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An Assessment of the Impact of Industry 4.0 Technological Advances on Employment in India

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Abstract

The Indian economy has seen the advent of the Industry 4.0 technological advancements in many sectors. Adoption of these new technologies is likely to impact employment. Some scholars see some potential adverse impact leading to unemployment whereas other scholars feel that it will bring about a creation of new jobs and a demand for newer skill sets. Given this, it is important to study and assess the net impact of Industry 4.0 changes on employment. In this paper, we have attempted to conceptualize and assess the possible impact of Industry 4.0 changes on employment in sectors like health, manufacturing and construction of the Indian economy, especially construction, which has not been studied much.

We find that the new emerging technologies will definitely create an impact in many of the large scale and capital-intensive industries and sectors.However, given the cost of adoption of these new technologies as well as adequate labour being available in India, it seems unlikely that these new technologies will be adapted in a major way in the small and medium scale industries so as to displace labour and create unemployment. Hence, the adverse impact of these new technologies on employment may only be marginal at this stage. However, we also conclude that if some of these technologies are adopted in a labour intensive sector like construction, some amount of unskilled labour could be displaced. The probability of

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adoption of these technologies in the construction sector cannot be ruled if the rental model emerges therein.

Key Words: Industry 4.0 Technology, Employment, Construction Sector, Labour Displacement, Rental Model.

JEL Classification Codes: O33 (Technological Change: Choices and Consequences), J23 Labour Demand, L74: Construction.

I. Introduction

The world and India too is currently witnessing the fourth Industrial revolution. This is seen in the increasing use of technologies like artificial intelligence, robots, cybernetics, cloud computing, etc. These technologies are revolutionizing the way work is done. For instance robots are being used in sectors like automobiles, textiles and others to carry out repetitive and precision requiring tasks. Robots are also being used for assistance in surgeries.

So far, the world has faced three earlier industrial revolutions (IR) and survived them. Bhat (2020) has put forth a time line of the four industrial revolutions. According to him, the first industrial revolution (IR 1.0) is said to have been from 1784 to 1870 and it saw the advent of steam power and an increased use of machines giving rise to industrialization and the accompanying factory system and economic growth. The second industrial revolution (IR 2.0) was from 1870 to 1969 which saw the advent and growth of electric power and electricity enabled mass production leading to large corporations with research and development branches. The third industrial revolution (IR 3.0) is said to have been between 1969 to 2010 when there was an increased use of electronics and information technology in production. Increased use of computerization lead to outsourcing of work from developed to developing nations bringing in new patterns of work and employment. The fourth industrial revolution (IR 4.0) is said to have begun in 2010 with increased use of cybernetics, artificial intelligence, robots etc. (Bhat, 2020)

During all the earlier three IRs too there was a fear of loss of employment; for instance in the third IR, it was feared that computerization would lead to a loss of jobs. And indeed the Voluntary Retirement Schemes (VRS) proposed by several public sector banks in the 1990s in India could be seen as a fall out the IR 3. (Payal, 2020, p.62). Likewise every IR has brought in fundamental changes in the way in which production is done and so the fear that this IR 4.0 will displace labour is not unfounded.

In case of IR 4.0 it is feared that robots and automation will replace human labour in many production processes and artificial intelligence too will render many current jobs redundant. According to a TOI report, Zomato laid off 540 employees in 2019 citing automation as the cause. (TOI, 2019).

Many of the innovations of the IR 4.0 have taken place in the developed, mostly labour scarce countries. Hence these innovations could really add value there and may not have much of an adverse impact. However, for countries like India where labour is abundant and employment generation is really needed, widespread use of such innovations could lead to a substantial displacement of labour and result in unemployment. Adding strength to this concern is the fact that due to these very innovations, technology transfers across countries is very easy and fast. So the fear that these technologies could be used in the Indian production processes leading to adverse impact on labour is a genuine concern.

Given the above, it is imperative to assess the possibility and the probability of the Indian production processes in various sectors adopting these technologies. A brief review of literature is undertaken to understand how other scholars have assessed these trends and their probable impacts.

