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Skill development for accelerating the manufacturing sector: the role of ‘new-age’ skills for ‘Make in India’

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ABSTRACT

India is one of the fastest growing major economies and has a burgeoning young workforce. The average age in India will be 29 years by 2020. Given the limitations of absorbing growing labor force—especially the unskilled and semi-skilled—in service sector, focus has to be on spurring manufacturing growth to take advantage of this large pool of manpower. The ‘Make in India’ has a grand vision of creating 100 million jobs by 2021. This ambitious program is designed to turn the subcontinent into a ‘global manufacturing hub’ and increase jobs by providing afresh impetus to the economy. Running high on this momentum, the government has initiated several policies such as ‘Skill India’ and ‘Digital India’ to complement ‘Make in India’. Attempting to tap this aggressive policy push, stakeholders are focusing on developing right skills to address the growing skill gap in various manufacturing sectors in the context of changing industrial landscape defined by new-age technologies. This chapter will present India’s perspective on how country is working towards developing a cohesive environment for ‘new-age’ manufacturing and ‘future ready’ manpower.

KEYWORDS

Make in India; Skill India; future ready workforce; Industry 4.0; poverty alleviation

Introduction

India is one of the fastest growing major economies in the world today with a year-on-year (YOY) growth of 7.2% (Central Statistics Office [CSO], 2019). Foreign Direct Investment (FDI) inflows stood at \$12.75 billion during April–June 2018. India’s foreign exchange reserves was \$397.35 billion as of January 2019 (Reserve Bank of India, 2019). Giving a positive outlook, the International Monetary Fund (IMF) reports, ‘India’s economy is picking up and growth prospects look bright, partly due to the implementation of recent policies, such as the nationwide goods and services tax. As one of the world’s fastest-growing economies, accounting for about 15% of global growth, India’s economy has helped lift millions out of poverty’ (International Monetary Fund (IMF), 2018). This positive outlook is echoed by other major multilateral agencies, such as the World Bank (World Bank 2019a) and United Nations Development Programme (UNDP), which show their confidence in the country’s major economic drives and the expectation that India will lead global economic growth (Table 1).

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Table 1. Economy growth projections.

Country/Region	Expected GDP Growth Rate (% range)		
	2019	2020	2021
India	7.4–7.8	7.7–7.9	7.7
China, People's Republic of	6.2–6.4	6.2–6.3	6.0
United States	2.5–2.7	1.8–1.9	1.7
European Union	2.0–2.1	1.8	1.7

GDP = gross domestic product.

By 2020, the average age in India will be 29 years with 65% of the population in the working-age group (15–59 years of age). India's burgeoning young workforce of 830 million can be an asset not just for India but for the aging developed world, provided it is nurtured and prepared for the future. To take advantage of this large pool of manpower and understand the limitations of the services sector to absorb the unskilled and semiskilled labour force, the Government of India (GoI) focused on spurring the growth of the manufacturing sector by launching the 'Make in India' campaign in September 2014, with a grand vision of creating 100 million jobs by FY2021. This ambitious program was designed to turn the subcontinent into a 'global manufacturing hub' and increase jobs by providing a fresh impetus to the economy. However, inadequate infrastructure and lack of availability of appropriately skilled manpower has been a challenge since the economic liberalization of the early 1990s. To combat these challenges, the government initiated several programs in mission mode that includes 'Skill India' to complement 'Make in India' (Table 2)

The advent of the Fourth Industrial Revolution (Industry 4.0) is impacting and changing the industrial landscape, and with it, skill requirements, thereby forcing government, industry, and academia to focus on developing twenty-first century skills (critical thinking, design thinking, creativity, sustainability, etc.) among fresh recruits and the existing workforce. Policy and implementation in a large country like India, where the central and state governments could play important roles, could cut across various dimensions. This paper presents an Indian perspective across some of the elements listed above on how the country is working toward developing a cohesive environment for 'manufacturing 4.0' and 'future ready' manpower.

Overview of manufacturing: Indian and global outlook

Creating a conducive environment and promoting the growth of the manufacturing sector remains one of the main priorities of the Government of India. The significance of manufacturing is displayed in Table 3, which shows its size in comparison with the shares of various sectors in terms of Gross Value Added (GVA) during the last 3 years (CSO, 2018).

Manufacturing has the potential to emerge as one of the high-growth sectors in India. It can provide large-scale employment and thereby enable a significant section of the population to move toward 'gainful employment'. With this in mind, the Indian government has adopted 'Make in India' as a core policy initiative to encourage and accelerate growth of the country's manufacturing sector. The government has set an ambitious target of increasing the contribution of manufacturing output to 25% of gross domestic product (GDP) by FY2025.

