A Study On Technological Change In The Manufacturing Sector Of Thane District

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Abstract*: The manufacturing sector is considered to be one of the important sectors of the Indian economy However when we review the growth of this sector over the years the results are not appealing. The Government of India has taken several measures which would boost the growth of this sector. some of them include National manufacturing policy 2012, Make in India initiative 2014, science and technology policy 2011 etc. One of the crucial weaknesses hindering the growth of this sector is limited ability of the organization to adapt to technological change. Through this paper an attempt is made to understand the technological change in the manufacturing sector and to highlight the role of appropriate technology along with technological capabilities of firms in Thane District. The finding of this study related to technological change is in keeping with the literature review. The major limitation of this study is that findings are confined to organizations in Thane Region. The paper concludes that there is a need to identify appropriate technology for the respective industry and should develop the same for sustainable development.*

Keywords***: Technological change, Manufacturing sector, Basic Manufacturing technology, Advanced manufacturing technology, Technological capabilities, Appropriate technology.***

Introduction: Change is the only permanent thing in this world. Every country of the world desires economic prosperity, welfare of its citizens etc. The desire for the same is more amongst the underdeveloped and developing country. Our country is no exception to it; we compare ourselves with the so called developed countries and try to follow their footprint even at the cost of environmental damage. Economic indicators are predominantly used indicator as a gateway to achieve overall development of the nation. GDP is one such economic indicator. We all know and understand that the manufacturing sector play a very crucial role, as it alone can provide a secure basis for a rapid growth of income, generate employment opportunities, with the incremental job opportunities in agriculture being negative. As technological advancement has played a crucial role in industrial development, almost every nation is concerned with monitoring technological change.(Byongsoo kim,2012) In this study technological change is not to measure the state of technology along changing path but to understand the changes taking place in organizations with respect to technology.

Objectives of the study

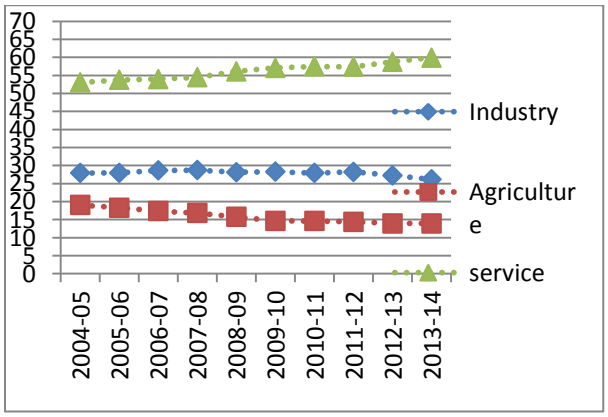
- To understand the significance and role of manufacturing sector in India
- To comprehend technological change in the manufacturing sector of Thane district
- To identify the need for appropriate technology in the manufacturing sector of Thane district

Research Methodology: The present study is exploratory in nature and makes use of primary as well as secondary data. The secondary data is collected from books and authentic source like Maharashtra development Report, Annual Survey of Industries Reports, science and technology policy, human development report, and others. The primary data is collected using a questionnaire. Likert scale is used for data collection. To identify the technological change a comparison is made between the technology used by the same company in the past as well as present. Present refers to the time during which data is collected and Past refers to a period of five years before the data is being collected. Primary data is collected from the companies of Thane district. The scope of this study is confined to industries like heavy metals, light engineering and other industries

wherein the technology specified in this study is likely to be used. The major limitation of this study is that the sample size is very small, as only 20 companies have been covered in this study.For the purpose of analysis of data excel and SPSS are used. However the findings are so significant that the same study may be extended to large number of companies.

Literature review: Different indicators are available to measure overall development of the nation. It includes economic indicators, social indicators and other composite indicators. . Economic development as an indicator to measure the development of any nation is a traditional measure. Despite the debate related to the appropriateness and method of calculating GDP, still GDP is the mostly widely used indicator to measure the economic development of the country. The other indicators may include purchasing power parity, GNP etc. Social indicators include infant mortality, Life expectancy, literacy rate other indicators like, Human development index, Gender empowerment measure, Gini coefficient, can also be used. The more comprehensive indicator would be the one given in the Brundtland commission i.e. of sustainable development.. "Sustainable development is development that meets the needs of the present generation without compromising the ability of the future generation to meet their own needs". The analysis of GDP of our country over a period of time shows that services sector continues to play a dominant role in its contribution to GDP. Agriculture, industry and services sectors contributed to nearly 17.9%, 24.2% and 5.9% respectively for the year 2014. The figure is 16.5%, 29.8% and 45.4% respectively for the year 2015-16.