II. Review of Literature

Singh and Nandini (1999) study the impact of technology on employment, specifically on the Indian software industry, using data for 22 firms in the Indian software industry during the period 1996-98. Their study posits that technological advancements, which are proxied by technical collaboration and quality certifications, will in fact have a positive impact on employment, productivity and salaries paid and no significant adverse impact on employment levels. **(**Singh and Nandini, 1999, p.968). Here one can say that since their study is focused

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on the software industry which is itself a technology producing industry, their findings may not be applicable for firms in other sectors or businesses. Also their period of 1996-98 is a period which is technically prior to the advent of IR 4.0. Hence these findings may not be directly applicable for IR 4 technologies.

A study by **Paul and Lal** (2020) analyses the impact of intensity of technology used on employment in the Indian economy from 2011–2012 to 2015–2016. They have included both manufacturing and services sectors i.e. consumer goods sector firms, financial sector firms and firms engaged in non-financial sectors in the analysis. The major findings of this study suggest a strong co-relation between re-skilling and welfare expenditures by firms and employment as such expenditures helps firms retain employees and help better technology adoption and expansion of markets as well. Intensity of technology used or staying up to date with technology in the market helps firms to expand their operations and thereby increases employment opportunities. The study finds that the size of operation is extremely important for acquisition and adoption of any new technologies to remain competitive and expand in the international market. (Paul and Lal 2020 p.45). Age of the firm also plays an important role in creation of employment opportunities as newer firms start with the latest technologies while the capital cost of implementing new technologies for existing firms may not work out to be an economically viable option.(Paul and Lal 2020 p.46) The study concludes that the adoption of new technologies may not lead to employment reduction. (Paul and Lal 2020 p.49)

A study by **Aggarwal** (2019) using empirical analysis of Indian industries, analyses the relationship between new technology, productivity and employment. The study tries to see how the pattern of growth in employment, value added and labour productivity differs between the Information and Communications Technology (ICT)-producing, ICT-using and non-ICT industries of the Indian economy. It uses the Reserve Bank of India (RBI) time series data for 27 Indian industries from 1999-2000 to 2014-15 to reflect the use of the new technologies. The study finds that new technology increases demand of high-skill persons; whereas it contracts the low skill employment in both, the manufacturing and services sectors. (Aggarwal, 2019 p.8). It is interesting to note that all sectors examined by the study saw a contraction in the low skilled jobs but the amount of contraction was higher in the ICT producing and using industries. (Aggarwal, 2019 p.7). It should be noted that the study does not include sectors like construction, mining, electricity or agriculture since these have a low exposure to ICT. (Aggarwal, 2019 p 8)

A study by **Tandem Research** (2018), an ILO Asia-Pacific working paper tilted, 'Emerging Technologies and The Future of Work In India' is focused on finding the likely impact of IR 4.0 in the next five to ten years. The study stresses the fact that automation potential and automation adoption are distinctly different. It states that lack of basic infrastructural facilities will limit the adoption of technology to a few pockets and so will the displacement of jobs in these sectors. The study also finds that the cost of technological up-gradation vis-à-vis the relative cost of labour is also an important determinant of up-gradation by existing firms. Capital intensive manufacturing companies, especially in the automobile industry are more likely to adopt automation thereby displacing labour. Labour intensive industries like textiles are less likely to invest in technological up-gradation except for a few processes which do displace labour. Health, education and care industries which mainly relies on the human touch rather than automation will remain a budding avenue for job creation.

According to the Tandem Research report (2018), the largest share of employment in India is in the agriculture and construction sector. Being labour intensive these sectors will witness technological advances by piecemeal leading to a limited displacement of labour. The report concludes that there will therefore be no large scale disruption in the labour market in the next 10 to 15 years. (Tandem Research, 2018; p.24)

Bhat's (2020) paper, 'India and Industry 4.0' takes a comprehensive view of the subject. He refers to Network Readiness Index for India and other counties. Here he shows that India has a low rank on this index implying that it is unlikely that the IR 4.0 will be adopted in a big way in India. (Bhat 2020, p. 8). He also refers to the density of robots in India and other countries and here too, he shows that the density of robots in India is comparatively very low, implying that the IR4.0 has not taken root in a major way in the Indian industry.(Bhat, 2020, p.15) He contends that IR 4.0 will bring about new employment opportunities (Bhat, 2020; p.32-33).

