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Factors Contributing Towards Technology Development in Small Firms

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Abstract**—**The importance of MSMEs in India became crucial in rural areas because it promoted economic growth. MSMEs play a significant role in the economic growth of the country owing to production, exports and employment. Technology development reflect a critical way in which organization respond to either technological or market challenges. The present survey examines the characteristics of technology development in MSMEs. The results show that Indian MSMEs do not co-operate with universities and R&D institutes. Government policies also affect the technology development activities. The awareness about the R&D infrastructure is very low as shown by the results in the study. There is a need to understand and assess the real needs of the MSMEs and accordingly devise approaches that ensure their sustainable growth.

Keywords**—**MSMEs, technology development, networks, financial management and R&D infrastructure.

I. Introduction

MICRO, Small and Medium Enterprises (MSMEs), including khadi and village/rural enterprises are credited with generating the highest rates of employment growth and 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. The socio-economic policies adopted by India since the Industries (Development and Regulation) Act, 1951 have laid stress on MSMEs as a means to improve the country's economic conditions [1].

A. Importance of MSMEs

The 11 million MSME units, which make up the Indian MSME sector, produce over 8000 products. MSMEs constitute over 90 per cent of total enterprises in most of the economies and are credited with generating high rates of employment and account for a major share of industrial production and exports. The MSME sector also plays a significant role in the development of entrepreneurial skills and forms a substantial portion of the country's export earnings [2]. The importance of MSMEs is well understood by national economies. World over half to two- thirds of all businesses are MSMEs and in many regions this proportion is much higher. MSMEs are capable of creating jobs with least amount of capital and in dispersed locations which makes MSMEs attractive to policy makers.

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The importance of MSMEs in India became crucial in rural areas because it promoted economic growth. In fact, MSMEs can be the factor through which productivity is increased and income generation for household local community is improved.

B. Technology Development

MSMEs have been considered one of the 'driving forces' of modern economies due to their multifaceted contributions in terms of technological development, employment generation, export promotion, etc. of these, the ability of MSMEs to develop assumes significance because innovation lends competitive edge to firms, industries and ultimately, economies. Therefore, technological development has the potential to spur growth of individual enterprises at the micro level and aggregate industries and economies at the macro level [3].

Technological development is a key factor in a firm's competitiveness. Technological development is unavoidable for firms which want to develop and maintain a competitive advantage and/or gain entry in to new markets [4]. Among firms of different sizes, MSMEs are generally more flexible, adapt themselves better, and are better placed to develop and implement new ideas. The flexibility of MSMEs, their simple organizational structure, their low risk and receptivity are the essential features facilitating them to be innovative [5]. Therefore, MSMEs across industries have the unrealized innovation potential [6].

There is substantial evidence to show that a number of MSMEs in a wide variety of sectors do engage in technological development, and that this development is likely to be an important determinant of their success. However, the ability and development capacity of MSMEs varies significantly, depending on their sector, size, focus, resources, and the business environment in which they operate. Particularly development in the manufacturing sector is a very complex process which is propelled by numerous factors [4].

To connect societal input to development in relation to the external environment of the firm, early studies assumed that growth in the short run was largely driven by capital investment, while long-term growth was attributed to exogenous technological change [7]. R&D leads to the creation of knowledge, which may have a direct impact on technological change [8].

II. Explanation of Technology Development Characteristics

The present work considers three main factors (components or aspects) for the overall assessment of technology development initiatives in the manufacturing industry. These include Network, Financial Management and R&D Infrastructure. Development Indicators, is the research output achieved by the organizations as a result of innovation initiatives. This factor is the resultant output. The purpose of this section is to access the explanation of each component of technology development in manufacturing MSMEs.

