc., has strong linkages with the IT industry. Higher the size of services sector greater is the employment level in the IT industry. Moreover, the global financial crisis may have affected employment generation in the Indian IT industry. The period 2007-08 to 2009-10 during which the global financial sector had seen huge uncertainty had dragged the overall global growth. This shrinking global demand was likely to have an adverse impact on the employment level in Indian IT industry.

Keeping the above postulations, the study has used the following empirical framework to examine determinants of employment in the Indian IT industry:

$$\ln LAB_t = \beta_0 + \beta_1 \ln EM_t + \beta_2 \ln DM_t + \beta_3 \ln SS_t + \beta_3 GF + \varepsilon_t \dots \dots \dots (1)$$

where explanatory variables are as measured in Table 3 and  $\varepsilon_t$  is the random error term.

**Table 3: Description and Measurement of Variables**

Variables	Symbols	Measurements
<i>Dependent Variable</i>		
Labour	$\ln LAB_t$	Natural log of number of employment in Indian IT industry in the year t.
<i>Independent variables</i>		
<i>Demand Conditions</i>		
Export Market	$\ln EM_t$	Natural log of IT exports (US\$ billion) from in year t.
Domestic Market	$\ln DM_t$	Natural log of domestic IT market size (US\$ billion) in India in year t.
<i>Size of Service Sector</i>		
Service Sector	$\ln SS_t$	Natural log of the size of service sector in India (constant Indian Rs.) of in year t.
<i>Global Financial Crisis</i>		
Global Financial Crisis Dummy	$GF_t$	Takes unity value for years 2007-08 to 2009-10, zero otherwise.

Equation 1 was estimated for the Indian IT industry for data concerning the period 1999-2000 to 2016-17. Given that issues of non-stationarity could arise only for a long time period and our study period is 18 years, the study has used the OLS method of estimation. The estimation results are presented in Table 4.

**Table 4: Determinants of Employment in the Indian IT Industry**

*Dependent Variable: Natural log of No. of Employment*

<i>Independent Variables</i>	Coefficients (Robust t-statistic)
$\ln EM_t$	0.554*** (5.608)
$\ln DM_t$	0.00656 (0.126)
$\ln SS_t$	0.112*** (4.062)
$GF_t$	0.0406 (0.430)
Constant	14.38*** (190.7)
F (4, 13)	27.88
Prob> F	0.0000
Observations	18
R-squared	0.837

Note: Robust t-statistics in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1;  $\ln EM_t$ ,  $\ln DM_t$ , and  $\ln SS_t$  are orthogonalized variables as described in the text.

The initial problem faced by the study was that our sample suffered from a strong multicollinearity as the mean value of variance inflating factor (VIF) for the independent variables was 22.47 while the condition number was 299. The VIF values for  $\ln EM_t$ ,  $\ln SS_t$  and  $\ln DM_t$ , respectively, stood at 45.14, 22.79 and 20.04.

To overcome the severity of this problem, the study preferred a modified Gram-Schmidt orthogonalization procedure (Golub and Van Loan, 1996) and created a new set of orthogonal for these three variables. In this successive orthogonalization process, we have arranged  $\ln EM_t$ ,  $\ln DM_t$  and  $\ln SS_t$  in accordance with their theoretical importance in affecting employment. Industry output, namely,  $\ln EM_t$  and  $\ln DM_t$  are the most important determinants compared to the size of the services sector in the economy. Re-calculation of the VIF on the new matrix of transformed explanatory variables reveals a mean VIF of 1.47 and a condition index of 2.67. The maximum VIF for individual explanatory variables is 1.93. This suggests that orthogonalization of concerned explanatory variables has contained the severity of multicollinearity in the sample.

Within the Indian IT industry, the two segments that have grown notably since the late 1990s are i. the IT services and ii. the IT-BPO/BPM segment. These were also the segments where external demand had remained high and the major share of jobs had been concentrated. In order to estimate the correlation coefficient between employment and exports by these segments, a bivariate Pearson correlation was run (on SPSS 16). The results have been presented in Table 5. It is obvious that the correlation between exports and employment in both the segments has been strong and significant.

**Table 5: Correlation Coefficient between Exports and Employment by Major IT Segments, 1999-2016**

Segment	Coefficient
IT Services	0.977**
BPO/BPM	0.892**

Notes: N = 17

\*\* Correlation is significant at the 0.01 level (2-tailed)

## Section II

### Emerging IT Services and New Technologies

Till around 2005, the Indian IT industry was largely dominated by call centres that focused on outsourcing services in business processes at costs considered low internationally. However, the industry has subsequently diversified in terms of IT services and the IT firms have grown into strategic business partners for their western clients. The number of BPO deals has been decreasing since 2013 with organizations typically looking for alternative options for cost reduction, such as greater use of shared services. It remains to be seen as to whether this points to a shrinking share of business process offshoring (KPMG, 2016).

Key growth drivers for global businesses for technology and BPM spending in 2019, according to the NASSCOM's (2018-19: 12) *CEO Survey*, would be to digitise the core and build a truly digital organization, build customer value through enhanced customer experience, unlock growth with new revenue opportunities, enhanced efficiency and modernisation and cost optimization in their decreasing order. Digitizing business than just silos and enhanced customer experience are the top two spending areas for IT and BPM, however, cost optimization was a much lower priority. Further, the top technology priorities for global businesses in 2019 were advanced analytics and AI, hybrid cloud, cyber security, devices and IoTs and blockchain. Advanced Analytics and AI are the top priorities for over 50 per cent of the CEOs and hybrid cloud and cyber security are witnessing increased spending (NASSCOM, 2018-19: 12).

New IT services have emerged and this industry has been adopting new business models over the last 15 years or so. The IT industry is a knowledge based and services centric sector and, hence, has been passing through a major technological transition. Such developments have posed a challenge before the Indian IT industry to assert its leadership position again. Constant innovations in Software Mobile Analytics Cloud (SMAC) technologies have been recognized as both a serious threat as well as a source of 'new' employment in the sector. Firms in India are exploring new opportunities in SMAC that have a tremendous potential to fulfil the demand not only in the so far untapped domestic market but also in other Asian and African countries. Newly set up firms during the last half a decade are attempting

to exploit the SMAC technologies for their businesses in agriculture, healthcare and education.

