Just in Time Manufacturing - A State of Art Review and Case Study

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Abstract

Just in Time manufacturing is a management philosophy of achieving major enhancement in a process through elimination of different types of waste. This study attempts to identify useful contributions in the field of Just in Time manufacturing philosophy. Literature related to concept, case studies, surveys have been systematically reviewed and important benefits achieved after implementing JIT approach have been discussed. JIT manufacturing by now is a widely discussed and applied manufacturing philosophy, in a variety of industries across the globe. This paper discusses different articles that have been published in this field and presents a review of literature systematically

Keywords: *Just in Time manufacturing; waste elimination and manufacturing industry.*

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Introduction

The ultimate objective of the manufacturing industries today is to provide the market with products of the highest quality, at reasonable prices, at the optimal time. This objective is driving most manufacturing companies to develop the systematic and integrated manufacturing systems. Companies seek competitive advantage by emphasizing on performance factors such as flexibility, quick responsiveness, cost, efficiency, quality, reliability and service. Just-In-Time (JIT) manufacturing is the ideal strategy to achieve these objectives. JIT is just not a technique or set of techniques of manufacturing, but is an advanced approach or philosophy which embraces both new and old techniques and provides a wide range of benefits by renovation of existing manufacturing systems. JIT is a system that produces the required items at the time and in the quantities needed (Gupta and Garg, 2012). The JIT advocates the elimination of waste by simplifying production processes, reductions in set up times, controlling material flows, and emphasizing preventive maintenance are seen as ways by which excess inventories can be reduced or eliminated, and resources utilized more efficiently (Kannan and Tan, 2005). JIT had its beginnings as a method of reducing inventory levels within Japanese shipyards. Today, JIT has evolved into a management philosophy containing a body of knowledge

and encompassing a comprehensive set of manufacturing principles and techniques. JIT manufacturing has the capacity, when properly adapted to the organization, to strengthen the organization's competitiveness in the marketplace substantially the organization's competitiveness in the marketplace substantially by reducing wastes and improving product quality and efficiency of production.

A growing and developing literature in this subject has been published after 1970. The present article presents a review of the literature and attempts to identify the important and useful contributions on this field. The paper attempts to review the brief review of literature on JIT approach. First section includes history and evolution of JIT approach. Second section includes literature related to concept of JIT philosophy, Case Studies performed by various researchers and Third section includes various benefits of implementing JIT manufacturing philosophy by conducting case study of manufacturing unit of Northern India.

History and Evolution of JIT approach

JIT is a Japanese management philosophy which has been applied in practice since the early 1970s in many Japanese manufacturing organizations. It was first developed and perfected within the Toyota manufacturing plants by Taiichi Ohno as a means of meeting consumer demands with minimum delays. For this reason, Taiichi Ohno is frequently referred to as the father of JIT. The Toyota production plants were the first to introduce JIT (Goddadrd, 1986). The basic idea of JIT was originally developed and brought to a high level of sophistication by the Toyota Motor Company in Japan. The idea was formalized into a management system when Toyota sought to meet the precise demand of customers for different models and colours with minimum delay. During the early 1970s, this approach to managing manufacturing began to attract wide attention in Japan, and by the mid 1910s many Japanese companies had adopted this approach. At that time, the approach was not known as JIT but was called the "Toyota Manufacturing System". The JIT philosophy began to attract significant attention from the West towards the late 1970s under the name of the Kanban system. This was partly misleading as Kanban is only one part of the total JIT system. Kanban is the name given to two cards: the Requisition Kanban which is used to authorize the movement of standard containers between work stations, and the production Kanban which authorizes the production of a standard container of parts at a work centre. Just in-Time management is the generic term now widely used to describe this overall approach to manufacturing (Chandra and Kodali, 1998). One motivating reason for developing JIT and other better production techniques was that after World War II, Japanese people had a very strong incentive to develop good manufacturing techniques to help them rebuild the economy (Cheng and Podolsky, 1996). The growing and developing literature on JIT philosophy has been published after 1982. This paper discusses different paper published from 1982 to 2013 in the context of JIT approach.

