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Robotisation of Textile Sector in China: Impact and Imperatives

Introduction

In the recent times, the increased adoption and usage of robots in multiple sectors is quite evident.[1] The rising traction towards Robotisation acknowledges the potential benefits accrued by the adopted sectors. Some of the major advantages of robots include decreased production cost, shorter cycle time, improvement in quality and reliability, increased safety, and so on. Technological advancements in the garment manufacturing includes high sewing machine speed, Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) applications, new techniques in cutting, fusing and pressing, and the application of robotics.[2] The use of robotic 3D technology has the potential to chalk out new dimensions in sewing as it can produce high-tech garments with high quality. It can also help in cost reduction and fast response to customer demands.[3]

According to Nayak and Padhye (2018), there are several segments in the garment manufacturing such as fabric inspection, CAD and CAM, fabric spreading and cutting, sewing, pressing, and material handling, where automation is being introduced. In other words, automation is possible at all four stages of textile production, viz. technology development, apparel design, and production and finishing.

Malik and Parmar (2012) identified various applications of robotics in the textile sector, such as handling of bales in blow room, carding, splicing in auto coners and other winders, Nonwovens, cleaning, garment manufacturing, fabric handling, welding textile machines, Laser cutting and in folding and packing. Gries and Lutz (2018) have also discussed the possible applications of robotics in garment manufacturing and its advantages and disadvantages.

It has been also observed in the USA, Europe and China, there is an increasing trend of robot deployment within the textile sector. Some companies are in the

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This Policy Brief has been prepared by Dr Amit Kumar, Research Associate, RIS.

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process of developing garment-sewing robot. "Sewbot" developed by a US-based company SoftWear Automation and 'sewbo' developed by Zoronow are important instances of advancement in creation of a sewing robot. [4], [5] According to Palaniswamy Rajan, Head of SoftWear Automation, their Sewbot T-shirt assembly lines would be able to turn out 3,300 items a day, and these would be ready for shipping within next two years. The demand for these 'sewbots' have already been placed by a Arkansas-based apparel producer, Tianyuan Garments, which is the largest producer of apparel for Adidas (The Economist, 2017).

This paper intends to review overall scenario of the textile sector, while throwing light on the recent developments, particularly with reference to robotisation in China, focusing on implications in terms of jobs and exports on India and some other developing countries. Reference to other automation technologies is beyond the scope of this paper, which is focusing mainly on robotics. Section II has captured the policy initiatives in China. Section III has analyzed the global trends in textile trade, while section IV illustrates the implications of Robotisation in terms of jobs and exports on India and some other developing countries. Section V discusses economic impacts of new technologies in terms of Global Value Chains. Finally, Section VI presents conclusion and way forward.

Made in China (MIC) 2025 Policy and Robotisation in China

According to the International Federation of Robotics (IFR), China has the maximum number of industrial robots in operation in the world since 2016, with a market share of 36 per cent of the total supply in 2017. With sales of about 138,000 industrial robots (2016-17), China's sales volume is higher than the total sales volume of Europe and the Americas combined (112,400 units). Density of robots in China in the manufacturing industry in 2017 was 97 per 10,000 employees.[6] Its industrial robot market was estimated to be of USD 4.22 bn in 2017.[7] By 2020, it is expected to reach USD 5.89 bn. In Guangdong province alone, the government plans to invest about US$ 154 bn to introduce robotics in manufacturing. In fact, Guangzhou, the capital of the province, has set a goal to automate 80 per cent of its manufacturing production by 2020.[8]

The government of China has launched favourable policy framework to promote adoption of robotics and automation across the sectors. One of the significant policy launched in 2015 is the "Made in China 2025" (MIC) policy. As per this policy, the Chinese government has categorically stated that "*creating an internationally competitive manufacturing industry is the only way for China to upgrade its overall national strength, safeguard national security, and build a world power*". [9] MIC 2025 is a ten-year comprehensive policy architecture aimed at transforming China into a world leader in advanced manufacturing. Nine tasks have been identified as priorities under this policy, viz. improving manufacturing innovation, integrating information technology and industry, strengthening the industrial base, fostering Chinese brands, enforcing green manufacturing, promoting breakthroughs in 10 key sectors, advancing restructuring of the manufacturing sector, promoting service-oriented manufacturing and manufacturing-related service industries, and internationalizing manufacturing.

