THE CENTRE FOR internet & society

The Future of Work in the Automotive Sector in India

WORKING PAPER, NOT FOR PUBLICATION

Perspectives from the Ground

By **Harsh Bajpai, Ambika Tandon and Amber Sinha**

Edited by **Rakhi Sehgal**

Research Assistant **Manav Mehta**

The Centre for Internet and Society, India

Designed by Saumyaa Naidu

Table of Contents

Introduction **2**

The Automotive Industry in India **5**

Stakeholder Ecosystem **7**

Methodology **8**

National Policy Framework **9**

Industry 4.0 and the Automotive Sector **12**

Key findings **12**

Changes in Job Tasks and Roles 14

Employment relations 18

Changes in Productivity 19

Stages of transformation 20

Growth and productivity 22

Work intensification and informality 23

Concerns and Challenges **25**

Key findings **25**

Education and skilling 26

Re-Orienting Skill Development 27

Social security 28

Gender 31

Policy Recommendations **34**

Introduction

The adoption of information and communication based technology (ICTs) for industrial use is not a new phenomenon. However, the advent of Industry 4.0 has been described as a paradigm shift in production, involving widespread automation and irreversible shifts in the structure of jobs. Industry 4.0 is widely understood as the technical integration of cyber-physical systems into production and logistics, and the use of Internet of Things (IoTs) in processes and systems. This may pose major challenges for industries, workers, and policymakers as they grapple with shifts in the structure of employment and content of jobs, bring about significant changes in business models, downstream services and the organisation of work.

Industry 4.0 is characterised by four elements. First, the use of intelligent machines could have significant impact on production through the introduction of automated processes in 'smart factories.' Second, real-time production would begin optimising utilisation capacity, with shorter lead times and avoidance of standstills. Third, the self-organisation of machines can lead to decentralisation of production. Finally, Industry 4.0 is commonly characterised by the individualisation of production, responding to customer requests[1]. The advancement of digital technology and consequent increase in automation has raised concerns about unemployment and changes in the structure of work. Globally, automation in manufacturing and services has been posited as replacing jobs with routine task content, while generating jobs with non-routine cognitive and manual tasks[2].

Some scholars have argued that unemployment will increase globally as technology eliminates tens of million of jobs in the manufacturing sector[3]. It could then result in the lowering of wages and employment opportunities for low skilled

[1] *Artificial Intelligence and Robotics and Their Impact on the Workplace*. IBA Global Employment Institute. (2017).
[2] Michaels, G. "Has ICT polarised skill demand? Evidence from eleven countries over 25 years." *Review of Economics and Statistics* 96(1) (2014): 60-77.
[3] Rifkin, J. *The end of work: the decline of the global labour force and the dawn of the post-market era.* New York: Tarcher/Putnam. 1996.

workers, and increased investment in capital-intensive technologies for employer[4]
.

However, this theory of technologically driven job loss and increasing inequality has been contested on numerous occasions, with the assertion that technology will be an enabler[5,6], will change task content[7] rather than displace workers, and will also create new jobs[8]. It has further been argued that other factors such as increasing globalisation, weakening trade unions and platforms for collective bargaining[9], and disaggregation of the supply chain through outsourcing[10] has led to declined wages, income inequality, inadequate health and safety conditions, and displacement of workers.

In India, there is little evidence of unemployment caused by adoption of technology due to Industry 4.0, but there is a strong consensus that technology affects labour by changing the job mix and skill demand[11]. It should be noted that technological adoption under Industry 4.0 in advanced industrial economies has been driven by cost-benefit analysis due to accessible technology, and a highly skilled labour force. However, these key factors are serious impediments in the Indian context, which brings the large scale adoption of cyber-physical systems into question[12].

The diffusion of low cost manual labour across a large majority of roles in manufacturing raises concerns about the cost-benefit analysis of investing capital inexpensive automative technology, while also accounting for the resultant displacement of labour. Further, the skill gap across the labour force implies that

[4] Kotlikoff, L. J., and Sachs, J. D. "Smart machines and long-term misery." *NBER Working Paper* 18629 (2012).
[5] Chui, M., Manyika, J., and Miremadi, M. "Where machines could replace humans—and where they can't (yet)." *McKinsey Quarterly* 7 (2016).
[6] Vivarelli, Marco, "Innovation, Employment & Skills in Advanced and Developing Countries: A Survey of the Literature, Institute for Study of Labour." Discussion Paper No. 6291 (2012) http://ftp.iza.org/dp6291.pdf.
[7] *Will robots really steal our jobs? An International analysis of the potential long term impact on automation.* PricewaterhouseCoopers. 2016.
https://www.pwc.com/hu/hu/kiadvanyok/assets/pdf/impact_of_automation_on_jobs.pdf
[8] Berg, A., Buffie, E. F., an Zanna, L. F. "Robots, growth, and inequality. *Finance & Development.*" 53(3) 2016: 10-13.
[9] Freeman, R. B. "Who owns the robots rules the world." *IZA World of Labor.* (2015)
[10] Weil, D. "The fissured workplace: Why Work Became so Bad for So many and What can be done to Improve it." Harvard University Press (2014).
[11] Vashisht, P., and Dubey, J. D. "Changing Task Contents of Jobs in India: Implications and Way Forward." *Indian Council for Research on International Relations.* Working Paper No. 355 (2018), http://icrier.org/pdf/Working_Paper_355.pdf
[12] Paris, "Industry 4.0 in India." (2017) https://rctom.hbs.org/submission/industry-4-0-in-india/

the adoption of cyber-physical systems would require significant up-skilling or re-skilling to meet the potential shortage in highly skilled professionals[13].

This is an in-depth case study on the future of work in the automotive sector in India. We chose to focus on the future of work in the automotive sector in India for two reasons: first, the Indian automotive sector is one of largest contributors to the GDP at 7.2 percent, and second, it is one of the largest employment generators among non-agricultural industries[14]. The first section details the structure of the automotive industry in India, including the range of stakeholders, and the national policy framework, through an analysis of academic literature, government reports, and legal documents.

The second section explores different aspects of the future of work in the automotive sector, through a combination of in-depth semi-structured interviews and enterprise-based surveys in the North Indian belt of Gurgaon-Manesar-Dharuhera-Bawal. Challenges posed by shifts in the industrial relations framework, with increasing casualization and emergence of atypical forms of work, will also be explored, with specific reference to crises in collective bargaining and social security. We will then move onto looking at the state of female participation in the workforce in the automotive industry. The report concludes with policy recommendations addressing some of the challenges outlined above.

[13] Chandrasekhar, C. P. "Revisiting the Policy Environment for Engendering Employment Intensive Growth." *Background Paper prepared for the International Labour Office, New Delhi* (2008).
[14] *India's Readiness for Industry 4.0.* Grant Thornton India. (2017). http://www.grantthornton.in/insights/articles/indias-readiness-for-industry-4.0--a-focus-on-automotive-sector/

The Automotive Industry in India

The automotive industry in India, comprising of Original Equipment Manufacturers (OEMs) and auto component manufacturers, is one of the largest manufacturing industries in the country, contributing to 5.6 percent of the national GDP in 2016-17 [15]. It is projected to contribute to over 12 percent over the next decade, according to the Automotive Mission Plan, 2026[16]. As of 2017, the Indian automobile industry is the fourth largest manufacturer of automobiles globally[17] and has been steadily growing.[18]. Two-wheelers dominate the industry and make up about 80 percent share in the domestic automobile sales., [19]. The industry has mushroomed in three major geographical clusters — *Gurgaon-Manesar-Bawal-Dharuhera* in North India, *Chennai-Bangalore-Dharmapuri-Vellore-Kanchipuram-Thiruvallore* in South India, and *Mumbai-Pune-Nasik-Aurangabad-Thane* in West India[20].

