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A Study on The Challenges And Solutions To Just In Time Manufacturing

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Abstract: *The objective of this study is to understandthe existingchallengesin JIT including the challenge of eliminating or neutralizing Safety stock, Improper methods of production, Industry specific success factors of JIT, Reduced Setup time, Batch Production, Lot Size and Supply Chain Management.The relationship between Just in Time manufacturing (JIT) and Total Quality Management (TQM), a broader management philosophy has been observed.The Research methodology used in this paper includes the Case Study Approach and Game Simulation Analysis obtained from the literature reviews. The benefits and limitations of JIT vary across different industries, type and volume of production. Thus, they should be carefully studied before operating in the JIT manufacturing environment. It has been observed that TQM and JIT provided synergized benefits when implemented simultaneously.*

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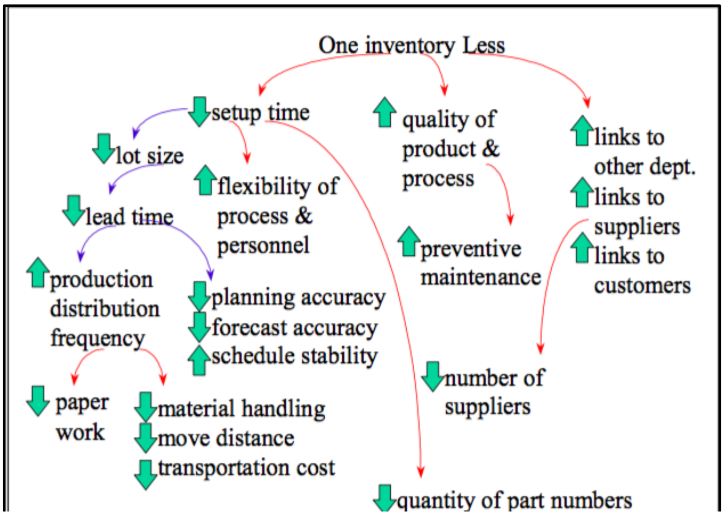
I. INTRODUCTION

JIT is a methodology developed by Taiichi Ohno and perfected within Toyota Motor Corporation manufacturing plants, aimed at primarily reducing flow times within the production systems as well as the response times from suppliers to the customers.

Graph 1: Impact of Just in Time Manufacturing System on associated factors



(Yeh)

1.Challenges in JIT Production

1.1 Reduction in Safety stock

Organizations have been following the Traditional mechanism of manufacturing which encouraged the concept of Safety stock due to the benefits of surplus resources. However, modern manufacturing mechanisms disparage the maintenance of Safety stock due to the benefits realized from their absence, which include Decreased costs, increased efficiency and effectiveness, etc. (Trinkaus, Dannerbring, & Nathan, 1996) The case of a Computer manufacturer, One shipment turned out to have larger number of defective parts than estimated and the operations of the entire plant came to a halt leading to a further disruption in the firm's Sales and Distribution network for several weeks. 2)The 1993-1994 Winters, Riders of a commuter rail line in the Northeast found that about one-third of their trains were shortened due to lack of operable cars. This happened after being hit by over a dozen major storms. The line could not return to rolling stock service in time because of shortage in parts necessary for the repairs. 3) The bad weather caused problems to local municipalities, due to lack of Salt for melting ice on highways, the delivery of supplies was implemented using slippery roads which lead to the total damage of roads due to them being not treated. 4) The case of United Automobile Workers v General Motors parts plant 1992 strike action, Within five days, four major assembly factories were closed, further within the next three days, seven more major assembly factories were closed due to lack of parts. This was a hazard for a firm operating in the world marketsfacing tremendous competition. 5) The hospitals function 24 hours a day and are expected to be fully operational. Deaths can happen due to lack of resources, economic realities and moral judgmentshave to be justified. 6) Other possible issues include relationship with the supplier, etc. "Act of God," as a variable is not accounted for in the JIT model. 'No more than one day's supply of materials and parts was to be kept near the production lines,' said Kichiro Toyota, founder Toyota Motor Corporation. Thus, the challenge of moving from holding Safety stock in different forms of inventory to holding negligible quantity of Safety stock arises while implementing JIT. The solutions to the traditional mindset of holding Safety stock include Increased data processing involvement in implementation planning efforts in order to upgrade systems to JIT level, statistical process control enhancement to provide timely feedback for engineering and managing tuning, meaningful contingency planning as a response to defects in critical parts, and materials and effective user supply dialogues to support delivery and quality issues.