Literature related to Concept of JIT philosophy

JIT philosophy has gained considerable interest of researchers because it allows a company to produce high-quality products, with increased levels of productivity with minimum efforts. Different concepts of JIT manufacturing philosophy as discussed by different researchers is discussed below:

Hoeffer (1982) defined that JIT system is a combination of purchasing, inventory control and production management functions. Materials are purchased in small quantities with frequent deliveries just in time when they are needed. Under the JIT system, the parts needed for one day's operations in a manufacturing or assembly line are supplied by in-plant sources of suppliers for immediate use.

Hall (1983) stated that JIT "is not confined to a set of techniques for improving production defined in the narrowest way as material conversion. It is a way to visualize the physical operations of the company from raw material to customer delivery". There is no aspect of management which JIT does not touch. It eliminates waste in all areas of manufacturing – including marketing, planning, sales and production – whilst maintaining and possibly improving customer services because it identifies and changes manufacturing conditions which cause waste to exist.

Voss and Robinson (1987) defined JIT as: "JIT may be viewed as a production methodology which aims to improve overall productivity through the elimination of waste and which leads to improved quality. In the manufacturing/assembly process JIT provides the cost-effective production and delivery of only the necessary quality parts, in the right quantity, at the right time and place, while using a minimum of facilities, equipment, materials and human resources. JIT is dependent on the balance between the stability of the user's scheduled requirements and the supplier's manufacturing flexibility. It is accompanied through the application of specific techniques which require total employee involvement and team work".

Toomey (1989) stated that the manufacturing and inventory control systems do not determine the process; the process determines the required systems. The JIT concept of continuous improvement calls for flexibility of inventory-control management in order to take advantage of each process improvement within the manufacturing operation. To maintain flexibility and continuous improvement, the organization must be committed to JIT philosophy, concept, and procedures.

Gupta and Haragu (1991) had shown that JIT is not just a way to reduce inventory, it is a means of solving problems that block the building of an excellent manufacturing organization. Its applications and benefits apply not only to the shop floor but also to the marketing, purchasing and accounting aspects. They concluded that JIT system can not be achieved overnight. It is a slow process and takes 5 to 10 years to achieve optimum results. The management must carefully evaluate the benefits and costs of implementing JIT before its implementation.

Vokurka and Davis (1996) had given historical background of JIT. They stated

that the system of production has changed from the mass production system in place for much of the past 100 years, the elimination of waste and continuous improvement has been accepted, and in most industries is required, as a prudent management practice. They concluded that JIT no longer exists as a specific implementable management technique, but is definitely here to stay as a management philosophy. The concept of JIT has completed its evolution from a manufacturing technique to a much broader philosophy of improvement.

Garg et al. (1999) identified that JIT encompasses several integrated function systems both within the firm and outside of it, all of which are motivated to work towards a common objectives of minimizing inventories and lead times. They concluded that JIT is suitable when the service level expectations of the customer are very high. Essentially the concept of JIT was evolved to take care of demanding customers in a competitive environment.

Telsung and Patil (2006) concluded that work culture in JIT implemented companies have a positive impact on competitive advantage and operational performance of the firm. The work culture system consists of those human resource practices that provide a cooperative and communicative atmosphere so that tasks within and across the functional units are coordinated.

Singh and Sharma(2007) explained various strategic factors affecting business environment such as reduced lead time, competitive cost, improved manufacturing environment, higher quality of product, integrated management techniques, customer satisfaction, role of information technology etc. they concluded that JIT works faster in IT environment because of improved communication between various sections/ departments in an organization. Improved communication removes the bottlenecks in the way of implementing JIT. Decision making becomes easier and faster resulting in improved efficiency in the organization.

Rajesh et al. (2013) identified that one of the major factors for effective inventory management is the motivation and efficiency of the workforce. This paper primarily focuses on studying the process productivity through JIT systems with an objective of studying the behaviour on finished goods inventory both for the assembly process and the fabrication process considering the delays in the raw material supply for assembly and fabrication. Since there is comparatively lesser research undertaken on the study on JIT application in a manufacturing sector, by considering the raw material inventory and production process, an effort is made in this paper to move in this direction. Table 1 shows the key findings of literature related to concept of JIT philosophy.

