This chapter presents overall design of study, which includes phases of research and methodology adopted for carrying out the research work. The details of work done in each phase, tools, techniques and models used in the dissertation have also been presented in this chapter.

3.1 Scope of Work

The study has been carried out in the medium and large scale manufacturing organizations in the country that have implemented or are in the process of implementing JIT. The study presents the comparative analysis of business performance enhancements accrued through these quality improvement approaches. The key success factors for realizing overall organizational objectives through strategic JIT paradigms have been evolved in the study. The research focuses on suggesting a strategic integrated JIT model for Indian manufacturing industry.

The status of manufacturing industry, with regards to various quality and maintenance practices, in general, and JIT implementation practices, in particular, has been elaborated in the study. Firstly, the study involves investigation of contributions of JIT initiatives towards realization of manufacturing performance enhancements and accruing of core competencies in Indian enterprises. Similarly, secondly the study involves investigation of contributions of JIT initiatives towards realization of manufacturing performance enhancements and accruing of core competencies in Indian enterprises. Lastly, a comparative analysis of business performance enhancements has been done of both quality improvement approaches.

For the purpose, key JIT combined approach implementation dimensions, and manufacturing performance achievements attributes have been evolved in the study. The inter-relationships of various implementation dimensions with manufacturing performance achievements attributes have been evaluated and validated by employing various statistical tools for both the approaches. The study also focuses on the impact of consistent JIT implementation period towards realization of manufacturing competencies. Moreover, the study focuses upon systematic identification of obstacles.
in JIT implementation and working out key success factors, enablers towards improving manufacturing performance in Indian industry. Finally, strategic integrated JIT model has been synthesized based upon extensive literature review, learnings from detailed ‘JIT Questionnaire’ analysis and results from case study process.

3.2 Phases of Research

The study has been carried out with the objective of developing effective strategies for JIT implementation in Indian manufacturing industry. Considering the complexity of theme and taking into view the fact that such studies can be carried out primarily by closely treading and analyzing the approaches adopted by various organizations and results thereof, it was considered appropriate to carry out the study under ‘flexible systems methodology’ framework. The three basic components of flexible systems methodology (FSM) are situation, actor and process (Sushil, 1994). The ‘situation’ is to be managed by an ‘actor’ through an appropriately evolved management ‘process’, which recreates the situation. The ‘actor’ forms a part of the ‘situation’ as well as the ‘process’. The research work involves following phases:

(a) Clarifying the context
(b) Understanding and assessing the situation
(c) Assessing the actors capability
(d) Evolving a management process

(a) Clarifying the Context

The detailed literature review has been conducted regarding the quality and maintenance methodologies adopted by manufacturing organizations world-wide, from time to time in the past and issues involved with the same. The evolution of processes i. e. JIT has been studied through various stages of quality and maintenance practices along with their relevance and shortcomings. The relationship between these philosophies with contemporary Lean Manufacturing practices has been discussed in the literature review. The literature review illustrates tools, techniques employed in implementation processes of these quality drives and the potential benefits accrued by Western world through effective JIT implementation programs.
(b) **Understanding and Assessing the Situation**

A survey of reasonably large number of manufacturing organizations (60 manufacturing units) has been carried out through a specially designed questionnaire for understanding and assessing the prevailing situation regarding maintenance competencies of Indian entrepreneurs. The survey design and analysis involves following steps:

i. Design of a questionnaire on various aspects of quality as well as maintenance strategies including organization policies, traditional quality and maintenance attributes, JIT implementation issues, measures and components of manufacturing performance.

ii. Pre-testing and validation of questionnaire on the representative sample of industries.

iii. Data collection using detailed ‘JIT questionnaire’ through postal mail, E-mail, personal visits, interviews and other communication means.

iv. Summarizing and analyzing the data to investigate status of various traditional maintenance strategies, besides evaluating exploits of Indian entrepreneurs with proactive JIT initiatives, thus evaluating the benefits accrued in terms of manufacturing performance achievements.

v. Statistical analysis pertaining to status of various performance indicators as a result of implementations. Appropriate qualitative and quantitative techniques have been employed to analyze the contributions of various JIT implementation dimensions towards realization of strategic manufacturing performance achievements in Indian manufacturing organizations.

vi. Identification of stumbling blocks for successful JIT implementation in Indian Enterprises.

vii. Identification of key success factors for strategic JIT implementation in Indian Manufacturing Organizations.