### *Cloud Computing*

Cloud computing is proving to be a breakthrough innovation as it offers benefits in terms of storing of huge volumes of data with security with reduced or no investments in hardware and software. With the explosion of voice and visual data, it has become untenable for each and every organization to cater to their requirements individually, thereby making the public cloud an attractive option to store important data (Cherian, 2014). Most small businesses that have migrated to cloud have reduced their cost of running applications as the cloud service provider has been investing in infrastructure and not the business firms. In the IT sphere, cloud computing includes Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS) and provides a perfect platform on which unorganized data could be loaded, crunched and analysed (Sen, 2015: 78-79). Cloud computing has opened up a whole world of possible industry disruptions allowing start-ups and SMEs to compete successfully with long-established enterprises (Bhattacharya, 2016) and SaaS is the preferred model of over 50 per cent of Indian product companies. In fact, software and services revenue crossed US\$ 150 Billion during 2017-18 (NASSCOM, 2018: 6). In India, 65 per cent of large enterprises are making use of cloud technology, services and solutions as part of their IT infrastructure (Bhattacharya, 2016).

Firms in the business of cloud computing possess sophisticated monitoring systems, multi-layered security safeguards and centralized management. Cloud-based applications, hosted by third party vendors, have been helping replace the traditional warehouse management system that requires substantial investments in physical infrastructure and its maintenance and software licenses. People from across places could share/store data in the public domain of cloud services.

Outsourcing IT software functions to distant data storage opens doors to new security threats such as security breaches, data theft and service traffic hijacking. The risk in cloud computing is much more serious particularly if it leads to a security breach or data loss by a bank or defence company or national security agency. The possible threats to cloud security identified by

experts of the Cloud Security Alliance (CSA) are data breaches, data loss, account or service traffic hijacking, insecure interfaces, denial of services, malicious insiders, abuse of cloud services, insufficient due diligence and shared technology vulnerability<sup>5</sup>. There were more than 10,000 cases of cybercrime in India in 2016. India is ranked third after the United States and Japan among the countries most affected by online banking malware (Dawar and Peter, 2017).

India needs a large number of cyber security experts to protect firms from the increasing number of cyber frauds, cyber attacks and theft of sensitive information. Government departments like vigilance, police, intelligence and defence demand cyber security experts for their own requirements. There is a whole range of demand arising from state agencies, corporate sector and even households and for investigation, surveillance and even spying.

### ***Internet of Things (IoT) and Automation***

IoT is a technology that connects devices such as mobile phones, digital watches, fitness bands and other digital machines through internet, WiFi or GPS to share information among concerned persons. It allows physical objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems and resulting in improved efficiency, accuracy and economic benefits (Modi, 2015). Examples could include drone, driverless car and chatbot. According to World Bank estimates, automation threatens 69 per cent of the jobs in India<sup>6</sup> but at the same time can potentially create numerous business opportunities to expand product and services offerings. It permits IT firms to harvest data on an unimaginable scale through devices that provide rich streams of data on a continuous basis. In the long run, the size of data generated will increase exponentially creating new avenues for data managers, researchers and analysts to map consumer tastes and preferences to obtain business insights. As Shrikanth (2015:12) predicted “By 2020, there will be 50 billion networked devices and this level of connectivity will have profound social, political and economic consequences.”

---

<sup>5</sup> <https://www.darkreading.com/vulnerabilities-threats/cloud-security-alliance-names-top-7-threats-to-the-cloud/d/d-id/1133074> (Accessed June 15, 2018)

<sup>6</sup> <http://www.thehindu.com/business/Industry/Automation-threatens-69-jobs-in-India-World-Bank/article 15427 005.ece> (Accessed June 5, 2018)

As per the *Business Process Management Report*, technology and automation are fast emerging as one of the key levers to create best-in-class business process management outcomes and Robotic Process Automation (RPA) is now emerging as an unassisted automation approach that offers high value creation at relatively lower risk along with the opportunities of significant cost savings, better service delivery and manageability, and quicker time-to-value. The chatbots function as robotic customer service representatives for a host of companies such as taxi, e-commerce, news and weather and are increasingly being deployed globally and in India (Agrawal, 2016a). The chatbots could spell significant loss of revenue for BPOs along with leading to erosion of low-end repetitive jobs (Agrawal, 2016b). Automation, with significant implications for employment in the Indian IT industry, is increasingly becoming a change enabler for Indian IT services. In 2018, an average of 71 per cent of total task hours across the 12 industries covered in the report were performed by humans, compared to 29 per cent by machines; but by 2022 this average is expected to have shifted to 58 per cent task hours performed by humans and 42 per cent by machines (WEF, 2018: 10).

### ***Big Data, Analytics and E-Commerce***

Big data will enable implementing and monitoring a number of interconnected systems managing public amenities and services and features that will support 'smart' aspects of smart cities. Big data and analytics are going to play a pivotal role in checking illegal use of resources like water and electricity and would prevent various types of wastage. Improving citizen security, optimization of water supply, and efficient power distribution are just a few examples of what big data could do to take the smart cities concept to the next level (Kiran, 2015).

Big data and analytics are helping business firms to predict on consumer tastes and preferences. E-commerce industry has brought a mixed bag of opportunities and threats. While this sector has created new employment opportunities for a range of other sectors the challenges of predatory pricing, sale of poor quality products, delivery of wrong products and non-payment of claimed refunds remain some of its grey areas. Further, there have been cases of illegal trade and smuggling of endangered animals, their body parts and rare species of plants on e-commerce portals.



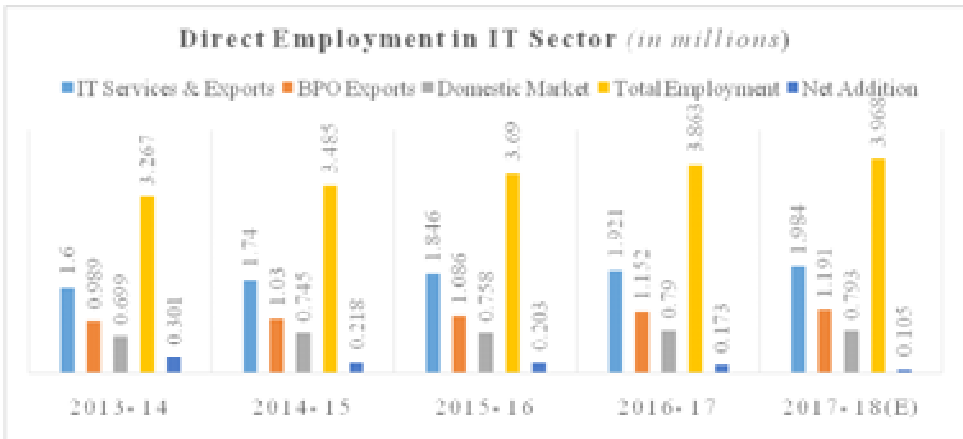
Cloud computing, e-commerce and domestic technology services grew at 43 per cent, 17 per cent and 10 per cent, respectively, during 2017-18 (NASSCOM, 2018: 5). The online business has been creating employment opportunities for transporters, courier and packaging companies. Having experienced cuts in their profit margins, even small retailers are increasingly going online. Smart phones have fuelled the growth of the e-commerce industry in India. Social media, particularly, Facebook and WhatsApp, have been extensively used in promoting online business in India. Although no country level information is available yet, global estimates<sup>7</sup> suggest that these disruptive technologies are likely to have a trillion dollar economic impact, viz., mobile technology (US\$ 3.7-10.8 trillion), automation and robotics (US\$ 5.2–6.7 trillion), IoT (US\$ 2.7-6.2 trillion) and cloud computing (US\$ 1.7-6.2 trillion) every year. These technologies can potentially be used in almost all sectors of the economy creating ample job opportunities for technicians, IT professionals and engineers. It is important to mention that 3D printing is another field that could potentially transform manufacturing in the entire world including India. Although 3D printing is in its nascent stage, it could potentially create an economic impact of US\$ 230-550 billion every year.