1.2 Improper methods of production

Implementation of JIT implies reduction in the available Lead time, a challenge to the organization. This is due to the improper manufacturing practices that have been followed in the traditional manufacturing mechanism. (Young, 1992)The whole system is built on the basis of 'Push'mechanism of manufacturing. Each worker is responsible for producing a subassembly at target based but self-paced production rate. High levels of Work in Progress inventory decouple the process and creates slack in the system. The worker is compensated on the basis of Hourly or Piece rate method of production. The qualifying output is of maximum quantity and lowest quality in nature incurring an increased cost and displaying decreased effectiveness. The product is only checked once by the quality control personnel after it is finalized. 1) The case of New United Motor Manufacturing Company where Kaizen was not implemented. 2) The case on Toyota Motor Corporation in which Santoshi Kamata, a seasonal worker at Toyota Motor Corporation reported the existing conditions on-site due to the cruel work environment caused by extremely tuff work rules, an extremely fast work pace and a large number of work-related injuries. 3) The case on Nissan, Work pace was found to be excessive by workers. 4) The case on Honda Motor Company plant in which a man got crushed on the rear door welding line due to a speed-up in production and dangerous working conditions. These Automobile cases indicate lack of concentration and work discipline among workers. Other challenges include improper methods of procuring material in terms of distances, miniscule subcontracting networks, low vendor performance-based incentives, use of obsolete cost accounting and performance management systems to allocate costs and assess performance. The solutions to the improper manufacturing practices include redesigning the pre-designed system on the 'Pull'based manufacturing mechanism, promoting team work, reducing job classification, modifying work rules for the manufacturing premises, cross training, developing lead by final stage production workers over the flow of production subassemblies, implementing Kanban or Signaling system, Kaizen, TQM, ensuring multiple quality checks over the production process with individual accounting, compensating on the basis of individual or group performance, building stronger concentration levels and discipline among workers, ensuring large subcontracting networks, and investing in upgrading the existing systems to re-design the existing methods of production.

1.3 Industry-specific success factors

JIT has been adopted in some industries over the period of time while it is in the process of being adopted in the others. The constraints involved in JIT vary across different industries. Thus, the challenge of Industry specific success of JIT arises while implementing and practicing JIT. (Hokoma, Khan, & Hussain, 2010) Observationsspecifically from the Iron and Steel industry. It is observed that JIT is formally implemented to only 8.3% respondent levels in the study cited above, signifying the existence of different challenges associated with JIT in the Iron and Steel industry. (1) Thechallenge of unfamiliarity with JIT philosophies and practices, due to lack of management support which account for 77% respondent levels while, (2) lack of management support accounts for 11% respondent levels and (3) lack of interest within the companies towards JIT accounts for 11% respondent levels. (4) Lack of implementation of any programme to reduce Setup time accounts for 55% respondent levels with a mean value of 2.56. (5) Lack of implementation of any programme for group technology accounts for 70% respondent levels with a mean value of 1.79. (6) Lack of Implementation of levelled and mixed scheduling programmes account for 73% respondent levels with a mean value of 1.79. (7) Not using Kanban cards or Signals as a production control system accounts for 90% respondent levels with a mean value of 1.54. (8) Lack of Implementation any quality circle (QC) programmes accounts for 55%

respondent levels with a mean value of 2.48. This signifies poor and ineffective implementation and execution. The challenges of Waste elimination programmes include(9) Waste elimination, due to over production with a mean value of 4.17, (10) by reducing ques and waiting times with a mean value of 3.5, (11) by using planned and controlled operations to avoid extra operations with a mean value of 4.5, (12) by eliminating waste due to a delay of materials before processing with a mean value of 3.75, (13) by eliminating waste due to unnecessary transportation and conveyance with a mean value of 3.33, (14) by reducing inventory with a mean value of 3.5, (15) by producing zero defects with a mean value of 4.33, and (16) by using proper employee utilization with a mean value of 4.33. This signifies a modest level of implementation exists to eliminate waste, needs to be further worked upon and developed. The solutions to the challenge of Industry-specific success, referring to the Iron and Steel industry, include re-designing the applied strategy, providing applied education and training, inculcating individual responsibility and the habit of working in teams, and research and development into industry specific manufacturing details. The success of implementing JIT will vary for each industry due to the existence of industry-specific factors that demand alteration of methods and solutions in JIT during its implementation and execution.

