

Role of Technological Innovation in Improving Manufacturing Performance: A Review

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Abstract—MSMEs are regarded as the sunrise sector of the Indian economy in view of its large potential for growth and likely socio economic impact specifically on employment and income generation. In today's competitive business environment, global competition forces companies to continuously seek ways of improving their products and services. The pressure on organizations to adapt to new technologies and external threats requires resourcefulness, creativity and innovation. Market has become more open, competitive and customers more demanding. Without continuous technology innovation, no organization can ever remain competitive. Innovations reflect a critical way in which organizations respond to either technological or market challenges. The need of the market is to deliver high quality products through continuous changing in features in product, improve existing products, reduce their cost, and improve employee skills, training, technology infrastructure and financial policies. Therefore, the key factor of organization's ability to change is innovation. The study presents a detailed review of literature on the role of technology innovation in improving manufacturing performance of industries.

Keywords—Competitive, Manufacturing performance, MSMEs, Technological Innovation.

I. INTRODUCTION

MICRO, Small and Medium Enterprises (MSMEs) previously known as Small Scale Industries (SSIs) play a predominant role in most developed and developing economies not only because of their number and variety but also due to their involvement in all segments of the economy. But MSMEs, especially in developing countries, have been exposed to intense competition due to the accelerated process of globalization, which brings out the need for them to develop competitiveness for their survival as well as growth. MSMEs, in general, are constrained in terms of resources such as technology, finance, marketing and human resources. The ability of MSMEs to compete in the global market depends on their access to these resources and those that have better access to these resources are able to exhibit better innovative and economic performance.

Most economic structures are largely composed of MSMEs, and despite the presence of large firms most employment is concentrated in this group. Whilst definitions vary, there is general recognition of the need to look closely at the characteristics and behavior of this majority of enterprises, especially in view of their perceived importance in economic

growth and job creation. Little is known, for example, about the volume of MSMEs involved in innovative activity, nor about the nature of that activity; since they do not necessarily innovate in formally recognized ways.

II. REVIEW OF LITERATURE

A. International Studies

MSMEs, including manufacturing and service enterprises are credited with generating the highest rates of employment growth, account for a major share of industrial production and exports. They also play a key role in the development of economies with their effective, efficient, flexible and innovative entrepreneurial spirit. These are considered as one of the important factors to work an economic miracle in many countries and regions. According to established practice in the world, the strength of an economic power lies not only in the success of large enterprises, but also in small industries [1].

For developing country enterprises, successful entry into global networks has emerged as a key challenge. Entry into global chains promises up-gradation of firm level capabilities from "learning" through technology diffusion and exposure to international best practice systems of corporate governance. However, the ability of developing country firms to move into global chains and graduate to "high-end" activities depends on their existing technology, as well as the support mechanism made available by national country governments. The productive entities that are mostly affected and face problems are the MSMEs. Small units are constantly struggling to survive and face pressure even in local and domestic markets. No enterprise can remain competitive without continuous technology up-gradation and development. Technological innovation is considered to be an important strategy for technological developments in the organizations. It is with this backdrop that the present study probes the various factors influencing the tactical and technological development of organizations.

Many factors have been identified by various authors as to be the possible cause or contribution factor for the premature death of small scale industries. The main problems related to the introduction of innovation in small firms were mainly the lack of a skilled workforce and market uncertainty. Entrepreneurs, who assessed the problems encountered by these small subcontracting firms in the introduction of innovation, concluded that the main problem was that of recruiting trained personnel. The manpower, as well as technically qualified personnel, favour employment in medium and large-sized industries where work conditions and the employment prospects are more attractive. The other

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issues related to innovation were financial risk linked to investments in innovation, the lack of technical know-how and the cost of innovation [2].