The IT industry is a major employer of the urban youth in India. As shown in Figure 10, more and more jobs were created in this industry between 2012-13 and 2017-18. It is estimated that about 3.97 million people were employed in this sector in 2017-18. Within the IT industry, the sub-sectors, namely, export driven IT services and BPO have the largest share in total employment. Domestic market of this industry had increased from 0.699 million to 0.793 million between 2012-13 and 2017-18, however, it makes just one fifth of the total employment in the sector. Moreover, the net addition to the direct employment in 2017-18 is reduced to its one third in 2013-14.

---

<sup>7</sup> Drawn on information obtained from McKinsey Global Institute (2013).

**Figure 10: Direct Employment in the IT Sector in India**



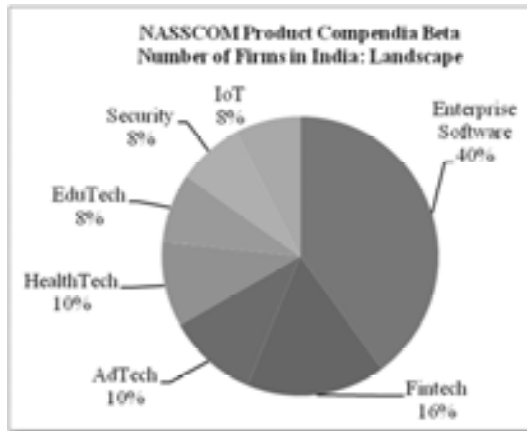
Source: Drawn on data sourced from <https://meity.gov.in/content/employment>

In the changing context of the rise of disruptive technologies as a business driver, it is imperative that IT service providers not only reduce costs but deliver business outcomes in terms of value and impact (Nair, 2015). The large IT corporate firms in India are increasingly becoming fast solution providers for their clients.

The IT industry has been moving into Tier-II cities as well. Among the IT landscape, greater number of firms belongs to enterprise software, fintech, healthtech and adtech category (Figure 11). It may be observed that the Indian IT industry provides service somewhere at the low-end or middle of the IT value chain. Looking at IT verticals, BFSI (18 per cent), across sectors (17 per cent), healthcare (17 per cent) and next generation commerce (15 per cent) occupy the dominant share (Figure 12). As per the NASSCOM's Product Compendia Beta, concentration of IT firms was found the highest in Bengaluru followed by Delhi NCR, Mumbai, Chennai, Hyderabad and Pune, in that order<sup>8</sup>. All these developments point to a maturing of the IT industry in India and building up of potential to handle high-end technology services.

<sup>8</sup> <http://www.productsma.de.in/> Accessed June 5, 2016

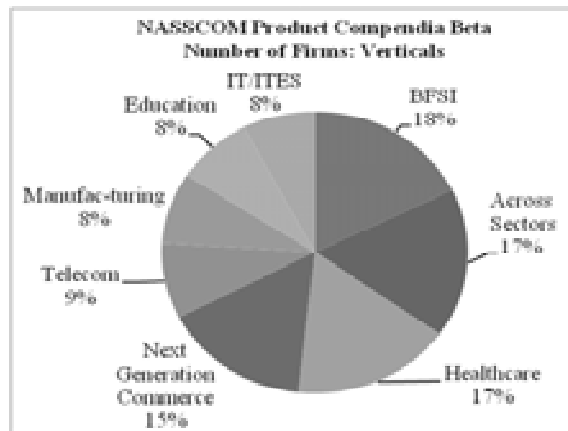
**Figure 11: IT Firms in India: Landscape**



Source: Drawn on data obtained from <http://www.productsma.de.in/>

Note: Product Compendia Beta for Landscape refers to digital technologies available as products for digital solutions across sectors

**Figure 12: IT Firms in India: Verticals**



Source: Drawn on data obtained from <http://www.productsma.de.in/>

Note: Product Compendia Beta for Verticals refers to a particular digital technology available for common problems across sectors

## Section III

### Opportunities and Challenges

Digital technologies have unleashed the *Industrie 4.0*. A combination of technological advancements is transforming consumer lives, creating value

for business, and unlocking broader societal benefits at an unprecedented scale. The potential value at stake is estimated at a massive US\$ 100 trillion over the next 10 years. In India alone, digitalization can lead to benefits valued at more than US\$ 5 trillion. The IT company Accenture estimated the impact of technological disruptions as follows: Virtual collaboration and talent portals can reduce hiring costs by approximately 10 per cent, cloud-based accounting systems and AI-driven automation can reduce costs by approximately 40 per cent, cloud computing can reduce IT system costs by 25-50 per cent, autonomous transport and sensors for monitoring supply chains can cut costs by 50 per cent, crowd sourcing and AI can improve productivity by 20-40 per cent (Dawar and Lacy, 2017). As technological breakthroughs rapidly shift the frontier between the work tasks performed by humans and those performed by machines and algorithms, global labour markets are undergoing major transformations, however, if these transformations are managed wisely, could lead to a new age of good work, good jobs and improved quality of life for all, but if managed poorly, pose the risk of widening skills gaps, greater inequality and broader polarization (WEF, 2018: 9).