**Table 2.** Stakeholders, programs and skill development.

Stakeholders/ Interventions	Start ups	Attract Investments	Promote Manufacturing	Adoption of Technology	Human Resource & Skill Development	Others
Central/Ministry	<ul style="list-style-type: none"> – Start up policy – Entrepreneurship Development 	<ul style="list-style-type: none"> – Sectoral policies: Electronics – Manufacturing – FDI policy – MSME policy – Ease of Doing Business – IoT policy – Industrial policy 	<ul style="list-style-type: none"> – Sectoral policies – Incentives for manufacturing zones 	<ul style="list-style-type: none"> – AI policy & schemes to promote adoption of technology – Centers of excellence 	<ul style="list-style-type: none"> – Sector skill councils – Higher education – Research & training on new-age skills 	<ul style="list-style-type: none"> – Financial assistance
States	<ul style="list-style-type: none"> – Start up policy – Incubators 	<ul style="list-style-type: none"> – Handholding – resolution of issues – Policy inputs – B2B connect 	<ul style="list-style-type: none"> – Industrial parks – Industrial clusters 	<ul style="list-style-type: none"> – Centers of excellence – Industry 4.0 parks 	<ul style="list-style-type: none"> – State skill development missions – Skill gap reports – Occupation standards (SSCs) 	<ul style="list-style-type: none"> – Financial assistance – Adoption of best practices
National Organizations	<ul style="list-style-type: none"> – Funding for start ups – Incubation centers 	<ul style="list-style-type: none"> – Policy inputs – B2B connect 	<ul style="list-style-type: none"> – Product standards – M2M standards 	<ul style="list-style-type: none"> – Industry 4.0 centers 	<ul style="list-style-type: none"> – Skill gap reports – Occupation standards (SSCs) 	<ul style="list-style-type: none"> – Research & development – Platform for collaborations
Industry Bodies	<ul style="list-style-type: none"> – Incubators – mentoring – Awards 	<ul style="list-style-type: none"> – Policy inputs – B2B connect 	<ul style="list-style-type: none"> – Policy inputs – Monitoring of schemes and output – Sharing of best practices 	<ul style="list-style-type: none"> – Demonstration centers – Industrial visits – Creating awareness 	<ul style="list-style-type: none"> – Career centers – Assessments – Skill development centers – Skill gap reports 	<ul style="list-style-type: none"> – National & international conferences – Country-specific business delegations
NGOs	<ul style="list-style-type: none"> – Creating conducive environment 	<ul style="list-style-type: none"> – Policy inputs 	<ul style="list-style-type: none"> – Sharing best practices 	<ul style="list-style-type: none"> – Sharing best practices 	<ul style="list-style-type: none"> – Skill development 	<ul style="list-style-type: none"> – Creating sustainable linkages
Industry	<ul style="list-style-type: none"> – Investing in R&D – Investing in startups 	<ul style="list-style-type: none"> – Policy inputs – Joint ventures – Setting up subsidiaries – Sharing best practices 	<ul style="list-style-type: none"> – Integrating into global supply chains – Setting up state-of-the-art manufacturing centers 	<ul style="list-style-type: none"> – Handholding vendors – Demonstration centers sharing technology 	<ul style="list-style-type: none"> – Skill development – Supporting SSCs apprenticeships 	<ul style="list-style-type: none"> – Support MSMEs with infrastructure and facilities sharing
Individuals	<ul style="list-style-type: none"> – Promote self-learning & exploration 	<ul style="list-style-type: none"> – Build network of investors 	<ul style="list-style-type: none"> – Cognitive and soft skill training 	<ul style="list-style-type: none"> – Promote digital literacy 	<ul style="list-style-type: none"> – Training and skill development 	<ul style="list-style-type: none"> – Promote peer learning

Table 3. Share of sectors in gross value added at current prices (%).

Sector	2015–16 (2nd RE)	2016–17 (1st RE)	2017–18 (PE)
Agriculture, Forestry, & Fishing	17.7	17.9	17.1
Industry	29.8	29.3	29.1
Manufacturing	16.8	16.8	16.7
Services	52.5	52.8	53.9

PE = provisional estimates, RE = revised estimates.

According to the Global Manufacturing Competitiveness Index, this would be a 9% increase from the current level of 16% (India Brand Equity Foundation [IBEF], 2018). Globally, India is the sixth-largest manufacturing nation and was the biggest recipient of FDI in 2016–17, with inflows touching \$60 billion, the highest-ever annual inflow into the country. India is expected to become the fifth largest manufacturing country in the world by the end of 2020. This flagship program focuses on placing India on the world map as a manufacturing hub and gaining global recognition for the Indian economy. The ‘Make in India’ initiative is built on four pillars:

- (1) **Change in approach.** The government has always been perceived as a regulator and not a facilitator. This initiative intends to usher a paradigm shift in the way the government interacts and engages with the industry. The focus has been to develop partnerships and engage with the industry effectively to give the required impetus to the economic development of the country.
- (2) **Focus sectors.** ‘Make in India’ focuses on 25 sectors and facilitates detailed information through an interactive web portal. The Department for Promotion of Industry and Internal Trade (DPIIT) is entrusted with the task of formulating FDI policy, monitoring the Ease of Doing Business reforms, and investment promotion and facilitation activities. To make India a preferred destination for investment into focused sectors, the government has put in place a comprehensive FDI policy by bringing in more activities under the automatic route, increasing sectoral caps, and easing conditionalities. Under the program, the government has allowed 100% FDI in railways, defense, and pharmaceutical sectors; and has removed restrictions in the construction sector.
- (3) **Evolved ecosystem.** A host of big bang reforms have been introduced recently by the government, such as the implementation of Goods and Services Tax (GST), enacting of Insolvency and Bankruptcy Code, the drive to digitize various aspects of governance, and developing industrial corridors and smart cities with state-of-the-art technology and high-speed communication. Innovation and research activities are supported by a fast-paced registration system and improved infrastructure for intellectual property rights registrations. Simultaneously, the training needs to provide for a skilled workforce is also being addressed. This is being done in a variety of ways. First, the skill gaps are being identified; second, interventions at different levels in the workforce – entry level, mid-level, and high end – are being identified and proposed, such as, specialized universities, like Railway University, Defence University, Skill Universities, etc., are being set up. Third, the training through apprenticeship mode is being aligned to the industry needs.
- (4) **Ease of Doing Business.** The government has introduced several reforms to simplify, remove duplication, bring in transparency in the regulatory and licensing

process and adoption of local content policy in public procurement processes. Uniform tax rates and structures under GST across all States (Provinces) and Union Territories are expected to reduce multiplicity of taxes and compliance costs. Best practices followed by various state governments are being shared as guidance on undertaking reforms. These reforms are also aligned with the World Bank's 'Ease of Doing Business' index to improve India's ranking. This has yielded positive results and India's position has improved from 142nd in FY2014 to 77th in FY2018 (World Bank, 2019b).