Figure 1: Sector wise share to GDP



The above figure shows that the share of manufacturing sector is much lower than the service sector over a period of time; Service sector contributes the most to the India's GDP. It has the biggest share in the country's GDP. Even though growth in the service sector is to have spillover effect and leading to growth of manufacturing sector, but in the long run service sector without a strong industrial base is bound to get stagnated.

The manufacturing sector is considered to be one of the important sectors of the Indian economy. Its significance could be seen in terms of its spread over the economy, large size of SME's, Employment and income generating capacity and its value addition to our natural and agricultural resources. However when we review the changes in this sector over the last decade, its growth is not appealing.

Agriculture is said to have near zero employment elasticity. Any addition to the existing labor force in agriculture would simply result in disguised unemployment or under employment ((**Report on Employment & Unemployment Survey** (2009-10).

Every job created in manufacturing sector has a multiplier effect of creating two to three additional jobs in related activities. Therefore the thrust is on the manufacturing sector(national manufacturing policy2011).It is estimated that India needs to create 7-8 million new jobs each year outside agriculture to stay at its current unemployment level of 7 percent. Manufacturing jobs are ideal for workers transitioning out of agriculture as service jobs require high level of education and professionalism. The revival of manufacturing sector can create close to 2.5 Million new jobs every year. Accordingly one of the objectives of National Manufacturing Policy is to increase the rate of job creation in manufacturing to create 100 million additional jobs by 2022.Recent economic growth has benefitted industries which rely more on skilled workers and capital as opposed to unskilled/semi skilled workers.. This combined with the rising capital intensity of production in both capital and labor intensive industries partly explains the limited contribution of the manufacturing sector to employment generation ((RadickaKapoor, 2014)

The government of India has announced a national manufacturing policy with the objective of enhancing the share of manufacturing in GDP to 25 % within a decade and creating 100 million jobs. It also seeks to empower rural youth by imparting necessary skill sets to make them employable. Government of India decided to bring out the National manufacturing policy to bring about a quantitative and qualitative

change in the Manufacturing sector. Some of the objectives of national manufacturing policy are as follows.

1. Increase manufacturing sector growth to 12-14% over the medium term to make it the engine of growth for the economy. The 2 to 4 % differential over the medium term growth rate of the overall economy will enable manufacturing to contribute at least 25% of the National GDP by 2022.

2. Increase the rate of job creation in manufacturing to create 100 million additional Jobs by 2022.

3. Creation of appropriate skill sets among the rural migrant and urban poor to make growth inclusive.

With the aim of boosting manufacturing sector in India, Prime Minister NarendraModi launched "MAKE IN INDIA" initiative on September 25, 2014 with an aim of development of India's manufacturing sector. The program includes major new initiatives designed to facilitate investment, foster innovation, protect intellectual property and build best in class manufacturing infrastructure. The major objective behind the initiative is to focus on 25 sectors of the economy for job creation and skill enhancement. The government has put in an investor-friendly policy on foreign direct Investment (FDI), under which FDI up to 100% is permitted under the automatic route in most sectors..

One of the key reason as to why liberal policy on FDI is sought by the country is that foreign capital usually brings it with other scarce productive factors like technical knowhow, technology, business expertise and knowledge.

The existence of interstate disparities in the growth of manufacturing sector is worth mentioning. The table below includes only 11 states for comparison which are selected randomly.

Maharashtra is the second largest state in terms of population and third largest in terms of geographical area, spread over 3.08 lakh sq.Km. The state has a population of 112.3 million which is 9.29% of the total population of India. The sex ratio of the state is 925 females to 1000 males (source Industrial policy of Maharashtra 2013).

Table 1: State-wise shares of Employment and Value added to Manufacturing sector.