Automation has the potential to bring revolutionary changes in the Indian IT industry. Automation, being seen as a labour-replacing technology, could also create new jobs. As, in all likelihood, it may eradicate the need for human intervention in different areas, especially high-volume, repetitive tasks, jobs related to IT support, remote infrastructure, and business processes may be adversely impacted. Additionally, the IT firms find high rate of labour attrition as a major concern. Therefore, they are switching over to newer technologies that involve limited human intervention. Seeing the potential of IoT, the government is promoting IoT to capitalize on the business opportunities by improving supply chain, better delivery of services by smart cities and closer monitoring of production lines. For example, in order to make Andhra Pradesh a hub for IoT by 2020, the state government has been creating 10 IoT hubs by providing land on lease on easy terms, offering relaxed fiscal and administrative procedural norms for companies, and building world-class IT infrastructure (*The Times of India*, 2016a).

As the *Industrie 4.0* unfolds, companies are seeking to harness new and emerging technologies to reach higher levels of efficiency of production and consumption, expand into new markets, and compete on new products for a global consumer base composed increasingly of digital natives

(WEF, 2018: 9). According to a report by Great Learning, “Over 50,000 positions in the fields of data science and machine learning are vacant in the country owing to a lack of skilled workforce”.<sup>9</sup> As, in all likelihood, it may eradicate the need for human intervention in different areas, especially high-volume, repetitive tasks, jobs related to IT support, remote infrastructure, and business processes may be adversely impacted. Therefore, they are switching over to newer technologies that involve limited human intervention.<sup>10</sup>

## **Threat of Technological Disruptions**

Most of the big IT companies in India are investing heavily in automation of processes in their traditional businesses like BPO, application management and infrastructure management (*The Times of India*, 2016b). At this stage, only big IT firms are able to create tools and platforms for automation in infrastructure, application, testing and BSP service due to their capability in terms of investment, sophisticated technology and business network with multinational corporations. This will have a two-fold impact on employment; firstly, drop in hiring and secondly, removing some of the existing labour. It has been argued that while all jobs are at risk of automation, it is the “routine” and “predictable” jobs that will be impacted most (Ford, 2015: 10). In order to shift to automation, major IT companies in India are reducing their employee strength in recent times (Figure 13). As shown in Figure 14, the headcount of six top IT companies - TCS, Cognizant, Infosys, Wipro, HCL and Tech Mahindra - put together dropped by 4157 in the first six months of 2017-18 compared to an increase of almost 60000 during the

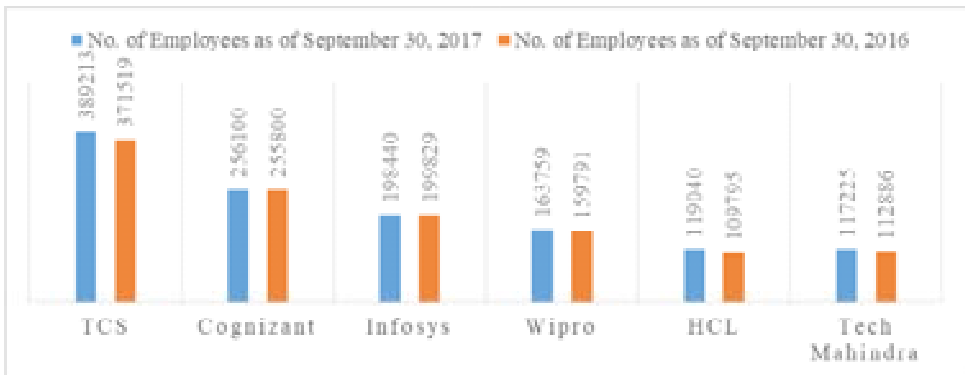
---

<sup>9</sup> [http://timesofindia.indiatimes.com/articleshow/66259707.cms?utm\\_source=contentofinterest&utm\\_medium=text&utm\\_campaign=cppst](http://timesofindia.indiatimes.com/articleshow/66259707.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst)

<sup>10</sup> This process is described thus: “Digital tools are creating a new informal “gig economy,” where workers can combine a number of disconnected tasks to earn their incomes. In many cases, these gig economy platforms have disrupted traditional markets in the ‘real world’ as well; for example, Uber has confronted taxi unions and regulators in a number of countries, while Airbnb (which allows someone to rent out their residence partly or in entirety) has challenged the hotel industry. Concerns about these platforms include the lack of price floors, little social safety nets, and difficulties in regulating the entry and behavior of workers, customers, and the platforms themselves. Regulating these platforms has proven to be challenging” (World Bank Group, 2015: 7).

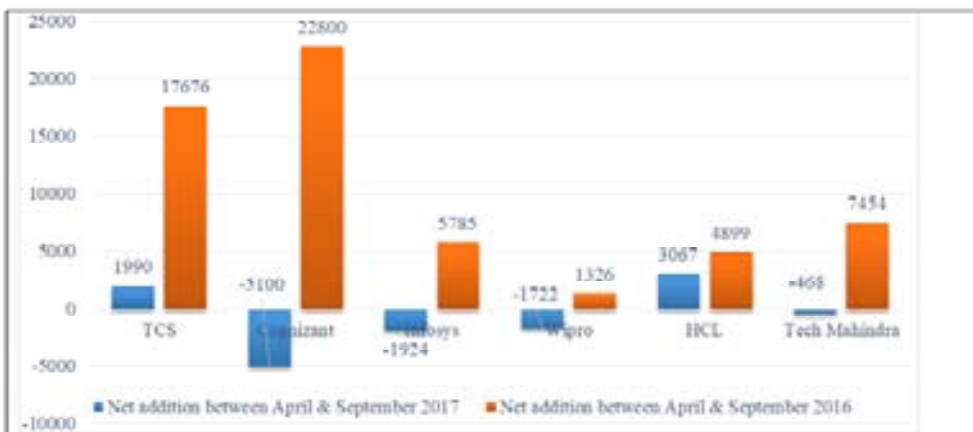
same period last fiscal year (Das and Phadnis, 2017). New sets of skill required for the existing workforce, automated machines replacing labour for repetitive tasks and artificial intelligence are important factors behind this shift in recruitment in the industry.

**Figure 13: Employment in Major IT-ITES Companies in India**



Source: Drawn on data sourced from Das and Phadnis (2017).

**Figure 14: Impact of Automation on Jobs in Select Indian IT-ITES Companies**



Source: Drawn on data sourced from Das and Phadnis (2017).

As the nature of IT application in various processes would undergo a transformation it would seriously impact employment prospects for conventional tasks in different industries. Both the possibilities and limits appear beyond easy comprehension.<sup>11</sup> Google's driverless car would reduce demand for the regular driver of cars. Similarly repetitive tasks in a factory would be handled by robots in the future, replacing human labour again. Interestingly, the impact of labour reducing and labour replacing would be felt more at the bottom of the pyramid of work hierarchy, however, the top management of the companies would be least affected by robotics and smart machines. Technological disruptions such as robotics and machine learning - rather than completely replacing existing occupations and job categories - are likely to substitute specific tasks previously carried out as part of these jobs, freeing workers up to focus on new tasks and leading to rapidly changing core skill sets in these occupations (WEF, 2016: 7).