Table 1. Key findings of Literature related to concept

Author and Year	Key Findings
Hoeffer (1982)	The author defined JIT from purchasing, inventory control and production management
Hall (1983)	JIT is a management approach for improving production

Author and Year	Key Findings
Voss and Robinson (1987)	JIT approach is helpful in improving productivity by eliminating waste.
Toomey (1989)	JIT concept is continuous improvement technique of inventory control.
Gupta and Haragu (1991)	JIT is a problem solving tool of achieving excellence on shop floor.
Vokurka and Davis (1996)	JIT is manufacturing technique of reducing waste through incremental improvement.
Garg et al. (1999)	JIT philosophy aims at meeting demanding customer needs in competitive environment.
Telsung and Patil (2006)	JIT has a positive impact on competitive advantage and operational performance of the firm.
Singh and Sharma (2007)	The authors highlighted the various benefits of implementing JIT approach.
Rajesh et al. (2013)	JIT preliminarily aimed at reducing inventory through process improvement.

Literature related to case studies and surveys

Billesbach (1991) conducted a survey of 68 companies of United States who were Implementing JIT. He stated that formal declaration of corporate JIT objectives and intent minimizes misunderstanding and ambiguity, thereby allowing more focused efforts and a better prioritization of resources to achieve those objectives. 83% respondents feel that changing product flow and layouts to a cellular manufacturing is extremely important for success. 73% feel group technology is important and 71% feels material handling simplification is important. However only 16% respondents indicated that product variety is important for successful JIT implementation.

Dyck et al. (1991) had carried out product line simulation at Fleetwood Travel Trailers, California using XCELL which is a simulation language designed to develop logical model of the factory on a personal computer, and to run that model to measure capacity and other aspects of the model's performance. They concluded that WIP inventory is substantially large in traditional production system as compared to JIT environment.

Ebrahimpour and Withers (1993) identified two manufacturing philosophies namely Static optimization which means that the emphasis is on management of the workforce, functional autonomy, cost minimization and maintaining stability. Second philosophy is dynamic evolution which means the philosophy of continual improvement. They conducted a survey of 221 US based firms with the help of questionnaire based on five point Likert scale. They analyze the data using ANOVA and tested at the 0.05 significance. Responses from non-JIT firms were indicative static optimization philosophy. Whereas JIT firms responses indicated that they are using dynamic evolution philosophy.

Payne (1993) conducted a case study at Acme manufacturing of Texas which was a forging company. He concluded that by applying JIT the cycle time had been reduced upto

45% within a period of 2 years. Furthermore inventory value had been reduced by 40%. Above all the company had shown steady growth and modest profits and the level of customer satisfaction increased to a great extent. Moreover employee morale become very high and reworks account declined due to increased quality of work performed on the parts and because of smaller batches problems were detected and corrected earlier.

Su (1994) had shown the benefits of implementing JIT such as reduced space requirement, reduced inventory investment, reduced manufacturing lead time and increased equipment utilization etc. they also raises some issues for the managers to be aware of before implementing JIT such as cooperation between management and the workforce, adhere to daily schedules, changes in layout, revision of purchase agreements, small containers use etc. he conducted is study in a heavy industry of Korea and identified the important activities which the company has followed for implementing JIT.

Huson and Nanda (1995) made an attempt to measure the impact of JIT on accounting measures of performance. Their results show that after JIT adoption firms reduced their labour content in facilities, increased inventory turnover and enhanced earnings. There was no significant impact on price charged by the firm. They concluded that JIT is necessitated by increasing in competitive pressure, demand of variety of products and a need for flexible production systems.

Ramarapu et al. (1995) compared the research done in the areas of JIT implementation in the past decade, identified critical elements, and groups the elements into broader factors. An extensive literature search was conducted to identify over 130 JIT implementation articles published in journals and proceedings. Articles were reviewed to identify 28 JIT implementation elements. These elements then grouped into five broader groups. The result obtained from this research showed that elimination of waste and production strategy are the most specific critical factors of JIT implementation followed by three other critical factors: quality control and quality improvement, management commitment and employee participation, and vendor/ supplier participation.