Tables I, II and III present the status of the Networks, Financial management and R&D Infrastructure respectively. A set of questions (from the questionnaire), which reflect different issues of these components are presented in the tables. For each question, central tendency (C.T) and percent points scored (P.P.S) are calculated. These measures reflect as to how well the area (issue) represented by a question is being looked after in the industry. Finally, overall average for each component is calculated (considering all the issues under the component), which represents the status of the entire component. Figs. 1, 2 and 3 represents issue wise performance of Networks, Financial management and R&D Infrastructure respectively.

TABLE I
Evaluation of Networks Issues

S. No	Topic in the aspect	No. of Responses (N)	No. of companies Scoring				Total Point scored (TPS)#	Percent Point Scored (PPS)	Central Tendency (TPS/N)
			1 (J)	2 (K)	3 (L)	4 (M)			
1	Network with government agencies	26	11	4	5	6	58	55.77	2.23
2	Network with Universities	26	19	1	6	0	39	37.50	1.50
3	Network with R&D institutes	26	13	6	4	3	49	47.12	1.88
4	Network with supplier	26	0	2	4	18	88	84.62	3.38
5	Government policy effect on raw material	26	6	5	6	9	70	67.31	2.69
6	Government provide funds for implementation of new technology	26	4	5	8	9	74	71.15	2.85
7	Government agencies provide employee training for improvement of technology development performance	26	10	5	7	4	57	54.81	2.19
8	Research institutes help MSMEs in technology development at lessor cost	26	6	4	8	8	70	67.31	2.69
9	Technology has become so complex that cannot be handled by individual corporations	26	3	7	8	8	73	70.19	2.81
10	R&D institutes provide facilities of technical knowledge, employee training for improvement of technology innovation performance	26	4	6	5	11	75	72.12	2.88
	Over all								2.51

TABLE II
Evaluation of Financial Management Issues

S. No	Topic in the aspect	No. of Responses (N)	No. of companies Scoring				Total Point scored (TPS)#	Percent Point Scored (PPS)	Central Tendency (C.T)
			1 (J)	2 (K)	3 (L)	4 (M)			
1	Government policies effects on firm	26	7	6	3	10	68	65.38	2.62
2	Slow process for loan from bank	26	4	10	8	4	64	61.54	2.46
3	tax and regulatory environment effect on firm	26	5	5	6	11	77	74.04	2.96
4	internal financial resources for technology development	26	11	7	4	4	53	50.96	2.04
5	enterprises take any benefits from government policies	26	11	5	4	4	49	47.12	1.88
6	problem of high rate of interest on loan	26	4	6	4	14	84	80.77	3.23
7	effective guarantee required for loan from banks	26	4	4	6	12	78	75.00	3.00
8	taxes are major barrier for technology development	26	4	5	7	10	75	72.12	2.88
9	lack of reliable credit information	26	4	8	7	7	69	66.35	2.65
	Over all								2.64

TABLE III
EVALUATION OF R&D INFRASTRUCTURE ISSUES

	Topic in the aspect	No. of Responses (N)	No. of companies Scoring				Total Point scored (TPS)#	Percent Point Scored (PPS)	Central Tendency (TPS/N)
			1 (J)	2 (K)	3 (L)	4 (M)			
1	Upto date plant equipment & machinery	26	12	5	5	4	53	50.96	2.04
2	Technical support services to firm	26	11	6	3	6	56	53.85	2.15
3	researcher and technicians are employed in the firm	26	5	7	6	8	69	66.35	2.65
4	Firm keeps the R&D funds for research purpose	26	13	3	6	4	53	50.96	2.04
5	Implement new technology for development in plant	26	10	8	4	4	54	51.92	2.08
6	Upto date equipment and machinery in an organization is linked to its innovation performance	26	6	4	6	10	72	69.23	2.77
7	Technical faculty to improve the R&D infrastructure	26	6	4	5	11	73	70.19	2.81
8	percentage of researcher and technicians in firm	26	8	4	8	6	64	61.54	2.46
9	annual budget for industrial training education and training activities	26	11	8	4	3	51	49.04	1.96
10	percentage of R&D fund in total funds in annual budget	26	9	7	6	4	57	54.81	2.19
	Overall Score								2.10