The ten key strategic sectors, which constitute nearly about 40 per cent of China's entire industrial value-added manufacturing, are as follows:

- Next-generation information technology
- High-end numerical control machinery and Robotics
- Aerospace and aviation equipment
- Maritime engineering equipment

1 The latest World Robotics Report (IFR, 2018a) points out that 3,81,000 units were shipped globally in 2017;which were 30 per cent more as compared to 2016, and the sales value had increased by 21 per cent as compared to 2016 touching USD 16.2 billion in 2017. The report highlights that the automotive industry has remained the largest adopter of robots globally with a share of 33 per cent of the total supply in 2017, followed by electrical/electronics industry and metal industry.

2 Nayak and Padhye. 2018. P.4.

3 Nayak and Padhye. 2018. P.15.

4 Fast Company. 2016. https://www.fastcompany.com/3064001/meet-the-garment-sewing-robot-that-could-disrupt-the-fashion-industry

5 https://www.fastcompany.com/40454692/this-t-shirt-sewing-robot-could-radically-shift-the-apparel-industry

6 IFR. 2018a.

7 IFR. 2017.

8 Middlehurst, C. 2015.

9 http://www.gov.cn/zhengce/content/2015-05/19/content_9784.htm

- Advanced rail components
- Energy-saving and new energy vehicles
- Electrical equipment
- New materials
- Biomedicine and high-performance medical devices
- Agricultural machinery and equipment

Unlike other countries recent manufacturing plans, such as Germany's Industry 4.0 and USA's Industrial Internet, MIC 2025 seems to affirm government's central role in transforming China's manufacturing scenario, by providing preferential access to capital to domestic companies in order to promote indigenous R&D and acquisition of foreign technology, to enable them enhance their overall global competitiveness. In this endeavor, it has identified robotics, along with AI and automation, as one of the priority sectors for high-end development to push forward transformation and upgrading of manufacturing industry (US Chamber of Commerce, 2017).

The other national and industry-specific plans and objectives have also been designed to complement and support the overarching policy architecture in the form of MIC 2025. The 13th national Five Year Plan, the industry specific Five Year Plans over the period 2016-2020, the recently launched "Strategic and Emerging Industry Guiding Catalogue", Internet Plus Action Plan, National Innovation-Driven Development Strategy Outline, etc. gels quite nicely with the broad objectives and aspirations of MIC 2025.

Particularly, in the realm of Robotics, the Chinese government launched the "Robotics Industry Development Plan (2016-2020)" in consonance with MIC 2025 to promote robot applications in a wide range of sectors, and to attract foreign investment, aiming to make 1,00,000 industrial robots by domestic technology annually by 2020.[10] There has been a rise in recent acquisitions of foreign robot making companies by the Chinese robots makers. Midea's acquisition of the German robot making company Kuka, Wanfeng buying the USA's robotics firm Paslin, Effort acquiring Italian Robot Company CMA Robotics are some of the prominent examples (MERICS, 2016).

The policy measures such as investment credits to support sales of indigenous industrial robots and co-bots have led to rapid increase in local vendors and manufacturers.[11] Backed with subsidies, the domestic companies have been encouraged to automate parts of their production processes using robots (European Chamber, 2017).

In terms of government funding support, the Chinese national government has pumped in huge amounts of money in the MIC 2025. The recently established 'Advanced Manufacturing Fund' and 'National Integrated Circuit Fund' alone have got Euro 2.7 Bn and Euro 19 Bn respectively; which is much higher than total federal funding that the German government has provided for research on Industry 4.0 technologies so far i.e. Euro 200 Mn (MERICS, 2016).