Garg et al. (1996) analyzed some vital issued in JIT purchasing in an Indian context on the basis of a questionnaire (n=28) sent to 80 different Indian Industries. The issues include the importance of JIT attributes, problems in implementing JIT, and expected benefits form JIT purchasing implementation. Some research directions are also identified for future work.

Kumar and Garg (2000) conducted a survey in 22 industries of Northern India. They analyze the data with the help of factor analysis on scale 1-100. They concluded that the elements like layout improvement, small lot size, continuous improvement, buffer stock remove and WIP reduction are easy to implement whereas zero defect, automation, cellular manufacturing process flexibility etc are difficult to implement in Indian industries. The greatest attribute of JIT which makes it suitable for Indian industries is that most of its elements do not require much investment. They strongly recommend that Indian industries must implement JIT, may

be in phased manner which will certainly make them competitive.

Fullerton and McWatters (2000) measured the degree of implementation of JIT in US by taking a sample of 254 companies with the help of ANOVA test. 28% of the responses indicate that the firms have had significant improvements in their operations since implementing JIT. More than 61% of the responses were positive, whereas only 5% of the responses were negative with respect to changes after adopting JIT. When examining only inventory effects, over three-fourth of the respondents report declines in total inventory.

Table 2 shows the key findings of literature related to case studies and survey of JIT philosophy.

Table 2 key findings of literature related to case studies and surveys.

Author and Year	Key Findings
Billesbach (1991)	The author claimed based on his survey in US companies that changing product flow and layouts to a cellular manufacturing is extremely important for success of JIT.
Dyck et al. (1991)	The authors based on study at Fleetwood Travel Trailers, California claimed that JIT is helpful in improving work in process (WIP) inventory.
Ebrahimpour and Withers (1993)	The authors based on survey in US firms claimed that JIT is helpful in management of the workforce, functional autonomy, cost minimization and maintaining stability.
Payne (1993)	The author based on his study at Acme manufacturing of Texas claims that JIT is helpful in reducing cycle time and inventory.
Su (1994)	The author claimed the potential benefits of implementing JIT in a heavy industry of Korea.
Huson and Nanda (1995)	JIT adoption firms reduced their labour content in facilities, increased inventory turnover and enhanced earnings.
Ramarapu et al. (1995)	The authors identifies critical elements of JIT also claims about elimination of waste by implementing JIT approach.
Garg et al. (1996)	The authors identified important barriers in implementing JIT based on survey in Indian Industry.
Kumar and Garg (2000)	The authors identified the elements of JIT difficult to implement based on survey in 22 Indian Industries.
Fullerton and McWatters (2000)	The authors based on survey in 254 US companies claimed that JIT is most helpful in reducing total inventory.

Link of Literature with Case study

Based on case study of Payne (1993) as discussed in literature, it is concluded that JIT is helpful in reducing cycle time and inventory. The literature given in the paper has outlined the significance of JIT approach as an improvement strategy that encompasses all aspects of the organization. JIT approach has been successfully implemented by Indian

organization to enhance the performance of their manufacturing operations through elimination of waste. The present study has been carried out to check the performance of JIT elements in manufacturing namely theory of constraint as discussed in literature.

Introduction to the Industry

This case study is of northern India plant which was opened in 1938 to increase production in the range of auto parts products produced by the group. The group has around 15,000 employees and achieves annual sales of some 9 crores covering a range of products. The plant spreads over an area of 80,000 square yards which speaks the volume of products and culture. The organization is specialized in manufacturing of suspension components for commercial vehicles (LCVs, MCVs, HCVs) and passenger cars for Indian as well as for overseas market. The company has following manufacturing capabilities: casting unit for ferrous and non-ferrous metals, forging facility for hot and cold components, machine shop for drawn as well as for forged components, heat treatment plant, design and planning section. The economic recession of the early 2005 badly affected the markets for the products of the plant at the focus of the study. In order to achieve success in this highly competitive market, Company recognized it would have to become "world class". An analysis of the product market highlighted the constant growth rate of the high-performance product segment and the need for: innovative products with progressively shorter life cycles; more rigorous quality standards for both original equipment (OE) and replacements; and greater attention to environmental matters. At the time this analysis was undertaken there was a gap between the activities of Company and the strategic targets of the group.. Every component passes through numerous tests and inspection at the stages of design, raw-material inspection and also throughout the manufacturing process. There are different shops including Machine Shop, Forging Shop, Heat Treatment Shop and Foundry equipped with latest machinery. Further, the organization has taken up major modernization and expansion plans, effectively catering to improvement in quality, production capacity and reduction in cycle time, for sustaining its market leadership and gaining international recognition in an auto parts manufacture.