Pankaj Vashist's (2018) study is specifically focused on determining the impact of technology on jobs in the Indian manufacturing sector. He finds that there is an increase in the demand for highly skilled professionals and this is not at the cost of unskilled labour but at the cost of the intermediate routine skill intensive occupations. (Vashist, 2018, p. 8) These findings are related to the manufacturing sector and are in line with the experiences of the developed countries. (Vasisht, 2018, p.19). He concludes that technology has not reduced the aggregate employment in the manufacturing sector. (Vasisht, 2018, p.19-20).

The review of literature undertaken shows that most scholars surveyed here posit that the adoption of IR 4.0 technology will have minimal adverse effect on total employment in India. Most of the authors come to this conclusion including Singh and Nandini whose findings could be more relevant for IR 3.0 rather than IR 4.0. Moreover, most authors predict a greater demand for skilled labour due to the new technologies being adopted. Displacement of labour, if at all it happens will be at the low end jobs, which are mostly unskilled, repetitive jobs. (Agarwal, 2109, p.8; Bhat, 2020, p.18; Vashisht, 2017, p.19.) Further, the adoption of the new technology will be mostly by big and capital intensive firms and is unlikely to happen in the construction and agriculture sector; in agriculture due to the presence of small land holdings and in construction due to availability of cheap labour. (Tandem Research, 2018, p.12)

III. Research Gap

From the review of literature, we see that most authors agree that the adverse impact of IR 4.0 on employment in the Indian economy would be minimal or negligible. However, here we would like to state that most of these studies are confined to either the manufacturing sector or service industry and whether the same holds good for other sectors say like construction is a moot point and an unanswered query. None of the studies have focused specifically on sectors which are highly labour intensive and which use a large amount of unskilled and semi-skilled and manual labour like construction except the Tandem Research report (2018) which has briefly commented on agriculture and construction sectors. These sectors, namely, construction, automobile manufacturing or the sub sectors in manufacturing where the adoption of the IR 4.0 tech is quite possible, are the ones likely to be affected by IR 4.0.. Hence it is pertinent to study the probable impact that the adoption of such technology could have on employment in these sector and so, in this paper, we focus on the three sectors of Health, manufacturing, particularly the automobile sector and Construction sector for which some data are available and some preliminary assessment can be made.

The concern of technological unemployment may be genuine but history has shown that though technology has been a great disrupter in the short run it is indeed a great enabler in the long run. Most authors say that the disruptions or adverse impact on employment if any would be only in the short run whereas in the long run the use of these new technologies will create more employment. Here we would like to contend that even if the disruptions in employment created by the IR 4.0 technologies are short term, if these can be pin pointed and policy can be readied with remedial measures to deal with them, the short term adverse impacts can be alleviated to a great extent.

IV. The Research Question:

In order to address the above question, we focus our attention on a few sectors of the Indian economy, namely Health, Manufacturing (automobile) and Construction to assess the **possibility** of the IR 4.0 technologies being adapted in these and the **likelihood or probability** of them displacing labour and reducing employment. In this paper we therefore attempt to assess the technical possibility of these innovations being adapted and the economic probability of the same.

V. Methodology

For this study have used a mixed method approach wherein we have tried to see the extent of the IR 4.0 adoption and its impact on employment in India in quantitative and qualitative terms. We have also focused on a sectoral analysis of use of IR 4.0 technologies. Given the sectoral data availability, we have focused on three sectors namely Health, Manufacturing and Construction, especially construction, since not much attention has been focused on IR 4.0 in construction and also because construction is a very labour- intensive sector in India and the use of IR 4.0 technologies could have a larger impact on here. For each of these sectors, we have examined the possible IR 4.0 technologies that could be adopted and the probability of these being adopted given the economics of these new technologies. We have also tried to estimate the labour displacement potential of these techniques.

The data for this have been sourced from World Robotics Report, NASSCOM and other reports and studies since there is as yet no standardized data set on the IR 4.0 technologies in use in different sectors in India.

The rest of the paper is presented in the following sections. In section **VI** we analyse the overall picture for the IR 4.0 adoption in India. In Section **VII** we analyse the Health Sector; in Section **VIII** we analyse the Manufacturing sector, particularly the automobile sector and in Sector **IX** we focus on the Construction sector and in Section **X** we conclude the paper.

VI. Adoption of IR 4.0 Technologies in India

To understand the adoption and growth of IR 4.0 technologies in India, we have used the data on annual installations of robots for the 10 year period from 2013 to 2023 published by World Robotics. This is shown in Table 1. Here we have computed the annual growth rate and the overall growth in the number of robots installed.