Keogh and Stewart conducted a survey of 40 units with sample size 14 in Aberdeen area of UK, aim of this is to investigated human resource issues in depth to establishment of a skilled workforce, and find the extent of future skill requirements. Research methodology involved a series of interviews with owner-managers, other staff within organization. Respondents provided information about staff recruitment, retention and training, importance of education. It was found that the majority of respondent companies did not use a sophisticated approach to identify current and future staffing needs. Recruitment and staff development were addressed as and when required, thereby catering for immediate operational needs. MSMEs do not follow any job description before recruitments, training need analysis [3].

Hyland and Beckett identified and clarified the barriers to successful inter-firm collaboration and sub-divided these barriers into four simple categories: 1. Integration: Unique capabilities need to be developed and embedded in the partner's organizations and also very complex mix of intra and inter-firm processes has to be aligned and implemented for successful integration. 2. Organizational barriers: Firms usually restrict access to their unique practices and maintain an independent management style which causes hindrance in collaborating with other firms. 3. Trust: Firms generally give priority to their internal work and do not trust other organizations for their work. 4. Ongoing Learning: Many organization find it difficult to establish collaboration relationship with other organizations due to their ongoing practices for learning which generally find resistant with new collaborating organizations, these type of collaborations generally need time and effort to sustain [4].

Ozgen and Huseyin conducted a survey; the population for this study is the 500 manufacturing companies determined by the Istanbul Chamber of Industry in Turkey. A sample size of 215 private sector companies was randomly drawn from the list of companies. Data were collected through questionnaire, and analyzed by SPSS program. Concluded that, organizations which are innovative, have adequate strength of multi-skilled workforce. Strategies range from identification of areas of skills in which shortfalls either occur or can occur and efforts are made to generate those skills. These organizations encourage their employees to work in various departments and divisions in order to gain a well-founded experience [5].

Terziovski studied the innovation practice and its effect on performance of Australian SMEs. Drawing data from a sample of 600 SMEs in the manufacturing sector, the study found that innovation strategy is a key driver to performance of SMEs, effect of innovation practice and its performance implications in Small and Medium Enterprises in the manufacturing sector. The impact of innovation factors like innovation strategy, formal structure, customer and supplier relationships and innovation culture on SMEs performance were studied which included number of product configurations, success of new products launched, faster speed to market, reduction in waste,

increased market opportunities, increased delivery-in-full-on-time, improved product innovations, and increased quality. After analysis of all these factors a significant positive impact of innovation strategy and formal structure on SMEs performance was found. But other factors like customer and supplier relationships were not found to affect the SMEs performance significantly. The study concludes that SMEs' performance is likely to improve as they increase the degree to which they recognize that innovation culture and strategy are closely aligned throughout the innovation process [6].

Yam et al. in their study analyzed the sources of innovation, technological innovation capabilities and its effect on the performance of manufacturing organizations in the empirical study carried out in Hong Kong. The study explores the relationship between Regional Innovation System (RIS) and Firm's Innovation System (FIS). The different innovation capabilities of a firm were regarded as the key components of the firm's innovation system. The source of information available within a RIS includes external sources and external expert organizations. A research model was proposed indicating the relationship between Regional perspectives i.e. Sources of innovation and firm perspective i.e. Technological Innovation Capabilities (TIC) and Technological Innovation Performance (TIP). The key component of TIC included – learning capability, R&D capability, resource allocation capability, manufacturing capability, marketing capability, organizational capability and strategic planning capability. The key indicator of TIP has been taken as Sales Performance of the firm. Research hypothesis indicating positive relation between Sources of Innovation and all the components of TIC were established, also these TIC components were hypothesized to have a positive impact on Sales performance of the firm. Questionnaire developed on 7 point Likert Scale was distributed among 1153 firms, of the 1153 successfully contacted firms, 202 responded to the survey for a response rate of 17.7%. The hypotheses were tested by way of structural equation modeling. The SEM results indicated that external sources have positive relationship with all the component of TIC, whereas external expert organizations do not show significant correlation with learning, manufacturing, marketing, organizational and strategic planning capability. Also only resource allocation, manufacturing and organization capabilities indicated a significant correlation with Sales performance of the firm [7].

