

THE EFFECTS OF TECHNOLOGICAL INNOVATIONS ON EMPLOYMENT: EVIDENCE FROM MANUFACTURING SECTOR OF PAKISTAN

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***ABSTRACT**-The objective of this research paper is to study the effects of technological innovations on employment. Time series data for the period of (1990-2009) was collected from World Development Indicators, IMF, Pakistan Economic Survey and State Bank of Pakistan databases. Technological innovation, Exports, Gross Domestic Product, and total Investment were taken as independent variable while Employment was taken as dependent variable. We used statistical techniques such as Co-Integration Test, Auto Regressive Distributed Lag Model, Bound Test, Error Correction Model (ECM), and Unit Root Test to test stationarity and determine short run and long run relationship between variables. Our findings show that technological innovations have significant impact on manufacturing sector growth and as such Government should focus on introduction of latest technology in this sector to improve its productivity and increase employment.*

Key words: Innovation, exports, GDP, total investment, employment.

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1.INTRODUCTION

1.1 Background of Study

Technological innovations are the hallmark and core need of modern economy and now economic growth of Advanced countries mostly depends upon it. The Advanced countries and even Asian countries like Japan, China, South Korea have been spending billions of dollars annually on research and development (R&D) to promote innovations. Similarly, multi-national companies have also been set up special divisions to boost inventions and innovations as being done all over the world for development of Corona vaccine to prevent Corona virus, which is causing millions of people deaths. Thus, technology and technological innovations are the core need of Advanced countries for expediting their economic growth and for developing countries to transform their economies from traditional orthodox economies to knowledge economies and for business forms to survive in the market and to sustain their growth and profitability.

1.2 Definition of Technology

Technology is an authoritative utensil which can change the learning process. Technology help us to create a relationship between educators and students, reinvent our tactics to learning and collaboration, to control long-standing equality and convenience gaps, and adapt learning experience to complete the needs of all learners. Technology is the knowledge of skills, processes, and it can be entrenched in machines which can be operating without detail knowledge of their working. Technological innovation is an extended concept of innovation (Pohjola, M, 2000).

1.3 Effects of Technology:

There are following effects of technology:

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1. Technology helps us to advance more modernized society like internet made this world a global village.
 2. The leisure time class enhanced with help of technology.
 3. Many technical methods create the problems like air and environmental pollution which are harmful for human survival in the real world.
 4. Innovation is a process which is always established the ideas of technical changes regarding the production of certain products. It is also enhancing the human capital by increasing the productivity of working class. Over the last 200 years the use of technology is significantly brought changed in human life, industry and business methods.

1.4 Technological Innovations:

It is the process to produce new products or brings significant technological changes in products and processes. Innovations are implemented if it is introduced in the market (product innovation). A technological innovation is new or improved products or process of which characteristics are significantly different from earlier products and services. These new products and services must be introduced in market (De Nooij, M. (2003).

1.5 Objectives of the study:

The objectives of this research paper are outlined as under:-

1. To examine the importance of technological innovations in employment creation.
2. To determine the impact of technological innovation on the level of employment
3. To find out relationship between technological innovations and employment.

4. To study the impact of the use of technology in industrial sector particularly export sector of Pakistan and its level of growth as well as employment generation in this sector.

1.6 Research Questions:

The main research questions of this study are as follows: -

1. What is the importance of technological innovations?
2. What is effect of technological innovation on level of employment?
3. What is relationship between technological innovations and employment?
4. What is the impact of the use of technology in export sector of Pakistan and employment level and growth?

1.7 Problem statement:

Today, Pakistan is facing is critical situation in the perspectives of economic crisis. Issues related to employment are becoming worse day by day in industrial sectors. Manufacturing industry is going to be eradicated due to negligence of government. Multiple factors are associated with employment downfall. Ample evidences from the literature that technological innovation is the core element to promote the level of employment. Therefore, it is needed to examine the determinant of employment. A research gap was understood in the area by conducting a study to investigate the effects of technological innovation on employment in industrial sector.

1.8 Significance of the study:

The outcomes of the study will be valuable and provide as recent literature in the field of industrial sector to enhance employment in Pakistan. The findings will enable industrial sector to promote employment and its productivity. Furthermore, the uncovering determinants; Export, Gross Domestic Product, Technological Innovation, and Total Investment that

predict level of employment in Pakistan will be supportive for the researcher in future to add more variables to expand this study. The results of this study will help the policy makers to frame policies for promoting innovations in industrial sector to enhance its productivity.