Apart from national-level policies and plans, the local governments and provinces also have set up funds and formulated policies to provide support to local robotics companies and customers. For example, the Guangdong provincial government offered 943 billion yuan in subsidies between 2015 and 2018 to help local manufacturers automate. Similarly, in Zhejiang province, local authorities have set aside 800 billion yuan to spur 36,000 enterprises to make a similar switch by 2020 (Huifeng and Chen, 2018).

According to the recent World Robotics Report 2018, China is the largest market in the world for industrial robots, with a share of 36 per cent of the total supply in 2017. About 1,37,900 industrial robots were sold to China in 2017, 59 per cent more than in 2016. This is higher than the total sales volume of Europe

[10] China Briefing. 2018.

[11] Technavio. 2017

and the Americas together (1,12,400 units). Furthermore, about 34,700 units of robots were sold by Chinese robot manufacturers alone in China, charting 29 per cent higher sales volume than in 2016. Foreign robot suppliers also increased their sales by 72 per cent to 1,03,200 units, including robots produced locally by the international robot suppliers in China (IFR, 2018b). This clearly depicts a scenario of increasing usage of robots by the Chinese industry in their production processes.

Through the ambitious MIC 2025 Policy and various inter-related policies and programmes, it seems that China is trying to achieve twin goals with one stroke, i.e. challenging the technological dominance of the advanced industrial countries and simultaneously defending China's low-end industries against the growing competition from other developing countries. With automation and digitization of industry, China wants to retain the status of the 'factory of the world' in the low-end manufacturing sectors such as textiles (MERICS, 2016).

Chinese textile industry has started moving towards robotisation of textile production in order to make it more efficient and profitable. This move is believed to be due to the following three major reasons:

Rising labour cost: The labour cost of textile workers in China has been increasing over a period of time.[12],[13] The labour wages are one-third lower in Vietnam as compared to China.[14] The minimum wage in the southern Chinese city of Shenzhen has been stated to be approx USD 336 per month, which is more than the double of the current wages in some Southeast Asian countries.[15] The wage pressure is proving to be an incentive for some Chinese garment companies to spend more on automated machines and robots.[16]

Aging workforce: The shortage of working population in China is also leading to this shift towards automation.[17] According to an estimate, China's working-age population (aged between 16 and 59), has declined steeply. In 2017 alone, it lowered by almost 5.5 million people to 901.99 million.[18]

Favourable policy environment: The Government of China has launched favourable policy framework such as MIC 2025, Robotics Industry Development Plan (2016-2020) and many sector-specific development plans for promoting adoption of robotics across sectors. It has recently launched Textile Industry Development Plan to infuse modern technological impetus into the textile sector. The Chinese government is giving incentives to encourage R&D and innovation, by offering subsidies, low interest loans and tax relief to domestic robot manufacturers.

However, at present, the application of robotics technology in the textiles sector has been found to be limited. This can be because of the cost advantage of using manual labour over robots for some operations as well as due to the limitation in adopting robotics for all tasks in the textile industry.

The value of export of textiles in China decreased by almost USD 20 Bn in 2016 to USD 253 Bn from USD 273 Bn in 2015. China losing market share in clothing exports has also been acknowledged in the latest Indian Economic Survey 2017-18. Although this cannot be attributed to robotisation or lack of it; it can be seen as an indication that exports may not increase considerably in future.

Global Trend in Textiles Trade

Globally, China is the largest exporter of textile and clothing in the world, followed by EU, India, Vietnam and Bangladesh. In this it is pertinent to note that the trade value of China's textile and clothing export is more than seven times that of India (see Table 1).

[12] Bloomberg. 2018.

[13] https://www.lesouk.co/articles/tex-style-news/china-invests-in-robots-to-modernize-textile-factories

[14] https://www.lesouk.co/articles/tex-style-news/china-invests-in-robots-to-modernize-textile-factories

[15] https://www.cnbc.com/2018/04/30/chinas-once-booming-textile-and-clothing-industry-faces-tough-times.html

[16] MERICS. 2016. P. 16.

[17] Bloomberg. 2018.