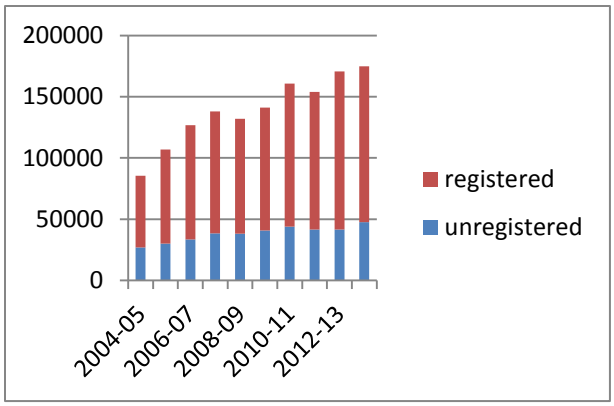
Sr. No	State	Share in total employment		Share in Total GVA	
		2000-01	2010-11	2000-01	2010-11
1	Andhra Pradesh	10.2	11.4	8.3	6.2
2	Gujarat	10.2	9.4	13.3	12.9
3	Maharashtra	13.4	14.7	20.4	21.1
4	Assam	1.3	1.4	0.9	0.9
5	Bihar	0.8	0.8	0.6	0.5
6	Uttar Pradesh	6.4	6.8	6.2	7.0
7	Rajasthan	3.4	2.9	2.6	3.6
8	Punjab	4.8	4.5	2.8	2.9
9	Madhya Pradesh	2.4	3.2	2.5	4.2
10	Karnataka	6.2	5.9	5.9	5.7
11	Tamil Nadu	15.3	14.2	10.4	11.4

Source: working paper ICRIER, September 2014

Mumbai is the capital city of the state; Mumbai is India's largest city and the financial capital of the nation. The population of Mumbai is growing much faster than any other city in the country, since 1980's planners have developed newer areas in the areas adjoining it i.e., Thane District in a bid to decongest Mumbai. This thane district is taken as an area of study here. The sample under study is one of thirty six district of Maharashtra.

The Gross State Domestic Product (GSDP) of Maharashtra at current prices for 2013-14 is estimated at 1510132 crore. Industry and Services sector both together contribute 88.7 per cent to the GSDP while the contribution of Agriculture & Allied Activities sector is 11.3 per cent.(Economic survey of maharshtra2014-2015)

Figure: 2. manufacturing sector contribution to Maharashtra GSDP



Source:Data taken from Report of Directorate of Economics and statistics. GoM

A high level committee on Balanced Regional Development issue in Maharashtra by the government of Maharashtra (planning Department) submitted its report on Oct 2013, under the chairman ship of Vijay Kelkar. According to the report Maharashtra, a leading State of the Indian Union, has been widely known as the 'Economic and Industrial Powerhouse' of the country. Primarily because of the presence of Mumbai – the commercial and financial capital of India and due to significant progress of industrialization in the Thane-Pune regions, Maharashtra has always been one of the topmost destinations for domestic as well as foreign investment and for the large and small industries alike. Barring few growth centers the situation has not changed much in terms of either inter district and inter regional imbalances.

1. As per the latest data of IEM (Industrial Entrepreneurs Memorandum - 2012), during the last decade, the four districts Pune, Raigad, Ratnagiri and Thane account for more than 50% investments in Maharashtra and three divisions i.e. Pune, Konkan and Nashik account for more than 80% of entire investment.
2. As regards employment the picture is not very different with just 6 districts accounting for more than half of total employment envisaged to be generated via IEMs. And Thane being one amongst them.
3. The situation is similar as regards the distribution of ‘mega-project as well as the distribution of SMEs within the state. Almost 50 % of all the MSME manufacturing units are located in just 5 districts and Thane in one amongst them.
4. As regards total investment in plants and machinery by the MSME of about 16000 crores almost 12000 crorei.e. 75% of MSME investment get concentrated in just 4 districts and thane is one amongst them.

This clearly shows the existence of inter-regional disparities in Industrial development in the state of Maharashtra. Further, Thane district more than being just one of the district which seem to be well developed in all the aspects. Research need to be done in this region for better understanding the development of this region.