2. REVIEW OF LITERATURE:

Gold (1964) examined the effects of technological innovation. For this purpose, his study is based on industrial and manufacturing sector. According to his point of view impact of new innovation is disrupt prevailing the relationship between the production process and the distribution between the factors. His work is based on the behavior of cost, wages, output and all related physical measures, and sees its the impacts on five basic industries. He found positive impacts of innovations on all manufacturing as well as industrial sector.

Zahra and Awan (014) analyzed the effect of innovation on appliances industry. They took Pakistan Electron Ltd, a leading appliances manufacturing company as a sample. Their results show that technological innovations have substantial effect on the performance and profitability of electronic firms.

Smith (1990) studied briefly the relationships between innovative firms and other organizations in the innovation process. For this purpose, he used a sample of advanced technology establishments in Oxford shire. He concluded that small firms play a variety of roles in the innovation process, both as sources and users of external inputs. He said that universities are a more important source of innovations which lead to the formation and growth of technologically advanced companies. This study revealed more positive result.

Reenen (1997) examined the effects of technical change on employment. The main purpose of this study is to find relationship between the technological innovation with higher firm-level employment. For this purpose, he used OLS method for analysis of data. His study also revealed meaningful results regarding technological innovation and employment.

Smolny (1998) explored the effects of process of invention and product on production, volume, usefulness and work. West German industrial sector micro data used to for empirical estimation of this study. The results of this study revealed that prices and sale of product are affected by invention process while invention process positively influenced the productivity and employment. He found that innovative industry output regarded large progress in employment level than others non innovative industries.

Khan and Burki (1999) examined how technology and substitution possibilities and return to scale are changed the Pakistani large scale manufacturing sector. They selected data from the census of manufacturing industries. They found that technology was changed 76 percent in manufacturing sector. This study is based on primary data. They included the variables, energy, capital, labor, raw material; they applied the t test and estimate the technological change. They concluded that technology is based on the extended set of factor inputs. They found that own price elasticity of capital is greater than one, while the same for labor is less than one.

Mahmoud and Siddiqui (2000) emphasized how we construct technological capability for the production of manufacturing site. In this study they used OLS method to measure technological effects in manufacturing sector. They design different strategic direction for enhancing the technology system.

Borrego and Collado (2002) analyzed the effects of innovation and job creation on the economy, by the Spanish manufacturing sector. Their study is based on the panel data, the variables are process innovation, technological innovation, employment, fixed capital, expenditure and contracting market are included in the model. They concluded variables have significant effects on innovation and job creation. In their study they said that the innovation in small firms and in medium size become a cause of job creation, while non-innovative firms are remains at average level and negatively employment level.

3.THEORETICALFRAMEWORK:

In this section we will describe theoretical frame work of technological innovation and employment. We will discuss different theories of innovations, employment, and economic growth. We will also formulate hypotheses which will be tested through data from real life.

3.1 Theories of Technological Innovation:

There are following technological innovation theories: -

3.1.1 Product Innovation:

Product innovation is defined as an industry involved in the creation of new goods through new techniques and technology at low cost. The product must be new in its look and function. It is necessary to improve significantly with respect to its quality and according to its features, for this purpose to use authentic software components and its material. The example of product innovation is firstly digital camera and microprocessor. In 2005 (OECD) defined change in design, characteristic and its quality of product as creation of a new good.

3.1.1.1 Dimensions of Product Innovation:

There are following dimensions of product innovation:

- i. According to customer perspective the product is innovative for customer.
 - ii. According to firm perspective the product is innovative in the industry or firm.
 - iii. The modifying or refined means to bring the new variations in the product.
- At the time of new introducing firms, the product innovation looks the less competition, but after some time the firm earn high profit. For the competition of one market with another market, the firm takes product innovation process. Due to the product innovation the firm satisfy its customer Chiva, R. (2006).

3.1.2 Process Innovation:

It means to improve the production level of any organization. It is the method which can bring the better improvement. Invention process means that betterment in production and logistic techniques substantially or bring drastically betterment in the secondary actions like buying, accounting, repairs and processing (Polder et al., 2010). Innovation process is the production accomplishment or the distribution techniques which is substantially better. Invention process brought drastically betterment in instruments, technology, production techniques or transfer mode. The firms that are involved in innovation process brought uniqueness in production routine and distribution techniques that brought proficiency in occupation. In innovation process either a single firm or number of firms involved and build up new techniques (Polder et al., 2010).