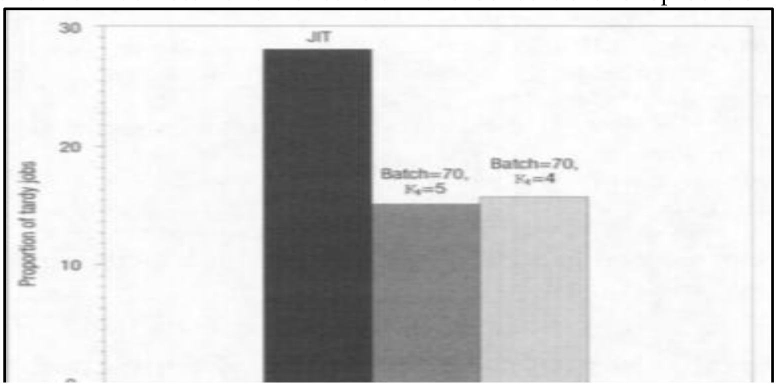
1.4 Reduction in Setup Time

Implementation and executionof JIT implies a reduction in the available Setup time, a challenge to JIT. (B.Biggart & Gargeya, 2002)1) The Total inventory to Sales ratio and 2) Raw material inventory to Sales ratio reduced substantially at a significance level of 0.01 post JIT implementation. 3) Work in Progress inventory to Sales ratio and 4) Finished goods inventory to Sales ratio did not witness any statistically significant change at 0.01 level post-JIT implementation. This signifies that organizations reduced their Total inventory primarily through reductions in the raw material by over stocking their supplier's raw material inventory in order to reduce their own inventory, and not through significant reductions in Work in Progress and Finished goods inventory. This indicates that the there exists a challenge of inventory management in JIT post the reduction in Setup time. Reduced Setup time in JIT highlights weak internal process resulting in piling up of Work in Progress and Finished goods inventory, leading to increased organizational inventory management expenses due to the cost of the excess inventory held, increased space requirements, decreased efficiency and effectiveness, etc. The solutions to tackle the challenge of reduced Setup time include making strategic changes with regard to layout re-configuration with cellular manufacturing/ group technology and adoption of setup time reduction technologies. However, tackling the challenge of excessive Work in Progress inventory due to reduced Setup time, by introducing statistical changes requires a long post-implementation time period.

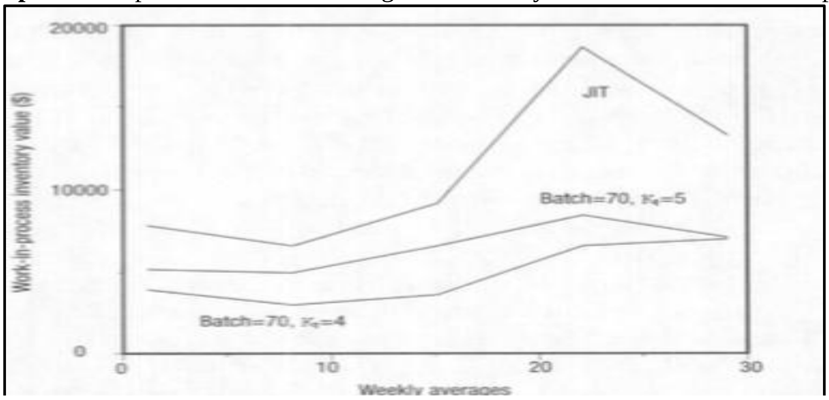
1.5 Batch Production

Batch processing, is a challenge to JIT. (Ziaul, 1999)The observations signify differential performance of shop control procedures in different manufacturing environments. Conventional shop procedures have been found to outperform JIT because during peak load periods, two workstations signify bottlenecks due to the disparateness involved in the job mix. The variability in processing times and the inability to allocate tasks to various production stages at equal levels creates imbalances in a job shop which do not suit JIT. The resulting blocking mechanism leads to excessive Work in progress inventory in certain production stages. This causes longer throughput times and missed dates of job certain jobs. (Sarker & Fitzsimmons, 1989) found that the efficiency of JIT decreased drastically at a nonlinear rate with a high coefficient of variation of processing time. Due to the bottlenecks and non-uniform distribution of job mix in batch processing, conventional shop control combinations have been found to outperform JIT in terms of Work in Progress inventory and tardy jobs. Therefore, according to the cited study, JIT is not a good option to consider implementing in job shops. However, these observations are only true for the tested shop in the study and may not be generalized.