Technology: The word technology is derived from two Greek words: „Techne‟ and „Logos‟. Techne means technique, the skill or craft to make something. Logos means discussion (knowledge of something). Thus technology can be defined as “tools, techniques and sum of knowledge required to convert resources into products and/or services”. According to Narhkede, Mantha and Gopani (2009), technology could be described as “Technology is the means for accomplishing a task; it includes whatever is needed to convert resources into product or services. Technology includes the knowledge and resources that are required to achieve an objective. Technology is the body of scientific and engineering knowledge which can be applied in the design of product and/or processes or in the search of new knowledge”. The common element underlying all Advanced Manufacturing technology (AMT) is the use of computers to store, manipulate and communicate data. AMT refers to a family of technologies that lie at the intersection of computer science and manufacturing engineering (office technology assessment 1984). It includes computer aided design(CAD), Computer aided manufacturing (CAM), Computer aided process planning (CAPP), manufacturing resource planning (MRP) and computer integrated manufacturing system(CIM), At a more detailed level, CAM includes robots, flexible manufacturing systems and computer-numerically controlled machines(CNC). AMT is not an isolated phenomenon restricted to production, but as the gradual penetration of computer technology into all the functions of manufacturing organizations, both production and support. Greenan (2003) analysed the correlations between technological change, organizational change and skill change using a survey on organizational change in manufacturing firms conducted in 1993. The survey listed four systems that are Computer aided design and manufacturing

(CADM), computer aided production control (CAPC), computer aided stock control (CASC) and computer aided maintenance management (CAMM). Economic theories, for long, highlighted capital and laboras the two primary factors of production and recognized them to be the key driving force behind production and growth. It was only in the 1950s that technological advancement as an important source of growth was brought into the discussion of mainstream economic theory. Basic technology is defined to mean the following as given in the book of workshop technology(Manufacturing processes)

1. The extent to which Foundry is used(Hand tools, Mouldingboxes,Moulding machines Melting and pouring equipments
2. The extent to which Moulding is used(material,sand,process, methods)
3. The extent to which casting is used(permanent, semi-permanent, slush, Die, Centrifugal, investment or lost wax, shell moulding etc.
4. The extent to which smithing and forging is used
5. The extent to which welding is used (forge or press welding, fusion, cold pressure welding)
6. The extent to which Fitting, Gauging, powder metallurgy is used.
7. The extent to which Quality control is used (TQC).

The basic objective of India's post-independence technology policy was "the development of indigenous technology and efficient absorption and adaptation of imported technology appropriate to national priorities and resources." Attainment of technological competence and self-reliance was placed at the heart of India's technological development. The aim was to achieve breakthroughs in indigenous technological development "appropriate to national priorities and resources" (i.e., maximum utilization of human resources, efficient use of energy, increasing productivity, maintenance of ecological balance). For the purpose of this study technology is defined as way it is designed for the purpose of study and used by US Bureau of the Census since 1989, 1993, 1994.

1**. Design and Engineering**

a. Computer Aided Design (CAD) and/or Computer Aided Engineering (CAE)—Use of computers for drawing and designing parts or products and for analysis and testing of designed parts or products.

b. Computer Aided Design (CAD)/ Computer Aided Manufacturing (CAM)—Use of CAD output for controlling machines used to manufacture the part or product.

c. Digital Data Representation—Use of digital representation of CAD output for controlling machines used in procurement activities.

2. **Fabrication/Machining and Assembly**

a. Flexible Manufacturing Cells (FMCs)—Two or more machines with automated material handling capabilities controlled by computers or programmable controllers, capable of single path acceptance of raw material and single path delivery of finished product. Flexible Manufacturing Systems (FMS)—Two or more machines with automated material handling capabilities controlled by computers or programmable controllers, capable of multiple path acceptance of raw material and multiple path delivery of finished product. A FMS also may be comprised of two or more FMCs linked in series or parallel.

b. NC/CNC Machines—A single machine either numerically controlled (NC) or computer numerically controlled (CNC) with or without automated material handling capabilities. NC machines are controlled by numerical commands punched on paper or plastic mylar tape. CNC machines are controlled electronically through a computer residing in the machine.

c. Materials Working Laser(s)—Laser technology used for welding, cutting, treating, scribing, and marking.

d. Pick & Place Robot(s)—A simple robot, with one, two, or three degrees of freedom, which transfers items from place to place by means of point-to-point moves. Little or no trajectory control is available.

e. Robot(s)—A reprogrammable, multifunctional manipulator designed to move materials, parts, tools, or specialized device through variable programmed motions for the performances of a variety of tasks.