3.1.3 Marketing Innovation:

The term marketing includes publicizing, wrapping, style, location, commodities up-gradation and setting prices of these commodities. While

marketing invention process is the course of marketing techniques that brought huge changes in above mentioned terms. The purpose of market innovation process is to develop new marketplace, enhanced transactions and share of market. Market invention process is different from other form of invention process in the sense that firm used those techniques for sake of marketing their produced goods which are applied by other firms.

3.1.4 Organizational Innovation:

It is another form of invention process which is the initiation of novel procedures of occupational techniques, coordination of location of methods, system of new techniques of control outside forces (Polder et al., 2010). Innovation process at managerial level is the realization of new methods of managing operational procedures, outside forces and workplace (OECD (2005). Innovation process at organizational level provides the new techniques of managing the firm's set goals. Through this process an organization adopt such method for managing their output level which is not used earleir (Polder et al., 2010).

3.2 Theories of Employment:

There are two types of theories of employment.

1. Classical Employment theory
2. Neo classical Employment theory

3.3 Hypothesis Formulation:

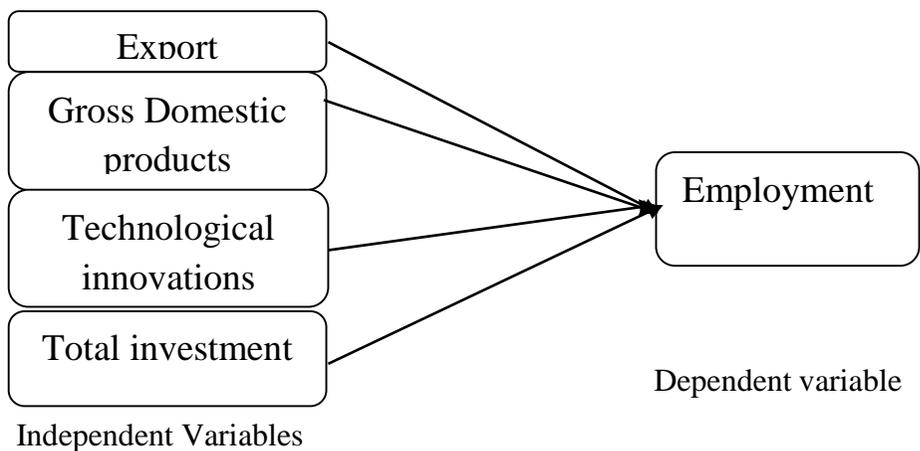
- 1) H_0 : Technological innovations does not affect employment level in manufacturing sector.
 H_1 : Technological innovations does affect employment level in manufacturing sector.

- 2) H₀: There is no relationship between technological innovations and Employment level.
H₁: There is relationship between technological innovations and employment level.
- 3) H₀: There is no importance of technological innovation in employment creation.
H₁: Total investment of manufacturing sector affects manufacturing sector employment level.
4. H₀: There is no impact of the use of technology in industrial sector particularly export sector of Pakistan and its level of growth as well as employment generation in this sector.
H₁: There is significant impact of the use of technology in industrial sector particularly export sector of Pakistan and its level of growth as well as employment generation in this sector.

3.4. Conceptual Model:

The conceptual mode has shown in Figure 1

Fig 1: Conceptual Model



4. DATA AND METHODOLOGY:

4.1 Types of data:

Secondary data has been used to explain the determinants of manufacturing sector employment level in Pakistan. We have used time series data for the period of 1990 to 2009. Er collected time series data from Pakistan Economic Survey, World Development Indicators, IMF, World Bank and State Bank of Pakistan databases.

4.2 Sample of Study:

The sampling period of the study is spread over 20-year period from 1990-2009. The secondary data is used to investigate the effect of technological innovations on employment level in manufacturing sector of Pakistan.

4.3 Selected variable:

The selected variables are technological innovation, total investment, GDP, exports and employment

4.4 Econometric Model:

The econometric model is given below:-

$$Y = \beta_0 + \beta_1 (E) + \beta_2 (GDP) + \beta_3 (INN) + \beta_4 (TI) + \mu$$

In this model, Y is the depended variable. β_0 is the intercept or constant. β_1 is the coefficient of employment. β_2 is the coefficient of gross domestic product. β_3 is the coefficient of technological innovation. β_4 is the coefficient of total investment. μ is the stochastic error.

