CHAPTER – 7 CONCLUSIONS, LIMITATIONS AND SCOPE FOR FUTURE WORK

Indian manufacturing industry has witnessed irrepressible competition in the recent times in terms of low costs, improved quality and diverse products with superior performance. Indian entrepreneurs have now understood that to meet the challenges posed by the competitive environment, the manufacturing organizations must infuse quality and maintenance improvement initiatives in all aspects of their processes to improve their competitiveness. Out of various lean manufacturing practices Just in Time (JIT) manufacturing is such popular initiatives employed by the manufacturing organizations in synergy as Organizational Performance Improvement Techniques.

JIT accelerates the benefits of continuous improvement activities within any manufacturing environment by challenging inefficient working practices, realizing true potential of workforce, targeting effectiveness and making processes work as planned. Indian manufacturing organizations have moved ahead aggressively by developing and adapting proactive JIT practices for overcoming inherent deficiencies in manufacturing systems for harnessing distinct competencies in comparison to their global competitors. In the quest for achieving manufacturing excellence through quality and as well as maintenance improvement initiatives, leading Indian entrepreneurs have made sincere efforts to adopt these practices in last one decade. Though, due to inactive organizational approaches and colonial roots of manufacturing environment, Indian entrepreneurs have faced difficulties and road blocks in effectively adapting to JIT principles.

7.1 Conclusions and Findings from the Research

The study is aimed at identifying the barriers of JIT implementations for evaluating the challenges, being faced by the Indian manufacturing organizations in order to adapt these proactive JIT drives. The study also critically examine the factors affecting the implementation of these drives and then devise various critical success factors for overcoming the obstacles for successful implementation of JIT in the Indian manufacturing industry. Moreover, the study illustrates how the synergistic relationship of JIT Paradigms can be helpful for Indian Manufacturing Industries to have overall
business performance, through a specially designed JIT Questionnaire. The major objective of this research is to examine, how effectiveness is the support of JIT contribution in improving business performance. Lastly the research culminates with presenting critical success factors for strategic JIT implementation for Indian Manufacturing industries.

The conclusions drawn from research work have been highlighted below:

a. The research provides an insight into exploits of Indian entrepreneurs regarding JIT initiatives and provides an assessment of prevailing status of Indian entrepreneurs regarding practices like Organizational Structure, Policies; General Quality and Maintenance practices and TPM practices, Quality etc.

b. The analysis of various issues reveal that most of the organizations have generally scored quite high rating (percent point scored ‘PPS’) regarding major Inventory related issues. It is observed from data that every product has well defined manufacturing and inventory deployment strategy with a significant PPS of 75.42. The data reveals that organizations lay more stress on work in process inventory management with a high PPS of 78.33, whereas raw material inventory has been found to be managed poorly with mediocre PPS of 58.33. Thus Indian organizations need to lay more stress on raw material/ component inventory management for reaping more benefits through JIT implementation.

c. In this study, organization culture, management commitment, employee’s involvement and work place organization issues have been abbreviated as A1. The close analysis of different issues related to various organizations reveals that most of the organizations have generally scored quite high rating (percent point scored ‘PPS’) regarding A1 issues. The PPS score of organization ranges from 69% to 90%. It clearly shows that organizations have shown commitment towards culture management, employee’s involvement and work place organization, for effectively adopting JIT initiatives at workplace. The data reveals that autonomous work teams, problem solving groups and quality circle need more attention in the
organizations. The organization can gain significant benefits from JIT if the above issues are taken care of and implemented more holistically.

d. JIT purchasing plays an important role in implementing JIT. The study highlights that most of the companies have implemented JIT Purchasing issues very effectively as PPS score ranges from 69% to 92% and most of the JIT Purchasing issues have scored more than 72%. It has been observed that selection criteria of suppliers in terms of location, delivery compliance and quality has obtained a high score (PPS) of 92.08, long term association (more than 4 years) with suppliers has obtained a high score (PPS) of 91.66, optimised delivery lead time (1 day to 7 days) has obtained a high score (PPS) of 81.25, number of delays from suppliers (less than 3 in a year) a high score (PPS) of 82.92. While the suppliers link with Pull Kanban system has obtained a mediocre score (PPS) of 69.17, which needs some attention while implementing JIT.