Steady progress. The Federation of Indian Chambers of Commerce and Industry (FICCI) and Pricewaterhouse Coopers (PWC) (FICCI & PWC, 2019) quotes DPIIT (2018) reports showing that the Indian manufacturing sector has posted steady recovery since 2015, with the growth rate increasing from 2.8% in FY2016 to 4.4% and 4.6% in FY2017 and FY2018, respectively (FDI in key manufacturing sectors, Figure 1). In the first half of 2018–2019 (April–September), the share of the manufacturing sector in GVA was 16.9%, higher compared to 16.5% in the first half of 2017–2018. The operational expansion of key major global corporations and entry of new manufacturing firms are contributing to exports and strengthening the industrial ecosystem in the country. New investments in sectors such as telecommunications, food processing, and automobiles have also contributed to the industrial growth.

In recent years, in order to provide necessary impetus to the manufacturing sector, the government has advanced the National Manufacturing Policy with the objective of enhancing the share of manufacturing in GDP to 25% and creating 100 million jobs over a decade. National Investment and Manufacturing Zones (NIMZs) are important instruments of the policy. NIMZs have been conceived as large, integrated industrial townships with state-of-the-art infrastructure, land use on the basis of zoning, clean and energy-efficient technology, necessary social infrastructure, skill development facilities, etc., to provide a conducive environment for manufacturing industries. So far, 16 such NIMZs have been approved (FY2018).

Sector-Wise FDI From April 2000 to June 2018 (in US\$ bn)

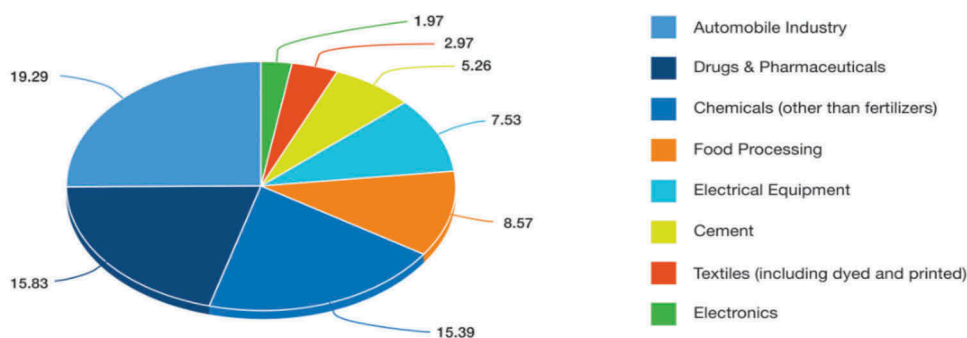


Figure 1. Sector-wise FDI in India, 2008–2018 (US\$b).

To promote the manufacture of electronics products, the government announced the National Policy on Electronics. The Indian market in 2008–2009 was \$45 billion and was expected to reach \$400 billion by FY2025. The strategies in the policy include the following:

- provide incentives through the Modified Special Incentive Package Scheme;
- set up semiconductor wafer fabrication facilities;
- secure preferential market access to domestically manufactured electronic products;
- provide incentives for setting up 200 electronic manufacturing clusters (EMCs) including greenfield EMCs and upgrades of brownfield EMCs; and
- establish a stable tax regime and market India as a destination to attract investment.

The global share of Indian electronics manufacturing in 2017–2018 was 26.7% with the aim of increasing this to 32% in the current fiscal year of 2019–2020. The National Policy on Electronics includes a scheme for increasing human resources to serve the needs of the sector. This includes coopting the two Sector Skill Councils (Telecom and Electronics); increasing the number of PhDs in electronics and information technology; and setting up training academies to train faculty. Schemes on skill development in the Electronics System Design and Manufacturing (ESDM) sector include a scheme for financial assistance to select States (Provinces) and Union Territories for skill development in ESDM; and a scheme for skill development in ESDM for the Digital India initiative of the government.

Action on the National Policy on Electronics since 2015 has resulted in India surpassing Viet Nam to become the No. 2 mobile manufacturer in the world. As of December 2018, the 268 manufacturing plants in India provided 0.65 million jobs. Production in FY2018 had reached \$31 billion, with 65 million chargers exported.

To build on that foundation and propel the growth of ESDM, the FY2019 National Policy on Electronics (NEITY, 2019) aims to 'position India as a global hub for ESDM with a thrust on exports by encouraging and driving capabilities in the country for developing core components, including chipsets and creating an enabling environment for the industry to compete globally'.

Make in India (Version 2) is supporting further growth in selected manufacturing sectors. Globally, new-age technologies are reshaping manufacturing by changing the drivers of growth and competitiveness. Innovation, flexibility, skilled workforce, and adaptability to change are becoming the key ingredients of global success parameters. In 2018, the World Economic Forum (WEF, 2018) report on 'Rediness for the Future of Production' highlighted Global Manufacturing Index putting India in 30th position, five places below the People's Republic of China (PRC), which is continuously striving to develop better avenues of manufacturing by boosting infrastructure.