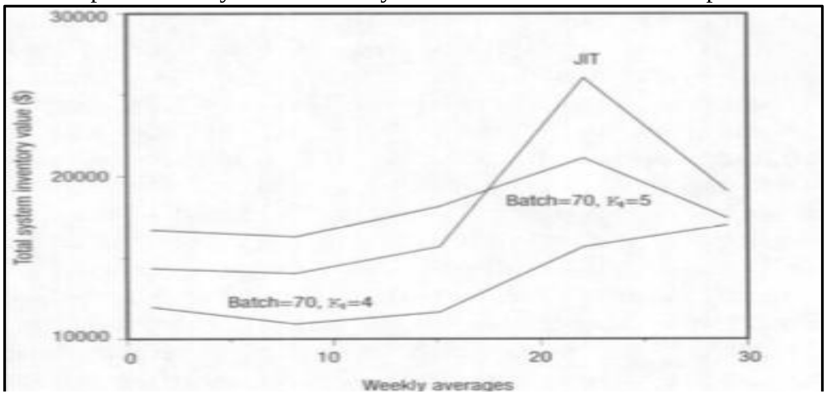
Graph 2: Comparison of Due Date Performance forJIT and Conventional Shop Control in a Job Shop



Graph 3: Comparison of Work in Progress Inventory inJIT&Conventional Shop



Graph 4: Comparison of System Inventory in JIT and Conventional Shop Control



1.6 Lot Size

Lot size is a bigger challenge to JIT when compared to Conventional manufacturing. (Shmanske, 2003)The challenge of Lot size exists because of multiple reasons including that JIT runs the potential risk of having to shut down operations if the planned production schedule is disrupted, reduced Setup and Lead time, etc. 1) The case summary on Supply chain management of Hewlett Packard as studied by Lee and Billington [13], according to Lee's and Billington's observations, Variabilities and uncertainties may occur at any point along the supply chain. Suppliers can be late in their shipments or the incoming material may be flawed. As a part of the strategic planning team, Lee and Billingtonanalysed inventory flows and production at Vancouver factory where inkjet printers were manufactured for Hewlett Packard, concluding that, "Supply chain problems are so complex that even defining and shaping the investigation is a challenge." Thus, the organization should be prepared to cope with the difficultyof delivering to the Lot size efficiently and effectively in unfavourable situations. Accuracyin forecasting Demand and Supply can play a big role in avoiding unfavourable situations and coping with the Lot size.2) Eliminating Buffer stocks is more likely to be beneficial when the Lot size is small compared to when it is large. The case of Northern California computer manufacturer's circuit assembly operation where in the cost per placement was used as its overriding performance measure, completely neglecting the fact that the site's performance affected the supply chain of computer manufacturing and distribution leading to excessive inventory in size. Thus, it implies that the Buffer size and Lot size need to be considered simultaneously. The benefits and limitations arising from the Lot sizewhile implementing and executing JIT need to be weighed and balanced to make the most ofJIT.

1.7 Supply Chain Management

Supply chain management is a challenge to JIT. The challenge of late delivery is the foremost challenge to be dealt with for the Supply chain managers. This challenge is thought to be existing due to external stakeholders involved in the Supply chain at the very first instinct. However, it is proved that the challenge may also exist due to the organization's internal procedures and internal inefficiency. For example, Long purchasing procedure and Delay in approvals. (Kram, Tosanovic, & Hegedic, 2015)Case study research conducted in a suspension and joining equipment factory in Croatia producing electrical equipment for high voltage transmission lines has been used. It was observed that the Suppliers had an impact on delivery delays as the supplies delivered by them were of poor quality and were delivered with a delay. These factors lead to delayed production lines eventually leading to late product deliveries to the company's clients. The strategy chosen for finalizing the supplier was the price-based strategy, ie the cheapest supplier got the job and other factors like estimated delivery, and time and quality of delivered supplies were not considered. Planned metrics including Customer service and Internal efficiency, ie on-time completion rate, on-time delivery rate, the value of late orders, number of warrant returns and repairs, inventory value, inventory returns and return on sales were considered for cross verification of the challenge. Data records containing accurate inventory lists and its value, and on time delivery dates list were found missing. Kaizen, Ishikawa/ Fishbone/ Cause and effect diagram and 5xWhy methodology was applied to find the root cause of the set challenge.