4.5 Analytical Techniques:

4.5.1 ADF's Unit Root Test:

This test is most popular, that is made by 'David Dickey, Wayne Fuller' this test is published in 19 Century. This test is used to check whether variables are stationary at same or at different level in order to decide which model can be used to analyze data.

4.5.2 Co-integration Test:

This test is used to check long-run relationship between variables

4.5.3 ARDL Model:

Auto Regressive Distributed lag (ARDL) Model was presented by Pearson et al (2001). This technique is used to check the long and short run relationship. The utilization of ARDL model ought to be defended on the premise of ADF test which states whether variables are stationary at different levels, for example, If variables are stationary at $I(0)$ and $I(1)$ level then we can used Auto Regressive Distribution Lag model (ARDL) model. Generally, if all variables are stationarity at $I(0)$ level then we will have to apply Ordinary Least Square (OLS) technique.

4.5.4 Bound Test:

Bound test indicates, the confirmation of long run relationship between variables. The bounds tests suggest that the variables of interest are bound together in the long run.

4.5.5 Error Correction Model (ECM):

This model is used to check short term relationship between variables and speed of their adjustment over a long period of time.

4.7 Explanation of variables:

In this portion we describe the explained and explanatory variables of the model.

4.7.1 Dependent Variable:

Employment is dependent variable of the model which denotes employment level of manufacturing sector. In this study researcher investigated which variables determine the employment level of manufacturing sector in Pakistan.

4.7.2 Explanatory Variables:

The explanatory variables of this model are (i) manufacturing sector involved in exports, (ii) gross domestic product, (iii) technological innovations and (iv) and total investment level. All these are explained as follows

4.7.2.1 Export:

It is assumed that exports of manufacturing sector is positively related to employment level of such sector. Higher exports of this sector enhances the employment level and vice versa.

4.7.2.2 Gross Domestic Product:

Gross domestic product (GDP) growth also significantly influence the employment level in manufacturing sector. That's why that variable integrates in the model. In this model it is supposed that gross domestic product (GDP) has direct and positive link with employment level of manufacturing sector. Higher gross domestic product leads more chances of employment in this sector.

4.7.2.3 Technological Innovation:

In developing countries like Pakistan technological innovations play an important role regarding determination of employment in manufacturing

sector. It is hypothesized that technological innovation positively affects employment level in manufacturing sector.

4.7.2.4 Total Investment:

Total investment in manufacturing sector also significantly influences the employment level that's why that variable is included in the model. In this model it is hypothesized that increment in total investment of manufacturing sector enhanced the employment level. So, there is positive association between employment level and total investment.

5. RESULTS AND DISCUSSION:

5.1. Descriptive Statistics:

The standard deviations, averages, kurtosis and skewness of variables are shown in table 1 which contains six columns. First column contains the name of variables. The arithmetic mean is showing in second column, median is in 3rd column, standard deviation is depicting in 4th column while skewness is showing in 5th column and last column contains kurtosis correspondingly.

The results in the table 2 shows that approximately 14% labor force employed in manufacturing sector and average export of manufacturing sector is 6.68%. The average gross domestic product of manufacturing sector is 6.22% while the mean of technological innovation is 77.6%, it shows that innovations play an important role in manufacturing sector development which further enhanced employment level. Average of total investment in manufacturing sector is about 16.84% with a standard deviation of 1.83. Likewise, the results of descriptive statistics all variables are shown in Table 1:

Table 2: Descriptive Statistics of variables

Variables	Mean	Median	Std. Dev	Skewness	Kurtosis
Employment (EMP)	13.70	13.80	0.81	-0.62	5.61
Export (EXPO)	6.68	4.50	10.54	0.365	2.37
Gross Domestic Product (GDP)	6.22	5.70	5.19	0.084	1.54
Innovation (INNO)	77.62	94.30	50.07	-0.36	1.54
Total investment (TI)	16.84	16.60	1.83	0.046	1.49

The table 1 shows normal distribution of the data that is used in this study in descriptive statistics, which indicate that this is accurate for the purpose of hypothesis testing and further analysis through different statistical techniques.