Sharp swings in labor costs, energy costs, and currency exchange rates in recent years have narrowed some of global differences in cost competitiveness. Such phenomena have underscored the need for companies to take a fresh look at their global manufacturing strategies. The cost advantage that the US had enjoyed over Japan and several European countries has recently narrowed, while the PRC's cost competitiveness has improved. Companies across the world are also working toward building an adaptive,

highly skilled workforce. As factories adopt advanced manufacturing technologies and trade regimes continue to shift, demand is growing for a highly skilled workforce that can adapt to this fast-paced change.

Emerging trends in India: manufacturing 4.0

As Industry 4.0 gathers momentum, decision-makers from the public and private sectors are confronted with a new set of uncertainties regarding the future of manufacturing. According to a WEF (2017), rapidly emerging exponential technologies, such as robotics and additive manufacturing triggered by artificial intelligence and deep machine learning; including the Internet of Things (IoT), that is driving industrial automation, are all spurring the development of new production techniques. These are leading to enhanced productivity and business models facilitating greater interconnectivity, monitoring, and efficiencies of resources used (Figure 2).

In the manufacturing sector, the deployment of mobile robotics worldwide is rising fast. The International Federation of Robotics' (IFR) World Robotics report forecasts that the world annual supply of industrial robots would grow at 13% YOY to reach 0.41 million units by FY2020. In FY2017, the global average robot density in the manufacturing industry was 85 robots per 10,000 employees (International Federation of Robotics, 2019). There are some key trends worth noting as to the direction of the manufacturing sector worldwide:

- Global IoT spending is projected to reach \$772 billion in FY2018 and surpass \$1 trillion in FY2020.
- The number of connected IoT devices by FY2021 is projected to be \$36.13 billion.
- IoT is projected to comprise \$15 trillion of global GDP by FY2030.
- Sales of collaborative robots are projected to increase by 159% between FY2018 and FY2020.

A survey by FICCI, NASSCOM, & EY (2017) conducted in 2016–17 revealed that most Indian auto companies are already deploying robots on the shop floor. While paint and welding shops are expected to be completely automated by 2020, the use of robots in

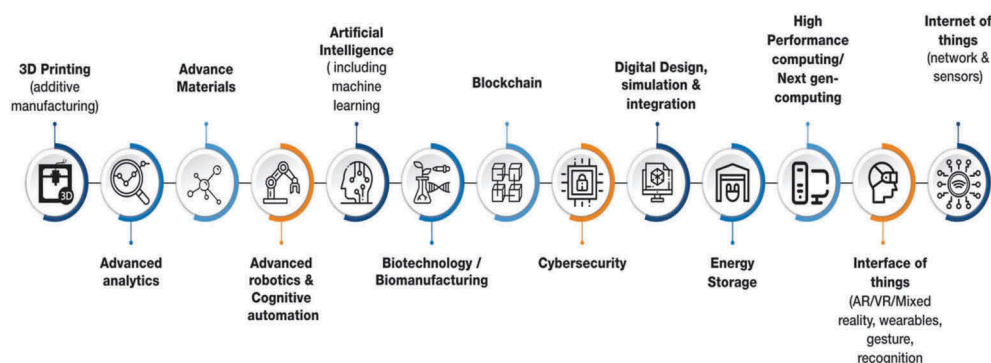


Figure 2. Key technologies used in manufacturing.

the assembly line is limited to 20% across companies. Plant-level automation at most original equipment manufacturers remains at 30%, while its level in the body shop is beyond 95%. Auto companies are increasingly deploying smart robots with artificial intelligence capabilities that are able to adapt, communicate, and interact with each other and with humans.

Relying on India's strength in information and communication technology (ICT) and large pool of skilled workforce of ICT professionals, the transformative journey of manufacturing through Industry 4.0 is very much evident in the country. Bosch, a German auto component manufacturer, began implementation of smart manufacturing at its 15 centers in India in FY2018. General Electric has invested \$200 million in the facility in its only multimodal factory in India where digitally interlinked supply chains, distribution networks, and servicing units form part of this intelligent ecosystem.

The Indian government has created green energy corridors to bring in more renewable energies and make smart grids that will support the variable input of renewable energies and create storage. India has committed over \$1 billion toward this initiative and has started projects in many States (Provinces), such as Andhra Pradesh, Gujarat, Himachal Pradesh, Rajasthan, and Tamil Nadu. Major Indian states have also taken initiatives to adapt to Industry 4.0-related manufacturing. Andhra Pradesh has approved an IoT policy – the first of its kind – that aims to turn the state into an IoT Hub by FY2020 and tap close to 10% of smart-manufacturing needs in the country.

Various Indian companies are increasing their focus and partnering with global companies for developing new IoT and Machine-to-Machine (M2M) solutions. The Digital India initiative is expected to enhance this focus in domestic manufacturing and other sectors. In this rapidly changing technological landscape, new-age skilling and labor demands have become unpredictable and variable.

Industry 4.0 manufacturing ecosystem

In India, the adoption of Industry 4.0 is at a nascent stage. Widespread implementation maybe years away due to challenges such as the need for high investment outlay, inadequate know-how, lack of infrastructure, and a lack of adequate cybersecurity norms. However, GoI has taken several steps to create robust manufacturing ecosystem in the country. NIMZs have been created to support the reforms in manufacturing. NIMZs are integrated industrial townships with state-of-the-art infrastructure, land use on the basis of zoning, clean and energy-efficient technology; necessary social infrastructure, new-age skill development facilities, etc., to provide a productive environment for persons transitioning from the primary to the secondary and tertiary sectors.