From Table 1 we see that the number of robot units installed annually has grown at an uneven pace, sometimes increasing and sometimes decreasing. The decrease is notable especially during the COVID year. However in 2023 the number has grown at an annual rate of almost 59 percent. Moreover, if we look at the cumulative growth of robots, it shows an increase of 2166.56 percent over the ten year period of 2013 to 2023 i.e. on an average a growth rate of 216.67 percent per year. This implies that IR 4.0 technologies are being rapidly adapted in the Indian production processes.

The sectoral adoption of IR 4.0 technologies from a NASSCOM study is shown in Table 2. According to NASSCOM (2024) report the following sectors have a high potential for AI adoption: Healthcare, Banking, Financial Sector and Insurance, Energy and Utilities, Consumer Packed Goods, Retail, Transport and Logistics, Manufacturing, Telecom, Media and Entertainment. According to NASSCOM (2024, p.38) the NASSCOM AI Adoption Index in the Indian context is a comprehensive maturity assessment framework that tracks and measures the degree of AI penetration in India and arrives at a composite score ranging between 1 - 4 both at the country and sector levels. The 2024 Index 2.0 score for India is 2.47. The index for the above mentioned sectors is shown in Table 2. From this we note that most of the sectors mentioned in Table 2 have a high index showing a relatively high adoption rate for the use of IR 4.0 technologies. Again it is to be noted that labour intensive sectors like agriculture and construction are not included here implying they have a low exposure to IR 4.0 technologies or are not being reported.

VII. IR 4.0 in the Health Sector

The main types of technological advances under IR 4.0 that are foreseen in the health sector are the use of robots for surgery and use of health apps for online medical consultations. In case of health apps, the use of these will only lead to an increase in the number of patients and will lead to increased demand for personnel to assist in managing these apps or the data. Hence this innovation may not lead to any reduction in employment.

According to Deo and Anjankar (2023) the first use of a robot for surgeries was made in 2006 at the All-India Institute of Medical Sciences (AIIMS) Delhi, where the urological robot was used. Further according to them, robotic surgeries have increase manifold and as of 2019 there have been 12,800 surgeries performed with the assistance of robots at 66 centers by more than 500 skilled robotic surgeons.

The use of robots in surgery will bring in more precision and may lead to less time required for surgeries. It may marginally decrease the requirement of personnel who assist in surgeries. On the other hand, it could increase demand for other skilled personnel who would be involved in the maintenance of the robots etc. This innovation we do not think will adversely affect employment substantially also because the cost of these robots is currently very high and it seems unlikely that they will be adopted in a big way in India, at least in the near future. According to Bora et al (2020) the robot currently costs around US $15,00,000 as initial investment with a annual maintenance cost of US $ 1,00,000. (Boral et al, 2020). Further device malfunction is also a reality with this innovation (Boral et al, 2020). Hence, given this steep cost and the chance of malfunction, we feel that this innovation may not get so readily adopted in India in the immediate future on a wide scale.

VIII. IR 4.0 in the Manufacturing Sector

The manufacturing sector is more likely to see the adoption of the IR 4.0 technologies. Technologies like automation, robotics, cloud computing and smart factory are the most probable candidates. These aid in achieving precision in the production processes, lead to timely delivery, better quality of products, increased safety, reduced bottlenecks and due to all this, less cost of production is incurred and it also results in less hassles of management. Some of these have already been adopted by some of the industries as listed in Table 3.

As can be seen from Table 3, some of the manufacturing units are adopting IR 4.0 innovations and some of these could displace labour. According to the Economic Times, Raymonds could cut down 10,000 jobs in three years which is a huge job loss coming from just one company in that sector. The other companies adopting the IR 4.0 innovations are not listing the job losses so it is difficult to say what they would be; but it would seem that there would be some job losses here too.

The adoption of these IR 4.0 technologies seems to be happening in some pockets or in some advanced and big companies only. If we try to assess the average adoption of IR 4.0 tech in India, we could look at the data given on the use of the number of robots per 10,000 employees. This is shown in Table 4.