[18] https://www.scmp.com/news/china/economy/article/2136185/china-can-ease-its-labour-shortage-giving-migrant-workers-better

[19] WITS. 2018.

Table 1: Top 10 Textile and Clothing Exporting Countries, 2017

Country	Textile and Clothing Exports Value (in USD Bn)
China	266.7
EU (28)	52.3
India	35.3
Vietnam	32.1
Bangladesh	30.9
Turkey	26.4
USA	21.9
Pakistan	13.2
Indonesia	12.2
Republic of Korea	11.8

Source: Author's analysis based on WITS (2018)

Note: Standard International Trade Classification (SITC) Product Codes 65 (textile, fabrics, yarns) and 84 (clothing and apparels) used.

An interesting development in the global textiles trade dynamics is the rise of exports from Bangladesh, Vietnam and Cambodia, in the last few years. The textiles and clothing export from Bangladesh increased from USD 16.4 Bn in 2010 to USD 30.9 Bn in 2017, whereas in the case of Vietnam, the textile exports rose from USD 13.3 Bn in 2010 to USD 32.8 Bn in 2017 (Table 2).[19]

Table 2: Textile and Clothing Exports (in USD Bn)

Country/Year	2010	2014	2017
India	24.0	35.8	35.3
China	206.6	298.2	266.7
Bangladesh	**16.4**	**21.2 (2013)**	**30.9**
Vietnam	**13.3**	**25.4**	**32.1**
Cambodia	**3.0**	**5.3**	**6.7 (2016)**
Indonesia	10.9	12.3	12.2
Malaysia	5.4	6.5	6.8
Thailand	7.9	7.9	6.7 (2016)
Sri Lanka	3.5	5.1	5.1
Pakistan	11.7	13.9	13.2
Turkey	21.9	29.1	26.4

Source: Author's analysis based on WITS (2018)

Note: Standard International Trade Classification (SITC) Product Codes 65 (textile, fabrics, yarns) and 84 (clothing and apparels) used.

The major export destinations for Indian textile and clothing exports were EU-28, UK and USA with 47 per cent of the total textile and clothing exports in 2016-17.[20] Similar scenario prevails in other developing countries such as Bangladesh, Vietnam and Cambodia. In Cambodia, EU represents the largest market for Cambodian garment exports, accounting for approximately 40 percent of the total manufacturing, followed by the United States (30 per cent) (ASEAN Briefing, 2018).

Implications for India and Some Other Developing Countries

The share of wage employment in the textiles, clothing and footwear (TCF) sector relative to all manufacturing sectors is much higher in many Asian developing countries including India. The following table (Table 3) depicts this scenario in some select countries including India.

Table 3: Percentage Share of Wage Employment in TCF Sector Relative to All Manufacturing Sectors

Country	Percentage Share
Cambodia	77
Bangladesh	63
Vietnam	38.8
Pakistan	46.7
India	29
Indonesia	29

Source: ILO (2016a).

Like several developing countries, textile sector is one of the largest providers of employment in India; employing directly about 22 million people and indirectly about 54 million people. It is also the largest provider of employment to women and workers with lower educational qualification.[21] Weaving and garmenting are the two larger sub sectors within the textile sector. Weaving provides employment to about 7.4 million people while garmenting employs about 17.43 million people in India.[22]

[20] Ministry of Textiles. 2017. P. 51.

[21] NASSCOM-FICCI-EY. 2017. P.30.

[22] NASSCOM-FICCI-EY. 2017. P.94.

[23] Ministry of Textiles. 2017. P. 51.

India's textile and clothing exports (excluding handicrafts) during 2016-17 stood at USD 36 bn; wherein the share of textiles and clothing exports from India was 13 per cent of the overall exports.[23] It is also important to note that the TCF sector in India comprised of 10.80 million total export-led employment in 2013, wherein 87 per cent were involved in direct export-led employment.[24]

The traditional labour-intensive manufacturing export industries that includes textiles and clothing, create a large number of employment in developing countries due to being highly labour intensive (direct effect) and having strong backward linkages with domestic agriculture (indirect effect).[25] As far as India is concerned, the textile sub-sectors with the highest employment coefficient include, 'readymade garments and miscellaneous textile products' (78.5) and 'silk textiles' (24.9).[26] Higher export growth in these sectors offers significant employment potential, particularly for the vast pool of India's low-skilled workforce. This scenario clearly indicates that textile sector as a whole is quite significant for the country in terms of revenue generation through exports as well as in generating employment.

