Analysis of Labour Market in India : Adoption of the Fourth Industrial Revolution

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Abstract

In this paper, we took into consideration the expenditure of the Government of India on the indispensable components of Industry 4.0 namely, telematics, promotion of electronics and HW manufacturing, and cyber security (ICERT, IT Act). The paper attempted to analyze the potential impact of these components of Industry 4.0 on the labour productivity of the India from 2013 – 2018 based on the government funding schemes. Newly – West Estimator was used taking into consideration the problems like multicollinearity and heteroscedasticity. The negative value of the coefficients indicated that the labour productivity is inversely related with the components of Industry 4.0. It was also found out that the government has reduced expenditure in two of the important components of industry 4.0 (telematics and cyber security), while increasing the expenditure in the promotion of electronics and HW manufacturing. The increase in labour productivity in the past 6 years might be due to some other factors in the economy.

Keywords : **Industry 4.0, promotion of IT, cyber-physical systems, smart factories, simple regression**

JEL Classification : J2, J3, O3, O4

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For centuries, humans have been producing goods such as weapons, houses, clothes, utensils, etc. to satisfy their wants using slow and unproductive methods. The greed to produce more has been the core reason why humans have been trying to find out various new strategies and techniques which can lead to a many-fold increase in the production potential of workers, while optimally using scarce resources. The modern manufacturing systems are expected to be agile, intelligent, integrated, and cost-effective to enable industrialists to stay competitive in international competition.

The first industrial revolution 'Industry 1.0' occurred in 1800 (around 1760s), which saw the use of steam power and mechanical production facilities to aid workers in production processes. It was followed by Industry 2.0 in the nineteenth century (around 1870s), which saw the use of electricity and assembly lines in production, which was much trouble-free when compared to the use of steam power. It is also known as the 'Technological Revolution.' A century down the timeline was Industry 3.0 in the twentieth century (around 1970s), which began from the computer era and introduced IT and electricity for automation of the production processes. At last, in the twenty - first century (around 2011), Industry 4.0 came into existence, which is referred to as the next leap in industrial manufacturing. The term 'Industry 4.0' first came up as “Industrie 4.0” by a group of representatives

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from different fields under an initiative to enhance German competitiveness in the manufacturing industry. Industry 4.0 is not just a catchphrase ; it is based on cyber-physical production systems that integrate communications, IT, data, and physical elements and wherein these systems transform the traditional plants into smart factories.

Besides its popularity in the manufacturing world, the term is still completely unknown to many. A recent survey conducted in Germany itself revealed that 82% of the sample had never heard the term Industry 4.0, while only a mere 18% had some kind of knowledge about the term. Out of the 18% people having some insight of Industry 4.0, 33% simply considered the internet and communication networks as the core of Industry 4.0, while 25% had no clue about the real content of Industry 4.0.

In the context of India, Industry 4.0 has just started making inroads in manufacturing and other sectors of the economy. However, it must be taken into account that India has been growing at an unprecedented rate. According to IBEF, the Government of India has planned to increase the contribution of the manufacturing sector to 25% of GDP by 2025 through enhancement of labour skills. The automobile sector of India is at the forefront to adopt Industry 4.0, and it is estimated that by the end of 2020, India will become a major automobile manufacturing hub. The growth of the Indian car industry has prepared the country for the era of 'Industrial Revolution 4.0' by capitalizing on the opportunity of increasing the micro-economic variable, that is, labour productivity by many-folds. It allows India to close that gap with its giant neighbours, and to avoid the productivity paradox that has so flummoxed developed nations over the last half-century. However, it must be taken into account that it won't be just machines driving this transformation, ongoing investment in human capabilities will be critical. This increased productivity due to the use of latest technologies comes with an important implication that is changing the whole dynamics of the labour market. Not only will there be a demand of more skilled labour and a downfall in the non-skilled labour market, but it will also be accompanied by the change in employment patterns of mostly all industries ; some new jobs may be created, while some might become extinct.

