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Japanese Manufacturing Techniques and Practices: An Indian Perspective

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Abstract

With rapid advancement in technology and availability of workforce at reasonable wages, India is becoming a preferred location for manufacturing companies from all over the world. The manufacturing sector in India has witnessed a growth of about 15 percent during the year 2007. Japanese techniques like kaizen, quality circles, total productive maintenance, and just-in-time, etc. have been implemented worldwide by various manufacturing organizations to improve their performance and competitiveness. The extent of success achieved has, however, been influenced significantly by the structure and culture of the organization concerned and the country as well. The present article attempts to study the experiences of a few selected Indian manufacturing organizations, operating in and around New Delhi region, regarding the implementation and adaptability of popular Japanese manufacturing techniques and practices. A structured questionnaire containing both open and close-ended questions is used for data collection. The results are obtained using descriptive analysis, hypothesis testing, and correlation analysis. Though implementation of Japanese manufacturing techniques and practices (JMTPs) has resulted in improvement of various production-related dimensions and other benefits, there is still a need to understand how to harbor such techniques and practices for the long-term growth and benefit of the organizations on the whole.

Keywords: Indian Manufacturing; Japanese Manufacturing Techniques and Practices; Productivity; Competitiveness.

1. Introduction

Manufacturing plays an important role in the economy of every nation. In India, manufacturing accounts for about 17% of the GDP and 12% of employment. Indian manufacturing sector shares three-fourths of all exports from India [1]. There has been a growth of around 15 percent in this sector in the year 2007. Product and process innovations, technological developments, improved managerial skills, and the availability of low cost workforce are the potential competitive capabilities of India's manufacturing. There are, however, several other aspects, which the country needs to address in order to improve its competitiveness in the global manufacturing scenario. Industries all over the world have been focusing on the technological and managerial dimensions of their operations to improve their performance and competitiveness.

Apart from such tools and techniques, Japan has conceived and evolved many other techniques and practices for improving the organizations' performance and competitiveness. Kaizen (continuous improvement), just-in-time (kanban), quality circles, total productive maintenance, poka-yoke, zero defects, and cellular manufacturing, etc. are among those techniques and practices that have been adapted by industries, particularly manufacturing ones, in various developed and developing countries. The culture of the organization concerned and that of the country, however, have a strong bearing on the extent to which these Japanese manufacturing techniques and practices (JMTPs) make their impact as desired. Ford and Honeycutt [2], in a comprehensive article, have discussed the relevance of the culture of a country in understanding the country's business practices. They have also established that corporate culture is company-specific, and therefore generalization of any company-specific observations can be misleading. It is, perhaps, for this reason why researchers have been addressing issues like adoption, implementation, and effectiveness of various Japanese techniques and management practices in the manufacturing sector of different countries. Examples of such studies include that in the USA, Singapore, Korea, and Scotland [3-6].

The Indian manufacturing ranks 2nd, just after Japanese manufacturing, in terms of Deming awards per country. There are about 13 companies that have won this award and many others are ISO-9000 certified [7]. Till the last couple of years of the 20th century, however, practices like statistical process control (SPC), total quality management (TQM), just-in-time (JIT), total productive maintenance (TPM), cellular manufacturing, and continuous improvement either failed to serve their purposes in the

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Indian manufacturing organizations or to even receive any attention from this sector [8].

In this context, and as inspired by the findings like that of Ford and Honeycutt [2], the authors have made an attempt to study the present scenario of Indian manufacturing with reference to the implementation and effectiveness of some popular Japanese manufacturing techniques and practices. This has further helped the authors assess the adaptability of these techniques and practices in the Indian context.

2. Some Previous Studies

This section explains briefly the Japanese manufacturing techniques and practices under study and presents a brief overview relevant literature. *Kaizen (KZN)* is based on making small changes on a regular basis - reducing waste and continuously improving productivity, safety, and effectiveness. While Kaizen has historically been applied in manufacturing settings, it is now becoming common to find it applied to service business processes as well [9, 10].

The basic principle of *Just-in-Time (JIT)* is to eliminate all forms of waste, and is defined as anything that does not add value to the product [11]. JIT applies primarily to repetitive manufacturing. Research has shown that successful implementation of the JIT philosophy can produce significant benefits for manufacturing firms such as improving quality, minimizing levels of inventory, improving relationships with suppliers [12], reducing the labour turnover rate, reducing manufacturing lead times, reducing set-up time [13], reducing operations and materials handling costs, and maximizing the use of space [14].