In the absence of any comprehensive database on the manner in which the future of work in this sector would unfold, a recent survey based study (FICCI *et al.*, 2017: 72) estimated that by 2022 in the Indian IT-BPM sector would have 4.5 million jobs of which while 10-20 per cent would be 'new' jobs (requiring hitherto-unavailable new skills), 60-65 per cent jobs would require 'changes' in existing skills implying upgrading skills. By 2022, no less than 54 per cent of all employees will require significant re- and upskilling. Of these, about 35 per cent are expected to require additional training of up to six months, 9 per cent will require re-skilling lasting six to 12 months, while 10 per cent will require additional skills training of more than a year (WEF, 2018: 11). HfS Research (2016) taking note of the fast progress in the automation and digital technologies predicted that by 2021 demand for low-skilled and routine jobs would drop sharply by 30 per cent globally and

---

<sup>11</sup> Regarding the possibilities and limits of new technologies, as these unfold through growing applications, "Opportunities exist to leverage analytics, algorithms, and drones in the near future to protect and potentially expand markets. In the medium to long term, robots and driverless cars will also likely gain adoption although, as with any technology, how they will be deployed will likely evolve over time. Factors affecting the adoption of the new technologies and business models examined in this paper include business profitability; environmental considerations that may accelerate the use the technology that save carbon emission, customary safety and trust concerns regarding new technology, labour issues with crowdsourcing and other models; and regulations governing drones, robots, and driverless cars" (Standard Business Graduate School, 2016: 13).

the number of loss of such low-end jobs would be around 0.64 million in India. However, new IT jobs in India would grow by 14 per cent to about 0.16 million. Job cuts in Indian IT companies would be around 0.2 million per year in the next 3 years, due to under-preparedness in adapting newer technologies (Lakshmikanth, 2017). Based on the job profiles of their employee base today, nearly 50 per cent of companies expect that automation would lead to some reduction in their full-time workforce by 2022 (WEF, 2018: 10).

Given the nature of employment-skill configuration in the Indian IT industry, as shown in Figure 16, the greatest and earliest risk of job losses would be in the massive low-end jobs, while the few top notch professionals might, in fact, move up in career performance through re-skilling and resilience with alacrity.

**Figure 15: Risk of Job Losses due to New Technologies at Different Work Hierarchy**



Source: <https://www.gsb.stanford.edu/sites/gsb/files/publication-pdf/vcii-publication-technological-disruption-innovation-last-mile-delivery.pdf>

## Section IV

### Concluding Observations

In order to make the Indian IT industry move up the value chain and thereby sustain its growth trajectory, a paradigm shift in the industry's strategy for the software sector is being observed. Focus of the IT industry is on software product development to contribute equitably and significantly along



with IT services. The Indian IT industry is passing through a crucial phase of technological disruptions that demands deeper specialization and constant innovations risking its ability and readiness to deliver quality IT services.

Cloud computing, big data and automation are creating tremendous business opportunities in India but then how to capitalize on such a situation falls in the domain of the stakeholders including the state. Constant innovation, improving IT infrastructure and removing legal and administrative bottlenecks are the need of the hour for the Indian IT sector to sustain its leadership position and to take anew (Das and Sagara, 2017). Though IT exports from India is largely dominated by corporates, there are numerous small firms working on highly technical, innovative and creative projects. Development of mobile applications and platforms for small business units is turning out to be a lucrative business opportunity for small IT firms and individual software developers.

In a joint study of Analytics India Magazine and Great Learning found that the artificial intelligence industry has grown by close to 30 per cent during financial year 2017-18 to US\$ 230 million and the industry is witnessing a shortage of over 4,000 mid and senior-level qualified job positions in the country<sup>12</sup>. Digital transformation has the potential to unlock value at an unprecedented scale and adaptive organizations that understand, embrace, and prepare for this change can gain significant business value as part of this transformation. While digitalization can be a net job creator in some industries and a destructor in others, there is a need to evaluate and up-skill employees to manage employment rates through relevant investment in enabling infrastructure.

New technologies can drive business growth, job creation and demand for specialist skills but they can also displace entire roles when certain tasks become obsolete or automated (WEF, 2018: 11). McGowan and Andrews (2015: 32) in their OECD Survey of Adult Skills suggested that while differences in skill mismatch across countries are associated with differences in the policy environment in different countries, skill mismatch is lower in countries with well-designed framework conditions that promote efficient reallocation, greater flexibility in wage negotiations and higher participation in lifelong learning as well as better managerial quality.

---

<sup>12</sup> //economictimes.indiatimes.com/articleshow/67131803.cms?utm\_source=contentofinterest&utm\_medium=text&utm\_campaign=cppst

The Indian IT industry will have to cope with challenges concerning to data security, privacy of individuals, content management and cybercrimes. Lower level of digital literacy, unreliable internet connectivity and shortage of power supply are major hindrances before the IT industry in India. It is predicted that India may experience a falling demand in the traditional BPO business, but with the setting up of adequate infrastructure and promoting constant innovations, India could hope to continue to dominate the world in the IT services in the future as well. Creation of relevant opportunities for 'new' jobs would hinge upon the nature and degree of proactive preparedness the state and even the private sector might show. There is a need for a comprehensive 'augmentation strategy', an approach where businesses look to utilize the automation of some job tasks to complement and enhance their human workforces' comparative strengths and, ultimately, to enable and empower employees to extend their full potential (WEF, 2018: 11).

For governments and businesses alike, there is a significant opportunity in strengthening cross-sectoral multi-stakeholder collaboration to promote corporate re-skilling and up-skilling among employers in affected countries and regions (WEF, 2018: 34). The *National Policy on Software Products* (2016) aims at creating synergies of efforts by the government and industry to create a robust software product industry that would buttress large number of software product start-ups, promote development of an ecosystem encouraging R and D and innovation, open up multitude of opportunities of access to capital and help build and improve domestic demand.

Governments and businesses will need to change profoundly their approach to education, skills and employment, and their approach to working with each other and the governments will need to show bolder leadership in putting through the curricula and labour market regulation changes that are already decades overdue in some economies (WEF, 2016: 9). It has been observed that the Digital India initiative of the Government of India has the potential to transform the entire service delivery system accelerating productivity, employment and literacy in areas that are not digitally connected in the country (Goel, 2014). Similarly, the Smart City Project, according to NASSCOM, would create a massive business opportunity of US\$ 30-40 billion for the IT industry over the next 5-10 years (Srikanth, 2015). However, progress on these mega programmes have been sluggish and far from the promises made when these were formally announced.