There are nine major components of Industry 4.0 namely, big data, additive manufacturing, augmented reality, cloud computing, autonomous robots, simulation, system integration, internet of things, and cyber security. Due to the lack of information, only a few of them are taken into account, namely development of telematics, promotion of electronics and HW manufacturing, and cyber security. All the three above-mentioned components play a vital role for India to successfully achieve the goals set for the new era of industrial manufacturing.

Cyber security is a big shift from the traditional way businesses think about IT resources and is a very vital component of Industry 4.0. The relationship between cyber security and Industry 4.0 is captivating, though the relationship is just in the maturing stages and needs time to yield results. A growing number of cybercrimes indicate towards stressing the need to strengthen cyber resilience. Cybersecurity and employee productivity are in a constant tug of war, that is, they are inversely related. Pull too hard in the direction of security and worker productivity is likely to suffer; pull too much towards the direction of productivity, and security is likely to lessen. It is the balance between the two that business leaders and IT personnel strive to achieve, and it's not an easy feat.

A Balabit survey showed that 70% of business respondents thought that employees are the biggest risk to the business due to lack of education. Thus, the major cause of an inverse relationship between labour productivity and cyber security is the vast unskilled labour force and a scare skilled labour force of India.

Telematics is a combination of two words – telecommunications and informatics. The field of telematics includes telecommunications, wireless communications, electrical engineering, computer science, information technology, vehicular technologies, and road transportation. The global telematics market is poised to grow exponentially in the future, especially in the automobile industry. Telematics includes two very important components of Industry 4.0: Internet of things, which means interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data and cloud computing (cloud telematics). Telematics helps to increase labour productivity as the employees can use the data stored and collected at one place to get a better understanding of the details of the work and perform the duties effectively and efficiently.

Promotion of electronics/ IT HW manufacturing of India is the key for India to develop the technology India lacks to reach the stage of Industry 4.0 successfully. Having a good electronics industry is the first step towards advancement in technology. Increasing labour productivity is generally said to be a positive result of technological progress. It is expected that with a better electronics industry, the production potential of the economy will also increase, and hence, so will the labour productivity.

Literature Review

Desilver (2017) said that although domestic manufacturing output in the U.S. has grown steadily over the past 30 years, surpassing $5.4 trillion in 2016, employment in the manufacturing sector has been on a decline for decades. Manufacturing employment has declined nearly 40% since its peak in the late 1970s, while the percentage of total employment in manufacturing had fallen to 8.5% from its peak of 32.1%. This meant that American manufacturers had to become more productive with a smaller portion of the workforce. According to the study, the Bureau of Labour Statistics's Index of Labour Productivity for the manufacturing industry was 2.5 times greater than what it was 20 years ago. Pelliccione (2015) stated that despite the gains in industrial productivity, 64% of manufacturing leaders surveyed during a 2015 workforce development study believed that the industry would experience a growing shortage of qualified workers in the next 3–5 years. Later, Nafchi and Mohelská (2018) aimed to find out how the adoption of Industry 4.0 will affect the labour markets of Iran and Japan and further analyzed if such a transition could take place in the two countries with their current infrastructures, economies, and policies. The paper stated that the unemployment rate of Iran was much more than Japan; thus, Japan could adopt Industry 4.0 with fewer hindrances.

Time analysis of occupations in Turkey during Industry 4.0 stated that Industry 4.0 might result in mass unemployment (Sumer, 2018). The conclusion suggested that there would be a loss in the number of jobs, especially in manual and comprehension. The same was also stated in the literature report by Baldassarre, Ricciardi, and Campo (2017). It provided a starting point to manage better the transition from the old to the new paradigm: the adoption of innovation policies was essential to obtain an improvement in manufacturing performance. The new paradigm was characterized by the ability to connect objects, guaranteeing control and traceability through sensors, applied directly to machines. Machine linkage, robots replacing man, availability of large amounts of data, flexibility in production and customization of products, and optimization of production through automatic control operations were the most important features of the phenomenon. It concluded that companies must change their business models, invest in staff training, improve internal processes, and invest in management tools & activities. A transformation of the tax system, especially in labour taxes, was suggested by Bonekamp and Sure (2015). They also stated that continuous learning, training, and education are essential in order for the workforce to be able to adapt to the required qualifications derived from Industry 4.0 technologies.