3. **Automated Material Handling**: a. Automated Storage and Retrieval Systems (AS/RS)—Computer controlled equipment providing for the automatic

handling and storage of materials, parts, subassemblies, or finished products.

b. Automated Guided Vehicle Systems (AGVS)—Vehicles equipped with automatic guidance devices programmed to follow a path that interfaces with work stations for automated or manual loading and unloading of materials.

4. Automated Sensor-Based Inspection and/or Testing Equipment Automated Sensor-Based Inspection and/or Testing Equipment—Includes automated sensor-based inspection and/or testing performed on incoming or in-process materials, or performed on the final product.

5**. Communications and Control:** a. Technical Data Network—Use of local area network (LAN) technology to exchange technical data within design and engineering departments.

b. Factory Network—Use of local area network (LAN) technology to exchange information between different points on the factory floor.

c. Inter-company computer network—Use of network technology to link subcontractors, suppliers, and/or customers with the plant.

d. Programmable Controller(s)—A solid state industrial control device that has programmable memory for storage of instructions, which performs functions equivalent to a relay panel or wired solid state logic control system.

e. Computer(s) Used for Control on the Factory Floor—Exclude computers imbedded within machines, or computers used solely for data acquisitions or monitoring. Include computers that may be dedicated to control but are capable of being programmed for other functions.

The Technological Capability Framework:According to Fransman and King (1987), this capability involves the following activities: a) the search for viable alternative technologies; b) selecting the most appropriate technologies; c) dominating the technology; d) adapting the technology to suit the specific productionconditions; e) development of technology by small innovations; f) institutionalized search for the most important innovations by the research and development department (R&D) and; g) conducting basic research. These activities are seen to be related to the three levels of technological capability proposed by Lall (1992), which are: basic, intermediate and advanced. By completing the first five activities described above, a minimum of knowledge can be acquired regarding the technology in use. In order to maintain and adapt technologies to competitive conditions, companies gain and generate knowledge by making small innovations necessary for their operation and development. These activities are linked to what Lall (1992) calls the basic technological capability. That is, the ability to adapt technology in order to maintain the efficiency of a process, grounded in empirical informal learning, so as to solve problems that impede the routine operation of the firm's production.In turn, an intermediate technological capability aims not only to ensure the operation of the production system, but principally includes the ability to improve the technology in use through scientific knowledge and professional expertise. Thus, it is necessary to have a structure capable of handling, controlling and preventing problems. Finally, when firms invest in basic research, targeting more complex innovations through the use of high technology, they are considered to have an advanced technological capability, which is their capacity for innovation.

Table2: Reliability statistics of variables used in study

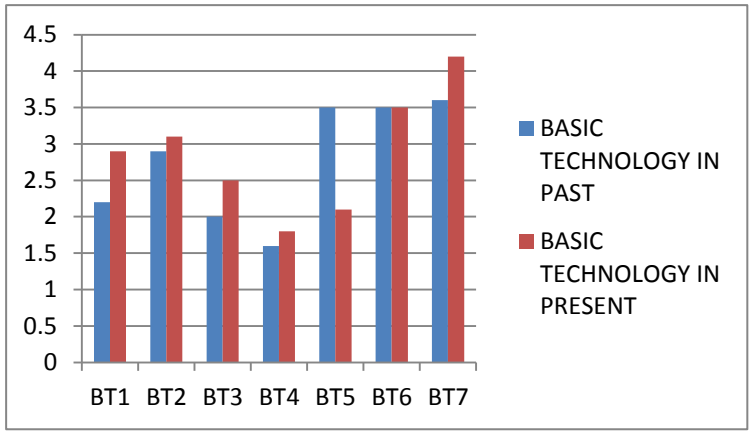
Variable	Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
Basic technology in the past	.689	.692	7
Basic technology in the present	.799	.813	7
Advanced Manufacturing technology in the past	.890	.894	5
Advanced Manufacturing technology in the present	.729	.725	5
Technological capabilities of the firm	.936	.940	16

Interpretation: Reliability test was done using SPSS in order to check the reliability. The items defining the variables are reliable, as the cronbach's alpha value is all cases are more than .700. In one case it's slightly less but that is not too less.

Data analysis:

TABLE4 and Graph 1: CHANGE IN THE USAGE OF BASIC MANUFACTURING TECHNOLOGY FROM PAST TO PRESENT.