As we can see from Table 4, India's use of robots in 2016 on an average is 3 per 10,0000 employees which is quite a bit below the global average of 74. The number is very high for developed and technologically advanced and labour scarce countries like Germany and US. In those countries, it could be the need to have robots because of the sheer cost of labour. In India, although we see that the use of robots is low on the average, it is quite high in the automobile sector. We have two estimates of this, one according to Bhat is 58 robots per 10,000 employees (Bhat, 2000 p.15) and the second according to Eklahare it is 85. (Eklahare, 2019, p.1). This difference in the estimates of the two could be due to the different years referred to. Whatsoever the difference in the estimate, it is quite high in the automobile sector. Hence we focus on the automobile sector to understand why the density of robots is high in that sector and how this could affect employment.

8.1 Automobile Sector

The Indian Automotive industry is an important sector of the Indian economy. According to Saxena (2022), the sector contributed 7.1 percent to the GDP in 2021, generated employment (both formal and informal) to the tune of 37 million and has a share of 4.7 percent in India's exports.

The automotive industry needs a lot of precision, quality as well as cost controls along with safety in the highly competitive market. This makes it necessary for companies to increase automation. However, despite the technological advantages, replacing labour is a costly affair. According to the manager of Ford India, one robot does the work of three technical worker but costs between $ 3,00,000 to $4,00,000 rendering automation 10 times more expensive than manual labour (Philip, 2015). Therefore, despite the increase in automation, the Indian automobile industry continues to be a big employer. Table 5 gives data on the number of robots in the different companies of the automobile sector of India.

As can be seen from Table 5, many of the top automobile companies in India have a large number of robots working in their plants. In case of Maruti Suzuki's Gurgaon plant, we can see that the number of robots is increasing over the years. The reasons for a large number of robots in the automobile manufacturing plants are many, as follows:

1. Large scale and capital-intensive production process
2. Lot of processes amenable for automated
3. Automation is economically feasible due to volumes.
4. Since exports are high in this sector, companies prefer automation to ensure precision and quality in work and to minimize errors. According to Bhargava (2020) 7,50,000 cars are exported in a year.
5. To avoid labour troubles and lockdowns e.g. as seen in the Maruti Suzuki plant in Manesar in 2011. According to Raj (2012) Maruti Suzuki faced labour protests and this caused production and revenue to fall and a recent lockout caused a revenue loss of Rs 1500 crores.
6. Increase in FDI in this sector is another major reason for automation (Narasimhan et al, 2015)
7. Some of the automation helps to reduce imports (Narasimhan et al, 2015)

Due to all these reasons, automation is high in the automobile sector and could increase further.

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8.2 Automation Versus Cheap Labour

Despite the high number of robots used in the automobile sector there is a limit to the level of automation that can occur in the automobile sector in India. Since many plants are located in India to take advantage of the relatively cheap labour, companies may not go in for too much automation. For instance according to Narasimhan et al (2015), the Wolkswagon body shop in Pune is about 30 percent automated whereas the one in Wolsburg in Germany is over 90 percent automated. This is because a Volkswagon built in Pune with only 30 percent automation is accepted on quality across Asia, Africa and North America. (Narasimhan et al, 2015). Thus automation may not always be feasible or economically viable in India due to availability of cheap labour. Table 6 shows the robot density in a few auto plants in India and we note that it is reasonably high for India though it may be lower compared to developed and advanced labour scarce countries.

8.3 Labour Displacement Due to Robots

Even if the number of robots is high or increasing in the auto sector, the main question that needs to be addressed is whether they are displacing labour or complementing it. Increased automation may not lead to decrease in jobs in the auto sector. According to Narsihman et al (2015), robots are rising in auto factories but there is no labour replacement yet. As the sector flourishes due to automation and exports, it will in fact generate more employment due to expansion of output. (Narsihman et al, 2015).

However, automation could affect the low end jobs. As per Raj (2012), in case of Maruti Suzuki, by employing robots it can reduce workforce by 2000 to 2500 workers. It is not clear whether by this he refers to all robots at all its plants or the only 800 robots planned for the Mehsana plant in Gujarat. If we consider the 800 robots displacing 2000 to 2500 workers, the **labour displacement per robot is 2.5 to 3.125**. If we consider all the robots, i.e 1800 robots then the labour displacement works out to be approximately **1.3**.

From the data available and examined, it appears that the automobile sector could see a rapid expansion in automation and as a result could see some layoffs of workers or a lower demand for workers as automation proceeds.