Formulation of steering Committee for JIT Practices

JIT Core-committee has a team of six members representing the heads of different departments and the chairman is usually the plant head. The committee has to work based on the following roles: Selecting JIT themes based on losses, setting targets and assigning teams to take responsibility for each identified project, identify bottleneck areas, fixing targets, set priorities and launching of project teams with pilot projects.

- Identifying aim and scope of JIT, training requirement and guiding the facilitators to focus losses on company performance.
- Knowledge sharing through horizontal deployment activities.

- Develop the master plan for JIT and track progress of JIT.
- Motivate people to do JIT.
- Giving inputs to the education and training pillar.
- Working in close co-ordination with other sub-committees for achieving the targets of JIT improvement projects. This committee will meet at least once a week or month for the above mentioned points.

Formation of core committee team is the very essential part of any movement at new place. JIT is new to this plant and it is required that this movement should be supported by the top management of the company. So it has been decided that following members are incorporated in the core committee team. This team will work together and they will decide all the major decision regarding the implementation of JIT practices in the company.

- Chief Executive Officer
- General Manager – Production
- General Manager – Mechanical Maintenance
- General Manager – Finance and Accounts
- General Manager – Systems
- Kaizen – Coordinator

JIT Improvement Projects

JIT improvement projects are the planned activities that do not need big investment, large resources, lengthy time and technology up gradation in order to make continuous improvement. JIT pillar deals only with those losses that cannot be handled by any other pillar. All the losses have to be considered by the JIT core- committee. Collecting all relevant data on losses and losses is based on priorities. The JIT core-committee had identified the priorities and assign project on specific losses on different machines and areas. The core committee had selected the JIT improvement projects on the basis of potential improvement needed for the basic requirement of the plant including OEE improvement, productivity improvement and quality improvement. The JIT office has done a substantial homework before selecting these projects. Low OEE, high down time and high rejections leads to the implementation of JIT Strategies. Following are the JIT improvement projects (JITIPs) that have been identified by JIT core committee based on critical areas identified earlier: -

a) JITIP1: To reduce /eliminate the rejection %age due to sand crush fettling and hard spot in SHBC-372

b) JITIP2: To increase in productivity of rocking and straightening operation of Tata U bolts and risk of damage by hammering USBT-957

c) JITIP3: To reduce the processing time of Re-Tapping and cost of Tooling.

d) JITIP4: To reduce the fettling time and force and increase yield %age in SHBC-461

JITIP1: To reduce /eliminate the rejection %age due to sand crush fettling and hard spot in SHBC-372.

Problem: Rejection %age is high i.e. 5.96% in September in SHBC-372.

Root Cause of the problem: Methoding problem causes problems like sand crush and hard spot in SHBC-372 due to lack of awareness. In correct methoding of mould was being done. As a result Methoding design has been changed, Sprue well has been provided to avoid sand crush, increase in the runner/riser height has been increased to avoid hard spot and modification in gate neck design to avoid cavity on material after fettling operations. The cost benefit has been calculated as shown in Table3.