The National Mission on Interdisciplinary Cyber-Physical Systems (CPS) was launched in December 2018 to promote application development, human resource development and skill enhancement, entrepreneurship, and start-up development in CPS and associated technologies. This Mission aims to establish 15 technology innovation hubs, six application innovation hubs, and four technology translation research parks. These will connect to academia, industry, central ministries, and state governments in developing solutions at reputed academic, research and development, and other organizations across the country in a hub and spoke model.

Several other initiatives support the goals of these developments. For example, The Automotive Mission Plan 2016–26 (AMP 2026) aims to make India one of the top three automotive manufacturers in the world and increase exports exponentially to reach 35–40% of overall output, increase its contribution to GDP to over 12% and generate 65 million new jobs. Similarly, the Ministry of Heavy Industries and Public Enterprises is setting up of four centers in the country to facilitate skill needs for small and medium-sized enterprises in implementation of Industry 4.0, while the DPIIT has notified the new industrial policy with the aim to create new jobs, promote foreign technology transfer, and attract \$100 billion in FDI annually.

To further build a robust ecosystem of understanding and facilitating stakeholders in adoption of Industry 4.0 related technologies, 'Industry 4.0 Demonstration Centers' are being set up at various Industrial clusters and Universities in collaboration with Department of Scientific and Industrial Research (DSIR), Govt. Many of the State Governments have also taken initiatives to set-up Centre of Excellence on Industry 4.0.

India's first smart factory is being set up at Bengaluru, which would be powered by data exchange in manufacturing, and IoT. This Smart Factory is being developed at the Indian Institute of Science's (IISc) Centre for Product Design and Manufacturing (CPDM) with the funding from The Boeing Company.

Government has also initiated setting up of multiple Technology Business Incubators (TBI) under the programs like National Initiative for Developing and Harnessing Innovation (NIDHI), Promoting and Accelerating Young and Aspiring Technology Entrepreneurs (PRAYAS). Further a Fund of Funds for Start Ups of INR 10,000 crore shall be released over two financial cycles by FY2025.

Skilling, Reskilling, and Upskilling Imperatives

There are numerous drivers impacting the manufacturing environment, which in turn are driving the changing skill-set needs in the sector. See Figure 3, which presents manufacturing trends in 2019 as gathered by Microsoft (Microsoft, 2019) and FICCI. Make in India is intended to attract companies from across the globe and make India a high-end global manufacturing hub. To meet this objective, the country needs a workforce with skills and educational qualifications at par with international standards. Industry 4.0 implies that all repeat jobs will get automated, and that the manufacturing sector will steadily shift toward new-age, high-order, skill-intensive jobs.

With economic liberalization in FY1991, the share of agriculture in India's GDP has more than halved, and the share of industry and services has more than doubled. However, the share of agriculture in employment has not come down drastically, with the sector still accounting for almost 50% of the overall employment. The manufacturing sector too has been a laggard in capturing the share of employment and has lost to the services sector.

This skewed labor and output distribution has implications for India's labor productivity. Data from the Conference Board, which is a global business membership and research association, shows that India had the highest labor productivity growth rate at an average rate of 5.8% in terms of output per worker between 2010–2017. However, India's overall productivity still lags behind that of other developing Asian economies. The difference with



Figure 3. Drivers impacting manufacturing.

developed economies is even starker. For instance, the productivity levels in Germany and the US are 5.1 and 6.8 times that of India, respectively (The Conference Board, [n.d.](#)).

Worryingly, the pace of productivity growth is also stagnating in India as per the Reserve Bank of India's KLEMS database [capital (K), labor (L), energy (E), materials (M), and Services (S)]. It shows the average growth in labor productivity slipping to 5.8% in FY2011 from 7.4% in the preceding years. Infact, with the exception of business services, the growth in labor productivity in all other sectors has been negative. This essentially means that an under-skilled or semi-skilled workforce was pulling India's global competitiveness down.

Nevertheless, the impact of new-age technologies is evident in India's two key manufacturing sectors, the automotive and textile and apparel sectors. The automotive sector will continue to hire at a rate of 2–2.5% YOY against the historical growth rate of 3–3.5% to reach 14.3 million in FY2022. Around 60–65% of the jobs in the sector will require new skill sets by FY2022. Some of the key job roles and skills imperatives for the sector as identified by FICCI, NASSCOM & EY (2017) can be seen in [Figure 4](#). The textile and apparel sector, which is the second largest employer in the country after agriculture, employs approximately 80 million people, with approximately 30 million people directly employed. While the weaving and garments subsector will continue to hire at a rate of 8–8.5% YOY against the historical growth rate of 9–9.5% to reach 40.7 million in FY2022, 45–55% of the jobs will require new skill sets. Some of the key job roles and skill imperatives were identified by FICCI, NASSCOM & EY (2017) as being more highly skilled than traditional textile and garment roles (see [Figure 5](#)).