The industry is structured such that the value chain is comprised of polar opposites: highly sophisticated original equipment manufacturers (OEMs) who are buyers on the one hand, and a large range of suppliers including small, medium, and large enterprises on the other[21]. 70 percent of firms in the sector are informal, leading to heterogeneity in the type of ownership, organisation, scale of operation, etc.[22] The sector is pegged as a major employment generator due to forward and backward linkages with other key industries, including transportation

[15] *Automobile sector's contribution to GDP*. Press Information Bureau, Government of India, Ministry of Heavy Industries & Public Enterprises. (2017). http://pib.nic.in/newsite/PrintRelease.aspx?relid=169436
[16] Ibid.
[17] *Automotive Sector Achievements Report*. Department of Industrial Policy and Promotion & Department of Heavy Industries. (2016).
http://www.makeinindia.com/documents/10281/114126/Automotive+Sector+-+Achievement+Report+%281%29.pdf
[18] Domestic automobiles sales increased at 7.01 per cent CAGR between FY 2013-18 with 24.97 million vehicles sold overall in FY18, and an overall increase of 9.5 per cent year-on-year. *Indian Automobile Industry Analysis: A Sectoral Report*. Indian Brand Equity Foundation. (2017).
https://www.ibef.org/industry/automobiles-presentation
[19] The dominance of two wheelers in automobile sales has been attributed to the penetration of two wheelers into rural markets, by meeting the needs of the youth, middle income groups, and female consumers. Doval, P. "India is now the world's biggest two-wheeler market." *The Times of India*, May 7, 2017.
https://timesofindia.indiatimes.com/auto/bikes/india-is-now-worlds-biggest-2-wheeler-market/articleshow/58555735.cms
[20] *Automotive: Market & Opportunities*. Indian Brand Equity Foundation.
[21] Paul, G. B., Jaganth, G., Abhishek, M. J., and Rahul, S.. "What Makes Enterprises in Auto Component Industry Perform? Emerging Role of Labour, Information Technology, and Knowledge Management." In *Globalisation of Technology* (2018): 253-283.
[22] Ibid.

and construction, leading to the multiplier effect and creation of direct and indirect employment[23]. It employs as many as 19 million workers, and is further expected to see a 8-12 percent increase in employment during FY19[24].

Growth in the sector, however, have been capital-intensive than labour-intensive, with net value added per person employed growing at 4% while net value at constant prices overall grew at 17% between 2013-14[25]. Even though the relationship between scale and productivity is well acknowledged in this capital-intensive sector, only four of India's 18 OEMs operate at the industry standard of 100,000 units per model[26]. This relatively low level of productivity can also be gleaned by comparing India's productivity rate, measured by value added per worker, with that of China's - from 1993 to 2004, the growth rate of Total Factor Productivity in China's automotive sector was 6.1% per year, compared to only 1.1% in India[27]. The growth rate of labor productivity was 9.8 percent per year in China, compared to 3.1 percent in India[28].

It can be concluded that key strengths of the sector in terms of projections for growth are its growing domestic consumption base, strategic geographic location, surplus of semi-skilled labour, a cost competitive value chain that includes low design, testing and validation costs, and low labor costs[29]. As a major employment generator and contributor to the GDP, it has emerged as instrumental in shaping the country's economic policies[30]. Challenges to growth in the sector include human resource and skills gaps, infrastructural constraints[31], heavy

[23] *Automotive Industry*. Department of Heavy Industry, Ministry of Heavy Industries & Public Enterprises, Government of India.
[24] "The Indian Automotive Industry: An International Perspective." Working Paper No. 59, *Export-Import Bank of India*, February 2017.
[25] *Indian Automobile Industry Analysis: A Sectoral Report*. Indian Brand Equity Foundation. (2018). https://www.ibef.org/industry/automobiles-presentation
[26] Ibid.
[27] Saraf, P. *Automotive in South Asia: From Fringe to Global*. World Bank. (2016).
[28] Ibid.
[29] *India's Readiness for Industry 4.0: A Focus on Automotive Sector*. Grant Thornton & Confederation of Indian Industry. (2017).
http://www.grantthornton.in/globalassets/1.-member-firms/india/assets/pdfs/indias_readiness_for_industry_4_a_focus_on_automotive_sector.pdf
[30] Ibid.
[31] Supra, note 27.

informalisation, and low investment in R&D - between 0 to 2 percent of sales across plants against a global average of 5 percent[32].

Stakeholder Ecosystem

When trying to understand the impact of technology on work in the automotive sector, there are a number of stakeholders whose perspectives need to be taken into account. These include:

- **Industry Bodies:** Industry bodies including Confederation of Indian Industry (CII), Automotive Component Manufacturers Association of India (ACMA), Society of Indian Automotive Manufacturers (SIAM), and Federation of Indian Chambers of Commerce & Industry (FICCI) play an important role in communicating and coordinating across companies in the sector. They have also carried out research on the future of work in the automotive sector and in some cases have access to relevant data.
- **Government Bodies:** At the central level, relevant bodies include the Ministry of Labour and Employment, the Ministry of Skill Development and Entrepreneurship, Ministry of Heavy Industries, Department of Electronics and Information Technology, Ministry of Human Resources Development and Niti Aayog. Such government bodies can also be found at the state level.
- **Trade unions:** Several companies have unions which are affiliated to central trade unions and tend to primarily represent regular workers.
- **Companies/manufacturing units:** Companies in the sector comprise of heterogeneous OEMs and auto component manufacturers, as mentioned above.
- **Universities and Training Centres:** Training is provided by both private and public organisations, including universities with courses related to

[32] Supra note, 12.

manufacturing (such as the Haryana Vishwakarma Skilling University), training centres (All India Council for Technical Education) and industry-university collaborations (such as AKGEC-KUKA Robotics).

- **Skilling Bodies:** There are skilling bodies which are set up under the aegis of government, including the National Skill Development Corporation (NSDC) and National Skill Development Agency (NSDA).

Methodology

The first part of this study is based on a review of existing literature on Industry 4.0 in manufacturing and the automotive industry globally. It also explores various aspects of political economy, and labour and industrial relations in the Indian automotive industry. This literature review informed the fieldwork for the project, conducted in the months of July and August 2018. We conducted semi-structured in-depth interviews with 25 interviewees, which were selected using maximum variation sampling within purposive sampling[33]. We attempted to map perspectives of the entire ecosystem of stakeholders as comprehensively as possible - including senior and mid management, trade unions, and HR representatives at OEMs and tier I auto component manufacturers, skilling agencies, consulting bodies such as Deloitte and KPMG, government agencies such as NITI Aayog and DIPP, industry bodies such as SIAM, ASSOCHAM and CII, and researchers and academics. We also conducted enterprise-based surveys.

We targeted the automotive manufacturing cluster in the Northern belt of Gurgaon-Manesar-Dharuhera-Bawal, due to its deep backward integration, presence of major OEMs, and technological adoption[34]. It is thus acknowledged that some of our findings will be contextual to this geographical region, although major trends are seen to exist across the industry largely than specific to any one

[33] Etikan, I., Musa, S. A., and Alkassim, R. S. "Comparison of convenience sampling and purposive sampling." *American Journal of Theoretical and Applied Statistics* 5(1) (2016): 1-4.
[34] Jha, P., and Chakraborty, A. "Post-fordism, Global Production Networks and Implications For Labour." *Institute for Studies in Industrial Development* Working Paper No. 172 (2014).

geographical region. We also consciously restricted ourselves to OEMs and tier I auto component manufacturers, with the assumption that technological disruption is likely to be witnessed first in companies at the higher end of the supply chain.