Table3 Data collection before and after implementing JITIP1

Before	After
Quantity Rejected = 3168pcs	Quantity Rejected = 3168pcs
Casting weight of the Product = 2.140kgs	Casting weight of the Product = 2.140kgs
Total weight = 3168*2.140 = 6779kgs	Total Weight = 643*2.140 = 1376kgs
Operating cost @Rupess 9/kg 6779*9 = 61011	Operating cost @Rs 9/kg 1376*9 = 61011
Annual Cost = 61011*3 = Rupees 183033	Annual Cost = 12384*4 = Rupees 49536
Savings/year = 183033 - 49536 = Rupees 133497	

Figure 1 and Figure 2 show methoding problem before and after implementing JITIP2.

Fig 1: Methoding Problem

Fig 2: Improved Methoding Design

JITIP2: To increase in productivity of rocking and straightening operation of Tata U bolts and risk of damage by hammering USBT-957

Root Cause of the Problem and Corrective Action Taken: More cycle time in coining and straightening operation resulting in inventory pile up. More time is needed for straightening process as a result of manually gap setting during hammering process. Manually operated press is replaced by hydraulic press. The central distance should be controlled by pressure on head and stem of U Bolt. Time taken for coining and straightening for 600 U Bolts was reduced from 8 hours to 6 hours. Cost saving calculations has been shown in Table 4.

Table 4 Data collection before and after implementing JITIP1

Average daily salary for one operator=Rupees 120 Average monthly requirement for Tata U Bolts=120*26=Rupees 31200	
Before	**After**
Manpower requirement for 600 pieces = 4 men Average daily salary for 4men = 4*120 = Rupees 480	Manpower requirement for 800 pieces = 4 men
Cost of operation / U Bolt (480/600) = Rupees 0.80	Cost of operation/ U Bolt (480/800) = Rupees 0.60
Cost of 31200 pieces = 31200*0.80 = Rupees 24960	Cost of 31200 pieces = 31200*0.60 = Rupees 18720
Monthly Savings in coining and straightening operation (24960 - 18720) = Rupees 6240	

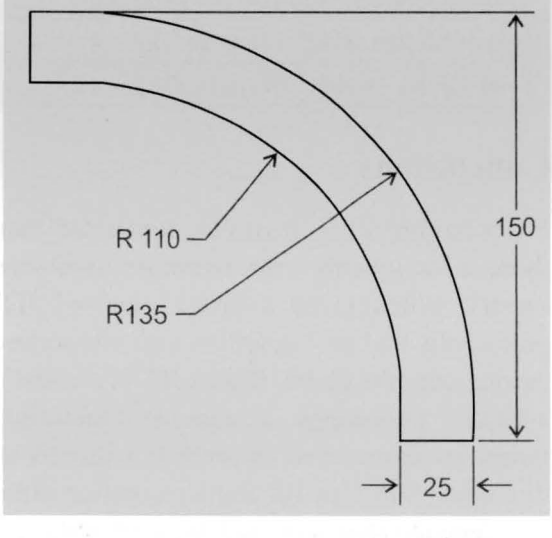

Fig 3: Design of U bolt before JIPIP2

Figure 3 and Figure 4 shows the design of U bolt before and after implementing JITIP2.

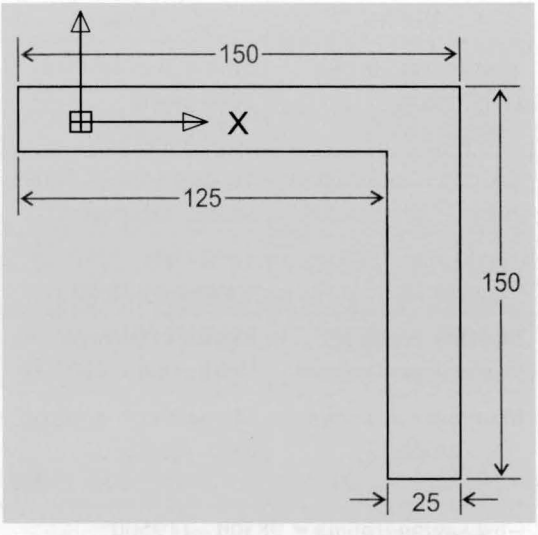

Fig 4: Design of U bolt after JIPIP2

JITIP3: To reduce the processing time of Re-Tapping and cost of Tooling

Root Cause of the Problem and Corrective Action Taken: Re-Tapping of nut after heat treatment is done one by one in forward and backward direction. Production rates are less and tooling cost is high. Small tap without handle has been used as a result in machine design constraint. Tap having handle has been introduced. Pillars to be fitted in machine bracket. Re-Tapping has to be done only in one direction by the use of tap with handle 12" long. The cost benefit has been shown in Table 5.