In addressing the increasing complexity of the roles and responsibilities required of the workforce in Industry 4.0, Longo, Nicoletti, and Padovano (2017) advocated for the adoption of a SOPHOS-MS, Sophos meaning "wisdom" in Latin and MS standing for manufacturing system, with AR as its primary interface device with human operators. According to the study, the SOPHOS-MS system is designed to deliver operator information on safety measures relevant to the machine/operation being worked, potential hazards, the ability to start and stop SMOs, change machine modes, set-up instructions, and maintenance messages. Empirical experimental research indicated that the adoption of a human-centered approach to training using AR reduced the learning curve for new employees by 4% points and reduced set-up times by 12%. The experiment was designed to compare traditional learning and set-up times on a controlled fabrication machine with the learning curve and set-up times leveraging a Sophos-MS system with AR technology. The results showed a statistically significant improvement in both measures. However, the results did not fully differentiate the long-term benefits of the suggested SOPHOS-MS model versus a focused application of IoT.

According to the research conducted by Breunig, Kelly, Mathis, and Wee (2016), Industry 4.0 represents the increasing digitization of the manufacturing industry driven by four major technological disruptions: (a) a rapid increase in the connectivity, volume, and computational power of manufacturing technology, (b) developments in data analytics and business intelligence, (c) new and emerging technologies for human-machine integration, and (d) improvements in transitioning digital content and instructions to the physical manufacturing space. The study conducted surveyed 300 leading manufacturing organizations, and less than half (48%) of the respondents reported that their organizations were prepared for the eight disruptions brought by Industry 4.0 (Breunig et al., 2016). The replacement of equipment represents a significant capital investment by organizations and it was estimated that 40 – 50% of today's industrial equipment will need to be upgraded to allow for Industry 4.0 transformation. This research added a valuable framework to understand the emerging trends of Industry 4.0, but did not adequately discuss the impacts on the workforce at the task level. As illustrated, the transition of manufacturing platforms would require retraining and retooling of the workforce.

According to Khan (2018), the relationship between women and the labour market is not straightforward, and to increase productivity, female participation needs to be increased in the Indian industry. According to Patanjali and Subramaniam (2019), India needs to take some serious steps to bring about the Fourth Industrial Revolution in the economy.

Objectives of the Study

The present study is conducted with the following specific objectives :

(1) To study the individual impact of telematics, promotion of electronics and HW manufacturing, and cyber security (ICERT, IT Act) on the labour productivity of India.

(2) To study the joint impact of telematics, promotion of electronics and HW manufacturing, and cyber security (ICERT, IT Act) on the labour productivity of India.

(3) To analyze the compound annual growth rate of labour productivity of India.

(4) To analyze the compound annual growth rate of expenditure by the Government of India on telematics, promotion of electronics and HW manufacturing, and cyber security (ICERT, IT Act).

Research Methodology

Secondary data is used in the present study. Data were collected for the financial years 2013 – 2018. Data for the Industry 4.0 components were collected from Indiastat (www.indiastat.com) from the government budgeting scheme for Industry 4.0. Telematics data were collected from Centre for Development of Telematics (C-DOT) under the Department of Telecommunications ; Cyber security data – (ICERT, IT Act) and data of Promotion of electronics/IT hardware manufacturing were collected from Regulatory Authority of India. Data for calculating labour productivity were collected from the Annual Survey of Industries for the period from 2013– 2018.

We also normalized data of different components of Industry 4.0 and labour productivity by using the normalization method :

$$\text{Normalized value} = X(\text{value}) - X(\text{minimum value}) / X(\text{maximum value}) - X(\text{minimum value})$$

➢ **Labour Productivity :** Labour productivity, also known as workforce productivity, is defined as real economic output per labour hour. Growth in labour productivity is measured by the change in economic output per labour hour over a defined period.