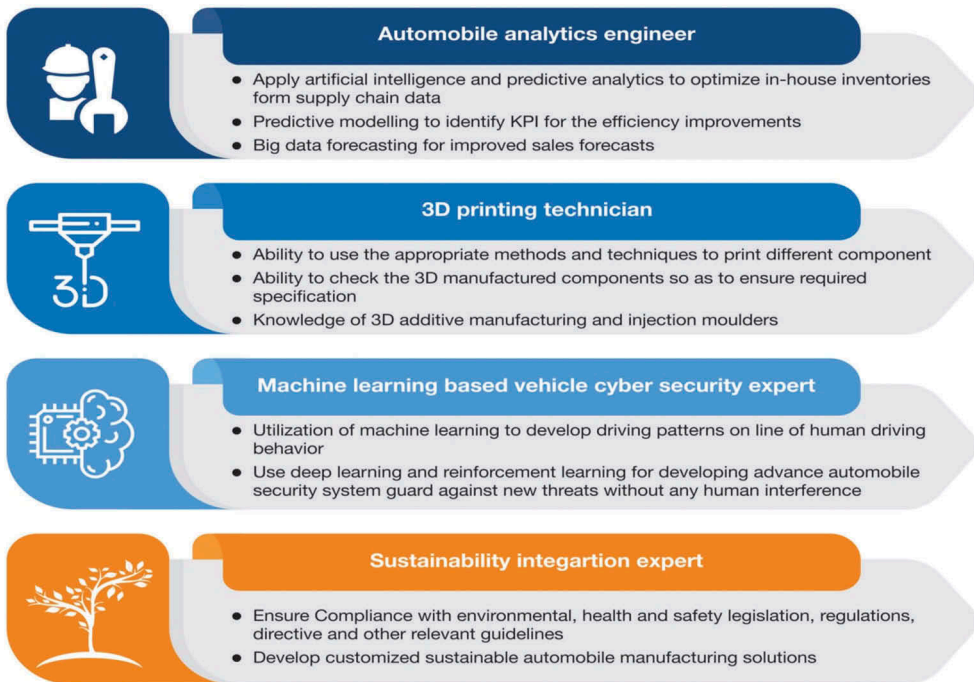


Figure 4. Emerging job roles in automotive sector in India.



Figure 5. Emerging job roles in textile & apparel sector in India.

The WEF (2016) has redefined the skill sets required to meet the needs of Industry 4.0. As India moves toward Manufacturing 4.0, it will need to make generational transformation in its schools, higher education, vocational education and skill development ecosystem to deliver the required twenty-first-century skills identified in Table 4.

While countries such as Indonesia, Malaysia, and Thailand are implementing Industry 4.0 to move swiftly toward a higher base of economic benefits, large economies are also increasing skills for innovation and competitiveness of their workforce. Japan launched its 'Revitalization Strategy 2016' to accelerate skilling activities and growth in advanced manufacturing sectors. The policy aims to build on the country's inherent strengths in manufacturing and technology while targeting the development of \$1.3 trillion of new industries and 4.7 million jobs by 2020. Similarly, Singapore, a hub for high-value manufacturing, recently launched the 'Singapore Smart Industry Readiness Index' (Economic Board Development of Singapore, 2019) to provide a common framework to motivate companies to start, scale, and sustain Industry 4.0 efforts. The country has also initiated multiple skill development activities on new-age technologies. People's Republic of China (PRC), which accounts for about 25% of the world's manufacturing activity, is also seeking to close the gap in manufacturing with Japan and Germany by embracing new technologies to enhance competitiveness. Initiatives such as 'Scientific Innovation 2030' and 'Made in China 2025' are further enabling manufacturers to reskill and upskill their workforce (Kennedy, 2015).

Government interventions to develop the skill ecosystem

Recognizing the need for skill development, Government of India initiated a National Skill Development Policy in FY2009 and established the National Skill Development Fund (NSDF) and the National Skill Development Corporation (NSDC) under the Ministry of Finance, GoI. The National Skill Development Authority (NSDA) and The National Skills Qualification Framework (NSQF) were established in FY2013. The role of the latter is to organize all qualifications according to a series of levels of knowledge, skills, and aptitude. After the fifth anniversary of notification in 2018, it was expected to be mandatory for all training and educational programmes and courses as well as admission requirements to be NSQF-compliant. However, due to complexities and diversities prevalent in the training ecosystem, only few states have fully implemented it.

To better streamline, organize and implement the skill development initiatives with focus on entrepreneurship development, Ministry of Skill Development and Entrepreneurship (MSDE) was set up in FY2014. NSDC and Directorate General of Training (DGT) under

Table 4. New-age skill requirements.

In 2015	In 2020
Complex Problem Solving	Complex Problem Solving
Coordinating with others	Critical Thinking
People Management	Creativity
Critical Thinking	People Management
Negotiation	Coordinating with others
Quality Control	Emotional Intelligence
Service Orientation	Judgement & Decision Making
Judgement & Decision Making	Service Orientation
Active Listening	Negotiation
Creativity	Cognitive Flexibility

Ministry of Labour and Employment (MoLE), GoI that regulates Industrial Training Institutes (ITIs) was brought under its fold. A new National Skill Development and Entrepreneurship Policy was launched in FY2015 that supports the National Skill Development Mission. This urges all States (Provinces) to set up the State Skill Development Missions (SSDMs) and integrate the central as well as state-run schemes. SSDMs acts as the nodal agency to work with NSDC, Sector Skill Councils (SSCs), training partners, different ministries, and other stakeholders.

NSDC (2018) is a public-private partnership organization with the aim of providing viability gap funding to the private sector in order to scale up the training capacity. FICCI is a shareholder along with seven other industry association bodies. NSDC has over 130 approved training projects across sectors, which are monitored for their financial placements and social targets. Figure 6 depicts the skill development ecosystem in India.