Lendel and Varmus proposed a model for successful implementation of innovation strategy. Research was conducted in the period from January to September 2010 in Slovak SMEs. A sample of 262 SMEs was selected for survey. Chi-square test was used to test the independence of the data and cluster analysis. To ensure their competitiveness through innovation it is necessary for organizations to implement an innovation strategy. Their proposed model of innovation strategy brings new insights primarily on analysis of internal environment and area of formulation of the strategy. The main effort of the organization should be to create an innovative corporate culture. The corporate culture significantly affects the development of organization as well as implementation of

an innovative strategy. Also, creating an innovative strategy requires a change in formal structure of the organization. The successful innovative strategy will in turn ensure the development of organization through innovation [8].

Necadova and Scholleova in their study of 252 Czech manufacturing firms investigated the motives and barriers of innovation behavior of companies and found that non-innovating firms see lack of financial possibilities as one of the main barrier. Economic factors and market barriers were leading to non-innovative nature of organizations. The economic factors included- difficult access to external financing, economic risks and cost on R&D, insufficient flexibility of the legislature. Market barriers included- customer resistance to new products, low dynamic and innovative market, lack of information about 33 markets, lack of qualified workers and technical equipment (large enterprises feel it more significantly) inflexibility of business organizational structure and insufficient spaces. The dynamic engine of a nation's economic growth is driven by micro, small and medium enterprises (MSMEs) whose activities are the spur to aggregate economic and social benefits. Several studies confirm that a nation's growth and sustenance is dictated, to a large extent, by the performance of small businesses. However, the reality is that MSMEs are constantly struggling to survive and maintain their schedule of activities. Firms should develop innovative capabilities for their survival and growth. Several studies have been carried out related to the factors influencing the technology innovation initiatives of MSMEs which in turn affect their manufacturing performance [9].

Juan et al. conduct a survey by observing 750 units which have number of employee maximum up to 100 employees. The data was conducted by questionnaires which including queries about the innovation activities in small firm. The dependent variables are product innovation (radial and incremental) and process innovation (radial, incremental, and adaption of new technology) are the indicators for innovation. The independent variables are personal characteristics of entrepreneur viz. level business education and previous experience before setting business, firm size viz. number of employees, level of capital income, dependency on the main client and supplier, identification of new markets and business opportunities. Research show that personal characteristics of entrepreneur, firm size, and identification of new markets and business opportunities are the positive related to product and process innovation whereas dependency on the main client and supplier negative related to product and process innovation [10].

Romero et al. found that the degree of innovation can be measure by the measuring internal and external variable of innovation. The external variable cover all the opportunities SMEs can seize from a surround environment include variable such as "collaboration with 33 other firm", "Linkage with knowledge centers", "Utilizing financial resources or support regulations", "suppliers", "business partners", or "customers". Internal variables include characteristics of SMEs and government policies for SMEs. Those can be roughly divide

into "Strategy", "Structure", "Technology policy", "Level of education" and "Investments in R&D" managerial factors such as organizational structure or corporate strategy etc.. He conducted the survey of 400 among 7731 small firm. The survey was supported by Korean Small & Medium Business Administration for the "New technology commercialization program" this government program aims at finding SMEs at a technology frontier, and facilitating their next-generation technology commercialization. However, the selection is based not on R&D capability but mainly on excellence of technology and commercialization potential [11].

B. National Studies

MSMEs play in extraordinarily important role as muscles for regional economic development. This sector is one of the most vital sectors of the Indian Economy in terms of employment generation, the strong entrepreneurial base it helps to create and its share in production.

Many Nations, both developed and developing exteriorized that the small industry sector is a useful vehicle for growth, in the later for the creation of new employment opportunities on a wide scale in the shortest possible time.