Participants were made fully aware of the objectives and scope of research before interviewing. We were sensitive to and reflexive of power dynamics between researchers and interviewees, and between different stakeholders in the occupational hierarchy and supply chain. A few key stakeholders we approached were resistant to being interviewed or revealing information - despite such information being in the domain of public knowledge, including Sectoral Skill Councils (SSCs), the Department of Heavy Industries, and the Automotive Component Manufacturers Association of India. It should be noted that companies and industry bodies were largely very receptive, and were also willing to give access to shop floor and R&D centres.

National Policy Framework

The Ministry of Shipping, Road Transport and Highways (MoSRT&H) is the primary agency for formulating, implementing and regulating automotive laws in India. The MoRT&H has constituted three committees to advise it on issues relating to safety and emission regulations. These include the CMVR-Technical Standing Committee (CMVR-TSC), Standing Committee on Implementation of Emission Legislation (SCOE) and the Automotive Industry Standards Committee (AISC). They usually have representatives from the Ministry of Heavy Industries & Public Enterprises (MoHI&PE), MoRT&H, Bureau Indian Standards (BIS), testing agencies such as Automotive Research Association of India (ARAI), Vehicle Research Development & Establishment (VRDE), Central Institute of Road Transport (CIRT), industry representatives from Society of Indian Automobile Manufacturers (SIAM),

Automotive Component Manufacturers Association (ACMA), Tractor Manufacturers Association (TMA) and representatives from State Transport Departments.[35]

In 2016, the Automotive Mission Plan 2016-2026 (AMP 2016) was announced as a collaboration between the Government of India and the Indian automotive industry which laid out the roadmap over the course of the next ten years in terms of size, global footprint and contribution of the GDP, but also notably, technological maturity, competitiveness and institutional structure. The AMP 2016 also speaks of the emphasis on need for skilling in India, and aims for automotive industry in India to becomes significant contributor to the Skills India Mission and become one of the biggest job creating sectors.

The policy document estimates that the automotive industry in India could create up to 65 million direct and indirect jobs over the next decade. However, the document does not specify the methodology or the basis for arriving at this number. More importantly, the policy document itself acknowledges that most of the jobs in this industry require specialized skills, both soft and technical and therefore, the ability to create new jobs would depend heavily on being able to impact skills. It is envisioned that the Auto Skill Sector Development Council will be in charge of leading the skilling programme and serve as the apex body. It may also expand in role and take up testing and certifying activities.[36]

It is interesting that the words 'automation' and 'Industry 4.0' do not feature even once in the policy document. This suggests that while the focus is on creating jobs and technological maturity to ensure that the automotive sector is competitive internationally and in compliance with the safety standards, enabling and facilitating automation is not central to either the government or the industry's agenda at this point. The reasons for this could be both the perceived threat of automation to jobs, particularly in an industry that the government views as key to job creation in the medium term; and also the lack of sufficient economic feasibility of investing heavily in machinery needed to lead to wide scale

[35] Regulatory Framework, *Society of Indian Automobile Manufacturers*, http://www.siamindia.com/technical-regulation.aspx?mpgid=31&pgidtrail=32
[36] Automotive Mission Plan 2016-2026 (A curtain raiser). http://www.siamindia.com/uploads/filemanager/47AUTOMOTIVEMISSIONPLAN.pdf

automation. However, our findings indicate that this does not completely capture the ground reality, as some forms automation are gradually being introduced at various levels of manufacturing.

The key labour legislations in India are the Industrial Employment (Standing Orders) Act, 1946, the Industrial Disputes Act, 1947, the Trade Unions Act, 1926, and the Contract Labour (Regulation & Abolition) Act, 1970. The Model Standing Order under the Industrial Employment (Standing Orders) Act classifies workmen as permanent, probationers, badlis or substitutes, temporary, casual, and apprentices.[37] In 2003, the term 'fixed term employment' was added to mean a workman who has been engaged on the basis of contract of employment for a fixed period. It was clarified that their working hours, wages, allowances and other benefits shall not be less than that of a permanent workman and that they would be eligible for all statutory benefits available to a permanent workman proportionately according to the period of service rendered by them.[38] However, in 2007, this amendment was deleted, thus rendering the legal position of fixed term employment unclear. Later, the Ministry of Labour and Employment (Ministry), notified the Industrial Employment (Standing Orders) Central (Amendment) Rules, in 2018.[39] It amended the Industrial Employment (Standing Orders) Central Rules, 1946 to include fixed term employment across all sectors. These amendments are particularly relevant to the automotive sectors where there is a regular need for temporary and skilled workers.

The Industrial Disputes Act, 1947 lays down the procedure for layoffs and retrenchment. For establishments with less than 50 workmen, there is no liability to compensate for layoffs; establishments with 50 or more workmen are required as a general rule to pay half the basic pay and dearness allowance of the past year for the period of layoff. In the case of industrial establishments (factories, mines and plantations) with 100 workmen or more, notice and compensation to workmen is not enough nor is prior notice to government. Whether it is

[37] Section 2 of Schedule I of the Model Standing Order.
[38] Classification of Workmen, Schedule I of the Model Standing Order.
[39] http://egazette.nic.in/WriteReadData/2018/183810.pdf.

retrenchment, layoffs or closure, prior permission of the appropriate government is required.

There have been suggestions about a need to reform labour laws for the automotive sector in India, including steps such as “single-window” labor compliance process for companies, simpler Provident Fund (compulsory employee insurance and pension) procedures and a new inspection scheme. In the last few years, there have been proposals for a dramatic overhaul of labour regulation in the country through the consolidation of labour laws into codes. The Labour Code on Wages Bill, 2017 aims to consolidate the Payment of Wages Act, 1936; Minimum Wages Act, 1948; Payment of Bonus Act, 1965; and Equal Remuneration Act, 1976.[40] According to this code, the central government may set a national minimum wage as well as have the power to set separate national minimum wages for different states or regions for certain employments including railways, and mines. State governments will set minimum wages for all other employments. Additionally, the Labour Code on Industrial Relations Bill, 2015 proposes to replace the Trade Unions Act, 1926; Industrial Employment (Standing Orders) Act, 1946; and Industrial Disputes Act, 1947.[41]

Industry 4.0 and the Automotive Sector

[40] The Code on Wages, 2017. http://www.prsindia.org/billtrack/code-wages-2017
[41] Labour Code on Industrial Relations Bill, 2015. http://www.prsindia.org/uploads/media/draft/Labour%20Code%20on%20Industrial%20Relations%20Bill%202015.pdf

Key findings:

- Respondents highlighted two kinds of technologies that were being adopted, those geared towards automating core manufacturing process, and those that enhanced efficiency by reducing production time, such as predictive maintenance and analytics.
- Some shops, such as press, paint, and weld are being heavily automated, with some greenfield factories having no workers at all. Some of the roles being automated involve hazardous tasks, leading to automation being welcomed by management and workers alike. Further, the results of these tasks are hypervisible to customers, increasing the benefits of standardization for the management.
- A number of companies across the supply chain were found to reduce production time and labour costs through work intensification rather than automation. Accordingly, in addition to growing contractualisation, fewer workers are performing the same task in a shorter span of time.
- Factors that impact the level of adoption of Industry 4.0 technology include: whether a plant is greenfield or brownfield - with the former having a greater level of integration; how far a firm has been integrated into the global value chain (as exporters or importers)
- Major barriers to adoption of Industry 4.0 technology are: piecemeal adoption of technology and lack of vision for transformation; high initial investment costs; slow returns on investment; abundant low cost labour; skill gaps in the labour market; heavily informalised supply chain.
- The lack of transfer of technology and skills from supplier firms in the global North meant that Indian firms were paying higher costs for purchase and maintenance of Industry 4.0, leading to lower levels of adoption.