8.4 Growth of Employment and Impact of IR 4.0 in the Manufacturing Sector

If we focus on the manufacturing sector as whole, similar trends may be seen here. Technology adoption may be scattered and could happen only in a few big firms in most of the sectors. Whatever the number of firms adopting new technology, the impact on employment may be similar in nature. It will be the low end or unskilled jobs or workers that will be rendered unemployed.

If we observe the growth of employment in the manufacturing sector, as per Aggarwal's (2019) study, we note that between the years of 1999-2000 and 2011-12 there was a negative growth of low skill jobs; in other words, low skill jobs have been lost in this sector. At the same time there is a positive growth of jobs in the medium and high skill jobs in the manufacturing sector. (Aggarwal 2019, p.7) Due to this, we can say that total employment may increase and it could lead to a greater demand for skilled and highly skilled personnel. The point to note here is that the time period for Aggarwal's analysis refers to 1999-2000 to 2011 -12 which covers only the beginning few years of the IR 4.0 technological advances. Thus, if it so happens that jobs of low skills have been lost in times of IR 3.0 and the initial years of IR 4.0, then it is likely to continue in the coming years with further IR 4.0 advances too.

Summing up for the manufacturing sector, we can say that although automation and IR 4.0 may bring in many benefits as also an increase in total employment in the manufacturing and is likely to be adopted by few large firms initially, it is likely to adversely affect the job creations or the demand for labour at the lower end (the unskilled or semi skilled) jobs. To what extent it could affect these jobs in the manufacturing sector is difficult to say at this point.

IX. The Construction Sector

The construction sector is an important sector in India. According to Sethi (2022), it contributes about 9 percent to the GDP of India and is the second largest employer in India with 51 million people being employed in this sector in 2020–21. According to FDI India (2022), the sector attracted $26 billion FDI inflows during April 2000 – March 2021, is the second largest recipient of FDI in India and is poised to become the third largest construction market globally by 2025. (FDI India, 2022)

In India the construction sector is a labour-intensive sector and as per Wikipedia (2022), it is a fragmented industry with only a handful of major companies involved in the construction activities across all segments. The rest of the sector comprises of medium sized companies specializing in niche activities and small and medium contractors who work on sub contract basis and carry out the work in the field.

This sector is peculiar and different compared to other sectors in the Indian economy. The key characteristic of this sector in India is that about 90 percent of it is in the unorganized sector. Another important characteristic is that it is very labour intensive and uses manual operations in many of its operations or production processes. Hence it is essential to study the probable impact of IR 4.0 on this. Given the structure, composition and importance of this sector we can posit that it could be majorly affected by the IR 4.0 innovations.

9.1 IR 4.0 Tech Possibilities in Construction

A lot of technologies are now available to be used for different operations in the construction sector. Which of them and to what extent these will be used remains to be seen. Table 7 lists the various technologies that can be used and their labour displacement potential.

9.2 Probability of Adoption of Tech 4.0 in Construction Sector

Most of the IR 4.0 technology innovations in the constructions sector, listed in Table 7, are such that they could reduce employment at the semi skilled and unskilled worker level if adopted in a big way by the industry. Hence the question to ask is whether they will be adopted or not and at what cost to employment.

Many studies predict a low probability of automation being adopted in the construction sector. As per Bhat, (2020, p.8), the Network Readyness Index for India is low so it is highly improbable that the Tech 4.0 will be adopted widely in India and therefore in its construction sector too. Moreover, according to Shrivastava (2020), construction industry globally has been resistant to change and the situation is even grimmer in India. As construction sector firms are mostly in the informal sector; a widespread use of automation may not be seen in the near future. Further he says that except for a few top private players most of the projects work with fragmented teams. Hence this may not lead to adoption of these cutting edge technologies. (Shrivastava, 2020). According to Singh and Mishra's (2020) survey, huge costs incurred in the implementation and maintenance and the problems in hiring people with the requisite expertise emerged as the biggest obstacles for firms in adopting IR 4.0 technologies in the construction sector. (Singh and Mishra 2020)