In Bangladesh, textiles sector provides about three million manufacturing jobs and accounts for about 81 per cent of Bangladesh's exports.[27] This shows huge role of textile sector in Bangladesh's revenue as well as employment generation. Similarly, in Cambodia, the textile sector accounted for about 78 per cent of the country's merchandise exports.[28]

According to a recent ILO Report (2016b), the disruptive impact of the robotics on the textile sector in the ASEAN can be very substantial, as robotic automation poses a significant threat to job-displacement. The implications for the TCF (Textile, Clothing and Footwear) sector in the ASEAN are profound, and likely to disproportionally affect the female workers, currently serving as the backbone of the TCF sector. The female share of TCF employment exceeds 70 per cent in Cambodia, Lao People's Democratic Republic, the Philippines, Thailand and Vietnam.

According to the NASSCOM-FICCI-EY (2017) report, within the Indian textile sector, the maximum impact of the automation technologies has been felt across spinning and weaving sub-sectors. However, the next phase of automation, which includes robotic handling, 3D garment design, automatic folding machines, etc. is going to reduce workforce in the garmenting sub-sector. Next to next phase (after five years or so) would see deployment of sewing robots (currently in experimentation stage in the USA), which would hugely impact large workforce involved in the sewing sub-sector. The report further mentioned the industry experts' apprehension that one robot has the potential to replace about 100 workers in a typical Indian textile manufacturing plant.[29] It is apprehended that robotisation will hit labour-intensive Indian textile sector.

A joint study conducted by the industry body Texprocil and EY on Indian textile sector stated that "*as textile and apparel industry is moving towards automation, the industry is unlikely to create more jobs along with the growth in the industry.*"[30]

According to a recent study (ILO, 2018), given the nature of work, which requires high dexterity, labour-intensive industries such as textile, apparel, are unlikely or would be slow to adopt Industry 4.0 technologies, including robotics. The big companies are more likely to adopt robotics in the future.

It is also interesting to note that according to a recent UNCTAD report, among all the manufacturing sectors, the robot deployment in textiles, apparel and leather sectors have been the lowest. However, it is

[24] EXIM Bank. 2016. Interlinkages between exports and employment in India.

[25] Ibid. P.30.

[26] Ibid. P.39.

[27] Emont, 2018.

[28] Larson. 2018.

[29] NASSCOM-FICCI-EY. 2017. P. 97.

[30] http://www.hrinasia.com/hr-tech/automation-hits-the-textile-sector-in-india-no-new-jobs-created/

[31] UNCTAD. 2017. P.49.

worth noting that though this sector ranks second in terms of the technical feasibility of automating many of its routine tasks using robots[31], the economic feasibility of such automation appears to be the lowest in textiles and apparel sectors.[32] Mani (2019) has also argued that the upcoming 'sewbot' technology would be very highly priced which may make its diffusion in the Indian textile industry rather slow and time-taking.

This could mean that in the near future, there may not be any negative impact on the employment, but as the availability and affordability of the textile robots increases in future, many activities (which are presently done by manual labour), can be taken over by robots, which might lead to job-losses.

It is also to be noted that, at present, there is not any widespread automation happening in the textile sector in China. The weaving and spinning process has been automated, but the cutting and sewing processes, which are highly labour-intensive sub-sectors, have seen little deployment of automation.[33]

Considering this scenario, it would be safe to assume that there would not be any high 'robotisation' going to happen in the Chinese textile sector soon. However, some development in this direction may take place in the medium term. Therefore, it would be pragmatic for the other developing countries, including India, to prepare for the future developments in this sector.