Changes in Job Tasks and Roles

One of our respondents, the plant head of a tier 1 supplier, differentiated the kinds of technology the industry requires in two ways: those that will be used on the shop floor to automate core manufacturing processes such as production, and those that will provide supporting services to make the production system more efficient. A majority of our respondents demarcated two primary reasons for technological adoption - increasing productivity, and improving occupational safety by automating hazardous tasks.

This is associated to 'skill biased technological change', engendered as a result of technological disruption that targets low-skilled professions.[42] The critics of the skill-biased theory of technological change argue that it is leading to task-based than skill-based technological change.[43] Thus, there is a need to understand the skill requirement of different jobs through different tasks: routine tasks and non-routine tasks.

The type of tasks that can be most easily automated are those that are highly repetitive, either manual or cognitive, while tasks requiring high levels of creativity, empathy, cognitive ability and high level of sensorimotor skills do not seem to be automotable in near future.[44] A report by ICRIER on changing task content in jobs in India argues that manufacturing has been rapidly automated since 1998, which is when 100 percent FDI was permitted across most manufacturing industries.[45] It demonstrates that routine[46] and non routine[47] manual tasks, including those requiring manual dexterity, saw a decrease in task

[42] Infra, note 75.
[43] Goos, M., Manning, A., and Salomons, A. "Job polarization in Europe." *American Economic Review* 99(2) (2009): 58-63. Also see, Infra, note 73.
[44] David, H. "Why are there still so many jobs? The history and future of workplace automation." *Journal of Economic Perspectives* 29(3) (2015): 3-30.
[45] Vashisht, P., and Dubey, J. D. "Changing Task Contents of Jobs in India: Implications and Way Forward." *Indian Council for Research on International Relations*. Working Paper No. 355 (2018). http://icrier.org/pdf/Working_Paper_355.pdf
[46] A task is considered routine if it can be accomplished by machines following explicit programmed rules.
[47] Non-routine tasks are those that people understand tacitly, for which explicit "rules" or "procedures" cannot be dictated (Autor, 2015).

intensity, over the previous decade while cognitive and analytical tasks saw an increase in task intensity[48].

Other professionals with the need for analytical and technical skills, as well as ability to build ecological sustainable systems, would include 3D printing technicians, cybersecurity experts, and machine learning experts. Occupations within the automotive sector include manufacturing and operations, product development, technical services, and sales and marketing. We attempted to identify changing task content in specific occupations, as well as areas where new occupations will be created.

For each plant shop in the integrated value chain, our respondents provided insights into what they considered to be widely diffused technologies in the manufacturing process, or those that will be adopted in the near future. We take the here example of two Maruti Suzuki India Limited (MSIL) plants in Manesar, plant A and plant B, as well as examples from some other companies we surveyed, to understand the production process and the impact of cyber physical systems.

Press Shop

The press shop at Plant A has six lines of power presses where the sheet metal is cut or pressed, a process that generally takes place a day in advance. The press tools of these machines change automatically i.e. without human intervention, according to the types of parts to be pressed. In the press shop there are almost 30-40 workers in one shift, but this number is declining due to increased automation. A number of studies have indicated the transformation of press shops into “smart press shops”, which will use predictive maintenance to improve the overall effectiveness of the equipment. Companies such as Schuler, for instance, have developed robots that move parts along the press lines and also monitor the condition of components.[49]

[48] Acemoglu, D., and Autor, D. “Skills, tasks and technologies: Implications for employment and earnings”. *Elsevier Handbook of Labor Economics* 4 (2011): 1043-1171.
[49] Schuler. (n.d.). *Automation Technology: Performance along the line.* https://www.schulergroup.com/technologien/automation_technology/index.html?sLang=en.

Weld Shop

Plant A currently has 250 workers across shifts who do spot welding by hand, while plant B is fully automated. The work stations at plant A have gradually reduced from 16 to 4, which is primarily driven by the implementation of robots. According to a member of the trade union, bringing in robots into the manufacturing process did not displace permanent workers, who were deployed elsewhere on the assembly line. Automation in this instance thus replaced a task and led to a change in task content. With reference to the weld shop, a respondent at the components manufacturer Kuka Robotics projected the replacement of workers by smart robots, and the integration of product simulations and intelligent systems connecting robots and monitoring their wear and tear in weld shops by 2030[50], as part of what they label 'factory of the future'.

According to a respondent from the management of ASAHI Glass Limited, a tier I auto component manufacturer, welders have been found to lack the ability to select appropriate welding techniques, leading to an inability to produce required strength and finish in joints. This has prompted the company to use automotive technologies such as electron beam welding or laser welding to provide tensile strength to glass. In other companies, we found that big data analytics is also used to set up correct temperature for different types of glasses, such as tempered or laminated, rear glass or frontal glass etc. Thus, the task of welding is highly prone to be fully automated.

Paint Shop

As of now, the paint shop is the most automated across the shop floor, primarily due to hazardous working conditions. There is minimal human intervention in paint shops apart from workers physically moving car screens within the shop floor. We also found instances of pick-and-place robots being installed, which will further reduce workers in this shop. Different types of paint require different settings regarding process values and application techniques. Tracking quality in

[50] Supra note, 37.

the paint shop has also largely been automated, with most companies starting to use big data and predictive analytics[51] with the goal to analyze data to identify factors that cause variances in paint jobs and improve quality. Quality improvement in this shop has been prioritized also due its visibility to the customer.

While paint shops are already automated to a large extent in terms of core production tasks, the introduction of artificial intelligence performing visual analytics will further automate the task of identifying appropriate paints.[52] This corroborates the theory that routine cognitive tasks will also be automated alongside routine manual tasks in the assembly line, thereby displacing a larger number of workers. In the instance of tasks in the paint shop, as noted above, this is seen as a positive change from all stakeholders given the hazardous nature of the task.

Assembly

The assembly line has the most labour intensive work and sees maximum number of workers being deployed in this part of the shop floor. The task performed by the worker is to reference a large matrix posted on the vehicle, which indicates details such as if the car is left or right hand drive, powered by petrol or diesel, and other such details, and choose seats, tires, air conditioning tubes, gearboxes, switches, locks and door trims depending upon the model variant. This task has to be carried out on an average of 50 seconds per car. The worker then steps onto the conveyor belt, fits the part into the structure and moves onto the next car. Given the complexity of the process and specificity in terms of model, type, option and colour (MTOC), it remains cost effective to deploy workers, implying that the assembly line remains largely human-intensive even in large OEMs[53].

[51] "Big Data at Audi: Root Cause Analysis in an Automotive Paint Shop Using MLlib", *DataBricks,* https://databricks.com/session/big-data-at-audi-root-cause-analysis-in-an-automotive-paint-shop-using-mllib
[52] Interview with Biswajit Bhattacharya, Partner and Executive Director, IBM.
[53] Sethi, A. "Gone in 50 seconds," *The Hindu*, November 6, 2011. https://www.thehindu.com/news/national/gone-in-50-seconds/article2601780.ece

Some 4-wheeler and 2-wheeler manufacturers have been deploying simple pick-and-place robots typically at the end of the Assembly line. Technological innovations are being made that would allow advanced robots to perform tasks which require a high degree of precision - the cost effectiveness of these technologies vis-à-vis workers, however, may not be optimal at current prices.

Quality Checker

Automation at this stage in the assembly line is meant primarily to facilitate customization of the product and while balancing the quality or performance of the vehicle. The task of a worker employed in quality checking would be to take measurements and produce quality control charts, integrating quality tools such as Kaizen - a Japanese system of constantly improving quality. Shortfalls in precision in human processing, and errors in implementation of statistical tools in fast moving assembly lines, are addressed through video inspection in OEMs. This enables workers to improve productivity and feed live data to detect errors and correct them in real time.