## References

Agrawal, Surabhi (2016a). BPOs beware! Chatbots are on their way. *The Times of India*, June 15. Retrieved on July 10, 2016 from <http://timesofindia.indiatimes.com/tech/tech-news/BPOs-beware-Chatbots-on-their-way/articleshow/52757547.cms>

Agrawal, Surabhi (2016b). How chatbots could soon put BPOs out of business. Retrieved on July 12, 2016 from [//economictimes.indiatimes.com/articleshow/52754634.cms?from=mdr&utm\\_source=contentofinterest&utm\\_medium=text&utm\\_campaign=cppst](http://economictimes.indiatimes.com/articleshow/52754634.cms?from=mdr&utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst)

Ahmed, Gouher (2012). Krugman trade theory and developing economies. *China-USA Business Review*, 11(12), 1557-1564

Antras, Pol & Helpman, Elhanan (2004). Global sourcing. *Journal of Political Economy*, 112(3), 552-580.

Baldwin, Richard (2011). Trade and industrialisation after globalisation's 2nd unbundling: How building and joining a supply chain are different and why it matters. *Working Paper 17716*, National Bureau of Economic Research, Cambridge MA. Retrieved on April 25, 2018 from <http://www.nber.org/papers/w17716>

Bhattacharya, Biswanath (2016). Cloud computing: The silver lining for SMEs and start-ups. *PCQUEST*, March 23. Retrieved on November 3, 2017 from <http://www.pcquest.com/cloud-computing-the-silver-lining-for-smes-start-ups/>

Cherian, Praveen (2014). Mobility and scalability of public cloud. *Dataquest*, 32(20), October 31, 60.

Das, Avik & Phadnis, Shilpa (2017, November 2). Infosys, Wipro's headcount shows the kind of IT jobs will survive. *The Economic Times*. Retrieved on November 3, 2017 from [https://economictimes.indiatimes.com/articleshow/61449803.cms?utm\\_source=contentofinterest&utm\\_medium=text&utm\\_campaign=cppst](https://economictimes.indiatimes.com/articleshow/61449803.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst)

Das, Keshab & Sagara, Hastimal (2017). State and the IT industry in India: An overview. *Economic and Political Weekly*, 52(41), 56-64.

Dawar, Sanjay & Lacy, Peter (2017, August 8). Digital disruption: Capitalizing on the 4th Industrial Revolution fuelled by digital technologies. *Live Mint*. Retrieved on April 10, 2018 from <https://www.livemint.com/Home-Page/2No24MFhEFWjwj4pNIEMML/Digital-disruption-Capitalizing-on-the-4th-Industrial-Revolution.html>

FICCI, NASSCOM & EY (2017). *Future of jobs in India: A 2022 perspective*. Retrieved on February 28, 2018 from [http://www.ey.com/Publication/vwLUAssets/ey-future-of-jobs-in-india/\\$FILE/ey-future-of-jobs-in-india.pdf](http://www.ey.com/Publication/vwLUAssets/ey-future-of-jobs-in-india/$FILE/ey-future-of-jobs-in-india.pdf)

Ford, Martin (2015). *Rise of the robots: Technology and the threat of a jobless future*. Basic Books, New York.

Goel, Ruchika (2014). Digital India is the need of the hour. *Dataquest*, 32(20), October 31, 40-43.

Golub, Gene H. & Van Loan, Charles F. (1996). *Matrix computations*. The Johns Hopkins University Press, Baltimore.

HfS Research (2016, July 5). Automation to impact 1.4 million global services jobs by 2021 with India the most affected. Retrieved on March 25, 2018 from <https://www.hfsresearch.com/press-releases/automation-to-impact-14-million-global-services-jobs-by-2021-with-india-the-most-affected>

KPMG (2016). Global IT-BPO Outsourcing deals analysis, February. Retrieved on June 8, 2018 from <https://assets.kpmg.com/content/dam/kpmg/pdf/2016/03/KPMG-Deal-Tracker-3Q15.pdf>

Kaur, Bhupinder (2015). Impact of E-Commerce on E-Retail, *Journal for Studies in Management and Planning*, 6(1). Retrieved on June 8, 2018 from <https://edupediapublications.org/journals/index.php/JSMaP/article/view/1548>

Kiran, P.C. (2015). When Smart Cities meet big data. *Dataquest*, 33(17), September 15, 52-53.

Krugman, Paul (1979). Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, 9, 469–479.

Lakshmikanth, K. (2017, May 14). Indian IT firms to layoff up to 2 lakh engineers annually for next 3 years. *Livemint*. Retrieved on April 20, 2018 from <https://www.livemint.com/Industry/Y0oIb1D6N1ADZDfq3BUhUM/Indian-IT-firms-to-layoff-up-to-2-lakh-engineers-annually-f.html>

Mani, Sunil (2014). Emergence of India as the world leader in computer and information services. *Economic and Political Weekly*, 49(49), 51-61.

McGowan, Müge Adalet & Dan Andrews (2015). Skill Mismatch and Public Policy in OECD Countries, The Future of Productivity: Main Background Papers, Economics Department Working Papers No. 1210, ECO/WKP(2015) 28. <https://www.oecd.org/eco/growth/Skill-mismatch-and-public-policy-in-OECD-countries.pdf>

McKinsey Global Institute (2013). Disruptive technologies: Advances that will transform life, business, and the global economy. Retrieved on November 7, 2017 from file:///C:/Users/Lenovo/AppData/Local/Packages/Microsoft.MicrosoftEdge\_8wekyb3d8bbwe/TempState/Downloads MGI\_Disruptive\_technologies\_Full\_report\_May2013.pdf

Melitz, Marc (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6), 1695–1725.

Modi, Dilip (2015). IoT shall be the next big force to drive mobility. *PCQUEST*, December 23, 24-25. Retrieved on November 3, 2017 from <http://www.pcquest.com/iot-shall-be-the-next-big-force-to-drive-mobility/>

Nair, E. (2015). The challenge of change. *Dataquest*, 33(13), 82.