Short-term: At present, the deployment of the industrial robots is seen mostly into the manufacturing sectors such as electronics and automobiles (having the share of 39 per cent of total robot use). These industries account for only 9.2 per cent and 4.2 per cent, respectively of the manufacturing sector employment in Asia (including India, Indonesia, Malaysia, the Peoples Republic of China, the Republic of Korea, Singapore, Thailand, Taipei China and Vietnam) while textiles, apparel and leather sectors, provide 19.2 per cent of manufacturing employment but have only 0.1 per cent of industrial robots' deployment.[34]

According to Mani (2019), the operational stock of industrial robots within the textile industry in India has been very low.[35] He further argued that since the "Sewbot" technology (presently being developed by a US-based company Softwear Automation), is very highly priced, it's diffusion in the textile industry is not going take place in near future.[36] ADB (2018) too has reflected the similar sentiment citing economical non-viability of robotisation in the cheaper labour-intensive manufacturing sectors such as textiles.[37] Therefore, in the short-term, the requirement of human workforce would be going to be intact, and the textile sector would not face any adverse impact of robotics.

In the meantime, it would be pragmatic on the part of countries like India to tap export market share lost by China in the last few years. The latest Economic Survey 2017-18 mentions that India has so far not been able to leverage this opportunity owing to competitors such as Bangladesh, Vietnam having a duty-free access to the EU and USA markets, high logistics cost, etc. These issues need to be resolved sooner to gain an edge over our competitors and boost our textile exports. The Economic Survey 2016-17 estimated that the FTAs with EU and UK could lead to creation of 1, 08,029 additional direct jobs per annum in the apparel sector.[38]

As discussed earlier, the employment generation in the textile sector is strongly driven by export potentialities. Therefore, if the exports increase by exploring newer markets (beyond US and Europe, where textile companies are increasingly inclining to go in for Robotisation), it would lead to higher employment generation.

[32] UNCTAD. 2017. P.42.

[33] ILO. 2016b. P.40.

[34] ADB. 2018. P.67.

[35] Mani. 2019. 45.

[36] Mani. 2019. P.47.

[37] ADB. 2018. P.69.

[38] Economic Survey 2017. P.136.

Medium-term: It is worth noting that the textile sector ranks second in terms of the technical feasibility of automating many of its routine tasks using robots.[39] The routine task intensity is very high in the textile and apparel sector.[40] Estimates suggest that with the induction of cheaper 'sewing robots', the apparel production cost will get reduced to only about USD 0.40 from the current USD 7.0 in the USA (while the production cost in India is USD 0.50).[41] Therefore, it is likely that countries like India would lose their cost-competitive edge in times to come. In addition to this, the domestic textile companies in other developing countries such as India and Bangladesh, have also given some indication that they would be going for robotisation in the medium-term future for ensuring labour cost saving, fast and quality production and getting rid of the problem of rising attrition and absenteeism.

Mani (2019) cautioned that the increasing robotisation efforts in China towards making more intelligent industrial robots in the recent times, might lead to making robots much cheaper and affordable, thus propelling their faster adoption in many sectors. In this scenario, there "*can have deleterious effect on employment intensities in Indian manufacturing- for instance in the labour intensive industries such as textiles and clothing*"[42]. Therefore, the government needs to plan well ahead for smooth transition of the displaced human workforce by training and skilling them in a way that equips them to face the changing job scenario.

Secondly, the domestic manufacturers need to shed their excessive reliance on the Western markets. They rather need to focus on their own domestic and regional markets. Enhanced regional trade integration among developing countries can help them retain the market size in these countries.[43] It would be pertinent to explore enhanced engagement of the Indian textile and clothing sector in the regional value chains to boost textile exports. Sengupta (2018) argues that it is in the interest of India to enter the Regional Value Chains (RVCs) in the garment sector with its neighbouring countries, especially when there is already the presence of FTAs with many of them from within the region. Strengthening RVCs would help in exploring newer markets, where the textile and clothing products from India could be exported, which would in turn lead to more employment generation.