5.2. Unit Root Test:

By using unit root test, first of all we check the stationary of employment variable. In intercept the probability value is less than (0.01) and critical value is in negative the result is shown on level. With the help of this result it is concluded that the variable employment is more significant. After this, we check trend of intercept, of the probability value is greater than (0.01) and critical value is negative. This variable is significant on first difference. We check the stationary of export variables in intercept the probability value is greater than (0.01) and critical value is in negative the result is shown on first difference. With the help of this result we conclude that variable export is more significant at first difference. After this checking trend intercept, we found the probability value is greater than (0.01) and critical value is negative. This variable is significant at first difference. We check the stationary of GDP variable. Intercept the probability value is greater than (0.01) and critical value is in negative. On first difference all probability values are less then (0.01). With the help of this result we may conclude that variable GDP is

more significant at first difference. After this check trend intercept the probability value is greater than (0.01) and critical value is negative. This variable is significant at first difference. Then we check the stationary of innovation variable. In intercept the calculated value is greater than (0.01) and critical value is in negative the result is shown at level. With the help of this result we can conclude that variable employment is less significant on intercept. On first difference all calculated values are less then (0.01), and critical value is negative. With the help of this result we conclude the variable innovation is more significant at first difference After this checking the trend intercept the calculated value is greater than (0.01) and critical value is negative. This variable is significant on first difference. We check the stationary of total investment variable. In intercept the calculated value is greater than (0.01) and critical value is in negative the result is shown at the level. With the help of this result we may conclude the variable total investment is less significant on intercept. After this check on trend and first difference the probability value is less than (0.05) and critical value is negative. This variable is significant on second difference. Thus, all variables are significant at different levels and as such we can use ARDL approach. The results of Unit Root test are given in Table 2:

Table 2: Results of Unit Root Test

Variables	Level			First Difference			Result
Employment	-1.2237 0.6415	-1.9734 0.5779	-0.0502 0.6533	-3.4653 0.0220	-3.3598 0.0886	-3.5642 0.0013	I (1)
Export	-1.8592 0.3428	-1.6769 0.7214	-1.0881 0.2402	-4.0633 0.0066	-3.2785 0.1032	-4.0931 0.0004	I (1)

GDP	- 3.021 2 0.050 8	- 3.157 8 0.122 1	- 0.837 8 0.339 7	-6.2734 0.0001	-6.0988 0.0006	-6.4658 0.0000	I (I)
Innovation	- 1.948 8 0.304 2	- 2.763 0 0.227 3	- 1.455 7 0.131 4	- 24.042 1 0.0000	- 24.317 5 0.0001	- 23.607 9 0.0001	I (I)
Total Investment	2.750 2 0.999 9	0.395 6 0.997 7	6.503 0 1.000 0	-1.8465 0.3478	-2.6428 0.2679	-1.1235 0.2272	I (II)

In statistics, a unit root test tests whether a time series variable is non-stationary and possesses a unit root. The null hypothesis is generally defined as the presence of a unit root and the alternative hypothesis is either stationarity, trend stationarity or explosive root depending on the test used. Results of all variables of the study are appropriate in the scenario of a time series type of secondary data.

5.3 ARDL Model:

The Results of ARLD Model are shown in table 3:

Table 3: Results of ARLD Model

R-Squared	0.783455	Mean dependent Var	12.32105
Adjusted R-Squared	0.675183	S.D. dependent Var	1.465435
S.E. of Regression	0.835191	Akaike info criterion	2.754997
Sum Squared resid	8.370526	Schwarz criterion	3.102948
Log likelihood	-19.17247	Hannan-Quinn criterion	2.813884
F-Statistic	7.235973	Durbin-Watson stat	2.02737
Prob(F-Statistic)	0.001917		

The value of R square lies between (0 to 1) or near to 1 then it is proved that the model is goodness of fit. If R Squared is not lie in that range, then it implies that model is not good. In the above table, R Square is 0.7834; it means that 78% variation in dependent variable, employment is due to variation in all independent variables. The value of Durbin Watson is 2.02737, which means that no auto correlation exists between variables. The AIC value is 2.7549 and SIW is 3.1029.