NASSCOM (2017), The IT-BPM Industry In India 2017: Strategic Review. Retrieved on June 7, 2018 from <https://www.nasscom.in/knowledge-center/publications/it-bpm-industry-india-2017-strategic-review>

NASSCOM (2018-19). CEO Survey: 2019-20 Industry Performance: 2018-19 and what lies ahead. [https://www.nasscom.in/sites/default/files/Industry-Performance2018-19-and-what-lies-ahead\\_0.pdf](https://www.nasscom.in/sites/default/files/Industry-Performance2018-19-and-what-lies-ahead_0.pdf)

Productivity Commission (2016). Digital disruption: What do governments need to do?, *Commission Research Paper*, Canberra, June. Retrieved on June 7, 2018 from <https://www.pc.gov.au/research/completed/digital-disruption/digital-disruption-research-paper.pdf>

Sadagopan, Sowmyanarayanan (2012). IT in India, *Yojana*, 56, September, 13-16.

Sen, Andy (2015). Marrying IoT with big data: Not possible without a cloud home. *Dataquest*, 33(13), 78-79.

Shrikanth, G. (2015). A utopia called secured cloud. *Dataquest*, 33(13), 28-31.

Srikanth, R.P. (2015). Smart cities: An opportunity to transform India. *Dataquest*, 33(17), September 15, 8.

Standard Business Graduate School (2016). Technological disruption and innovation in last-mile delivery. Stanford Value Chain Innovation Initiative in Collaboration with United States Postal Service Office of Inspector General GSB.Stanford.Edu/R/Vcii, White Paper, June.

*The Times of India* (2016a, March 3). Andhra cabinet okays internet of things (IoT) policy. Retrieved on June 10, 2016 from [http://timesofindia.indiatimes.com/good-governance/andhra-pradesh/Andhra-cabinet-okays-Internet-of-Things-IoT-olicy/articleshow/51237426.cms?](http://timesofindia.indiatimes.com/good-governance/andhra-pradesh/Andhra-cabinet-okays-Internet-of-Things-IoT-olicy/articleshow/51237426.cms)

*The Times of India* (2016b, November 2). Amid IT layoffs, this could be a reason to cheer. Retrieved on November 2, 2017 from <https://timesofindia.indiatimes.com/business/india-business/amid-it-layoffs-this-could-be-a-reason-to-cheer/articleshow/61459252.cms>

World Bank Group (2015). The effects of technology on employment and implications for public employment services, *G20 Employment Working Group Meeting Report*, Istanbul, Turkey, May 6-8. Retrieved on June 7, 2018 from <http://g20.org.tr/wp-content/uploads/2015/11/The-Effects-of-Technology-on-Employment-and-Implications-for-Public-Employment-Services.pdf>

World Economic Forum (WEF) (2018). *The Future of Jobs: An Insight Report*, Centre for New Economy and Society. [http://www3.weforum.org/docs/WEF\\_Future\\_of\\_Jobs\\_2018.pdf](http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf)

World Economic Forum (WEF) (2016). *The Future of Jobs Employment: Skills and Workforce Strategy for the Fourth Industrial Revolution*, Global Challenge Insight Report, Executive Summary, January. [http://www3.weforum.org/docs/WEF\\_FOJ\\_Executive\\_Summary\\_Jobs.pdf](http://www3.weforum.org/docs/WEF_FOJ_Executive_Summary_Jobs.pdf)

## THE GIDR WORKING PAPER SERIES (No. 211 onwards)

211. P.K. Viswanathan, “Rationalisation of Agriculture in Kerala and Its Implications for Natural Environment, Agro-Ecosystems and Livelihoods”, September 2012. Rs. 40.00.
212. Keshab Das, “Situating Labour in the Global Production Network Debate: As if the ‘South’ Mattered”, December 2012. Rs. 40.00
213. Jaya Prakash Pradhan and Keshab Das, “Determinants of Regional Patterns of Manufacturing Exports: Indian Firms since the Mid-1990s”, January 2013. Rs. 40.00.
214. Madhusudan Bandi, “A Review of Decentralisation in India with Particular Reference to PRIs in Gujarat”, February 2013. Rs. 30.00.
215. Madhusudan Bandi, “*Samras* in Gujarat Gram Panchayats: A Constructive Experiment or Challenge to Electoral Democracy?”, March 2013. Rs. 30.00.
216. P.K. Viswanathan and Amita Shah, “Has Indian Plantation Sector Weathered the Crisis? A Critical Assessment of Tea Plantation Industry in the Post-reforms Context”, April 2013. Rs. 40.00.
217. Keshab Das, “Developing Regional Value Chains in South Asian Leather Clusters: Issues, Options and an Indian Case”, May 2013. Rs. 45.00.
218. Chandra Sekhar Bahinipati, “Determinants of Farm-Level Adaptation Diversity to Cyclone and Flood: Insights from a Farm Household-Level Survey in Eastern India”, August 2013. Rs. 40.00.
219. Chandra Sekhar Bahinipati, “Farm-level Adaptation to Climate Extremes in India: Do We Need a Separate Adaptation Policy?”, December 2013. Rs. 40.00.
220. Tara S. Nair, Milind Sathye, Muni Perumal, Craig Applegate and Suneeta Sathye, “Regulating Microfinance through Codes of Conduct: A Critical Review of the Indian Experience”, by March 2014. Rs. 45.00
221. Keshab Das, “The Sector Reforms Process in Rural Drinking Water and Sanitation: A Review of the Role of WASMO in Gujarat”, August 2014. Rs. 100.00.
222. Itishree Pattnaik and Amita Shah, “Trend in Agricultural Growth and Decomposition of Crop Output in Gujarat: A Recent Evidence”, September 2014. Rs. 100.00.

223. Madhusudan Bandi and P.K. Viswanathan, "Forest Governance Sustainability in India: Determinants and Challenges", October 2014. Rs. 100.00.
224. Jharna Pathak, "Class Gains in Fisheries Management: Problems and Prospects", December 2014. Rs. 100.00
225. Keshab Das, "Provisioning Drinking Water in Gujarat's Tribal Areas: An Assessment", January, 2015. Rs. 100.00.
226. Chandra Sekhar Bahinipati and Unmesh Patnaik, "Climate Change Economics: A Review on Theoretical Understanding and Controversies", April 2015. Rs. 100.00.
227. Keshab Das, "Institutional Constraints to Innovation: Artisan Clusters in Rural India", June 2015. Rs. 100.00
228. N. Lalitha and Amrita Ghatak, "Occupational Health Risks among Workers in the Informal Sector in India", September 2015. Rs. 100.00.
229. Leela Visaria and Rudra N. Mishra, "Health Training Programme for Adolescent Girls: Some Lessons from India's NGO Initiative", October 2015. . Rs. 100.00.
230. Tara Nair and Keshab Das, "Financing the MSME Sector in India: Approaches, Challenges and Options", December 2015. . Rs. 100.00.
231. Chandra Sekhar Bahinipati and P.K. Viswanathan, "Role of Policies and Institution in the Diffusion of Micro-Irrigation in Gujarat, Western India", February 2016. . Rs. 100.00.
232. Keshab Das and Hastimal Sagara, "State and the IT Industry in India: A Policy Critique", March 2016. Rs. 100.00.
233. Tara Nair , "Media, Technology and Family: Exploring the Dynamics of Interactions", May 2016. Rs. 100.00.
234. Amrita Ghatak, Debasish Nandy and Suddhasil Siddhanta, "Burden of Diseases due to Air Pollution in Urban India", July 2016. Rs. 100.00.
235. Unmesh Patnaik, Prasun Kumar Das, Chandra Sekhar Bahinipati, Onkar Nath, "Can Developmental Interventions Reduce Households' Vulnerability? Empirical Evidence from Rural India", August 2016. Rs. 100.00.
236. N. Lalitha and Amrita Ghatak, "India's Social Science Research Publications from an International Perspective", September 2016. Rs. 100.00.