Quality Circle (QC) is a management tool that has many benefits for various work environments such as control and improvement of quality, more effective company communication, utilization of employees' problem solving capabilities, and more job involvement. Literature presents numerous studies such as those by Park [15] and Mandal *et al.* [16], on quality circles and other quality related practices. Better quality and enhanced productivity have been among the major benefits of practicing QCs. *Total Productive Maintenance (TPM)* is a manufacturing program designed primarily to maximize the effectiveness of equipment throughout its entire life by the participation and motivation of the entire workforce. The benefits from implementing TPM have been well documented at numerous plants. TPM management brings everyone, from equipment designer to operators, together to work under an autonomous and small group environment [17].

The *5-S* Philosophy focuses on effective work place organization and standardized work procedures. 5-S simplifies work environment and reduces waste and non-value activity while improving quality, efficiency and safety. The five Ss in the Japanese language are Seiri (sort), Seiton (set-in-order), Seiso (shine), Seiketsu (standardize), and Shitsuke (sustain). *Single Minute Exchange of Dies (SMED)* is an approach to reduce the loss of output quantity and quality that occurs due to changeovers and set-up activities. The method has been developed in Japan by Shigeo Shingo and has proven its effectiveness in many companies by reducing changeover times from hours to minutes.

The Japanese concept *Poka-yoke (PKYK)*, mistake-proofing, is oriented towards both finding and correcting problems as close to the source as possible. There are six mistake-proofing principles or methods, namely, elimination, replacement, prevention, facilitation, detection, and mitigation. Process improvement is among the major outcomes of poka-yoke implementation [18]. *Zero Defect (ZD)* method endorses continuous improvement. The ZDs' objectives are limited to quality improvement, whereas, QCs aim at improvement in quality, methods, morale, and motivation. The focus of ZD programs is to produce as little defectives as possible, theoretically no defectives.

A *Work Improvement Team (WIT)* is formed to improve the work processes in an organization. There are multiple reasons, anything from improving quality of products to that of processes or systems, etc., for which an organization chooses to implement WITs. *Cellular Manufacturing (CM)* is a philosophy that attempts to recognize and exploit similarities among components to be manufactured and to group them into families based on these similarities in shapes, production processes, or on both [19]. Comprehensive reviews of different cell design approaches and their features are presented by several researchers including that by Mansouri *et al.* [20].

3. Objectives and Methodology

Manufacturing covers a large variety of operations and products and hence a huge number of organizations. Many organizations, out of this population, use one or more JMTPs. Since these organizations are scattered all over the country, and also a true sampling frame of such organizations was not available, judgmental sampling method has been used to draw the sample with the help of personal references of the authors and the professional bodies in the country like CII and ASSOCHAM. Presuming that larger organizations can provide us with more useful data, annual turnover was chosen as the criterion to select the sample companies. Manufacturing organizations with an annual turnover of Rs. 1 billion (US$ 20 million) and above are included in the study. Moreover, administrative and other limitations, like that of time and cost, restrict the scope of this study to the regions in and around New Delhi. A preliminary survey was also conducted to finalize the list of the JMTPs to be included in the study. Data availability has been the major criterion for this selection. Non-inclusion of the JMTPs that are left out of the study does not seem to affect the validity and reliability of the findings, as previous researchers too have not necessarily considered all of them together.

This study aims to determine (i) the implementation status of JMTPs and their effectiveness, (ii) the relative importance of various triggers, facilitators, barriers, outputs, and benefits and also their effect on JMTPs effectiveness, (iii) the effect of those triggers, facilitators, and barriers along with the stage of JMTPs development on the benefits and outputs, (iv) the correlation among the various variables of the study, and (v) adaptability of JMTPs in the Indian context. A structured questionnaire, consisting of 15 items, was designed to collect data. The

questionnaire, along with a brief write up was sent to the executives of 170 companies, selected through the above-mentioned procedure and criteria. With a low response rate of about 32 percent, 54 completed questionnaires were received back and of them, 35 were found valid. The results are obtained by using descriptive analysis, multiple regression method to test hypotheses, and coefficient of correlation. Percentage in fraction has been rounded off to the nearest number while analyzing the data.

4. Analysis and Findings

The first three questions in the questionnaire deal with the profile of the organizations. Next six questions are designed to collect data on the JMTPs and their implementation and effectiveness. Another set of questions (10-14) has been used for gathering information on variables like triggers, facilitators, barriers, benefits, and outputs. The last question invites opinions of the respondents on adaptation of JMTPs in the Indian context.