(c) **Assessing the Actor’s Capability**

The survey has been followed by case study in selected Indian manufacturing organizations to ascertain the manufacturing performance exploits by Indian
entrepreneurs through JIT initiatives and those are considered actors in the present context. The case study emphasize upon step-by-step implementation procedure adopted by the organizations towards achieving manufacturing competencies. The case study have been developed to determine the tools and techniques adopted by manufacturing organizations towards ensuring effectiveness of JIT implementation programs and results accrued through successful implementation. The data thus obtained regarding key performance indicators has been analyzed for arriving at their role in improving effectiveness of JIT implementation in the organizations. The case study includes: overview of manufacturing organizations, reasons behind adoption of JIT principals by organizations, strategies adopted by organizations, their time frame, sequence and performance enhancements accrued by the organizations as a result of successful implementation.

(e) Evolving the Management Process

Finally, the inferences drawn from literature, empirical study carried out in Indian manufacturing industry and case study conducted in various manufacturing organizations. Inferences drawn from the survey and case study have been synthesized to evolve critical success factors for strategic JIT implementation for Indian Manufacturing industries. The SWOT analysis of JIT implementation in Indian industries has also been presented.

3.3 Research Methodology

The research framework developed and used for this study is presented in the form of block diagram in Figure 3.1. The study has been carried out in the medium and large scale manufacturing organizations in the country that have implemented or are in the process of implementing JIT to study the comparative analysis of business performance enhancements accrued through these quality improvement drives and also to understand the key success factors for realizing overall organizational objectives through strategic JIT paradigms. The objective is to explain the relationships between implementation factors and performance parameters for JIT approach and to extract those factors for each approach, which significantly contribute to improvement in performance. In order to ensure the contributions made by JIT manufacturing initiatives towards realization of manufacturing performances, a detailed ‘JIT questionnaire’ has
been designed for accessing the JIT implementation capabilities of the Indian manufacturing industry and recognition of manufacturing performances. In the present study the questionnaire survey technique has been used for gathering information on the status of JIT implementation issues and the recognition of various manufacturing performances in the Indian manufacturing industry.

Figure 3.1 Block diagram of Methodology

For carrying out the survey effectively, the JIT questionnaire has been designed by conducting extensive literature review, and got it validated through peer review from academicians, consultants and JIT practitioners from the industry. To ensure that the questions been pre-tested on an exemplary sample of industry. The suggestions received from the peers, consultants, managers, senior executives from the industries and academicians have been added to make the questionnaire more accordant to the purpose and bring out major outcomes as a result of strategic JIT implementation. The JIT questionnaire delivers the purpose of divulge the exploits of Indian organization with JIT practices and highlights the major contributions of JIT in recognizing the overall organization’s goals and objectives. Figure 3.2 shows the steps undertaken in finalization of the JIT questionnaire.
In this study, a reasonably large number of manufacturing organizations have been extensively surveyed, to ascertain contributions made by JIT quality drives in the Indian manufacturing industries. Survey of various manufacturing industries had been carried out through a specially designed JIT questionnaire for understanding and assessing the prevailing situations. The approach has been directed towards justifying the support of JIT in providing a synergetic effect in improving business performance.

For effectively conducting the survey, the ‘JIT questionnaire’ has been designed through extensive literature review Benson (1986); Lee and Seah (2007); Golhar and Stamm (1991); Clark and Mia (1993); Ramarapu et al. (1995); Spencer and Guide (1995); Yasin and Wafa (1996); McLachlin (1997); Wafa and Yasin (1998); Claycomb et al. (1999b); Canel et al. (2000); Kumar (2010) and validated through peer review from academicians, consultants, JIT councilors and practitioners (JIT co-coordinators) from the industry. The questions framed are based on four points scale ranging from 1 to 4. Each dimension and performance parameter is taken as a group of many related items.
The manufacturing organizations across the country were first screened and an industrial database was created for the purpose of mailing the ‘JIT Questionnaire’. JIT questionnaires were mailed to the selected prominent organizations practicing JIT initiatives effectively, and the organizations were subsequently contacted through various communication means like: postal mail, E-mail, telephonic interviews, besides personal interviews through visits to various manufacturing units to explain context of the research work, its significance and to clarify any queries/doubts to facilitate comprehensive and clear-cut responses to the ‘JIT Questionnaire’. The suggestions received from the prominent industrial units and peers from academia were then appropriately incorporated in the questionnaire to carefully address the concerns of the Industrial resource persons and peer academicians.