Automation and Global Value Chains

Global Value Chains (GVCs) have served as an important driver of globalization during all these decades, ever since their emergence in 1980s. They allowed companies to offshore activities over large distances across borders to leverage advantages in terms of lower production cost and scale economies. This was not only evident in the labour-intensive manufacturing sectors, such as textiles, but also in the more technology-intensive products such as electronics as well as in the services sector. Emerging or developing economies became crucial partners in GVCs, particularly, in producing manufactured goods at a much lower cost. The significant technological advancements in the ICT domain (which eventually led the Industry 3.0) have played a significant role in promoting GVCs.

However, in the recent times, certain factors, such as growing protectionism, rising wages in the emerging economies, high hidden costs of off-shoring, weak IPR protection regime in the host countries, shifting trend from mass production to mass customization, poor quality issues, thrust for green/sustainable production and increasing use of automation technologies such as Robotics and AI, are increasingly challenging further growth of GVCs, and may even lead to shortening of GVCs in future.[44]

[39] UNCTAD. 2017.P.49.

[40] ADB. 2018. P.70.

[41] ADB. 2018. P.70.

[42] Mani. 2019. P.48.

[43] UNCTAD. 2017. P.59.

[44] OECD. 2017. P.6.

The easy availability of the latest technologies such robotics, automation, 3D printing, AI, etc. these days at lower costs is upsetting cost advantage of retaining production centres in the labour-intensive manufacturing sectors of the emerging and developing economies as the companies are switching to these new technologies to gain both cost as well as quality advantages. It is argued that shorter GVCs that would emerge subsequently may result in direct saving in trade and transport cost, and it would also lower risk of low quality products manufactured in the distant off-shored locations.[45]

It is also argued (Strange and Zucchella, 2017) that with the emergence and diffusion of new technologies such as robots, IoT, 3D printing, there would be reorientation of the present structure of the GVCs. They further argued that the greater availability and lowering of cost of industrial robots have impact on companies based in the developed economies, which would be compelled to may consider relocation in view of the rising labour and other production costs.

The integration of Indian textile and clothing sector is not very high in the Global Value Chains (Gupta, 2015). It is also important to note that Indian textile sector has strong presence only in the low end of the global value chain (IIFT, 2018). This means that as far as GVCs in textile sector are concerned, India has done well in the lower stage of Assembly/Cut, Make, and Trim (CMT), where apparel manufacturers' cut and sew woven or knitted fabric or knitting apparel directly from yarn are concerned. Sengupta (2018) cautions that with more and more developed nations going for robotics, 3D printing and AI, there would be reduction in the need for outsourcing, and for this reason, it is important for India to be engaged more with Regional Value Chains (RVCs).

It is also argued that since the goods cater to similar local market demand and consumption patterns across the countries in a region, RVCs do not put forth strict standard demands like in the case of GVCs (Sengupta, 2018). Mohanty (2012) had also argued that RVC would be an appropriate model to foster intra-regional trade by deepening regional process. Since the export employment coefficient of the textile sector is quite high, it would help generating more employment in the sector.

Conclusion and Way forward

As discussed in the above sections, there are set of issues that need to be taken into consideration while deliberating on the impact of robotisation in the Chinese textile sectors and its impact India and other developing countries in terms of jobs and exports. Though the Indian and other developing countries textile sector are not going to be robotized in the near future, there are some indications that the industry might tread on the path of robotisation in the medium term in order to save labor cost, to improve productivity and quality; and to tackle the growing problem of workers' absenteeism (Jain, 2018).

As mentioned earlier, many of the activities within the textile sector are highly amenable to robotisation and considering the fact that there are evidences of the coming up of 'sewbots' in future, there are chances that the economic feasibility might also get increased; which can drive textile companies towards replacing human workforce by robots. If this happens, there might be some adverse implications in terms of job loss and exports, affecting India and some other developing countries.

According to NASSCOM-FICCI-EY (2017) report, the key factors which would have an impact on the growth of Indian textile sector in next five years are: level

[45] Ibid. P.20.

of exports of Indian-based companies, rising middle class and creation of highly optimized supply chains.