4.1. Organizations Profile

According to the number of employees, the sample organizations can be classified into three classes - those employing less than 2500 employees (54%), 2500-4999 (32%), and those with 5000 or more employees (14%). The annual turnover-wise distribution of the organizations exhibit that the majority (37%) have annual turnovers of Rs. 10 billion or above, 11% each with Rs. 7.5-10 billion and Rs. 5-7.5 billion, 18% with Rs. 2.5-5 billion, and the annual turnover of the remaining 23% has been Rs. 10-25 million. This pattern could have emerged possibly due to the fact that organizations that have more resources at their disposal are more flexible in experimenting with techniques and practices other than traditional ones. Nearly two-thirds of the organizations (66%) have reported that they have a joint venture with at least one foreign company. This figure may be interpreted as an indication that foreign tie-ups could be one of the reasons for which organizations adopt a JMTP to align themselves with the best global practices, as also to compete with their global players. The foreign partners belong to the countries like France, Japan, Germany, USA, and UK. The organizations having just 1-2 years old joint venture with any foreign country, and those with no such tie-ups account for 43% (15 out of 35). Around 35% have been operating jointly with a foreign company for over 10 years. The age of the joint venture for 14% of the companies has been between 3-5 years, and that of the remaining 8% is 6-10 years.

4.2. Implementation and Effectiveness of JMTPs

Table 1 presents the distribution of the organizations implementing various JMTPs, the length of implementation, the stage of development, and the effectiveness (in terms of mean score) of each JMTP. The findings reveal that 5-S and KZN have been implemented in most of the organizations, followed by WITS, QCs, TPM, and JIT. PKYK and SMED are, however, rarely adopted by Indian manufacturers. A survey of 34 industries conducted in 2002 by Kumar and Garg [21] has reported a positive attitude of around 60 percent of the respondents towards JIT implementation. A recent study [22] on JIT practices in Indian manufacturing concludes that the art of designing the right strategy for implementing JIT is still debatable. 5–S, being oriented towards a healthy work atmosphere and based on behavioral changes, rather than physical ones, has been relatively inexpensive to implement than other JMTPs. Rane *et al.* [23] has found companies, particularly in automobile sector, using 5S effectively as a stepping-stone for JIT implementation. The low usage of SMED may be attributed to the nature of business under which most of the Indian companies operate where, unless the production limits of the company are stretched beyond compliance, the targets necessitate faster changeovers of machinery and production setup. Thus, SMED was not found suitable.

This can been observed from Table 1 that almost in each case the majority of organizations had been practicing the JMTP for over two years (at the time of data collection). Moreover, most of the JMTPs in use, except ZD, PKYK, and SMED, are found in their well-developed stage of implementation. While investigating the respondent's understanding of the various stages of implementing JMTPs, their explanation was that a well-developed stage is achieved when the practice has been totally internalized or institutionalized, which means even the shop floor workers know and practice the JMTP in question.

As far as the effectiveness of these techniques is concerned, Kaizen was rated as the most effective technique with mean as 4.27 followed by 5-S (3.65). Besides these, JMTPs that were found to obtain scores above the median were TPM (2.78), WITs (2.56) and QCs (2.51). The respondents were asked to explain the factors they took into account when assessing the effectiveness of JMTPs. A clear-cut response format was not found due to the complexities involved in measuring the intangible benefits of JMTPs. Number of people participating in the JMTP, monetary benefits like cost cutting, material consumption, productivity, lead-time and output, and change in work culture like employees becoming more customer-oriented and taking on more responsibilities were, however, found as the key considerations. The most ineffective techniques among all the JMTPs under study are CM and JIT. A possible reason for low implementation & effectiveness of JIT could be that many of the suppliers of the organizations in question are small-scale firms, and they do not have the capability and resources to match the strict requirements laid down by JIT.

The findings also indicate that a given JMTP does not necessarily score high on the effectiveness scale despite it being well-developed. For example, the practice of QCs has been developed well in 73 percent of the organizations implementing it as against 66 percent in the case of Kaizen and 5-S. QCs however, have not been as effective as Kaizen and 5-S.

Effectiveness being an important resulting parameter of JMTP implementation, a null hypothesis (H01) was formed to investigate the statistical relationship, if any, between the effectiveness of a JMTP and the combined effect of four relevant independent variables. These variables are stages of development of the JMTPs, annual turnover, facilitators to JMTPs implementation, and the size of the organization (number of employees). The null hypothesis was stated as "the coefficient of multiple determination in the population is zero". This is equivalent

Table 1. Implementation and Effectiveness of JMTPs.