237. Keshab Das, “Craft Clusters and Work in Rural India: An Exploration”, October 2016. Rs. 100.00.
238. N. Lalitha, “Creating Viable Markets through Use of Geographical Indications: What can India Learn from Thailand?”, November 2016. Rs. 100.00.
239. Unmesh Patnaik, Prasun Kumar Das and Chandra Sekhar Bahinipati, “Effect of Rural Livelihoods Project on Adaptation Decision and Farmers’ Wellbeing in Western Odisha, India: Application of Endogenous Switching Regression”, December 2016. Rs. 100.00.
240. N. Lalitha and Soumya Vinayan, “GIs for Protecting Agro-Biodiversity and Promoting Rural Livelihoods: Status, Strategies and Way Forward”, January 2017. Rs. 100.00.
241. Itishree Pattnaik, “Land Ownership Rights and Women Empowerment in Gujarat: A Critical Assessment”, February 2017. Rs. 100.00.
242. Itishree Pattnaik and Kuntala Lahiri-Dutt, “Tracking Women in Agriculture through Recent Census Data in India”, March 2017. Rs. 100.00.
243. Tara Nair, “Institutional Credit and Transformation of Rural India: Chequered Trajectories and Contested Connections”, April 2017. Rs. 100.00.
244. Keshab Das, “Labour Market Resilience in India: Conceptual and Policy Issues”, May 2017. Rs. 100.00.
245. Chandra Sekhar Bahinipati and Unmesh Patnaik, “Can Increasing Human Development and Income Reduce Impact from Natural Disaster? Empirical Evidence for Floods in India”, June 2017. Rs. 100.00.
246. Anil Gumber, Biplab Dhak and N. Lalitha, “Rising Healthcare Costs and Universal Health Coverage in India: An Analysis of National Sample Surveys, 1986-2014”, July 2017. Rs. 100.00.
247. Keshab Das, “Children’s Right to Safe Sanitation in Urban Gujarat: Evidence from the Margins”, January 2018. Rs. 100.00.

## About the Institute

The Gujarat Institute of Development Research (GIDR), established in 1970, is a premier organisation recognised and supported by the Indian Council of Social Science Research, New Delhi and Government of Gujarat. It is an approved institute of Maharaja Krishnakumarsinhji Bhavnagar University, Bhavnagar, Gujarat. GIDR undertakes analytical and policy-oriented research concerning development issues.

The broad thrust areas of research at the Institute include Natural Resource Management, Agriculture and Climate Change, Industry, Infrastructure, Trade and Finance, Employment, Migration and Urbanisation, Poverty and Human Resource Development and Regional Development, Institutions and Governance.

- In the area of **Natural Resource Management, Agriculture and Climate Change**, in-depth studies have been carried out relating to some of the major development interventions like Participatory Irrigation Management, Watershed Development Programmes, Joint Forest Management and Protected Area Management. The studies have focused mainly on aspects relating to economic viability, equity and institutional mechanisms. In the sphere of management of natural resources, these studies often explore the interrelationships between the community, government and civil society. Many of these studies, based on careful empirical enquiry at the micro level, have contributed to the on-going debates on sustainable environment and institutions. Issues in Common Property Land Resources and land use have also been researched extensively.
- The research in the area of **Industry, Infrastructure, Trade and Finance** focuses on the response of micro, small and medium enterprises to the changing government policies in the wake of liberalisation. The research has contributed to work on industrial clusters, flexible specialization and addresses issues involving intellectual property regimes, especially for pharmaceuticals and biotechnology. Studies dealing with issues in provisioning of and access to basic infrastructure both in the rural and urban areas, the linkages between infrastructure, trade and finance, regional growth and aspects of governance have also been carried out at the Institute.
- Studies under the theme **Employment, Migration and Urbanisation** relate to population, demographic changes, labour, nature of employment, diversification of economic activities and migration. An emerging aspect has been to study international migration to trace social, economic, cultural and political influences through remittances, social spending and norms setting. Urban services and aspects of urban economy and governance have also been an important emerging area of research at the Institute.
- The research in **Poverty and Human Resource Development** focuses on population, labour and poverty issues. The studies relate to quality of life, education, social infrastructure, diversification of economic activities and migration. The informalisation process in the labour and production systems leading to poverty and social security issues forms another important theme. The research on health and family welfare has contributed towards developing a framework for target-free approach in family planning. In the informal sector debate the research has focused on the collection of social statistics to influence policies for better labour conditions and social security reforms.
- The enquiry in **Regional Development, Institutions and Governance** concentrates on application of regional planning models, data collection and analysis for regional planning exercises, impact of area development plans on growth and development of the regional economy. Studies have also focused on studying the role and participation of Non-Governmental Organisations (NGOs) in the development process, the changes in the characteristics of the NGOs and so on.

The major strength of the Institute is a thorough understanding of the micro processes and a consolidated effort to link these to macro issues. The faculty members have made considerable endeavour towards developing policy-sensitive database of the Indian economy, especially relating to the informal activities, including child labour. The Institute has played a useful role in promoting empirical research in the country and the evolution of related conceptual framework and approaches. Overtime, the Institute's research agenda has broadened to cover a fairly wide range of issues pertaining to development policy both at the regional and the national levels. The results of the Institute's research are shared with policy makers, non-governmental organisations and other academicians. The faculty members at the Institute also participate in government panels, committees and working groups to influence certain policy decisions. The Institute promotes public discussion through the publication of its research findings and through seminars, conferences and consultation and undertakes collaborative research along with NGOs, international organisations, government and academic institutions.