	BASIC TECHNOLOGY IN PAST	BASIC TECHNOLOGY IN PRESENT
BT1	2.2	2.9
BT2	2.9	3.1
BT3	2	2.5
BT4	1.6	1.8
BT5	3.5	2.1
BT6	3.5	3.5
BT7	3.6	4.2

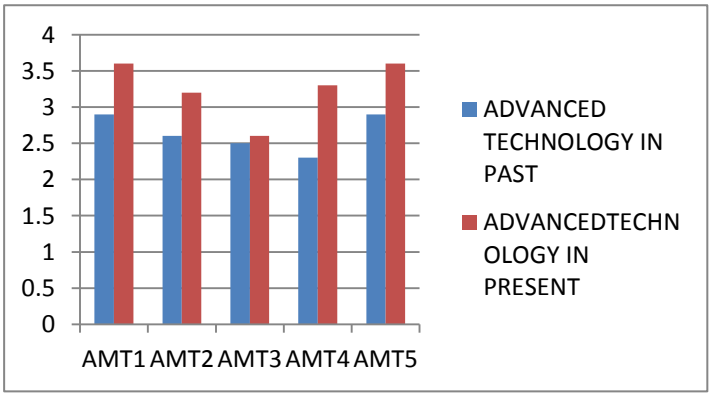


Interpretation:

From the above graph it could be clearly seen that basic manufacturing technology was used in past . It is being continued to be used in the present as well. Further it could be seen only few of the basic technology is being used rarely. None of the basic manufacturing technology is used very frequently(average being less than 4)

Table 5 & Graph 2: CHANGE IN THE USAGE OF AVANCED MANUFACTURING TECHNOLGY FROM PAST TO PRESENT

	ADVANCED TECHNOLOGY IN PAST	ADVANCED TECHNOLOGY IN PRESENT
AMT1	2.9	3.6
AMT2	2.6	3.2
AMT3	2.5	2.6
AMT4	2.3	3.3
AMT5	2.9	3.6

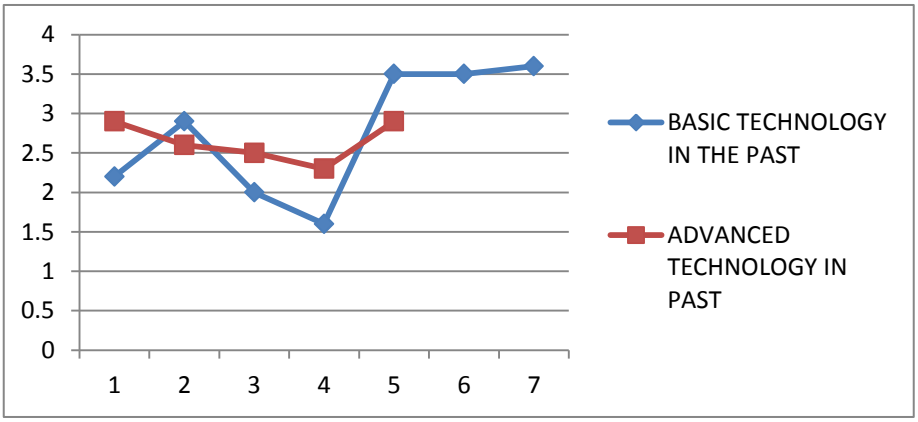


Interpretation:

From the above graph it is seen that the Advanced manufacturing technology were used in the past and it continues to be used in the present as well. It is further seen that the mean use of advanced technology in the present is more compared to that in the past. But still we cannot say that that advanced manufacturing technology is used very frequently (average being less than 4)

TABLE 6 & Graph 3:USAGE OF BASIC AND ADVANCED MANUFACTURING TECHNOLOGY IN THE PAST

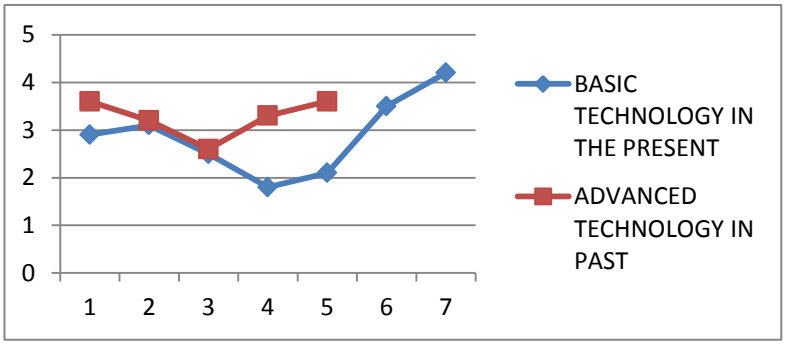
	1	2	3	4	5	6	7
BASIC TECHNOLOGY IN THE PAST	2.2	2.9	2	1.6	3.5	3.5	3.6
ADVANCED TECHNOLOGY IN PAST	2.9	2.6	2.5	2.3	2.9		