Employment relations

There has been a gradual increase in contractualisation of workers in the manufacturing sectors in India over the past few years. While this has been spoken of as one of the key impacts of Industry 4.0 globally, in India this has been a result of the desire of large manufacturing plants to side-step requirements for laying off staff and retrenchments according to Indian labour laws.[54] There is also evidence to suggest that the increased contractualisation is accompanied by circumvention of the minimum wage and other labour regulations.[55] Contractualisation has been used a key tool towards achieving what is termed as labour flexibility in the manufacturing sectors for some time now. However, it

[54] Saha, B., Sen, K., and Maiti, D. "Trade openness, labour institutions and flexibilisation: Theory and evidence from India." *Labour Economics* 24 (2013): 180-195.
[55] Roy, S. D. "Employment dynamics in Indian industry: adjustment lags and the impact of job security regulations." *Journal of Development Economics* 73(1), 233-256; Ramaswamy, K. V. "Liberalization, outsourcing and industrial labor markets in India: Some preliminary results." Uchikawa, S. *Labour Market and Institution in India: 1990s and Beyond*. New Delhi: Manohar Publishers, 2004.

inevitably leads to collateral results such as compromising the collective bargaining powers of the workers and a reduction in worker benefits.

Employment relations have undergone significant changes in the automotive industry in the last decade in India. There were several organised demands made by the unions in 2011-12 in the Manesar belt, including the demand for the abolition of illegal contract system in the plant and absorption of all non-standard employment workers as “regular” workers.[56] After protracted negotiations, this led to direct contractual relationship between the companies and workers in some cases. However, there continue to be serious discrepancies in wages and benefits between employed and non-standard employment workers. As we discuss later, employing casual workers in the main production activity is contrary to the Industrial Disputes Act, 1947. According to the legislation, if a casual workers works for 240 days in a year, they can claim to be made permanent. However, it has been noticed that in order to avoid this eventuality, workers are laid off every 7 months just shy of 240 days.

Our field research revealed a 50-50 split between regular and non-standard employment workers in the press shops of the suppliers to automotive companies, with clear points of difference in salaries. This trend is also reflected across welding shop, paint shop and assembly line. *It has also been reported that in order to increase worker productivity instead of relying on automation and use of technology, the focus so far has been on increasing worker intensity - several aspects of which are dealt with in the following sections.* While earlier, there were relievers in each assembly line, to help run the process of production in case someone was absent from the line or from duty, now there are none.

Changes in Productivity

Factors impacting productivity as part of Industry 4.0 in the sector will be understood in this case study as both exogenous and endogenous to the local structure of production, including the distribution of labour and capital within the

[56] Ibid.

Indian context. Accordingly, while sustainability hasn't been a major focus area of literature on Industry 4.0, we found that the policy push towards Electric Vehicles (EV) from the Indian government is being responded to by the entire industry. EVs have thus been labelled as the "future of mobility" in India[57], as OEMs are adapting to global standards on cleaner fuels by jumping to BS-VI from BS-IV compliance[58]. OEMs are thus investing in R&D to meet global technological standards on cleaner vehicles, which is also propelling auto component manufacturers to adapt.

Stages of transformation

It is expected that there will be a disparity in technological upgradation between those sections of the industry that are imbricated within Global Value Chains (GVCs) as either exporters or importers, and those that are localized in terms of both production and consumption[59]. While the former might be threatened by global trends on technological uptake, the latter will have significantly lower level of incentive and capital to transform their production to match global standards of technological adoption. Accordingly, Harendar Singh, plant head of Mark Exhaust, an Indian tier I auto component manufacturer for Maruti Suzuki, expressed concerns about the increasing market presence of Japanese vendors, which has made the returns on investment more uncertain for Indian vendors. Other endogenous factors in the Indian economy include the capital intensity of the automotive sector, and labour surplus in the economy broadly[60].

The adoption of technology in the industry can be understood through a three stage framework[61]. Retrofitting machines with sensors, including RFID tags and QR codes, for real time data production, as well as cloud computing for data storage is the first stage of introduction of Industry 4.0. This stage is being implemented gradually across shop floors in OEMs and tier I companies. The increased visibility

[57] Interview with Jasleen Kaur, Executive Officer at the SIAM.
[58] *Policy Update: India Bharat Stage VI Emission Standards.* International Council on Clean Transportation. (2016).
https://www.theicct.org/sites/default/files/publications/India%20BS%20VI%20Policy%20Update%20vF.pdf
[59] Interview with Ratika Jain, Chief Executive Officer of Global Innovation and Technology Alliance.
[60] Hasan, R., Mitra, D., and Sundaram, A. "What explains the high capital intensity of Indian manufacturing?" *Indian Growth and Development Review* 6(2) (2013): 212-241.
[61] Interview with Biswajit Bhattacharya, IBM.

of the production process has drastically decreased the changeover time on the shop floor, by generating real time data to allow early identification of issues, faster analysis and rectification, and reduction of error. Digitized Andon systems are also part of this stage, as they allow workers to record and address defects or safety issues in real time[62].

The next stage with a major impact on the level of productivity would be that of data analysis for predictive maintenance and overall equipment effectiveness. A representative from the top management of HMSI detailed that they have introduced a system called SCADA, which uses data from sensors in centralized systems, which allows them to predict failure and monitor work efficiency. Traceability of parts also allows recalling or tracking parts in case of defects. Predictive technology would allow plants to move beyond real time troubleshooting and maintenance to predictive maintenance, thereby further streamlining the process. We found that this was the stage with which OEMs and tier I companies alike were struggling, due to a number of reasons. Companies were unable to accurately generate data, store it, or structure it for analysis. Despite having generous amounts of data, from consumers and factories, utilization has been minimal due to lack of a framework and direction from upper management for creating meaningful solutions.

A related concern, which has been detailed in the section on education and skilling, is the lack of adequate skills for both data analysis and streamlining business processes, across mid and senior management. The final stage of transformation, which is yet to be implemented across most producers, would be where cognitive processing would be instrumentalized to automate the process of predictive maintenance and connect the entire factory floor. The inability to optimize data was also pegged to a gap in formulating a vision for technological adoption in senior management, and a parallel gap in sector-level policymaking or incentivization by the government.

[62] Holmes, C. Designing and Implementing the Factory of the Future at Mahindra Vehicle Manufacturers (2015).

Growth and productivity

The uptake of cyber physical systems across each shop has been described in the section on the impact of Industry 4.0 above. As this demonstrates, the introduction of robots in a number of areas on the shop floor has increased productivity. A representative from the top management of a large OEM in Manesar stated that their plant in Bangalore, which was farther ahead in adopting automotive technologies, was at least 25 to 30% more efficient than their plant in Manesar. To take an example from the shop floor, at Bellsonica, an Indian vendor of a number of components, the introduction of a robot in the press shop increased production from 350 parts an hour, using 10 workers on 4 manual machines, to 55 parts per minute, or 3300 parts per hour. Relatively low cost technologies, such as pick-and-place robotic implements, have been implemented across smaller auto component suppliers[63]. At Bellsonica, the increase in productivity was met with a parallel increase in demand, which meant increased employment as more manpower was required to meet demands.

The projection of overall growth in the auto sector is a major driver of employment, according to a top management representative of an OEM. The respondent argued that large-scale automation at a level that would cause major job loss would only be achieved at a stage and scale when the industry itself is able to adopt technology, which is still in the process of unfolding. They also pointed out that the current stage of Industry 4.0 in the sector is characterized by the piecemeal uptake of technologies, without a sense of an overall vision to transform assembly lines and shop floors. Industry 4.0 technologies are thus being explored and developed by OEMs through major investments in state-of-the-art research centres, which are also hubs for in-house technical training for personnel. These have also been the locus of prototyping for technologies such as 3D printers.