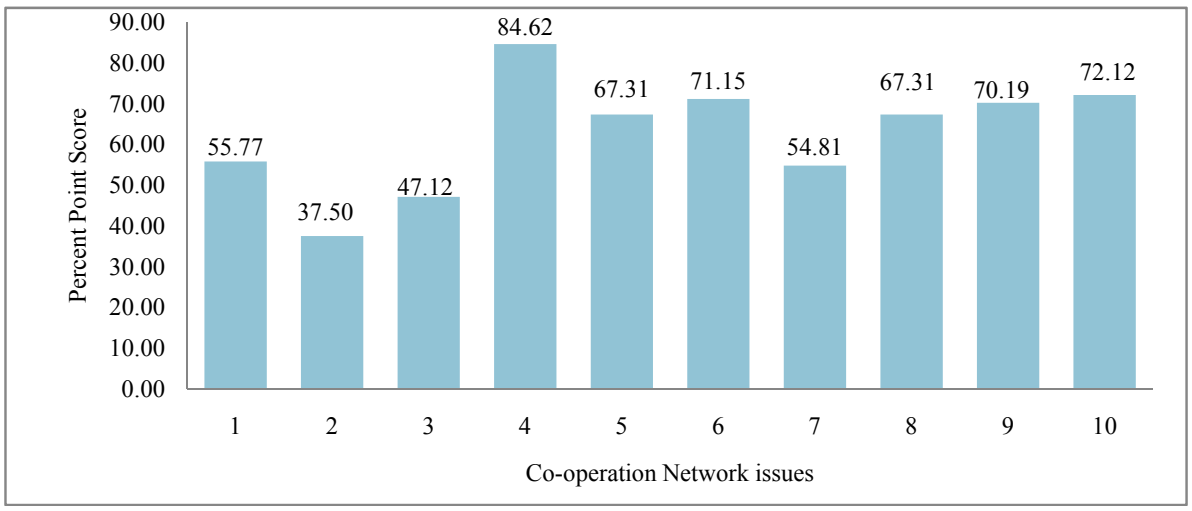

Fig. 1 Issue wise performance regarding Network

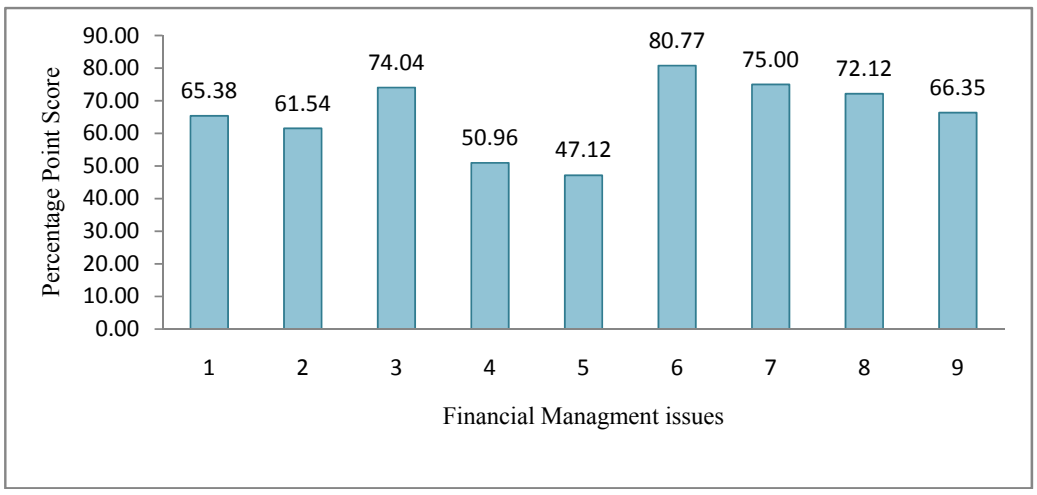

Fig. 2 Issue wise performance regarding Financial Management

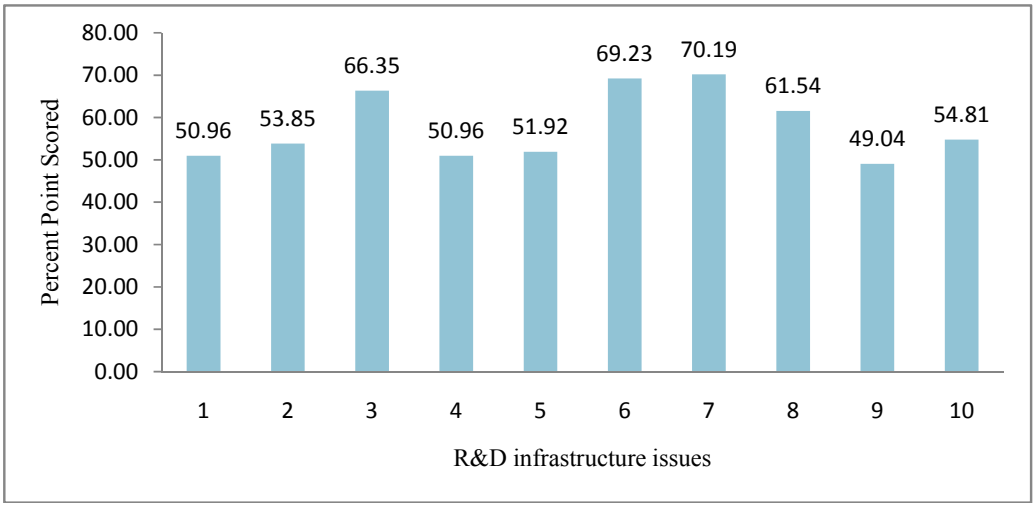

Fig. 3 Issue wise performance regarding R&D Infrastructure

A. Networks

In the response of network with suppliers the firms agreed that with supplier increase the sale performance (PPS= 84.62). Effect of government policy effect on raw material and cost of electric power in the region shows a relatively low rating (PPS= 67.31) and is considered as a major problem impairing the performance of industry. Nearly one third of the organizations consider this factor amongst the most significant reasons behind poor performance of the industry.

Manufacturing industries interact relatively low with research institutes. The industry shows unreasonably low rating, in terms of percent points scored in this issue (PPS= 47.12).

Nearly fifty percent the units have never worked in with research institutes. Universities provide latest technology, but between universities and firms is also poor (PPS= 37.50). The average score of this aspect is 2.51 (out of 4.00). With government agencies, universities, and research institutes and suppliers for technology development are critical areas needing improvement.

B. Financial Management

Financial support to the research functions is critical for the success of technology development. However, most of the organizations faces acute shortage of funds for developmental work and considers this factor as most significant in impairing the performance of industry.

Small scale industrial sector requires active support from government with regards to availability of funds for development activities, subsides, assistance in import of technologies, favorable excise duties etc. Most of the organizations consider lack of government support as the most significant factor in lowering the performance of industry.

Government has not properly involved (PPS= 65.38) in providing financial support to the industry for technology development initiatives. So almost fifty percent of firms not taken any benefit from government (PPS=47.12).

Banks consume more time to provide loans and conditions are very tough for small firms (PPS= 61.54). Also banks give loans on high rate of interest (PPS= 80.77). This is the major barriers for technology development.

C. R&D Infrastructure

Most of the organizations value the fact (PPS=50.96) that technology is the most important to up to date plant machinery and equipment. Though the industry appreciates the importance of technology as a resource for meeting competition, a lot needs to be done. Maximum numbers of industries are using old technology.