Labour productivity = Net value added /Total number of people engaged.

➢ **Compound Annual Growth Rate :** The CAGR is a mathematical formula that provides a "smoothed" rate of return. It can be defined as the growth in some factor over the number of years for which the data is given.

$$CAGR = \left(\frac{Ending\ Value}{Begining\ Value}\right) Powered \left(\frac{1}{No.\ of\ years}\right) - 1$$

➢ **Regression :** The present study uses the time series analysis of least square method. The present study analyzes the components of the impact of Industry 4.0 on labour productivity.

$$X_1 = \alpha + \beta_1.(X_2) + \beta_2.(X_3) + \beta_3.(X_4) + \epsilon \quad (1)$$

where,

X_1= Normalized value of labour productivity.
X_2= Normalized value of Government budgeting in Centre for Development for Telematics (C-DOT).
X_3= Normalized value of government budgeting in and promotion of electronics/IT hardware manufacturing.
X_4 = Normalized value of government budgeting in cyber security.
α = Intercept.
β_1= Regression coefficients of telematics.
β_2= Regression coefficients of promotion of electronics/IT hardware manufacturing.
β_3= Regression coefficients of cyber security.
ϵ = Error term includes all the other factors which affect labour productivity.

In equation (1), we apply the least square estimator. Along with that, we also check the various problems of OLS estimators. Multicollinearity is checked using the intercorrelation matrix between the various variables which are included in the study like contribution of government budgeting in microelectronic and nano technology, advances in computing, which is the sub - variable of the major variable of Industry 4. 0, but we drop the values because they have high correlation with telematics.

➢ **H0 :** $\rho = 0$: There is correlation between the variables.

➢ **Ha :** $\rho \neq 0$: There is no correlation between the variables.

At 5% significance level, we reject the variable which has high p-value.

Heteroscedasticity and auto correlation are checked through the Newey – West estimator to provide an estimate of the covariance matrix of the parameters of a regression-type model. This model is applied in situations where the standard assumptions of regression analysis do not apply. Further, Newey – West estimator is applied to identify and overcome the autocorrelation and heteroskedasticity in the error terms in the model.

Empirically, it is observed that as the time between the error terms increases, the correlation between the error terms decreases. The estimator in this study is used to improve the ordinary least squares (OLS) regression when the residuals are heteroskedastic and/or auto-correlated.

Hypotheses

The hypotheses set up in conformity with the aforementioned objectives are as follows :

- **H_{01} :** $\beta 1 = 0$; There is no significant statistical relationship of telematics with labour productivity in India.
- **H_{a1}:** $\beta 1 \neq 0$; There is a significant statistical relationship of telematics with labour productivity in India.

- **H_{02} :** $\beta 2 = 0$; There is no significant statistical relationship of promotion of electronics and HW manufacturing with labour productivity in India.
- **H_{a2} :** $\beta 2 \neq 0$; There is a significant statistical relationship of promotion of electronics and HW manufacturing with labour productivity in India.

- **H_{03} :** $\beta 3 = 0$; There is no significant statistical relationship of cyber security with labour productivity in India.
- **H_{a3}:** $\beta 3 \neq 0$; There is a significant statistical relationship of cyber security with labour productivity in India.

- **H_{04} :** $\beta 1, \beta 2, \beta 3 = 0$; There is no significant joint statistical relation of telematics, promotion of electronics and HW manufacturing, and cyber security with labour productivity in India.
- **H_{a4}:** $\beta 1, \beta 2, \beta 3 \neq 0$; There is a significant joint statistical relation of telematics, promotion of electronics and HW manufacturing, and cyber security with labour productivity in India.

Analysis and Results

After removing all the loopholes of the least squared method like multicollinearity, heteroscedasticity, and autocorrelation, the empirical results are depicted in Table 1.