There is also a move towards customization of products, modular vehicles, and enhancing the user experience of the customer. This is done by increasing

[63] Interview with Goutam Das, journalist.

modularity at the end of the product cycle, through sub-assembly lines. However, most of these are still in the stages of planning and development.

A major driver of automation in specific areas has been the hazardous nature of work in these shops, automating which has increased safety and the quality of the product - as reiterated above - making standardization more precise and efficient. However, earlier research has shown that in cases where precision and efficiency are not visible to the customer, unlike in painting or pressing, but the work has been hazardous or strenuous, automation has not taken place[64].

Another top management representative from an OEM further argued that the lack of clear use-cases is inhibiting the adoption of technologies as it is not yet clear what the short or longer term Returns on Investment (ROI) will be in the Indian context. It was found that ROI was a major challenge across both local and multinational companies, despite the increase in productivity. This is largely due to the requirement of heavy initial investment - which remain significant although gradually reducing. While Indian companies argued that they have limited funds with which to make these investments, subsidiaries of multinational corporations were also hesitant about unclear returns and use cases within the Indian labour market.

Work intensification and informality

As has now become common knowledge, life cycles of products in the automotive industry are becoming shorter[65]. This inhibits companies from making long-term investments in technology that might be functional only for certain products or might itself become redundant. Another consideration for management is the labour cost of technological disruption in brownfield factories, regardless of whether the solution would be redeployment, re-skilling, or termination. The economic and labour cost of retrofitting technologies in functional plants has meant that upgradation is being piloted in greenfield factories, and then might

[64] Supra note, 56.
[65] Sabadka, D. “Impacts of shortening Product Life Cycle in the Automotive Industry.” In *Transfer inovácií*, (2013): 251-253.

move to brownfield factories, as Das explained. This was seen despite the capital-intensity of the automotive sector.

A major endogenous driver of the manufacturing sector in India and the automotive sector specifically is the overabundance of semi-skilled labour with low wages. As she explained, the labour surplus and low penetration of automobiles have historically been and will continue to be drivers of growth in the automotive sector. This creates barriers for automation by providing cheaper alternatives to costly technological investment, and parallelly, increasing the opportunity cost of automation by propelling job loss. This, in combination with other factors, could majorly affect the ROI of radical technological upgradation.

The shortening of the life cycle of products has instead been accompanied by work intensification and shorter production cycles for workers. One of the strategies to implement this has been to shorten time periods for each task on the assembly line, such that the same task is being executed in a shorter period of time. This, however, has been seen globally since the onset of the "lean production" process, as companies aim to achieve "continually declining cost, zero defects, zero inventories, and endless product variety"[66]. It is not as such a characteristic of Industry 4.0, and reiterates the argument that earlier forms of industrial revolutions are still unfolding in the Indian context. Recent studies on the link between access to technological capital and productivity in the automotive sector have also found that while advanced technology was believed to increase production, most firms were still at the stage of digitization than automation, and were facing problems with erratic power supply and internet connectivity[67].

This is a consequent of another inhibiting factor - the informal nature of major sections of the supply chain. Tier I companies source their component from tier II and III suppliers, which are largely informalized and have access to cheap labour and low levels of quality control[68]. They therefore do not have the funds or incentive to invest heavily in technological capital such as 3D printers, which makes the gradual diffusion of Industry 4.0 technology untenable in the Indian context in the short to mid term. Parts supplied by tier II and III companies often

[66] Womack, J. P., Womack, J. P., Jones, D. T., and Roos, D. *Machine that changed the world*. Simon and Schuster. Scribner (1990).
[67] Supra note, 8.
[68] Interview with Harandar Singh, plant head, Mark Exhaust.

had defects which would cause robots in the weld shop to reject them, eventually requiring human intervention. This meant that in some companies, robots were now being dismantled in favour of human labour on the shop floor[69].

Concerns and Challenges

Key findings:

- There is a significant gap in data regarding the task content of jobs, which makes it difficult to anticipate shifts in jobs or the impact of technology on un/employment.
- Stakeholders from across the spectrum felt the need for increased access to high quality skilling for workers, including in areas such as analytics and advanced problem solving.
- Non standard employment has been growing in the sector, with such workers performing the same tasks as regular workers without adequate pay, job security, benefits, representation in trade unions, etc. They also have shorter training periods, implying that they often have to pick up skills on the shop floor with a much lower margin of error. Costs of work intensification are being transferred to workers.
- Contract workers are a higher risk of unemployment through technological upgradation. In addition to the precarity built into non-standard forms of employment, this is also because contract workers are more likely to be concentrated in repetitive manual labour, while regular employees take on managerial roles.

[69] ibid.

- There is high degree of gendered occupational segregation in the industry, both vertically and horizontally. Female workers are concentrated in white collar jobs in departments such as R&D and HR, with most firms having no female workers on the shop floor.
- Some OEMs have introduced female-only assembly lines, indicating a degree of inroads being made by female workers in a traditionally male domain.

Education and skilling

With the automotive sector going through a phase of transformation, and projections of technological disruption and a shift in the future of mobility away from conventional modes to sustainable solutions, a shift has also been projected in the kinds of skill sets that will be valued in the future. Skilling takes place at a number of different levels in India - government developed and led skilling programmes, third party services offered by the private sector, industry bodies, university led skilling programmes, and in-house skilling programmes within companies. The Working Draft of the World Development Report 2019 on the changing nature of work highlights a 3-pronged strategy to transforming skilling ecosystems: a) early time investment b) tertiary education and, c) adult learning outside jobs, with an emphasis on lifelong skill development[70].

The hiring rate in the Indian automobile industry is likely to slow down to 2-2.5% year-on-year basis as the emergence of new technologies demands a new set of skills from the auto workforce.[71] Projections for the next few years indicate increasing demand for engineers who specialise in cutting edge technologies such

[70] *World Development Report 2019 - The Changing Nature of Work*. World Bank Group (2019), http://pubdocs.worldbank.org/en/816281518818814423/2019-WDR-Draft-Report.pdf
[71] *Future of Jobs in India: A 2022 perspective.* FICCI, NASSCOM & EY. (2017). https://www.ey.com/Publication/vwLUAssets/ey-future-of-jobs-in-india/$FILE/ey-future-of-jobs-in-india.pdf

as artificial intelligence, robotics, cognitive solutions, and machine learning. “The increasing appetite for innovative technologies in the automotive industry has increased the demand for a skilled workforce. The industry is required to create a collaborative learning environment and develop re-training programs across levels in the organization to be future ready for the new roles like automobile analytics engineer, 3D-printing, cybersecurity expert and sustainability integration expert”, points out Ritupurna Chakraborty of the Indian Staffing Federation.[72]

There are 5,15,000 people employed in R&D and engineering across all sectors of which 15% are in the automotive industry[73]. Global auto giants including Mercedes, BMW, Renault, Suzuki, Honda and Bosch have set up specific R&D units in India for global requirements for which they are hiring high skilled professionals[74].

Re-Orienting Skill Development

One of the perspectives that emerged from the government was that there will need to be a greater emphasis on basic skills to adapt to this changing world of work, including cognitive skills, logic skills, advanced problem solving, socio-behavioral skills, empathy, emotional intelligence. Data gaps in understanding the skilling ecosystem were also pointed out, specifically identifying the task content of occupations.

It was noted that there are a number of skill gaps across the occupational hierarchy in the sector, stemming from a primary gap in the understanding of advanced engineering and system design, analytical skills to streamline business processes, and low levels of technical training in the workforce - especially in auto component manufacturing units. This suggests a need to re-orient skill development initiatives in India.

[72] Drishti Pant, “Future of Talent in Automotive Industry.” *PeopleMatters*, 2018 https://www.peoplematters.in/news/recruitment/future-of-talent-in-automotive-industry-17182?utm_source=peoplematters&utm_medium=interstitial&utm_campaign=learnings-of-the-day
[73] Verma, “Auto engineers likely to be in demand,” *The Economic Times*, 2018 https://economictimes.indiatimes.com/jobs/auto-engineers-likely-to-be-in-demand/articleshow/62320863.cms?from=mdr
[74] Ibid.