Currently, there are 37 SSCs (2008) with a mandate to have fair representation of employers in terms of subsectors, size, and geography; and are expected to ensure wider participation of employers and other stakeholders in the skill development initiative. One of the key deliverables of SSCs is to develop National Occupational Standards and Qualification Packs, apart from empanelment of training partners and qualified assessment providers. With the availability of trainers being a major challenge in scaling up capacity, SSCs are also expected to play a crucial role in getting right industry support to facilitate training of trainers for their respective sectors. Following is the list of SSCs in India per the Ministry of Skill Development (Figure 7).

Besides NSDC and SSCs, the National Council for Vocational Training (NCVT) conducts All India Trade Tests for those who complete training in ITIs, and awards National Trade Certificates to successful candidates. The State Council for Vocational Training at the state levels and the subcommittees have been established to assist the National Council. To further strengthen the Vocational Education & Training in India, in 2018, the Government merged NSDA and NCVT into National Council for Vocational Education and Training



Figure 6. Skill development ecosystem in India.



Figure 7. Sector skill councils in India.

(NCVET) to form a integrated regulatory framework. The Quality Council of India promotes the establishment of quality improvement and benchmarking.

Apart from creating the institutional framework for skill development, several national programs have been launched. Some of the flagship initiatives of the government to promote skill development activities in the country are the Pradhan Mantri Kaushal Vikas Yojana (PMKVY), Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDUGKY), Pradhan Mantri Kaushal Kendras (PMKK), and National Apprenticeship Promotion Scheme (NAPS). In order to boost the Skill India Mission, two new schemes, namely, 'Skills Acquisition and the Knowledge Awareness for Livelihood Promotion' and 'Skill Strengthening for Industrial Value Enhancement', have been approved by the Cabinet Committee on Economic Affairs, with an outlay of Rs 6,655 crore (\$1.02 billion) supported by the World Bank.

MSDE initiated comprehensive reforms in the Apprenticeship Act in 2014 to make apprenticeship industry-friendly and, in 2018, launched operational guidelines on the roles and responsibilities of stakeholders at the national and state level. The operational framework also provides detailed information regarding the execution of NAPS, information to be disseminated and incentives under the scheme to attract corporates across sectors to engage apprentices.

FICCI works closely with MSDE, NSDC, and DGT to create awareness about Apprenticeship and engage industry across India. MSDE, supported by FICCI has developed a comprehensive 360-degree communications strategy along with a targeted industry engagement plan. The

program, if implemented effectively, can be the entry point of developing a 'new-age' workforce with hands-on experience.

The entire skill ecosystem described in this section is to train the school graduate, school drop outs, provide continuing skill development programs for the workforce and Recognition of Prior Learning (RPL) for uncertified but skilled manpower trained on the job. As per the Skills Stock Survey done by Centre for Monitoring Indian Economy (CMIE) and NSDC in FY 2018, 42% of the workforce is skilled out of which only 4% is formally certified and 5% are women. Hence, there is an urgent need for RPL and increasing women in the workforce.

India started leveraging the World Skills Competitions since 2011 to make Vocational Education and Skilling aspirational. In 2016 MSDE, GoI and NSDC launched India Skills Competition, however, response from states were moderate. In 2017, a large contingent of state governments and industry participated in WorldSkills, Abudhabi. This led to a momentum and resulted in participation of 23 states in India Skills (2018), where competitions were held in 46 skills and 10 demonstration skills (India Skills, 2018).

Preparedness for Industry 4.0 and related 'new-age' skills

To prepare twenty-first century new age skilled workforce, Government of India has initiated several flagship interventions across the continuum of education. In FY2014, 'Atal Innovation Mission' under NITI Aayog – the Government Think Tank, was initiated to set up Atal Tinkering Labs (ATL) in Schools across the country. More than 5500 such labs have already been set up until December FY2018 to inculcate amongst young learners, the spirit of innovation, design thinking, creativity, problem-solving, environment consciousness, sustainability, etc., and provide training on new-age skills like AI, coding data analytics, etc. ATL is facilitating creation of over one million Neoteric Innovators by 2022.

FICCI is closely engaged with the government in developing a cohesive ecosystem for new-age skill development in India. As the India Secretariat for the BRICS Business Council, in FY2016, FICCI supported by BRICS countries and German consulting company, Rolland Berger, published a research paper on 'Industry 4.0 and Required Skill Development in BRICS Countries' (BRICS Skill Development Working Group, 2016). The report analyzed the level of preparedness for adoption of Industry 4.0 in BRICS countries and compared it with adoption levels in developed nations like Japan, the Republic of Korea, Germany, and the USA. Another significant initiative by FICCI in FY 2017 was the publication of *Future of Jobs in India – A 2022 Perspective* (FICCI, NASSCOM, & EY, 2017) This report was the first indigenous research on the future of jobs in five key sectors in India, namely, Information and Communication Technology-Business Process Management (ICT-BPM), Retail, Textiles & Apparel, Automoti, and Banking Financial Services and Insurance (BFSI). The findings were based on interactions with 100+ Chief Executive Officers (CXOs) in India. These reports amongst several others sparked discussions on Industry 4.0- related preparedness in India.