The empirical results in Table 1 obtained from HAC show that the regression model with dependent variable labour productivity as well as independent variables of components of Industry 4.0 show that the value of adjusted *R*- squared is significant (0.54).

The coefficient of government budgeting in Centre for Development for Telematics, Promotion of electronics/IT and HW manufacturing, and cybersecurity are statistically insignificant at the 5% level, which helps to draw the inference that these are not potential determinants of labour productivity as individuals. This is because Industry 4.0 is not just a single method, but it is a complex mechanism which requires all these parameters to work in unison to get the desired results. The negative values of the coefficients shows that the labour productivity is inversely related with the components of Industry 4.0 (refer to Table 1). This signifies that a change in telematics by 1 leads to a decrease in labour productivity by –1.01. Similarly, a ₹ 1 change in the promotion of electronics/IT & HW manufacturing and cybersecurity leads to a fall in labour productivity by –0.02 and –0.07, respectively. These results are obtained because a vast majority of the labour force in India is unskilled. Therefore, it is not able to take advantage of such advancements. The inverse relation of cybersecurity is because pulling too hard in the direction of security curbs the freedom of employees and thus reduces employee productivity. On the contrary, the reason behind an inverse relation of telematics and promotion of electronics/IT

Table 1. *Estimated Results*

Dependant Variable : Labour Productivity
Method : Least Squares
Date : 03/12/19 Time : 14:31
Sample : 2013 2018
Included observations : 6
HAC standard errors & covariance (Bartlett Kernel, Newey – West fixed Bandwidth = 3.0000)
Labour Productivity = $\alpha + \beta(1)$ * *TELEMATICS* + $\beta(2)$ * *PROMOTION* + $\beta(3)$ * *CYBER SECURITY* + $\in$

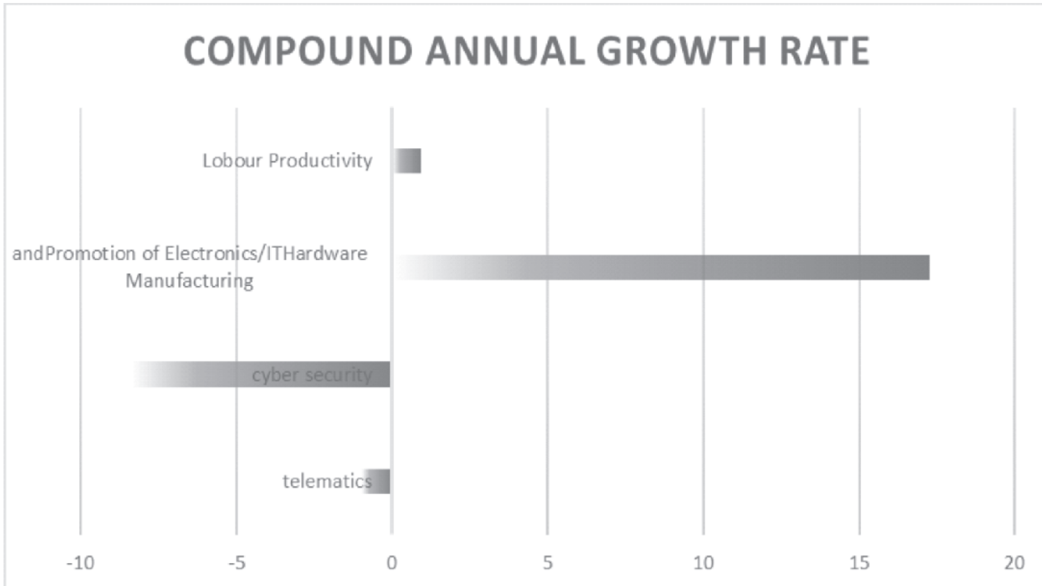
	Coefficient	Std. Error	*t*-Statistic	Prob.
α	1.142359	0.972501	1.174661	0.3611
β (1)	–1.017178	0.915776	–1.110727	0.3823
β (2)	–0.021340	0.804758	–0.026518	0.9813
β (3)	–0.071526	0.612950	–0.116691	0.9178
R-squared	0.818227	Mean dependant var		0.571667
Adjusted *R*-squared	0.545568	S.D. dependant var		0.395445
S.E. of regression	0.266576			
Sum squared resid	0.142125			
Log likelihood	2.714788			
F-statistic	3.000913			
Prob (*F*-statistic)	0.259865			

& HW manufacturing on labour productivity is due to a large population of unskilled labour in India. Migrant skilled and unskilled labourers of India constitute about 40 – 85% of the wage working population.