Social security

Growing contractualization and consequences for social security

Global production networks, with sites of production geographically diverse but functionally integrated, have given rise to increasing flexibilization of labour globally[75]. Similarly, the auto sector in India is witnessing increased casualization of the workforce[76]. We found a significant ratio of non-standard employment to permanent workers across OEMs and tier I vendors, with a bulk of the work on the shop floor being performed by workers in non-standard employment. For instance, a major OEM such as Maruti Suzuki India Limited (MSIL) had a workforce of 65 percent non-standard employment labourers deployed on their floor in their plant in Manesar[77], and Munjal Kiriu, a tier I auto component manufacturer, had 70 percent at their plant. This is excluding the number of trainees and apprentices, which have been found to be as much as 8 percent in OEMs[78].

Permanent and casual workers, including trainees and apprentices, perform largely the same kinds of tasks in the assembly line. However, permanent workers have a greater level of representation in roles involving supervision, while casual workers perform core production (manual repetitive) tasks only. Contract workers thus end up performing more physically strenuous and even dangerous tasks with lesser training. All the companies we interviewed apart from MSIL - who differentiated between tasks for trainees - had all categories of casual workers and permanent workers doing similar tasks.

Wages for workers in non-standard employment were significantly lower than permanent workers, with wages being static for the former as the latter get incremental salaries and bonuses yearly. When compared with minimum wage

[75] Supra note, 7
[76] "Emerging technologies and the future of work in India" Asia-Pacific Working Paper Series, *Tandem Research* (2018).
[77] MSIL has been functioning on a model of employing 'company contract' workers since the episode of unrest in 2012. However, this has been critiqued for replicating work conditions, contract duration, wages, and benefits as in contract workers through external contractors: Supra note, 50.
[78] Ibid.

standards[79], all workers at OEMs were earning above minimum wage, tier I companies were meeting standards, while workers at tier III and IV earning well below state standards for semi-skilled workers. As was explained by some of the workers we interviewed, it becomes difficult to support families on such income, causing barriers to retention of workers non-standard employment, or causing additional economic stress on workers that predominantly tend to be migrants from neighbouring states. While both category of workers are legally entitled to Employees State Insurance and provident funds, they often did not have access to these. Pensions are only in place for permanent workers, and facilities such as transport are severely limited for workers in non-standard employment. They are also not able to collectively represent their concerns or join labour unions, due to the precarious nature of their employment.

Workers in non-standard employment are typically hired for contracts between 6 months to a year. Depending on the contractual model the company employs, workers in some companies take theoretical examinations to qualify as permanent at the end of one or two terms. Apart from the increasing presence of contract labour, periods for which workers remain contracted have also been increasing. We found several instances of workers remaining contracted for 10-15 years before being fired for a range of reasons. Their hours were found to be more flexible than permanent workers as the former are often subject to mandatory overtime. The increasing contractualization of labour, given the similarity of job profile, differing wages and benefits, and worse working conditions, was even characterised as a major cause of social unrest in the Northern cluster of automotive manufacturing[80].

Intensification of work and the labour force

The section above on changes in work productivity describes the work intensification the sector has witnessed under systems of lean production, and the push for shorter production cycles. Apart from shortening the time under

[79] *Minimum Wages Notification dated 1.7.2018*. Labour Department Haryana. (2018). https://hrylabour.gov.in/home/readmore?cat_id=53&status=1
[80] Interview with Prabhat Chaturvedi, Secretary Labour and Employment, Government of India, 2009-2011.

which a task is performed, this has also been implemented by a smaller number of workers performing functions that were earlier handled by a larger cohort. Speeding assembly lines with lesser manpower has translated into instances of safety measures being bypassed. Further, 'spare' or 'relief' workers have also been removed or deployed elsewhere on the shop floor. Training periods have also been shortened from a month to 5 or 6 days, which entails that workers in non-standard employment, including apprentices and trainees, have to pick up skills on the shop floor itself. This also then leaves a much smaller margin of error for contract workers at initial stages of work. Thus we can discern a pattern of costs for intensified work, often through lowering standards of occupational health and safety, for increased production being transferred onto workers.

Future trends: Contextualizing social security under Industry 4.0

Growing informalization in industries that have historically been predicated on the single and stable employer-employee relationships has been characterised by a rise in atypical forms of employment globally[81]. Rise in precarious and flexible work under intensified working conditions, and failing systems of collective bargaining are also central factors determining the future of social security provisioning.

These factors are further compounded by the conditions of precarity under which contract and other casual workers function. With the private sector demanding even greater flexibility to align production and periods of employment with consumer demand, casualization will continue across the formal sector. Further, it is casual workers that have been and will continue to be expendable in the event of technological disruption. As seen across OEMs and auto component manufacturers, automation of a task function in brownfield factories meant that casual workers would be laid off as permanent workers are either trained to work with robots or re-deployed elsewhere in the assembly line. Long-term insecurity and flexibility of hours on low pay also causes mental and emotional stress upon young workers. It can be seen that in the absence of imaginative forms of

[81] Interview with Miranda Fajerman, Specialist on International Labour Standards, International Labour Organization

protection, the contractual structure of employment could itself be a hindrance to provisioning of social security and benefits to workers.

The potential of the global move towards protectionism in developed economies and decreasing costs of production through large-scale adoption for Industry 4.0 technologies is predicted to create additional pressure on productivity in developing economies, the brunt of which could be borne by workers[82]. It then becomes important to develop policy frameworks under which basic fundamental social security provisions, such as minimum wages, decent standards of occupational health and safety, maternity and disability benefits, and pensions and gratuity, are extended to a vast category of casual workers in both the formal and informal sectors.

Gender

Understanding gendered industrial and occupational segregation in the Indian context

The automotive industry in India has historically been overwhelmingly populated by male workers across both blue and white collar jobs[83]. The theory of occupational segregation, which posits that occupations with certain tasks and crafts are treated as male domains[84], can be used to understand the lack of female workers in jobs involving intensive manual labour. Industrial segregation, which posits that different industries show different patterns of gendered occupational segregation[85], explains the lack of female labour even across jobs in the automotive industry that require cognitive, or non-intensive manual labour.

Female participation in the automotive sector in India needs to be contextualized with a discussion on female participation in manufacturing. According to the NSS

[82] Interview with Sehaj Malik, Policy Programmes Advisor, Friedrich Ebert Stiftung
[83] *Statistical Profile on Women Labour*. Labour Bureau, Ministry of Labour and Employment, Government of India (2011).
[84] Cockburn, C. "Women and technology: opportunity is not enough." In *The Changing Experience of Employment.* London: Palgrave Macmillan (1986) 173-187.
[85] Weeden, K. A., and Sorensen, J. "A framework for analyzing industrial and occupational sex segregation in the United States" In *Occupational Ghettos: The Worldwide Segregation of Women and Men*. Stanford University Press, (2004) 245-296.

data for 2011-12, 29 percent females were concentrated in manufacturing industrial work[86], while 91 percent were concentrated in the informal sector[87]. Major causes of lack of participation in the automotive sector include education and skilling: skilling gaps in female workers[88], gaps in engineering and technology education in the country[89], as well as vocational training through Industrial Training Institutes[90]. Data derived from NSDC Qualification Packs (QPs), which shows that 40 percent of all graduates from NSDC programmes were female, with a 42 percent placement rate[91]. Percentage of other minorities was 12 percent for scheduled castes, 7 percent for scheduled tribes, and 7 percent Muslims. However, it was not clear how many of these females, if at all, were engaged in technical education. Females have tended to be engaged in activities in industries such as beauty and wellness, which has had industry engagements and high placements rates[92]. Literature on vocational training in advanced industrial economies also demonstrates this trend in vocational training, with gender stereotyped skills being promoted for females[93].