e. Regarding the performance of manufacturing organizations related to various issues related to product and manufacturing flexibility and layout, the data reveals that most of the organization have shown reasonably acceptable performance. The organizations have focussed and effectively deployed various JIT strategies by showing successful adaptation of various JIT implementation issues like cellular manufacturing (PPS 79.17), close proximity of products and facilities (PPS 83.34), continuous flow of product from raw material to finished goods (PPS 82.5), flexibility in manufacturing (PPS 77.92), design of manufacturing system in such a way to expand it easily (PPS 78.75), minimum movement of men, machine and materials (PPS 77.5), low inventory and fast throughput (PPS 81.67), leveled production (PPS 77.5). The proves that issue A3 is implemented with great success in the organizations.

f. The analysis of various issues related to production system and process control, kanban and pull production, set up time and quality (A4) shows that most of the organizations have scored reasonable rating regarding most of these issues, since most of the organizations have scored PPS more than 70% for most of the issues related to Production System and Process Control,
Kanban and Pull Production, Set-Up Time, Quality. Thus, it is evident that most of organizations have appropriately implemented Production System and Process Control, Kanban and Pull Production, Set-Up Time, Quality issues at the workplace. But, the data also reveals some immediate areas of concern too, which need serious consideration. These areas include Kanban implementation issues (PPS-66.25), automation of loading and unloading of parts (PPS 63.75), CAD / CAM / Robotics implementation issues (PPS-67.5).

g. The analysis of daily schedule adherence, maintenance management, and distribution and transportation (A5) issues depict that most of the organizations have scored more than 70% PPS regarding most of the issues covered under A5. This depicts that issue A5 is well taken care by most of the organizations with PPS range from 65 to 88.33. Thus, the organizations implementing JIT are having well planned and structured maintenance with PPS of 88.33. Preventive maintenance has also been well taken care with PPS of 82.92. The organizations also have well planned delivery system with more than 60% items delivered well in time (PPS 82.5). Whereas organizations implementing JIT need to look after more effectively outside warehouse PPS 64.58 and bar coding of containers with PPS 66.67.

h. The study highlights that the companies implementing JIT are taking care of customer’s requirements and most of the products are being produced in accordance with the customer’s orders (PPS 82.08). The data reveals that the companies are also improving product quality according to need of customers (PPS 83.75), customer’s feedback is also well taken care of with a high PPS score of 82.08 and organizations also pay attention to solve complaints of customers (PPS 80.83). Moreover, it is also observed from the data that the manufacturing organizations need to strengthen JIT implementation to improve their credibility from the customers regarding acceptability the orders without inspection (PPS 66.67) and repeat orders placed by customers (PPS 62.95).

i. The percentage point scored by performance measures due to successful implementation of strategic JIT initiatives show that manufacturing
organizations have shown significant improvement in strengthening the organizational culture and values with PPS scores range 78.17 to 82.92. Inventory levels and production also gained significantly with PPS more than 70. Figure 4.21 depicts the issue wise improvement in manufacturing performance by implementing JIT in various manufacturing organizations. Further, it is evident from Figure 4.22 from Chapter 4 that most of the manufacturing organizations have witnessed significant manufacturing performance enhancement through strategic JIT implementation, with improvement exceeding 60% in their performance. Figure 4.22 from Chapter 4 clearly shows that 20 organizations out of 60 have reported more than 80% improvement in the manufacturing performance, while 24 organization have reported more than 60% improvement in the manufacturing performance which comes out to be significant.

2. The research has highlighted contributions of various JIT implementation initiatives in Indian industry for accruing strategic benefits for meeting challenges posed by global competition. The empirical analysis has been employed in this study to investigate role of success factors of JIT in achieving significant manufacturing performance improvements in the organizations. For the purpose, various success factors, manufacturing performance parameters that have been established in the research (Figure 3.3).

The inter-relationships between success factors and manufacturing performance parameters can be used to develop an understanding of contributions of various JIT factors towards realization of organizational objectives of growth and sustainability. The manufacturing managers must be aware of existing interdependencies within the system to be able to manage strategic JIT initiatives effectively towards achieving world-class-manufacturing performance standards. The findings suggest that effective initiatives of these quality drives can significantly contribute towards improvements for competing in the highly dynamic global marketplace.

a. The analysis of survey reveals that Just in Time (JIT) initiatives have yielded considerable significant benefits to Indian manufacturing organizations in terms of enhancing the productivity, quality, equipment availability and reliability, ensuring participation of employees at all levels and aiming at long term success
through customer satisfaction, with benefits to all members of the organization and to society (Table 4.9).