Although the factors discussed above may strengthen the argument that the IR 4.0 tech will not be adopted in a big way in the construction sector, according to us, there are reasons why these technologies could get adopted. Some automations like WALT (painting robot) can become quite popular as they ensure a dirty job can be done quickly. These robots, even if expensive, can be rented and the renting model could render this automation viable for the small and medium sized construction businesses. The same argument can hold for SAM (automated bricklaying) and for the 3-D printing tech. In fact, new businesses which will own and rent out these automations may surface in the country. If the cost of these technologies falls to reasonable levels, construction sector firms may go for these techs in a big way as these may overcome the problems of ensuring safety at the work place, ensuring dirty jobs getting done quickly and efficiently, ensuring timely work and reducing manpower management hassles. The costs of these technologies may fall if the renting model can emerge successfully. Therefore, under this scenario, if these technologies are adopted in this sector, it could lead to substantial displacement of labour. If this happens it could lead to short run disruptions in the construction sector employment rendering a pool of people unemployed.

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Hence, the question is: what is the likelihood that the rental model for these IR4 technologies will emerge in the construction sector? Some developments in this direction can be seen. For instance, according to the Tandem Research report (2018), start ups like EM3 agri-services are providing agricultural equipment and services on a pay-for-use basis. (Tandem Research, 2018, p.12). A similar model could evolve in the construction technology too. According to Balasubramanium (2018), 'Endless Robotics', a Hyderabad based Indian start up is developing WALT, a robot which can undertake painting jobs quickly and efficiently. (Balasubramanium, 2018).

Further, we see that the cost of robots is continually falling. As per Mani (Mani 2017, p.9), the average price of industrial robotic systems has declined from $182000 in 2005 to $ 133000 in 2014, amounting to a fall of approximately 27 percent over a nine year period.

We should also note that as per FDI India (2022), the construction sector has seen a high amount of FDI in 2020-21 and is also likely to emerge as the third largest market globally. Increased FDI would indicate that automation in this sector, wherever possible, will increase.

Hence we note that given all the above factors this could become a trend and many more such technologies will come into the construction sector and these could be adopted by small and medium firms too.

Thus, although according to the Tandem Research stud (2018), it is unlikely that the new IR 4 techs will be used in the Indian construction sector due to the availability of cheap labour, we feel that if these technologies are rendered cheaper due to the rental or the pay-per –use model then they could easily displace labour as labour in construction sector has a host of problems associated with it like inefficiency, safety issues and management issues.

X. Concluding Remarks

Industry 4.0 technologies are permeating the Indian economy but it is doing so rapidly only in the limited sphere of the automobile sector and in a limited way in other manufacturing and other sectors. In the rest of the production processes and especially in sectors like construction and health it is being adapted only in pockets. Thus, this adaptation may not adversely affect the total employment generation in these sectors.

The main adverse impact that can be concluded is that the low skill jobs especially in manufacturing sector particularly in automobile sector may get curtailed. Further study needs to be done to estimate its size and decide the policy for skilling and re-skilling workers appropriately. In case of the construction sector, there are a lot of potential IR 4.0 technologies which could get adopted. Although the cost of these technologies may render the adoption of these improbable at this stage, if a rental model emerges for these technologies, these could get widely adopted. And in that case there could be a fall in the demand for unskilled and semi skilled workers in the construction sector of country and could lead to increased unemployment.

In light of this possibility, it is essential to closely monitor these developments in all sectors especially labour-intensive sectors like constructions to see if these technologies are getting adopted rapidly. If that happens we need to be ready to deal with the likely displacement of labour and the low growth of new labour demand. In that case timely policy response will be needed. It would require some sort of a safety net creation or re-skilling programmes to be adopted in a big way.

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Table 1: Growth of Industrial Robots in India

Year	No of robot units installed*	Annual Growth Rate (In Percent)	Cumulative Number of Robots
2013	1917	---	1917
2014	2126	10.90	4043
2015	2065	-2.87	6108
2016	2627	27.22	8735

2017	3424	30.34	12,159
2018	4771	39.34	16,930
2019	4299	-9.89	21,229
2020	3216	-25.19	24,445
2021	5142	59.89	29,587
2022	5353	4.10	34,940
2023	8510	58.98	43,450

*Source: World Robotics 2024; p.2.

Table 2 Sector Wise Adoption Index of IR 4.0 Technologies in India 2024.