The white-collared skilled workforce supply for the manufacturing sector comes from engineering colleges that falls under Ministry of Human Resource Development (MHRD), GoI, State Education Departments and All India Council for Technical Education (AICTE) as the regulator. Over the years, AICTE has undertaken several proactive steps for the growth of engineering education, maintenance of standards, and to keep the curricula current and relevant. In FY2018 AICTE, set up an Experts Working Group (FICCI was also a member) to recommend the short-term and medium-term reforms in Engineering Education. One of the

key reforms recommended was introduction of undergraduate engineering programs exclusively focused in AI, IoT, Blockchain, Robotics, Quantum Computing, Data Sciences, Cyber Security, 3D Printing & Design, AR/VR (Indicative list), also to bring in a greater focus on multi-disciplinary engineering courses, especially in computational biology, biotechnology, biomedical, mechatronics, space, aerospace, agriculture, and environmental engineering. Atal Innovation Labs are also being set by several Universities and Higher Education Institutions (HEIs) under Atal Innovation Mission. 19 Incubation Centers have been set up in the first phase in FY 2017–2018. In the recently announced second phase, 80 more Incubation Centers have been shortlisted for funding. To further develop convergence between Education and Skill Development, MHRD, GoI launched the Scheme for Higher Education Youth in Apprenticeship and Skills (SHREYAS) and to provide industry apprenticeship opportunities under Apprenticeship Act 2016. The program aims to enhance the employability of Indian graduates of higher educational institutes by providing 'on the job work exposure'.

The grey and blue-collared workforce supply is from ITIs. Several of these ITIs are adopted and mentored by large corporations like Larsen & Tubro, Maruti Suzuki, TATA Sons, etc., for making the training relevant to industry needs. The findings from above mentioned studies also triggered the development of National Occupational Standards (NOSs) and Qualification Packs (QPs) by SSCs that led to introduction of short-term 'Future Skills Courses' by several ITIs, Training Providers, Universities and HEIs. There has been greater convergence between MHRD, MSDE, and MoLE, GoI for better implementation of apprenticeship program. Alignment with Ministry of Micro Small and Medium Enterprises (MSME) is being worked upon as 97% of industry is unorganized. Make in India will be successful only if productivity and efficiency of SME sector improves with better skilled workforce and use of technology.

India is a diverse country in terms of economic and socio-political development, one of the key challenges is a lack of awareness and knowledge of new developments in technology, their impacts on industry and associated opportunities for employment growth. This makes the redundancy of human resource in India a huge challenge. To address this, MoLE, GoI (under the National Career Service initiative) and FICCI have partnered with Samsung to establish a Model Career Center (MCC) in National Capital Region. Its aim is to focus exclusively on career counseling for employment and entrepreneurship, policy design, and standardization of norms for career counseling. It will also act as a catalyst in promoting and harmonizing young job seekers with twenty-first-century skills. MoLE jointly with State Governments has also set up 100 model Career Centers and plans to set up 200 more.

Another key FICCI led initiative is 'FICCI Future-X' program which provides a platform to key stakeholders, to impart a better understanding of the changing nature of the 'world of work'. FICCI has partnered with leading technology companies for this program as well as Niti Aayog and AICTE. There are three key offerings under FICCI Future-X:

- **Future Talk Series-** *Series of 'Future Talks' led by Senior Industry Leaders highlighting the impact of exponential technologies and changing skill-sets requirement;*
- **Capacity Building-** *Faculty development programs to help support the academia to deal with constantly changing technological advancements and be future ready;*

- **Immersion Program-** *To orient and expose students and faculty to technological evolution and opportunities to trigger and sustain start-ups and innovation ecosystem in HEIs/Universities.*

Conclusion

Industry 4.0 will accrue benefits such as cost reduction, higher efficiencies, safer factories, and faster speed to market. It can also provide a country's manufacturing sector with a much-needed push to stay competitive in the global market. Government programs such as 'Make in India', and policies such as the 'National Policy for Advanced Manufacturing', will aid implementation of Industry 4.0 and will help in boosting the manufacturing sector's share in the country's GDP to 25% by FY2022 from the current 17%. However, the success of Make in India depends largely on the success of the Skill India Mission. Convergence of all the key ministries – MSDE, MHRD, and MoLE – would help in better implementation of Programs like Apprenticeship and RPL.

India's demographic advantages can be realized only if the existing workforce is reskilled and upskilled through lifelong learning initiatives, and new recruits are prepared with twenty-first-century skill sets. It is a mammoth task for the government alone to develop a skill-based workforce and drive the Make in India initiative. Therefore, it is imperative that government and industry partner and take collective actions to develop the skilled workforce.

The large and organized industry has its own induction and training processes and programs in place to train human resources for their requirements. They also engage and support Vocational Training Institutes & ITIs for developing skilled labor pools in their respective sectors. However, it is the 97% of the unorganized SME industry, that struggles in meeting these goals. As per the notified compliance norms for SSCs by MSDE, GoI, in FY2019, SSCs will have to engage with Industry Association Bodies for greater cooperation to get relevant labor market information and understand the supply demand trends of skilled manpower. Large industries can be incentivized to train surplus human resources in advanced technologies that can be absorbed by SMEs.

While a number of initiatives have been launched, it is important to create a national ecosystem that harmonizes and coordinates the efforts. This ecosystem would include:

- A fund to demystify and popularize Industry 4.0 – focused technologies and provide required training in AI, machine learning, cybersecurity, data analytics, etc., in higher and vocational educational institutions, and by international and national experts from industry and academia.
- National incentives across sectors along the lines of ESDM to develop on-the-floor skilling and reskilling in both public and private sectors.
- The creation of industry-specific curriculum in schools, colleges, and universities to develop technological acumen and workforce through a robust model of industry and education partnerships.
- Sector-specific, higher education PhD programs and Centers of Excellence to be created in Universities/HEIs.

- A national database of future jobs must be compiled on the basis of projected industry-based requirements by SSCs.
- Continued thrust on labor laws reforms to meet the changing needs of labor market.

Disclosure statement

No potential conflict of interest was reported by the authors.

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