b. The values of Cronbach’s Alpha for all the input and output parameters are in excess of 0.65. This indicates the significantly high reliability of data for various input and output parameters as shown in Table 4.10.

c. The validation of all the input variables (A1, A2, A3, A4, A5 and A6) and output variables (B1, B2, B3, B4, B5, B6, B7, B8, B9 and B10) has been done by Discriminant Validity Analysis. It is clear from the Table 4.11 that all the respective with-in covariance values of variances are more than the between variables covariance values. So input and output variables are further validated.

d. The detailed inter-relationships between various success factors and manufacturing performance parameters for JIT companies indicate that there is a strong correlation of A3- with B1- (0.764**), B2- (0.785**), B3- (0.743**), B4- (0.789**), B6- (0.820**), B7- (0.804**), B8 (0.852**) and B9 (0.813**). A2- found to be closely related to B1- (0.800**), B2- (0.796**), B5- (0.788**) and B10- (0.786**). A1 is related to B3- (0.694**), B4- (0.762**), B8- (0.612**) and B10- (0.681**). The input factor A4 is related to B7 (0.797**) and B8- (0.823**). A5 is related to B6- (0.692**).

e. The Canonical Correlation Analysis has been used to depict the inter-relationship between various JIT success factors and manufacturing performance. The main aim in utilizing canonical correlation analysis for data analysis is to know the relationships between a set of multiple dependent (manufacturing performance parameters) and multiple predictor variables (JIT success factors). The bivariate correlation between linear composites of the predictor (JIT success factors) and criterion variables (manufacturing performance parameters) is measured with Canonical correlation. The results obtained by applying canonical correlation analysis are shown in Table 4.14. The results shown in column 1 of Table 4.14 shows very strong and significant canonical correlation function ($\beta= 0.975$ at F statistic probability of 0.00) between the predictor set of JIT implementation dimensions and the criterion set of manufacturing performance parameters. The observations of the multivariate test statistics have also been statistically significant ($p < 0.001$). The redundancy indices are 0.666 and 0.695 for the
dependent and independent canonical variates respectively. The redundancy index indicates the amount of variance in a canonical variate explained by the other canonical variate in the canonical function.

f. The canonical loadings for predictor set of various JIT success factors (A1, A2, A3, A4, A5, A6) on the independent variate has a range from 0.765 to 0.948. The criterion set of Manufacturing Performance Parameter variates (B1, B2, B3, B4, B5, B6, B7, B8, B9, and B10) have also been found to be strongly loaded (range from 0.724 to 0.892) on the dependent variate.

g. The correlation between the individual predictor and criterion variables and their respective canonical variates is measured by Canonical correlation, and are similar in interpretation to factor loadings. Columns 3, 4, 5, 6, 7 and 8 in Table 4.14 show the results of these stability runs corresponding to the deletion of criterion variables A1, A2, A3, A4, A5, and A6 respectively. It is clear from the results in column 3 to 8 in Table 4.14 that there is a stability of the canonical loadings.

h. It has been observed from Table 4.13 that Culture of management, Employee’s involvement and Work place organization (A1) has significant effect of Supplier’s coordination and relationship (B3), Inventory levels (B4), Maintainability (B8) and quality enhancement (B10). As in JIT environment purchasing of materials play a very important role and multiple suppliers are used to purchase the material. To give a fair deal to each supplier an organization must have ethical business values and should be fair to each supplier and it must imbibe ethical values to deal with its suppliers.

i. The input factor JIT purchasing (A2) has a significant effect on output factors such as over all Organizational Achievements (B1), Firm’s Culture and Values (B2), Product Variety and Flexibility (B5) and Quality Enhancement (B10). The JIT purchasing leads to reduction in waste, increases cyclic times, quality of product got enhanced and very less and few inspections are required and good quality material will be received.

j. The factor (A3) Product and Manufacturing Flexibility, Facility Layout has exhibited significance on most of the manufacturing performance measures like
Overall Organizational Achievements (B1), Firm's Culture and Values (B2), Supplier's Coordination and Relations (B3), Inventory Levels (B4), Set-Up Time (B6), Production (B7), Maintainability of Equipment (B8), Delivery Compliance (B9) by commitment of management, workers participation, multi skill labour, quality circles, better and ethical relationship with suppliers, improving synergy between production and maintenance functions, affecting improvements in equipment reliability, providing safe work environment, ensuring better upkeep of the production facilities, improvements in operational efficiency, increased emphasis on planning and control, elimination of procedural hassles, lowering in inventory, and elimination of all kinds of wastes associated with the manufacturing system.