The *p* - values for the individual components of Industry 4.0 are greater than 0.05 (5% significance level), that is, for the government budgeting in Centre for Development for Telematics, it is 0.38 ; for promotion of IT/electronics and HW manufacturing, it is 0.98 ; and for cybersecurity, it is 0.91 ; thus, we accept the null hypotheses, H_{01}, H_{02}, and H_{03}. It shows that government budgeting to the components of Industry 4.0 does not significantly impact the labour productivity in the economy. A big reason behind the result is the reduced expenditure over the years in these components of the Fourth Industrial Revolution. It is also observed that we accept the joint null hypothesis H_{04} because we get the probability value of *F*–statistics as 0.25, which is again greater than 0.05.

The compound annual growth rate of labour productivity in the economy has increased by 0.947, signifying that the labour productivity of the labour force has increased over the years, but at a very low pace. On the other hand, the compound growth rate of telematics and cybersecurity is –0.95 and –8.388, respectively showing a negative trend in their growth, while the compound growth rate of promotion of electronics/IT hardware manufacturing is 17.255. The figures clearly show that the government has decreased expenditure in cybersecurity and telematics over the years instead of increasing, considering they are two vital components of Industry 4.0. This even strengthens the claims that Industry 4.0 is not significantly impacting labour productivity as the results show the reason being that the government isn't spending enough to have this transformation towards Industry 4.0. Though the government has increased expenditure in promotion of electronics/IT hardware manufacturing, it is not enough to have a significant impact. It can also be inferred that the increase in labour productivity might be due to some other factors in the economy.

Figure 1. *CAGR Figures*



Conclusion and Implications

Industry 4.0 has not been able to bring a positive change in labour productivity in the Indian economy mainly because the vast population of the Indian labour force is unskilled. The study reveals that there is no significant impact of the components of Industry 4.0 taken in the study namely, telematics, promotion of electronics and HW manufacturing, and cyber security (ICERT, IT Act) on the labour productivity of India. The following results are due to the decreased expenditure by the Government of India in the telematics and cyber security Industry by –8.38 and –0.95, respectively.

The Government of India needs to make new policy changes and expenditure budgets to transform the country as well as work for developing strategies to transform the labour market from a majority of unskilled labour to skilled labour. Labour productivity in India has been experiencing a slowdown in recent years. There are two reasons behind the slowdown: first, technology and ideas accumulated by research and development (R&D) and management of resources such as capital and labour are not utilized efficiently ; and second, these resources are not efficiently reallocated among corporations.

The government and the concerned persons can use this study to develop policies and strategies to upskill the workers, which is the essential for the Fourth Industrial Revolution. It also helps the government to look into their budgeting schemes and invest more in the components of Industry 4.0.

Limitations of the Study and Scope for Further Research

The study analyzes the impact of only three components affecting the Industry 4.0 and not the other factors such as artificial intelligence, system integration, and additive manufacturing due to unavailability of data. If all the data for the Industry 4.0 are provided, a much more detailed and extensive study can be carried out. In addition to that, further research can be done to estimate the amount of unemployment caused by Industry 4.0 and an estimate can be drawn for the need of skilled labour.

Authors' Contribution

Neha Anand conceived the idea and developed quantitative design to undertake the empirical study. She found the relevant data and did all numerical computations. Tushar Bhareja extracted research papers with high repute and generated concepts and codes relevant to the study design. Both authors equally contributed in the writing of the manuscript.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter, or materials discussed in this manuscript.

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