Given this and other factors, some of the sector-specific policy suggestions can be as follows:

Capacity-Building, Education and Training: The government as well as firms needs to step up their efforts to educate and train existing as well as future workforce engaged in this sector with latest skills, which are required in the future. Schools, colleges as well as ITIs should include courses on AI and robotics in their curriculum. NITI Aayog (2018) has rightly stated education as one of its priority focus area. DIPP (2017) Task Force Report also advocated for devising an AI Education Strategy to develop human resource with necessary skill set. It would be useful to have sector-specific education and training programmes, such as for the textile sector, to cater to the needs and requirements of respective sector. The Ministry of Human Resource Development, Ministry of Textiles and the Ministry of Skill Development and Entrepreneurship should lead in this effort.

In 2018, the Ministry of Textiles, in its study on "Garment Sector to understand their requirement for Capacity-building", realizing the growing trends in robotics and Pneumatics globally, made the recommendation that to harness and build human resource on these advanced technologies, 'Robotics and Pneumatics' should be included in the curriculum for Garment Manufacturing Technology in the institutions under the aegis of Ministry of Textiles such as NIFT, NID etc.[46]

Most of the Indian private companies do not carry out any real R&D activity. Only a few of the big textile companies have their in-house R&D division, but they too are mostly involved in process innovation activities rather than product innovation. In this scenario, the Ministry of Textiles should take steps (including adequate financial support) to revive and rejuvenate the four textile research associations - Northern India Textile Research Association (NITRA), Ahmedabad Textile Industry's Research Association (ATIRA), Bombay Textile Research Association, and South India Textile Research Association (SITRA) - which were established to carry out scientific research in the field of textile as well as to promote and foster scientific research studies for the extension of knowledge related to or connected with textile. Further, textile colleges/universities also need to be encouraged to include product development courses in their curriculum. In this regard, there is also need to strengthen laboratory infrastructure support (Chattopadhayay, 2018). These government-supported textile research associations, located across the country, can play vital role in fostering an ecosystem among the private companies, academia and research institutes, which would greatly help in research and innovation in the Indian textile sector.

All this is more critical for the workforce engaged in the textile sector because majority of these employees have low academic qualification and possess low skills, which make them vulnerable in terms of finding an alternative job. In case of job displacement, the efforts should be made to provide relevant skills to the effected workforce to help them find alternative job opportunities in other sectors, such as services. Therefore, the textile industry needs to take lead in this direction.

Diversification into New Markets and Better Engagement with RVCs: As already discussed, the proportion of export-led employment as well as revenue generation is quite significant in the textile sector. With increasing trend of robotisation of the textile sector in the West, there are chances of shrinkage in demand for the

[46] Ministry of Textiles. 2018. P. 30.

textiles exports from India in near future, as argued by (Sengupta, 2018). In this scenario, as advocated by the NASSCOM-FICCI-EY (2017) report as well as ILO (2016a) and UNCTAD (2017) reports, it would be appropriate and timely to explore domestic and regional markets for the textile products to help, on the one hand, to lower the dependence on the West-oriented export model and on the other, to cater to the growing middle-class demand. Diversification of exports in terms of products and exploring new markets can also be thought of. The greater engagement with the Regional Value Chains (RVCs) can be explored within the textile sector to offset negative impact of the shrinkage of Western markets due to lesser demands, which may be triggered by the production of textile products within their own boundaries, aided by robots.

Need for Technology Assessment Studies: There have been very limited or a few studies done so far for analyzing the impact of robotisation on textile sector in India. The available data at present seems to be inadequate to help policy-makers make appropriate policy interventions. It is, therefore, suggested that detailed techno-economic assessment studies should be undertaken to analyse the impact of robotisation on employment and economy pertaining to the textile sector in India.

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Core IV-B, Fourth Floor
India Habitat Centre
Lodhi Road, New Delhi-110 003, India.
Ph. 91-11-24682177-80
Fax: 91-11-24682173-74-75
Email: dgoffice@ris.org.in
Website: www.ris.org.in