Further, JIT initiative A4 (Production System and Process Control, Kanban and Pull Production, Set-Up Time, Quality) has been found to be contributing effectively towards realization of Production (B7) and maintainability (B8) shows lessening in downtime of production equipment, production system stabilization, enhancement in productivity and capabilities of human resource and improvements in the manufacturing system reliability.

The results highlight that JIT implementation initiatives (A3) can contribute effectively towards improvement of set up time (B6) in the organization by affecting improvements in operational efficiency.

Further, two tailed t-test has been carried out to ascertain the effectiveness of JIT initiatives over considerable period of time. The $t$ (II/I) (Stabilizing Phase), $t$ (III/I) (Maturity Phase), $t$ (III/II) (intermediate phase between Stabilizing Phase and Maturity Phase) values, are depicted in Table 4.17. The values of various manufacturing performance improvement parameters for $t$ (II/I) phase indicates the significant realization of improvement in manufacturing performance in stabilizing phase as compare to introductory phase. Similarly $t$ (III/I) values show that maturity phases also have significant realization of manufacturing performance improvements as compare to introductory phase. The values of $t$ III/II in Table 4.17 also show that there is significant improvement in manufacturing performance during the stabilizing and maturity phase. It is thus
concluded that organizations starts reaping of JIT benefits since the implementation of JIT.

3. The research has been extended for determination of significant performance measures by using Fuzzy Based Model Simulation. The fuzzy toolbox helps developing models of complex system behaviors using simple logic rules, and then those rules are implementing in a fuzzy inference system. The study has focused on finding out significant performance measures Fuzzy Based Simulation (FBS) model. Therefore, the most important factors that affect the performance measures of any organization like percentage of JIT implementation and percentage gain in performance measure by implementing JIT are taken into account as input factors and in output following performance measures are taken into account: setup time (ST), delivery compliance (DC), inventory level (IL), firm’s culture and values (FCV), productivity (P) and quality (Q). These factors had been taken after considering the view points of JIT coordinators from different manufacturing industries.

a. Percentage of JIT implemented in the organization has remarkable effect on the performance measures of the organization. The fuzzy set rules defined for percentage JIT implemented in organization are: If the percentage JIT implemented lies between 0-25% of required value then the system is considered low, If the it lies between 25-50 % it is considered as medium or partial implemented, If the value is between 50-75%, it is considered as high and if the value is between 75-100% then it is considered as very high or fully implemented as shown in Table 6.1 and the transfer function in fuzzy format is shown in Figure 6.12.

b. Performance measures are considered as key element in determining whether or not an improvement effort in the organization will succeed. Lack of an appropriate performance measurement system could also impede a successful JIT implementation. There are many performance measures from which an organization can reap its goals. Most critical performance measures which effects the performance of the organization are setup time (ST), delivery compliance (DC), inventory level (IL), firm’s culture and values (FCV), productivity (P) and quality (Q). These performance measures are divided
according to weight age gained from the feedback response from various organizations. These weightage are shown in Table 6.3 and transfer function in fuzzy format is shown in Figure 6.14.

c. In the fuzzy tool box of MATLAB there are two inputs that can be set within the upper and lower specification limits and the output is calculated as a point that can be translated into linguistic form. In current problem, input data as 50 and 25 has been taken and resultant data has come out to be 25. This means 50 points are coming from input 1(percentage JIT implemented), 25 coming from input 2, (percentage gain in performance measure) and output for significant performance measure has been obtained as 25 according to the fuzzy rule. It can be seen in Figure 6.16 and output surface view of significant performance measures is shown in Figure 6.17. It is clear from the output that all the six performance measures lie within the range of 25. Therefore, all six performance measures play a significant role in realizing benefits through all these performance measures.

4. For validating the fuzzy study empirically, the Structural Equation Modeling (SEM) study has been done. This study uses the confirmatory factor analysis (CFA) approach using Structural Equation Modeling (SEM) in AMOS 20.0 (Analysis of Moment Structures) software to employ the inter-relationship among JIT variables in the study.

a. Model Fit summary has been made in Table 6.10 showing the indices before and after modification. It was seen that after modifying the model 1, there has been slight improvement in the model 2 as the value of RMR decreased to 0.061. Similarly, the value of GFI increased to 0.590. The RMSEA value is coming closer to 0.08 showing a near model fit. The other values as shown in Table 6.9 are also coming closer to model fit values like CFI, NFI, and RFI etc.