Finalized ‘JIT Questionnaire’ was sent to around 400 industries which are implementing JIT practices. More than 275 calls were made to interact with the coordinators of JIT and around 250 mails and 300 postages regarding questionnaire were sent to various industries across the country that were at different stages of implementing JIT. Besides this various interviews with the resource persons were made and clarifications were sort regarding implementations of JIT. Moreover, in case of large organizations having multiple production facilities, multiple responses have also been received from different manufacturing units. The responses thus received have been compiled and analyzed critically to ascertain the performance of the Indian industry regarding various JIT-related issues. Most of the respondents to ‘JIT Questionnaire’ belonged to the top brass of management executives that included several Vice Presidents, Heads of Maintenance, Head – Operations, Head – Quality Assurance, General Managers (GM), Head – Process Engineering, JIT Co-ordinators, Head – Improvement Management, Chief Managers, Manufacturing Managers, GM – Technical, Quality Managers, and President – Operations etc.

In response to all these 60 in total questionnaires were received. Further segregation of these questionnaires has also been done, which has been discussed in Table 3.1.
Table 3.1 Responses obtained through questionnaire

<table>
<thead>
<tr>
<th>Years of implementation</th>
<th>JIT Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>22</td>
</tr>
<tr>
<td>3-5</td>
<td>18</td>
</tr>
<tr>
<td>&gt;5</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

The simple, relevant and a comprehensive questionnaire, covering various aspects of JIT related issues has been specially designed and used to obtain data necessary to accomplish objectives of the study. Detailed description of ‘JIT Questionnaire’ has been presented in Appendix – I.

The various sections involved in the JIT questionnaire have been depicted below:

(a) General Organizational Information

(b) Query

(c) Issues Related to Inventory Control

(d) Just in Time Issues

- Organization Culture and Management Commitment
- Employee’s Involvement and Commitment Issues
- Work Place Organization
- Issues Related to JIT Purchasing
- Product and Manufacturing Flexibility
- Facility Layout
- Production System and Process Control
- Kanban and Pull Production system
- Set up Time
- Quality
- Daily Schedule Adherence and Maintenance Management
- Distribution, Containerization and Transportation System
- Customer Orientation

In order to ascertain the benefits realized by an effective JIT approach, it becomes imperative that different implementation success factors and manufacturing performance achievements be scrutinized carefully. In the present study, six key implementation success factors (A1, A2, A3, A4, A5 and A6) and ten manufacturing performance achievements (B1, B2, B3, B4, B5, B6, B7, B8, B9 and B10) have been identified as significant for analyzing the impact of JIT initiatives towards realizing manufacturing performance achievements. Figure 3.3 depicts the proposed model showing the success factors and manufacturing performance achievements for evaluating the inter-relationships between both approaches.

![Diagram](image.png)

**Figure 3.3 Inter-relationships between JIT implementation dimensions and manufacturing performance measures**
The various statistical analysis tools like Cronbach’s Alpha, Pearson Correlation Coefficient, Canonical Factor Loading Analysis, Multiple Regression Analysis, Canonical Correlation and Two tailed ‘t’ Test have been employed to evaluate and validate contributions of holistic implementation initiatives towards building manufacturing performance improvements and realization of core competencies in the manufacturing organizations. For the present study, the formulation of hypotheses are shown below:

**Manufacturing performance improvements related hypothesis**

H1. A significant overall association exists between JIT success factors and JIT Manufacturing Performance Parameters.

H2. There exists significant association between Strategic JIT Manufacturing Performance Parameters with major individual JIT implementation success factors.

**Hypotheses related to manufacturing performance improvements**

H3. Strategic Enhancement in Manufacturing Performance depends on the gain in experience by manufacturing organizations with respect to time period.

Furthermore, the effect of comparative effectiveness of JIT on performance parameters with respect to ‘time frame of JIT implementation’ has also been ascertained to validate the fact that these implementation are not an overnight programs and it takes quite a long period of holistic interventions, varying between 3 – 5 years, to realize the true potential of these quality initiatives. The research has revealed significant improvements in manufacturing performance and core competencies over time period extending up to five years and beyond.

Further, for assessing the actor’s capability, the multiple-descriptive case study method has been used in the research and the survey has been followed by case study in selected manufacturing organizations. In the study, case study method has been preferred due to the following reasons:

i. The study embodies more variables than data points covered under the survey.

ii. The study cannot rely on a single data collection method but is likely to use multiple sources of evidence.
Distinctive strategies are needed for research design and analysis.