Technicians and researchers improve the productivity and quality of the product. Manufacturing industry in the region seems to overlook this fact. Organizations have shown unreasonably low rating, in terms of percent points scored in this issue (PPS= 66.35y). Organizations do not provide any formal training to the employees to enhance innovation skills.

Literature reveals that innovative organizations rely heavily on proper technical support and services to enhance creativity and innovation skills. Manufacturing industry in the region seems to overlook this fact. Organizations have shown unreasonably low rating, in terms of percent points scored in this issue (PPS=53.85).

The overall score of this aspect is 2.10 (out of 4.00). The critical analysis of this component reveals that some issues have shown very low ratings. There is an urgent need to use the research function for technology development rather than using it for solving production or maintenance problems.

Further, utilization of well defined R&D policy and strategic approaches for technology development can greatly improve the effectiveness of research function in the manufacturing organizations.

The internal reliability of items (inter-item analysis) under each input and output parameter has been assessed by using Cronbach's Alpha co-efficient, as recommended for empirical research in operations management [9]. This static measures the extent to which a set of variables are consistent in what

they are intended to measure [10]. Cronbach's Alpha values for various categories are more than 0.5, which is considered adequate for exploratory work. This indicates high reliability of data collected through the 'Technology Development Questionnaire'. Cronbach's Alpha values for key parameters are given in Table IV.

TABLE IV
CRONBACH'S ALPHA FOR KEY PARAMETERS

Parameter	Cronbach's Alpha Value
Network (I1)	0.512
Financial Management (I2)	0.533
R&D Infrastructure (I3)	0.497
Innovation Performance (O1)	0.537
Sale performance (O2)	0.502

TABLE V
PEARSON'S CORRELATION AND T-TEST ANALYSIS BETWEEN 'TECHNOLOGY DEVELOPMENT INPUT FACTORS' AND 'DEVELOPMENT INDICATORS OUTPUT FACTORS'

Technology Development (input parameter)		Development Indicators (Output Parameters)	
		Innovation Performance (O1)	Sales Performance (O2)
Network (I1)	r	0.41	0.48
	t(p)	2.17(0.040)	2.68(0.0131)
Financial Management (I2)	r	0.114	-0.0314
	t(p)	0.56(0.579)	-0.154 (0.879)
R&D Infrastructure (I3)	r	0.567	0.393
	t(p)	3.376(0.0025)	2.097(0.046)

TABLE VI
MULTIPLE REGRESSION ANALYSIS BETWEEN 'TECHNOLOGY DEVELOPMENT INPUT FACTORS' AND 'DEVELOPMENT INDICATORS'

Development indicators	Significance factors	Beta value (β)	F value	R value
O1	I1	0.2302	5.949	0.447
	I3	0.5011		
O2	I1	0.3046	3.992	0.352

D. Correlation between Technology Development Input Factors and Development Indicators

Pearson correlation coefficient is utilized to measure the relationship among research variables. It can be used to determine both the direction and strength of the relationship between two variables. For this, Pearson's correlation coefficient values (r values) between each input factor and the 'Development Indicators' (output parameters) have been calculated. The correlation values obtained have been further validated and authenticated using statistical tools like t-Test and Multiple Regression analysis.

Table V depicts the Pearson's correlations, t-values and significance levels (p-values) for pairs of interrelationships of various 'Technology Development Input Factors' with 'Development Indicators'. Table VI depicts the values for regression analysis between 'Technology Development Input Factors' and 'Development Indicators'.

With reference to (1), the t-values can also be worked out through empirical expression.

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \geq t_{n-2} \text{ (from 't' Tables)} \qquad (1)$$

where, '*n*-2' represents degrees of freedom (df) for a particular test, 'r' represents Pearson's correlation coefficient between a particular input factor and an output parameter, t_{n-2} is the $t_{Critical}$ value from statistical 't' tables for (n – 2) degrees of freedom.