5.3 Bound Test:

The bounds tests suggest that the variables of interest are bound together in the long-run when employment is the dependent variable. The associated equilibrium correction was also significant confirming the existence of long-run relationship. Bound test is used to check long run relationship. The results of Bound Test are given in Table 6:

Table 6: Results of Bound Test

F-statistic		0.8500
Critical value bound	LB	UB
Significance10%	2.2	3.09
Significance5%	2.56	3.49
Significance2.5%	2.88	3.87
Significance1%	3.29	4.37

In table 6 the value of F- statistics is smaller than all upper and lower boundaries. It means that our model has not existed long run relationship of co integration. Bound testing as an extension of ARDL modelling uses F and t- statistics to test the significance of the lagged levels of the variables in a univariate equilibrium correction system when it is unclear if the data

generating process underlying a time series is trend or stationarity at first difference.

5.4 Results of Error Correction Model:

Table 7: Short-run: Results of ECM Model

ARDL (1, 0, 0, 1, 0)				
Dependent Variable =	EMP			
Variable	Coefficient	Std. Error	t-statistic	Probability
GDP	0.048840	0.082133	0.594645	0.5631
INNO	0.000002	0.000022	0.073288	0.9428
TI	0.000000	0.000001	0.147433	0.8852
EXPO	0.002811	0.003763	0.747013	0.8709
ECM(-1)	-0.159798	0.064536	-2.476111	0.0292

This table shows the coefficient of short run relationship among the variables. The results show that there is not significant relationship or the association between variables in short run. Short run relationship among these variables is not significant.

Table 8: Coefficient of Long Run Relationship:

Variables	Coefficient	Std.Error	t-statistics	p-value
GDP	0.327	0.675	5.876	0.000
INNP	0.543	0.231	4.876	0.000
TI	0.041	0.233	3.564	0.000
EXOP	0.676	0.543	9.432	0.000
ECM(-1)	-0.961	0.320	-3.121	0.000

The table 8 describes the coefficient of long run relationship among the variables of study. The results in table 8 reveal that these variables have significant long run relationship. So, the results support the researcher point of view for the exploration of such type of study. As a conclusion, the relationship in the long run is significant between variables. For example, one unit changes in GDP will cause 32 percent increase in employment level. Similarly, if one unit changes in innovation it will likely to increase 54.3 percent increase in employment. If one unit increase in total investment is will likely to increase employment by 4 percent. Likewise, if one unit changes in export, it will likely to increase 67.6 percent in employment. Thus, the results show that all variables particularly innovations, exports and GDP have significant positive impact on employment level while total investment cases just 4 percent increase in employment. The low impact of investment may be due to the fact it might have been made in non-operating fixed assets or in speculative financial assets which has nominal effect on employment in short term or long term employment.

6. CONCLUSIONS:

We can draw conclusion from the above results that increase in gross domestic product (GDP), rate of innovation, improvement in exports and investment in productive assets will increase employment level in the country. So the Pakistan must focus on introduction of latest technology in industrial sector in order to improve its productivity. In past the productivity of industrial sector particularly exports sector was not remarkable due to power shortage, high interest rate, lack of incentives and political and economic instability. It causes closure of a large number of industrial units, causing high unemployment in the country. So the government of Pakistan now should focus on adoption of latest technology in industrial sector so that industrial base of the country may be expanded, which does not only enhance quantity of goods and services in the country but also decrease level of unemployment.

Our exports sector needs modernization because it has to face tough competition in the international market. We can follow industrialization model of China which has not only produced surplus goods for exports but also eliminated high level of unemployment and poverty from the most populous country of the world.

6.2 Policy Recommendations:

There are some recommendations that must be taken to increase the employment level in manufacturing sector of Pakistan. These are the followings: -

1. There is needed to take alterations in exports level by introducing more labor-intensive techniques. This is because Pakistan is a developing country so more labors are available at lower costs which are helpful to enhanced employment level in manufacturing sector.
2. Labour ministry should prepare a plan against capital intensive projects and promote labour intensive.
3. Gross domestic product may be increased so that its benefits must reach to the bottom.
4. Labour intensive technological innovations may be promoted in manufacturing sector and avoid more capital-intensive innovations that causes unemployment in the country.
5. Government should provide financial incentives on short-term and long-term basis to boost productivity of manufacturing sector.
6. Restrictive economic policies may be abandoned and period of doing business be reduced in order to encourage new entrepreneur to invest in new venture.

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CONTRIBUTION OF AUTHORS AND CONFLICT OF INTEREST

This research work was carried out in collaboration between two authors.

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