Salient Features of MSME Sector in India

a) Number of Enterprises: The total number of enterprises in this sector in country (as per the Fourth Census of MSMEs with reference year 2006-07) was 361.76 lakh enterprises in India. As per the estimates compiled for the year 2011-12, the working enterprises are 447.73 lakh. The annual growth rate of working enterprises is approximate 17.12 lakh.

b) Employment Profile: The total employment in this sector in the country (as per the Fourth Census of MSMEs with reference year 2006-07) was 805.23 lakh persons. As per the estimates compiled for the year 2011-12, the employment is 1012.59 lakh persons in the sector. The estimated numbers of enterprises and employment, as per Fourth All India Census of MSME, have increased at an annual compound growth rate of 28.02% and 26.42% respectively as compared to third All India Census of SSI, during the period 2001-02 to 2006-07.

c) Gross Output: Production in terms of gross output in the sector during the last ten years has recorded an annual average growth rate of 8.6 percent. The share of these industries in the countries industrial output is around 56 percent. The gross output in the total MSME sector is estimated to be Rs. 18,34,332.05 crore in 2011-12.

d) Fixed Investment: The fixed investment in the this sector is projected to be Rs. 11,76,939.36 crore. The fixed investment has been increased from Rs 8,68,543.79 crore in 2006-07 to Rs. 11,76,939.36 crore in 2011-12.

The development of small businesses is viewed as highly important for the Indian economy. This is due to the fact that growth-potential of small businesses in general and, on technology-based export-oriented small businesses in particular, can act as catalysis to further drive the industrialization process in India. Small and medium enterprises are known to have contributed significantly to

economic development job creation and sustainable livelihood [12].

Vohra conducted a survey by filling a questionnaire prepared on different categories of problems. Target population was the exporters who deal in hand tool and textiles in the industrial city of Ludhiana, Punjab. Finally, a sample of 65 exporters was chosen on the basis of their experience in the exports. This method of data collection has been used keeping in mind the attitude of the Indian managers and achieving high-response rate (61%) of the survey. According to them, small firms have scarce resources for market intelligence generation and thus, there is no room for marketing specialist. But they very much rely on secondary data (such as business journals, newspapers, or even personal contacts, word-to-mouth, suppliers, bankers, etc.) for generating sustainable market intelligence. It is evident that there exists a direct relationship between the firm's experience in the market and the market orientation. The result indicate the major problems in exports include: lack of competitive pricing, red tape in public institutions, poor organization of firms' export department, lack of personnel qualified in export marketing activities, lack of export marketing research, ineffective communication with overseas buyers [13].

Nanda and Singh conducted a study of 93 small scale cutting tool and auto-component units which highlighted the performance of Indian manufacturing organizations in different components of technology development implementation program to make significant organizational transformation from a technology dependent regime to proactive adaptation to technology innovation initiatives for affecting organizational performance improvements. The study presented the five main components comprising the technology development implementation program. These included, Manpower Competence and Management Commitment; Technology Infrastructure; Regulatory Support; Interaction with Others and 30 Research Outputs. Descriptive analysis was conducted to evaluate the status of each factor and to categorize industries according to their performance in different factors. The performance of industries was poorest in Technology Infrastructure [14].

Subrahmanya et al. studied the importance of technological innovation for SME growth in Bangalore region. They found that most of the innovative SMEs attribute the origin of their innovations to firm level technological capability, owing to internal factors such as self-motivation, technical qualification, knowledge, experience, and innovative ideas of entrepreneurs and external factors like customer requirements and demand, information provided by suppliers of equipments and materials, market opportunities, and competition. The survey was carried out on SMEs consisting of 72 auto component SMEs, 67 electronic SMEs and 75 machine tool SMEs. Both "technology push" and "demand pull" have contributed to the emergence of innovations. They found that innovative SMEs registered higher growth in terms of sales turnover and sales growth [15].