Table 5. Data collection before and after implementing JITIP3

Before	After
Production /11hours = 1800 pieces	Production/11 hours = 2400 pieces
Tap Life = 4000 pieces	Tap Life = 14000 pieces

Before	After
Man power cost for 1000 pieces = Rupees 83	Man power cost for 1000 pieces = Rupees 62.50
Tooling Cost of 1000 pieces = Rupees 200	Tooling Cost of 1000 pieces = Rupees 57
Total Cost = rupees 283	Total Cost = Rupees 119.50
Monthly Average Production = 100000	Monthly Average Production = 100000
Manpower + Tooling cost / month = 283*100 = 28300	Manpower + Tooling Cost /month = 119.50*100 = 11950
Cost saving /month = 28300 - 119500 = Rupees 16350	

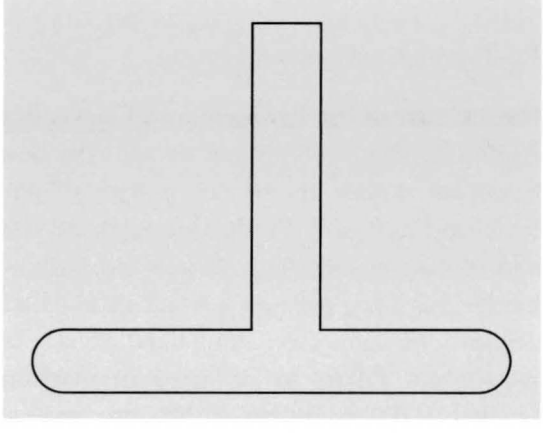

Fig 5: Tap with handle

Figure 5 shows Tap with handle after implementing JITIP4

JITIP4: To reduce the fettling time and force and increase yield %age in SHBC-461

Root Cause of the Problem and Corrective Action Taken: More time and force is required to separate the product from runner. Product is connected to runner at 4 places. Runner design was complicated. The design of runner has been changed with product with 2 places. The cost benefit has been shown in Table 4

Table 4 Data collection before and after implementing JITIP4

Before	After
Casting weight of part = 12500 kgs	Casting weight of part = 12500 kgs
Weight of 2 pieces = 25000 kgs	Weight of 2 pieces = 25000 kgs
Runner/ Riser Weight = 9700 kgs	Runner/ Riser Weight = 7300 kgs
Total Weight of box = 34700 kgs	Total Weight of box = 32300 kgs
Yield % age = 72%	Yield % age = 77%
Reduction in Runner / Riser weight per box = 9700-7300 = 2400	
Reduction in Runner/Riser weight per piece = 2400/2 = 1200 kgs	
Average Production in 200 pieces/Month	
Cost of Molten Metal = Rupees 9/kg	
Total Saving /Month = Rupees 2160	

Conclusions

From the literature, it can be concluded that there is reasonably vast literature available on JIT which gives a broad view of JIT philosophy and past practices and researches carried over the globe. But as JIT is a widely accepted philosophy in the manufacturing industries more research work is required in this field. Although JIT implementation does not depend upon size and type of industry but the strategies needs to be modified before implementing it to small scale industries. The author feels that there are some areas where there are some gaps where a great

scope of research is available for the new researchers. Secondly, it can be seen that there is a general consensus that JIT form a very effective manufacturing philosophy. These strategies are universal in nature and encompass all aspects of manufacturing. These include the generation of an appropriate cultural environment, which includes total commitment at all levels of management and within the workforce. A net savings of rupees 35875 per month has been obtained after implementing JIT approach in a medium scale industry of northern India. The study can be extended in Non ferrous foundry and forging shop of the same organization. Automation solution can be introduced. The selection of manufacturing Industry under study is based on convenience sampling technique.

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