JMTP	No. of Orgns.	Length of Implementation			Stage of Development			Effectiveness Score
		Up to 1 year	1 – 2 years	Over 2 years	Well developed	Growth	Introductory	
KZN	29 (83%)	5 (18%)	3 (10%)	21 (72%)	19 (66%)	8 (28%)	2 (6%)	4.27
JIT	16 (46%)	3 (19%)	2 (12%)	11 (69%)	9 (56%)	6 (38%)	1 (6%)	1.91
QCS	22 (63%)	3 (14%)	2 (9%)	17 (77%)	16 (73%)	5 (23%)	1 (4%)	2.51
TPM	19 (54%)	4 (21%)	2 (11%)	13 (68%)	8 (39%)	9 (50%)	2 (11%)	2.78
5-S	32 (91%)	3 (9%)	6 (19%)	23 (72%)	21 (66%)	7 (22%)	4 (12%)	3.65
SMED	7 (20%)	NIL	2 (29%)	5 (71%)	1 (20%)	6 (80%)	NIL	1.10
PKYK	11 (31%)	1 (9%)	2 (18%)	8 (73%)	7 (64%)	3 (27%)	1 (9%)	1.65
ZDS	13 (37%)	3 (23%)	3 (23%)	7 (54%)	5 (38%)	7 (54%)	1 (8%)	1.32
WITS	24 (69%)	3 (13%)	3 (13%)	18 (74%)	17 (68%)	7 (32%)	NIL	2.56
CM	13 (37%)	4 (30%)	1 (8%)	8 (62%)	7 (54%)	5 (38%)	1 (8%)	1.20

For abbreviations pl refer to section 2.

Table 2. Statistical Tables.

Statistic	$H_0 1$		$H_0 2$		$H_0 3$	
Multiple regression						
Multiple R	0.297		0.328		0.363	
R^2	0.088		0.108		0.131	
Adjusted R^2	-0.033		0.021		0.016	
Std. Error	1.0908		0.661		0.299	
F test	Reg	Res	Reg	Res	Reg	Res
D.o.f.	4	30	4	30	4	30
Sum of sqs	3.457	35.696	1.633	13.529	0.405	2.678
Mean sq	0.864	1.190	0.544	0.436	0.101	0.089

to saying that the coefficient of each independent variable in the multiple regression equation is equal to zero.

The hypothesis is tested using multiple regression and F statistics. At 5% level of significance, the hypothesis is found statistically accepted (Table 2). This means the overall effect of the four independent variables on the effectiveness of JMTPs is insignificant. This might have happened due to either insufficient data or the fact that the overall culture of an organization matters a lot in how JMTPs perform.

4.3. Triggers, Facilitators, Barriers, Outputs, and Benefits

Triggers of any process are the factors responsible for its initiation. The major factors that have been considered important, based on this study and as extracted from the literature, for the initiation of various JMTPs include the need (a) to reduce manufacturing cycle time, production cost, waste, and inventory, and (b) to improve on production flexibility, size of the organization, and market share. Initiatives were also taken to implement JMTPs, as this was insisted by the customers or by the presence of a joint venture with a foreign company, particularly from Japan. The need to reduce waste, production cost, and inventory has scored high (mean scores as 4.48, 4.22 and 4, respectively) on a 5-point scale of importance. Whereas, presence of a joint venture, concern over declining market share, and customers' insistence were rated on the lower side of the scale with mean scores as 2.58, 2.48, and 2.29, respectively. The aim of reducing manufacturing cycle time, enhancing production flexibility, or right sizing an organization, has played an important role in JMTPs implementation, but scoring only between 4 and 3 on the scale.

Eight factors were considered as facilitators in the implementation of various JMTPs. In order of their increasing importance (on a 5-point scale), the factors are incentives given to employees, organizational structure, linking business goals to JMTPs, organizational and individual discipline, internal & external benchmarking, top management initiatives, effective communication, and training programs.