Sector	Score
Healthcare	2.11
Banking Financial Sector and Insurance (BFSI)	2.45
Energy and Utilities	2.47

Consumer Packed Goods (CPG) and Retail	2.37
Transport and Logistics	2.54
Manufacturing	2.67
Telecom, Media and Entertainment	2.67

Source: Compiled from NASSCOM (2024) p 38

Table 3: Some IR 4.0 Technologies Adopted in the Indian Manufacturing Sector

SNo	Name of Company	Industry 4.0 Tech Adopted	Sector

1.	Raymonds	To adopt automation in processes to cut down 10,000 jobs out of 32,000 workers to be replaced by robots. in 3 years	Textiles
2.	Kirloskar Brothers	Using 3D Printing and Internet of things (IoT) in production operations. Plants are run through remote management systems.	Manufacturing
3.	Marico Industries	Is implementing the cyber physical system.	FMCG/Manufacturing
4.	Textiles (Company not mentioned)	Automation of spinning, auto-comer and auto splicer divisions have replaced 20 workers with 2.	Textiles

Source: Compiled from Economic Times, 2016(Raymonds), Bhat,2020 p.16 (Kirloskar Br and Marico); and. Tandem Research 2018, p.9 (Textiles)

Table 4: Robots per 10,000 Employees

S.No	**Country/Sector**	**Robots per 10,000 employees 2016**
1.	Germany	309
2.	US	189
3.	China	68
4.	Brazil	10
5.	Russia	3
6.	**Global Average**	**74**
7.	**India**	**3**
8.	Automobile Sector of India	58
9.	Automobile Sector of India *	85 **(2019)**

Source: Bhat T.P., 2020; p.15 (for 1 to 8) *Eklahare Juili, 2019,p.1

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Table 5: Number of Robots in the Various Automobile Companies in India

Sr No	Name of Company/Plant/State	No. of Robots
1.	Ford, Sanand, Gujarat	437
2.	Tata Motors, Sanand, Gujarat	100
3.	Hyundai	400
4.	Bajaj Auto	100-120
5.	Volkswagon Pune	123
6.	Maruti Suzuki, Mehsana, Gujarat	800
7.	Maruti Suzuki, Gurgaon, Manesar (2015)	1000
8	Maruti Suzuki, Gurgaon, Manesar) (2019)	5000

Source: Compiled from Bhat, T.P. 2020, p.15-16 (for 1,2,3,4), Philip L (2015) for 5; Raj Amrit (2012),p.1 for 6; Narasimhan et al (2015) p.1 for 7; Rais Alam 2019 for 8.

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Table 6. Density of Robots in the Automobile Plants 2015

S.No	Company	Location	Robots	Workers/Employees	Robot Density	Robot: worker ratio
1	Ford Motors India	Sanand, Gujarat	453	2500	18.12%	1: 5.5
2	Hyundai Motors India	Irugattukottai, Tamil Nadu	400	4848	8.25%	1: 12.12
3	Volkswagen India	Chakan, Pune	123	2000	6.15%	1: 16.26

Source: Computations based on data from Mani, S. (2017;p30) and Philip Lejee (2015)

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Table 7: Technologies in Construction and the Probable Impact on Output and Labour

SN	Technology	Expected Impact on Product /Output	Expected Impact on Labour Displacement
1	Robots for brick laying : Semi-Automated Mason (SAM) which can lay 3,000 bricks per day	Greater speed and precision in work; reduction in the waste generation, timely work and less errors	Could displace manual labour substantially.
2	The robot, called WALT, can paint walls about 30 times quicker than a human at a speed of about 60 square feet per minute and can work at heights from 8ft to 14ft.	Greater speed in work; prevents exposure of labour to dangerous situations. Skilled work force is needed to use these robots.	Could displace unskilled labour substantially.
3	Automation and robots used for material production, concrete mixing, laying, leveling and finishing.	Precision in work; reduction in the waste generation; saves workers from exposure to unhealthy situations.	Could displace manual labour to some extent
4.	Robots used for dismantling concrete slabs, walls and other interior structures.	Saves workers from exposure to unhealthy situations.	Could displace manual labour.
5.	3D printing: Robots used in the 3D printing technology to effectively print an entire prefabricated building structure and later assemble them into a whole building on-site.	Greater speed and precision in work. Increased demand for skilled personnel.	Could decrease demand for labour.
6.	'Hadrian' a robot to build a house. Developed by an Australian engineer.	Can build a house in just 2 days.	Could decrease demand for labour.

Source: Compiled from Balasubramanium (2018) and Tandem Research, 2018, p.12