Interpretation: From the above table and graph it is clearly seen that in the past both basic and advanced manufacturing technologyeused.It is further seen that that the basic technology was predominantly used over advanced manufacturing technology

TABLE7 & Graph 4 :USAGE OF BASIC AND ADVANCED MANUFACTURING TECHNOLOGY IN THE PRESENT.

	1	2	3	4	5	6	7
BASIC TECHNOLOGY IN THE PRESENT	2.9	3.1	2.5	1.8	2.1	3.5	4.2
ADVANCED TECHNOLOGY IN PRESENT	3.6	3.2	2.6	3.3	3.6		



Interpretation: it could be interpreted from the above table and graph that even in the present both advanced and basic technology is used. It is further seen that in present the advanced manufacturing technology is predominantly used over basic technology

Findings:

1. To boost the growth of manufacturing sector, Government of India has taken several measures. Some of the measures include National manufacturing policy 2012, Make in India initiative 2014, science and technology policy 2011 etc.
2. There exist not only inter-state disparities but inter regional disparities in the development of manufacturing sector.
3. Both basic and advanced manufacturing technology were used in the past and it continues to be used in the present
4. Further with reference to the use of advanced manufacturing technology,it is seen that the mean use of advanced technology in the present is more compared to that in the past.But still we cannot say that that advanced manufacturing technology is used very frequently(average being less than 4)
5. In this study we could see that in the present both advanced and basic technology is used. It is further seen that in present the advanced manufacturing technology is predominantly used over basic teachnology.
6. It is only in few areas like performing auxiliary services, collaboration with technological institution and selling internally developed technologies the companies under study lack behind in terms of technological capbilities.

Conclusion:

Harrison (1980), a freelance journalist specializIng in Third World development issues, stated that appropriate technology means simply any technology that makes the most economical use of a country's natural resources and its relative proportions of capital, labor and skills, and that furthers national and social goals. Fostering AT means consciously encouraging the right choice of technology, not simply letting businessmen make the decision for you. (p. 140)

Todaro(1997), an economist, defined appropriate technology as: technology that is appropriate for existing factor endowments. For example, a technology employing a higher proportion of labor relative to other factors in a labor-abundant economy is usually more appropriate than one that uses smaller labor proportions relative to other factors. (p. 667)

Writing in the Economic Journal, Morawetz(1974) defined appropriate technology as the "set of techniques which makes optimum use of available resources in a given environment. For each process and project, it is the technology which maximizes social welfare if factors and products are shadow priced" (p. 517).

In the definition by Betz et al. (1984), appropriate technology equated with providing technical solutions that are appropriate to the economic structure of those influenced: to their ability to finance the activity, to their ability to operate and maintain the facility, to the environmental conditions involved, and to the management capabilities of the population.

In order to observe the progress and evaluate the appropriateness of technology, a restructured version of Wicklein‟s evaluation is described below and later utilized to provide insight into case studies from the North and South. Since no evaluation is perfect, one of the criteria, the image of modernity was taken out as it undermines the importance of retaining tradition within a community and buys into the modernity theory. Our version of Wicklein‟sevaluation includes 6 criteria:

1. Ability of technology to stand alone without additional support systems
2. Individual versus collective technology, with regard to which one the culture values
3. Cost of technology which takes into account full costs to social, economic, and environmental impacts
4. The risk factor including internal risks, that relate to the fit in local production systems and external risks, which relate to the needed support systems
5. Evolutionary capacity of technology, with regard to its capability of being reconfigured to grow with the society it benefits, whereby solving different problems that the community encounters
6. Single-purpose versus multi-purpose technology, where the latter refers to technology that has the ability to complete different tasks at the same time.

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