The respondents were found reluctant in mentioning barriers to JMTPs implementation. This hesitation can be understood because identification of any such factor may reflect some negative aspects of their organization's policies. Five factors are, however, considered by them as barriers to JMTPs implementation. Resistance from

employees and lack of expertise have emerged out as the two most obstructing factors with their respective mean scores as 2.32 and 2.12 on a 5-point rating scale. The other barriers that have been found relatively less influential are changes required in the organizational structure (2.03), perceived cost of implementation (1.97), and lack of commitment at the top management level (1.90). Literature reports several barriers in JMTP adoption in India. For example, regarding implementation of TPM in the Indian context, a study [24] finds TPM by no means an easy task as a variety of internal and external barriers exist.

Outcomes of JMTPs implementation have been measured in the form of production-related outputs (more of quantitative nature) and benefits (more of qualitative nature). Figure 1 presents the mean score of each output, as obtained through the responses measured on a 5-point scale. Inventory levels, overtime requirements, raw materials consumption, maintenance costs, workforce requirements, and manufacturing cycle time have decreased marginally or significantly as a result of using one or more JMTPs. On the other hand, JMTPs have resulted in the improvement of product quality, on-time deliveries, and output per shift. A worldwide scenario of Japanese production and manufacturing techniques has been presented by Blakemore [25], and is supporting the findings of this study. Higher quality levels, lower costs and shorter production times are highlighted as the major outcomes of implementing such techniques all over, including the countries like USA, France, Australia, China and Germany.

The respondents were also asked to show their degree of agreement on a similar 5-point Likert scale with the statements regarding the benefits of the JMTPs being practiced in their organizations. The results indicate that organizations have experienced improvement in team coordination, employees efficiency, employees ability to take initiatives, work culture, sense of responsibility among the employees, employees motivation and morale, quality consciousness, customer-orientation, profit margin, and market share. Employee turnover, absenteeism, and number of complaints from the customers were found decreasing in the organizations practicing one or more JMTPs (Figure 2).

Factors responsible for taking an initiative to implement a JMTP and for facilitating or obstructing this implementation may be diverse for different organizations, but each organization looks forward to many returns as possible. It is quite rational to assume that such factors have some effect on how productive and beneficial a JMTP is. Statistical investigation to this effect, therefore, seems to be justified at this juncture. Two null hypotheses regarding outputs and benefits, $H_0 2$ and $H_0 3$ respectively, were formulated and tested on the same lines, as was done for $H_0 1$. The combined effect of the facilitators, triggers, barriers, and stage of development is examined on the outputs and benefits separately, using multiple regression and F statistic. It is found that the combined effect of the four variables on the outputs and the benefits are statistically insignificant (Table 2). The results, however, do not appear to be in line with a non-statistically assumed relationship among such variables. Apart from the inadequacy of data, leaving many other variables out of the study may have a significant bearing on these results. Organization culture, the manner in which a JMTP is implemented, and whether an organization is public, private, national, or multinational, are examples of those variables.

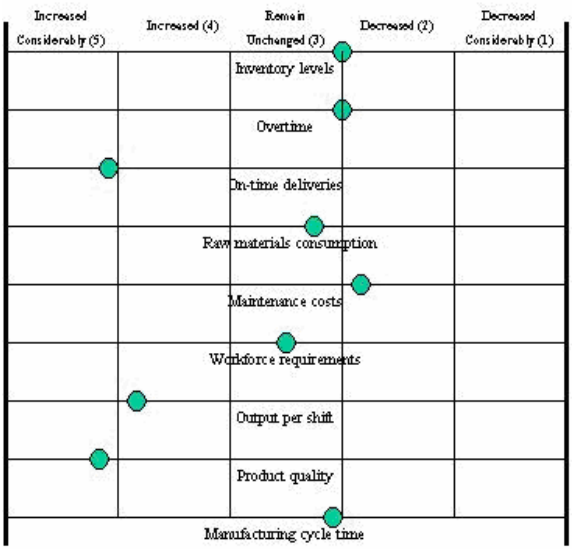

Figure 1. Responses on output.