While selecting the organization for detailed case study, the following factors have been considered:

i. The selected organization should represent the manufacturing sector in terms of competition, complexity and other aspects need to be included in the study.

ii. The selected organization should include organizations, which have made holistic efforts over a reasonable period of time at managing JIT programs with varying degree of success.

iii. The organizations participating in the survey through ‘JIT Questionnaire’ responses have been given preference.

iv. There is the feasibility of getting authentic information and data related to JIT implementation from the unit through personal interactions, observations and published data. Here it is pertinent to mention that although reasonably high numbers of questionnaire responses have been obtained from leading Indian entrepreneurs, very few organizations have come out openly and share their exploits and performance achievements.

v. The descriptive case study has emphasized upon the step-by-step implementation procedure adopted by the organizations towards achieving the organizational objectives. The industry confirming to support the proposed research work and which was selected for doing case study was DSM Anti-Invectives India Ltd, Toansa, Distt. Nawanshar, Punjab.

vi. The case study has been conducted at DSM Anti-Invectives India Ltd., Toansa which is a part of DSM Group of Industries to assess JIT implementation issues involved therein. The case study has elaborated organizational information, need for implementation, strategies adopted, their time frame, sequence and impact of implementation strategies towards realization of manufacturing performance improvements.
3.4 Strategic JIT Methodology for Indian Manufacturing Industry

Considering the vast literature review, questionnaire survey and case study of the JIT quality drives, a strategic JIT Methodology is synthesized to evolve critical success factors for strategic JIT implementation for Indian Manufacturing industries recommended by the authors in chapter 6. It has been observed through surveys and case study that most of the failures regarding implementation of these programmes arise on account of poor planning and false start-ups. This phase involves the careful planning and deployment of prerequisites to successfully manage JIT initiatives in the organization and is crucial to the success of its implementation.

The Implementation phase containing attributes regarding implementation of JIT. The detailed description of the various issues like quality planning, long term as well short term goals, quality planning issues etc that are related to the JIT implementation are elaborated to strategically focus upon the different aspects of their implementation and finally the standardization phase which requires these initiatives to be stabilized and holistically pursued over a reasonable period of time to reap the true potential from JIT implementation. JIT initiatives should be horizontally deployed to all organizational activity areas/departments besides maintenance and manufacturing functions to include R&D, design, product development, service areas, assembly work, procurement, sales, marketing, administrative, management (accounting, general affairs, planning and quality assurance) and production scheduling.

The analysis of survey has also revealed critical stumbling blocks/obstacles faced by Indian manufacturing organizations in realizing the true potential of JIT and the reasons behind relatively low success with these exploits. This information has proved to be extremely useful for developing strategic integrated JIT framework for Indian manufacturing industry.

The work has been further extended by applying fuzzy logic to the above study. Fuzzy logic is a Multi Criteria Decision Making (MCDM) technique employed by manufactures now days along with JIT drives for effective production process. The study shows the significant performance measure due to implementation of JIT. For the study, the most relevant factors affecting the performance measure like Percentage JIT implementation and percentage gain in performance measure has been considered from
the literature and further these factors has been simulated by the data given by experts in this fields using Fuzzy Logic Toolbox of MATLAB which provides the steps for designing fuzzy inference systems using graphical tools, and a Semolina block for analyzing, designing, and simulating systems based on fuzzy logic. In the output 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) has been considered.

For validating the fuzzy study empirically, in which the synergistic suitability of JIT was obtained by constructing fuzzy model, using Fuzzy Logic Toolbox of MATLAB. 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 JIT variables in the study. The required data for the study have been collected through ‘JIT Questionnaire’ from various Indian Manufacturing industries and using the data two different SEM models were constructed using AMOS 20.0 software i.e SEM_JIT model. Also the SEM study confirms and validate JIT fuzzy model, which justifies the previous study.

Finally, the Justification of JIT implementations in manufacturing organizations has been made using analytical hierarchy process (AHP), which is a decision-making approach under uncertainty. The study evaluates the JIT strategic factors to determine the critical success factors in environment of uncertainty using analytical hierarchy process (AHP). The study decision criteria include JIT, whereas the competitive advantages taken are strategic business performance, quality, production, cost, employee safety and morale. The research findings are applicable to manufacturing organizations, suggesting them the adoption of flexibility of JIT as a major competitive advantage with a higher uncertainty and delivery with a lower uncertainty.

The research also highlights the success factors for smooth and fruitful JIT implementation in Indian Manufacturing Organizations. The study also presents conclusions of the research based upon interpretation of the results obtained through ‘JIT Questionnaire’ and case study. A summary of the research accomplishments have also been highlighted. Finally, limitations of the research have been presented and recommendations for future research directions have also been suggested.
3.5 Concluding Remarks

In this chapter, the methodology adopted along with step-by-step approach employed for the dissertation has been elaborated. The tools and techniques employed for analysis of various areas and activities for development of implementation strategy have also been briefly described. For the study of research propositions, a detailed survey and case study have been carried out. The details of the survey, responses obtained and correlations established between various variables have been described in the next chapter, while case study has been presented in Chapter – 5.