Thampy state that the major bottleneck to the growth of the vital Indian small and medium enterprises (SMEs) sector is the

lack of adequate access to finance. The major issues in the financing of SMEs in the Indian context are examined under this paper such as the information asymmetry facing banks and the utility of measures such as credit scoring for SMEs; whether transaction lending would be adequate to address the information issues or would lending have to be based on a relationship with the SMEs, using both "hard" and "soft" information; and whether the size and origin of the bank affect the availability of credit to SMEs. The author also gives an importance of the credit appraisal and risk assessment processes in today's banking landscape and the role that banks can play in developing the SME sector in India [16].

Jeswal has discussed the role of MSMEs in Indian economy. The role of small and medium enterprises in the economic and social development of the country is well established. MSMEs emerges leaders during the period of recession, restoring jobs and business activity lost during the time despite a slow and fragile economy. The small-scale industries sector plays a vital role in the growth of the country. It contributes almost 40% of the gross industrial value added in the Indian economy [17].

Venkatesh and Muthiah suggest that the Small and Medium enterprises play a vital role in the Indian economic structure due to its significant contribution in terms of output, exports and employment. For a developing nation like India, where the labor is abundant and capital is scarce, the small sector is a major source of employment for millions of people. Keeping in view the importance of MSMEs, the Indian government has included this sector in its five-year plans. The MSMEs are still hampered by the problems of finance, marketing and low quality. Taking into account the enormous potential of the small sector, the entrepreneurs and the policy-makers must act collectively to facilitate growth in this sector [18].

III. SIGNIFICANCE OF THE STUDY

To attain the business environmental policy goals, enterprises will either have to bring about modifications in the way people do something or changes in technology. Innovation is one of the main processes by which those changes come about. Reasons why enterprises undertake innovation:

- Improved quality
- Creation of new markets
- Extension of the product range
- Reduced labor costs
- Improved production processes
- Reduced materials
- Reduced environmental damage
- Replacement of products/services
- Reduced energy consumption
- Conformance to regulations [19].

Modernization, technological and quality up-gradation have assumed great significance in the present day's context. With the inflow of latest technology reducing the cost of production and the increasing competition from within and outside, the small scale sector will have to attach more importance and pay attention to the areas of technology innovation and

modernization. However, due to lack of information on the areas of technology innovation, entrepreneurs who have plans for technical up-gradation are not able to go ahead [20].

In order to enable MSMEs tide-over the problems of technological backwardness and enhance their access to new technologies, it is imperative to offer them a conducive environment, which in the present context of globalization, calls for approach with knowledge playing a predominant role.

There is a need to understand and assess the real needs of the MSMEs and accordingly devise approaches that ensure their sustainable growth. The need today is also to leverage on modern technologies to harness human capabilities through the process of increased communication, cooperation and linkages, both within the enterprise as well as across enterprises and knowledge-producing organizations. Therefore, it can be concluded that MSMEs should perceive the technological innovation initiatives for conditions that encourage firm's performance.

IV. SUMMARY

Industries from the backbone for national development and are one of the important components for growth of national economy and growth of the MSMEs sector at a healthy rate is crucial for overall growth of industry. However, lack of proper technology innovation activities facilities barriers of better performance.

The beginning of liberalization, privatization and globalization has brought onward agreement economic, social, environmental and technological pressure on the organizations. Increasing global competition coupled with rapidly changing technology, and improving the features of product, have made corporations susceptible to failure more than any time in the past. The aggressive competition situation arising out of globalization and liberalization is forcing the organization across the globe to realize that their survival is not feasible in the absence of technological innovation. Therefore, technological innovation is the most important aspect for improving the manufacturing performance of MSMEs.