Other major factors of low female participation in the labour force include the disproportional care burden on females[94], cultural barriers, such as lack of mobility[95], as well as the social status attached to females confined in private spaces in amongst the upper and middle classes, especially in Hindu communities [96]. The lack of mobility has been attributed to cultural barriers to accessing public

[86] Mehrotra S., "'The Indian Labour Market: A Fallacy, Two Looming Crises and a Tragedy." *Centre for Sustainable Employment Working Paper* (2018).
[87] *Empowering women through skill development - challenges and opportunities.* Gender and Economic Policy Discussion Forum. (2012).
[88] *India Skills Report 2018: Future Skills, Future Jobs*. United Nations Development Programme.
[89] *Table 35: Out-Turn/Pass-Out at UnderGraduate Level in Major Disciplines/Subjects (Based on Actual Response)*. Government of India, Ministry of Human Resource Development, All India Survey on Higher Education (2015-16):: T-103.
[90] Mohit M. Rao, "Tech ceiling? Women's setas go begging in ITIs." *The Hindu*, 2016. https://www.thehindu.com/news/cities/Mangalore/tech-ceiling-womens-seats-go-begging-in-itis/article4587973.ece
[91] Interview with Srikar Gullapalli, NSDC.
[92] Ibid.
[93] Charles, M., Buchmann, M., Halebsky, S., Powers, J. M., and Smith, M. M. "The context of women's market careers: A cross-national study." *Work and Occupations* 28(3) (2001): 371-396.
[94] Narayan, L. "Contextualising unpaid care work and women empowerment." *IJAR 3*(7) (2017): 654-659.
[95] Kantor, P. "Female mobility in India: the influence of seclusion norms on economic outcomes." *International Development Planning Review* 24(2) (2002): 145-159.
[96] Dube, L. "On the construction of gender: Hindu girls in patrilineal India." *Economic and Political Weekly* 23(18) (1988): WS11-WS19.

space[97], and the lack of adequate infrastructure. The need to enhance female participation in the automotive sector by creating adequate physical infrastructure, including toilets, and transportation within factories, as well as keeping in place safety measures, was reiterated by a representative from the Human Resources department at Maruti Suzuki India Limited.

Making inroads: Recent moves towards increasing participation

Over the last few years, large OEMs such as Tata Motors, Mahindra and Mahindra (M&M), Hero Motocorp, and Bajaj, have introduced female-only assembly lines on the shop floor, with females comprising at most 4% of the workforce in any of these plants[98]. Female staff was found to be concentrated in white collar jobs, across areas such as HR and data management, and the proportion of participation is thus extremely small on the shop floor. There is, however, direction in large OEMs to work towards achieving gender diversity. Maruti, for instance, has set targets for 2023 for a pilot project on increasing gender and regional diversity across their plants, and across senior and mid management as well as on the shop floor.

In places where entirely female lines are being implemented, workers are performing the same task functions, and have been recruited through the same technical education and skilling programmes run by the Automotive Skill Development Council, as their male counterparts[99]. Use cases in other large OEMs have been encouraging top management to invest in creating 'pink lines'. Section 66 of the Factories Act, 1948, which disallows female workers from working in night shifts, was demarcated as a major challenge to exponential hiring of female line workers, as lines work across all three shifts, two during the day and one at night. Recognizing the barriers this creates for female labour participation, the central

[97] Phadke, S. "Dangerous liaisons: Women and men: Risk and reputation in Mumbai." *Economic and Political Weekly* (2007): 1510-1518.
[98] "May her tribe increase: Auto companies hire more women for shop floor roles," *Economic Times,* 2018 https://economictimes.indiatimes.com/industry/auto/auto-news/may-her-tribe-increase-auto-companies-hire-more-women-for-shop-floor-roles/articleshow/65459207.cms
[99] Ibid.

government has issued an advisory to states to permit females to work in night shifts provided adequate safety precautions are in place[100].

As mentioned above, most manufacturing jobs with intensive manual labour, including heavy manufacturing have been employing male workers historically[101]. With regards to this, it has been asserted that the participation of female workers on the shop floor will have a reciprocal relation with the uptake of robots for mechanical hauling and lifting across various shops[102]. The automation of tasks requiring biomechanical power is touted to increase female participation in jobs with manual tasks[103], and the exponential participation of female workers will better incentivize plants to adopt technologies such as relatively low cost 'pick-and-place' robotic implements. Combined with the move towards increasing gender parity, automation of hazardous tasks which have been historically inaccessible to females could prove to give a push to female labour force participation in the sector. This has to be met with a parallel increment in female participation in technical and mechanical skilling, and STEM education.

Policy Recommendations

1. There should be strengthened collaboration between government and private sector to identify that what kind of jobs are created or re-shaped due to the emergence of Industry 4.0. This would need to be followed by the creation of strategies to enhance the skilling system to match demand and supply. Accordingly, the government should incentivize lifelong learning, while the industry needs to take greater initiative and ownership

[100] "Female Employment Rate," Press Information Bureau (2018).
[101] *Women in Male-Dominated Industries and Occupations*. Catalyst (2018). https://www.catalyst.org/knowledge/women-male-dominated-industries-and-occupations
[102] Ibid.
[103] Carmignani, F. "Women are less likely to be replaced by robots and might even benefit from automation." *The Conversation* (2018). https://theconversation.com/women-are-less-likely-to-be-replaced-by-robots-and-might-even-benefit-from-automation-96728

in re-skilling and up-skilling workers. There also needs to be greater emphasis on primary and tertiary education, with a stronger component of STEM skills and learnability.

2. The needs of SMEs should be addressed by deeper backward linkages within the supply chain, and formulating industry-level policies on technological adoption keeping in mind the interests and capacities of SMEs[104].

3. Given that safety standards in manufacturing continue to be regulated under the Factories Act, 1948, it would be necessary for states to contextualize and examine the changing nature of work across different industries, and formulate industry-specific safety standards and norms which would then be enforced by state-appointed safety officers under existing provisions.

4. As the organization of work becomes more precarious and flexible, it has become increasingly necessary to disassociate social security and permanent employment and standard employer-employee relations, in order to extend prevailing market wages, security, pensions, and benefits equally. Industry and state bodies will equally have to respond to this casualization of the workforce in a traditionally formal sector with imaginative ways of ensuring conditions of decent work[105] for non-standard employed workers across the formal and informal sector.

5. Government and industry bodies need to provide targeted enabling structures to support female participation in the sector. Skilling gaps should be addressed by creating targets within ITIs and other skilling institutes to increase female participation in courses that impart technical and mechanical skills. Further, companies could create targets for

[104] *A Reflection on the Future of Work and Society International Labour Organization.* Geneva: International Labour Organization, (2017). https://www.ilo.org/wcmsp5/groups/public/---dgreports/---cabinet/documents/newsitem/wcms_617754.pdf
[105] Bhandari, A. K., & Heshmati, A. "Wage inequality and job insecurity among permanent and contract workers in India: evidence from organized manufacturing industries." *ICFAI Journal of Applied Economics* 7(1) (2008): 80-111.

employment from these ITIs - especially in institutes that companies themselves have adopted. State-led initiatives on providing digital access and literacy, as well as financial inclusion and entrepreneurial skills would also improve female participation in the workforce broadly.

6. Targeted strategies on increasing gender diversity to ease large-scale entry of female workers taken up by some of our respondents can be replicated across the industry. Other necessary steps to ease transition include provisioning of adequate infrastructure within plants and offices, including transportation, toilets, and creches, and building safe work environments.