The results of t test can be used to identify the input parameters (Technology Development Input Factors) which have a significant contribution towards realization of performance improvements in the organizations. The '$t_{Critical}$' value for the confidence limits corresponding to 'n-2' (= 24) degrees of freedom and significance level of 5 percent (from statistical t-tables) works out to be 2.064. So, pairs with t-value greater than or equal to 2.064 are considered as having a significant association.

Finally, the inter-relationships between significant 'Technology development Input Factors' and 'Development Indicators' have been validated through multiple regression analysis as depicted in Table VI. The notations employed in this test include: β= Regression Coefficient (Beta Coefficient), R= Multiple Correlation Coefficient. The results of the analysis imply that there is a strong association of several input parameters with output parameters.

III. DISCUSSION OF RESULTS

The present research provides an empirical evidence of a significant relationship between various Technology Development Input Factors and Development Indicators output factor. The critical examination of Pearson's correlations and t-test results shows that Network (I1) issues are significantly associated with level of Innovation Performance (O1) in small scale organization as shown in Table V. Innovation activity is enhanced, and depends upon, cooperation with other organizations, has become more and more important to the success of industrial innovation for most countries. Collaboration between industry and academia should be enhanced to improve the innovation capability [11]-[14].

It has been observed that Network issues (I1) affect the Sales Performance (O2) in organizations. Networks are increasingly important for firms to survive in competitive markets [15].

R&D Infrastructure (I3) is the third input factor of Technology Development characteristics in manufacturing enterprises. Result shows that Innovation Performance (O1) is affected by R&D Infrastructure (I3) issues up to large extent as indicated by the Pearson's correlation value (0.567) in Table V.

Multiple Regression analysis between 'Technology Development' Input factors and 'Development Indicators' shows results when all the three inputs are combined together and their collective effect is examined both on the performance indicators. The Innovation Performance (O1) and Sales performance (O2) are depending upon the Network (I1). The significance value (F) shows this relationship at 95% level of significance. Innovation performance (O1) is dependent upon R&D Infrastructure as shown by result in Table VI by the (F) value which is coming out to be significant.

IV. Conclusions

Increasing global competition with continuously changing technology, and shortening of product life cycles, has made corporations vulnerable to failure more than any time in the past. These formidable changes have forced MSMEs to failure more than any time in the past. Technology has a major impact on every organization. MSME's face many of the same competitive problems as larger organizations, but have limited resources, experience and staffing skills to tackle these problems. The present work studies three key input factors and two output factor for overall assessment of technology development initiatives and development indicators in manufacturing industries. These include input factors as *Networks, Financial Management* and *R&D Infrastructure* for technology development and output factors as *Innovation Performance* and *Sales Performance.*

The main conclusions of this study are described as follows:

1. Manufacturing industries are not interacting with universities and research institutes for training the employees, improvement in the products and upgrading the knowledge to improve the performance. 71% of industries in the region never interact with universities.
2. Taxes effect the growth of manufacturing industries in the region. 68% of industries agree that the taxes set by government are too high. So, this is the major barrier to the growth of manufacturing industries. Government provides lack of facilities to manufacturing industries like subsides, relief in taxes, relaxation in power supply bills etc. This has shown a response rate of (PPS=49).
3. 55% of industries in the region have not upgraded the plant machinery and equipment. Due to this they are failing to upgrade technology in the competitive environment which leads to their poor performance.
4. The level of Innovation Performance in firms (O1) has shown significant correlation with Networks (I1) and R&D Infrastructure (I3).
5. The results reveal that Sales Performance (O2) mainly achieved through availability of Networks (I1).
6. The area such as up to date plant machinery and equipment, no. of researcher and technician, percentage of R&D funds in total funds, government policies and facilities and internal financial resources are critical and needing improvement. The performance of manufacturing industry in developing technology through cooperation networks with universities and research institutes is below desired levels.

Finally, it can be said that if technology development initiatives implemented successfully in organizations, it can lead manufacturing industries to attain new levels of achievements in technological development thereby improving their manufacturing performance.

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