REFERENCES

- [1] Qinglan, Q. and Yingbiao, C. "SME, Technological Innovation and Regional Environment: The Case of Guangdong, China", *Procedia Earth and Planetary Science*, Vol.2, 2011, pp. 327-333.
- [2] De Toni, A. and Nassimbeni, G. "Strategic and operational choices for small subcontracting firms- Empirical results and an interpretative mode", *International Journal of Operations and Production Management*, Bradford, Vol. 16, 1996, pp. 41.
- [3] Keogh, W. and Stewart, V. "Identifying the skill requirements of the workforce in SMEs: Findings from a European Social Fund Project", *Journal of Small Business and Enterprise Development*, Vol. 8, No. 2, 2000, pp. 140-149.
- [4] Hyland, P. and Beckett, R. "Engendering an innovative culture and maintaining operational balance", *Journal of Small Business and Enterprise Development*, Vol. 12, No. 3, 2005, pp. 336-35.
- [5] Ozgen, Olcer, H. and Ferit "An evaluative study of innovation management practices in Turkish firms", *International Journal of Business Research*, Vol. 7, No. 2, 2007, pp. 46-55.
- [6] Terziovski, M. "Innovation practice and its performance implications in small and medium Enterprises (SMEs) in the manufacturing Sector: A resource-based view", *Strategic Management Journal*, Vol. 31, No. 4, 2010, pp. 892-902.
- [7] Yam, R.C.M., Lo, W., Tang, P.Y.E. and Lau, A.K.M. "Technological Innovation Capabilities and Firm Performance" *World Academy of Science, Engineering and Technology*, Vol. 42, 2010, pp. 1009-1017.
- [8] Lendel, V. and Varmus, M. "Creation and Implementation of the Innovation Strategy in the Enterprise", *Economics and Management*, Vol. 16, 2011, pp. 819-825.
- [9] Necadova, M. and Scholleova, H. "Motives and barriers of innovation behavior of companies", *Economics and Management*, Vol. 16, 2011, pp. 832-839.
- [10] Juan A., Isidoro R., Martinez R. "Self-employment and innovation. Exploring the determinants of innovative behavior in small businesses", *Research Policy*, Vol. 41, No. 1, 2012, pp. 178-189.
- [11] Romero, I. and Martinez-Roman, J.A. "Self-employment and innovation. Exploring the determinants of innovative behavior in small businesses", *Research Policy*, Vol. 41, 2012, pp. 178- 189.
- [12] Schlögl, H. "Small and medium enterprises: Seizing the potential", *Organizational for Economic Cooperation and Development, OECD Observer No. 243*, May 2004.
- [13] Vohra, K. "Export-Marketing Problems of SMEs: the case of Ludhiana", A Dissertation presented in part consideration for the degree of "MA Marketing", The University of Nottingham, 2008.
- [14] Nanda, T. and Singh, T.P. "An assessment of the technology innovation initiatives in the Indian small manufacturing industry", *International Journal of Technology*, Vol. 9, No. 2, 2009, pp. 173-207.
- [15] Subrahmanya, B.M.H., Mathirajan, M. and Krishnaswamy, K.N. "Innovation for SME Growth Evidence from India", *United Nations University, Working Paper No. 3*, 2010.
- [16] Thampy, A. "Financing of SME firms in India", *IIMB Management Review*, Vol. 22, 2010, pp.93-101.
- [17] Jeswal, R. "Role of SME in Indian Economy", *National Conference on Emerging Challenges for Sustainable Business*, 2012.
- [18] Venkatesh, S. and Muthiah, K. "SMEs in India: Importance and Contribution ", *Asian Journal of Management Research*, Research Article, Vol. 2, No. 2, 2012, pp. 2229-3795.
- [19] Davila, T., Marc, J. E. and Robert, S. "Making Innovation Work: How to Manage It, Measure It, and Profit from It", Upper Saddle River: Wharton School Publishing. ISBN: 0-13-149786-3, 2006.
- [20] Laranja, M. "The Development of Technology Infrastructure in Portugal And The Need to Pull Innovation Using Proactive Intermediation Policies", *Technovation*, Vol. 29, 2009, pp. 23-34.