5. The Justification of JIT implementation in manufacturing organisations has been made using analytical hierarchy process (AHP). Thus calculating Consistency Ratio (CR), which is a comparison between Consistency Index (CI) and Random Consistency Index (RI). For the present study, the value of CR is coming less than 0.1 (10%), which means the judgments considered for the study is consistent and acceptable.

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6. Further, a detailed multiple-descriptive case study has been conducted in selected manufacturing organizations across the country that has made serious interventions regarding JIT implementation over a considerable period of time and has reaped significant organizational performance enhancements as a result of successful adaptation of these initiatives. The following key issues have been highlighted through the case study:

a. The case study has revealed that organizations have adopted proactive JIT principals for meeting the competition thereby affecting significant production system improvements, improving cost effectiveness of production, reducing production defects/losses, aligning the workforce with organizational growth and development, improving employee competencies through empowerment and facilitation, and realizing improved workplace environment.

b. The results of JIT implementation have been broadly reflected in Figures 5.14 to 5.21. The study reveals that holistic approach towards JIT implementation has resulted in host of benefits for the organization. A brief account of benefits realized by making proactive investments in JIT initiatives has been presented below to highlight the contributions made by JIT initiatives in enhancing the manufacturing performance.

Some of the intangible results as a result of JIT implementation, which are very evident are as follows:

i) A better quality of product with less cost.

ii) Low level of Inventories.

iii) A sense of self-prestige in the employees for being their plant clean and arranged compared to other plants.

iv) Better communication between the various functions. People at last started looking at the problems in the mill above their functional responsibilities.

v) Employees are coming forward without any hesitation for implementing any kaizen.

vi) A culture developed where people started being more open to sharing knowledge and developing their colleagues.
7. Finally, research presents the evolution of a strategic SWOT analysis of JIT has been conducted.

Thus, it can be concluded that, in a highly competitive scenario, JIT has proven to be the most significant proactive strategic initiative that can lead the organizations to scale new levels of achievements and could really make the difference between success and failure of Indian manufacturing organizations. JIT can prove to be an effective global strategy for Indian manufacturing organizations, rendering firms a consistent enhancement of performance in terms of achieving strategic core competencies.

7.2 Limitations of the Research

The methodology for the study has following limitations:

i. The research is aimed at developing a strategic JIT implementation plan for Indian manufacturing organizations, while major changes will have to be made to adapt this for service industries.

ii. The present methodology has been developed for adopting JIT strategies in manufacturing organizations, while some modifications will have to be incorporated in the suggested philosophies for adapting the proposed methodology to marketing and other related situations.

iii. The research suggests a generalized implementation of JIT approach for Indian manufacturing industry as a whole and all manufacturing organizations have been treated alike, without paying attention to specific requirements of various sectors. Thus, minor changes might have to be incorporated to effectively adopt this program.

iv. This methodology has been designed to be used by experienced and skilled quality facilitators and may warrant use of a flexible approach depending upon varying situations, requirements of the organizations. These facilitators are assumed to be knowledgeable of transformation concepts and skilled in implementing these concepts. Any attempt of using this methodology by individuals who are not competent in deploying these programs shall only have limited success.
7.3 **Scope for future work**

The research is aimed at developing strategies for JIT implementation for manufacturing organizations, while the similar study can also be conducted in future for Indian process industries and service industries as well.

The study is aimed at developing strategic JIT methodology for Indian manufacturing organizations and various manufacturers have been treated alike irrespective of the type of products manufactured. Another direction for future research is developing sector-wise implementation of these programs. Thus, individual case studies can be conducted for different sectors of manufacturing industry and accordingly the typical methodologies for individual sectors can also be evolved in future.

The research is aimed at evaluating contributions of successful implementation of JIT initiatives in Indian manufacturing industry. In this research the role of JIT is studied with respect to business performance. However, as a future research, the contributions of these drives in conjunction with other related lean manufacturing initiatives like TQM, TPM, Quality Function Deployment (QFD), Six Sigma, Business Process Reengineering (BPR) etc. can also be undertaken for assessing the contributions of multiple world class performance enhancement programs towards accruing overall organizational competencies.