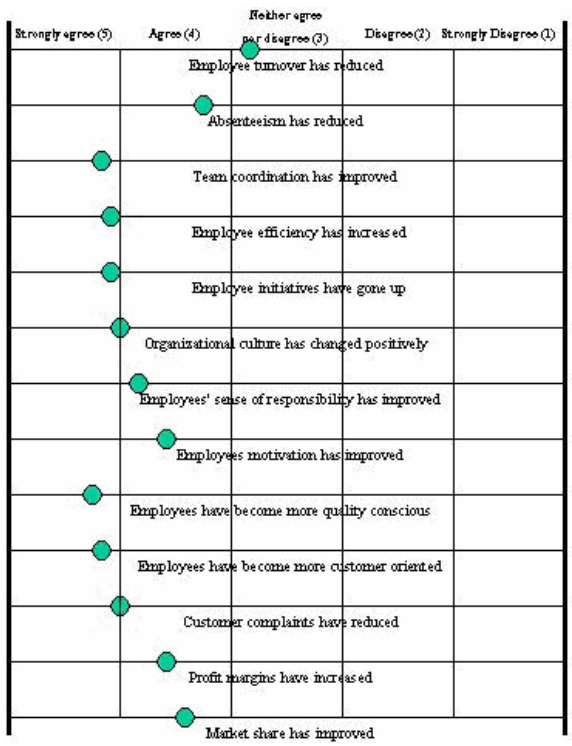

Figure 2. Responses on benefits.

4.4. Correlations

Finally, a correlation analysis is conducted to determine the mutual relationships and their directions among the variables involved in the study. Triggers, facilitators, barriers, effectiveness, outputs, benefits, stage of development, age of the joint venture, annual turnover, and size of the organization have been considered for this part of the analysis. At 5 % or better level of significance, only three relationships were found significant. These relationships are between benefits and outputs (0.417, $p<0.05$); age of joint venture and stage of development

(0.499, $p<0.01$); and annual turnover and barriers (0.467, $p<0.01$). A significant positive correlation between the outputs and benefits of JMTPs seems to be justified, as these variables are, in fact, two different forms of the results that an organization achieves through implementation of JMTPs.

Age of the joint venture in an organization and the stage of development of the JMTPs implemented there are also found to co-vary in the same direction. Reasoning behind this relationship may be that a foreign partner, which has already reaped the benefits of JMTPs in its home country, attempts to inculcate the same culture in the Indian company, too. However, in the section that deals with triggers, it was revealed that a joint venture with a foreign company has not been a major factor responsible for JMTPs implementation in the Indian companies. These two findings related to a possible relationship between the presence of a joint venture and JMTPs effectiveness reflect some contradiction. The importance of a joint venture was measured along with eight other factors. So it is possible that this factor scores relatively lower than some others on the importance scale. This argument is supposed to remove the element of contradiction referred above.

Annual turnover of an organization and barriers to JMTPs implementation are surprisingly found correlated and that too with a +ve sign. Apparently, going for a JMTP, even on an experimental basis, is easier for a company with a high turnover as it can safely absorb adverse (financial) results, if any. On the other hand, three out of the five barriers identified in this study, namely, resistance from employees, lack of commitment at the top level, and fear of organizational changes, might be more dominating as barriers in companies with high turnover. If this is true, it may be accepted that the higher the annual turnover the stronger are the obstructions in JMTPs adaptation.

5. Conclusions

The manufacturing sector is so vast and diversified that the findings of any study, based on a small sample and with the inclusion of only a limited number of variables, cannot be safely generalized for the whole sector. This study also has a limited scope of application for the same reasons. It is, however, believed that the findings of this study shall be useful as suggestive guidelines for those manufacturing organizations in the country that are planning to implement Japanese manufacturing techniques and practices in order to enhance their productivity and improve competitiveness. The major findings are listed below.

- 5-S is the most widely used techniques followed by Kaizen. Effectiveness-wise, it is the other way round. JIT and CM are on the lower end of the effectiveness scale.
- The need to reduce waste, production cost, and inventory has triggered the implementation of JMTPs in most of the cases.
- Resistance from employees and lack of expertise have emerged out as the major barriers to JMTPs implementation, whereas training programs and effective communication channels have facilitated the implementation process most.
- Improved product quality, increased on-time deliveries, and reduced inventory levels have been the major outputs of JMTPs implementation. Team spirit, quality consciousness, and attitude towards work have also improved.
- The combined effect of the stage of development, annual turnover, facilitators, and size of the organization on effectiveness of a JMTP are insignificant.
- The facilitators, triggers, barriers, and stage of development combined together do not make any significant effect on the outputs and benefits of JMTPs.
- The correlations between benefits and outputs; age of joint venture and stage of development; annual turnover and barriers are found positive and significant.

Based on the analysis and interpretation of the data, this may be concluded that achieving successful implementation of Japanese techniques and practices is not an issue for Indian manufacturing. The issue is, however, how to harbor such practices for the long-term growth and benefit of the organizations on the whole. The study, therefore, recommends that organizations intending to go for any JMTP should first understand the need to use that JMTP and its application, prepare for its adaptation, and then identify the ways and measures required for its successful implementation.

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