Graph 5: Fishbone diagram depicting the problem of delay in delivery

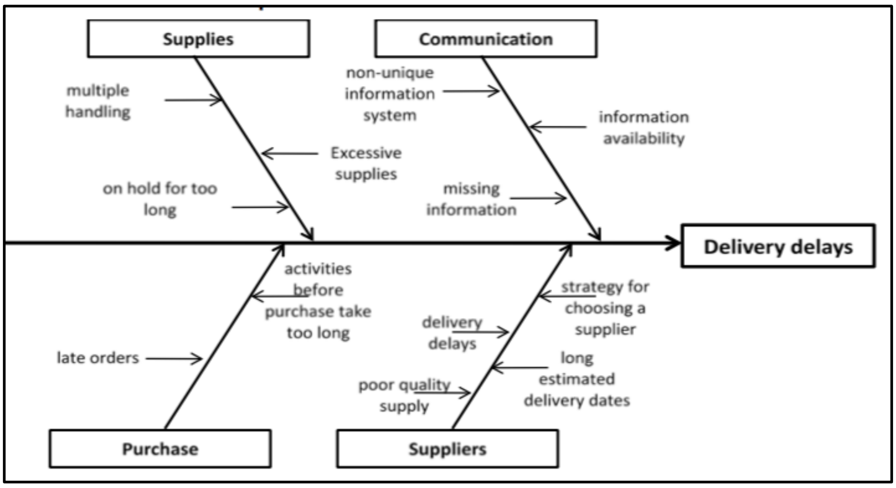
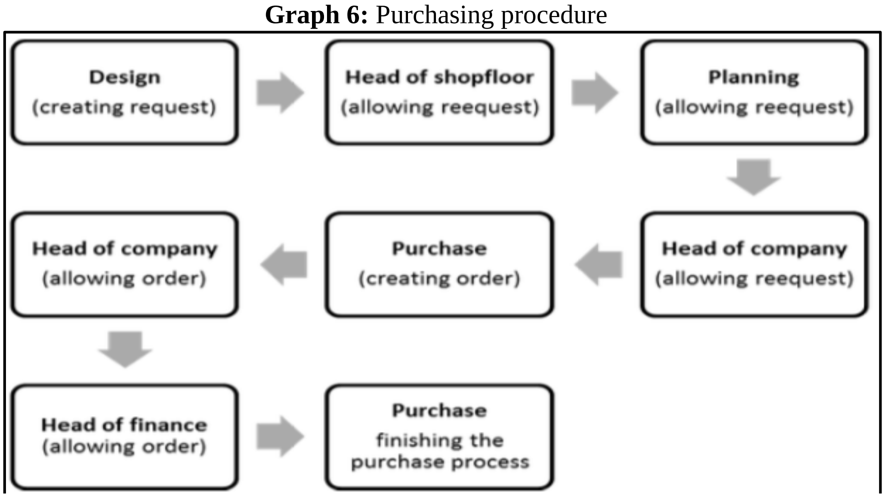


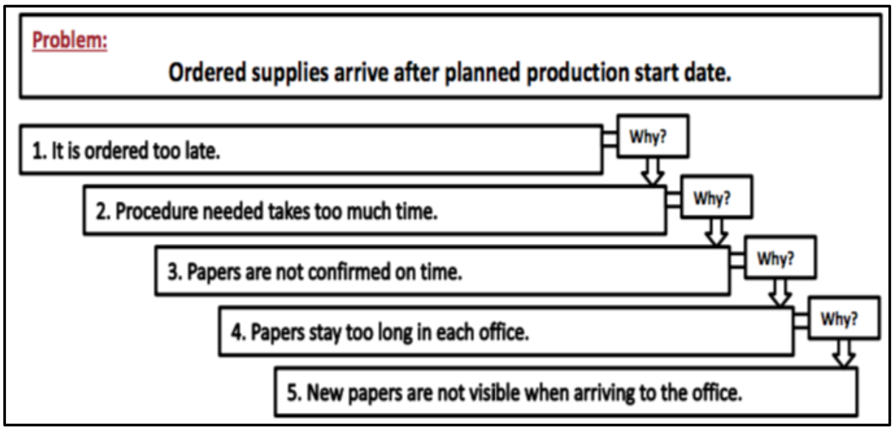
Table 1: Main causes for the delay in delivery

Sr No	Root Cause	Explanation
1.	Excessive supply	Took a lot of space, required additional handling for current projects, lead to high amount of frozen capital and less capital for investing in supplier relations.
2.	Ineffective Communication	Very slow communication. A complicated flow of information despite the functioning Information systems. Interdepartmental information exchange was missing leading to lapse in product planning. Eg Final date of supply delivery date did not reach the planning department from purchasing department in any form, making planning impossible and leading to production gaps.
3.	Complicated purchasing procedure	Graph 6. Physical papers were transferred between different person's office. Up to 50 different papers used daily. The procedure at times took up to a month leading to late order with unrealistically expected short delivery dates which weren't met due to long estimated delivery dates insupplier's delivery policies.
4.	Suppliers	Constitute only ¼th of theabove-mentioned challenges. Supplier related challenges include the wrong basis for choosing the supplier and lack of relationships with the supplier.

Graph 6: Purchasing procedure



Graph 7: 5xWhy sheet for the set challenge



A simple and temporary solution to the challenge of Delayed delivery has been mentioned below.

Graph 8: Visual board for managing purchase

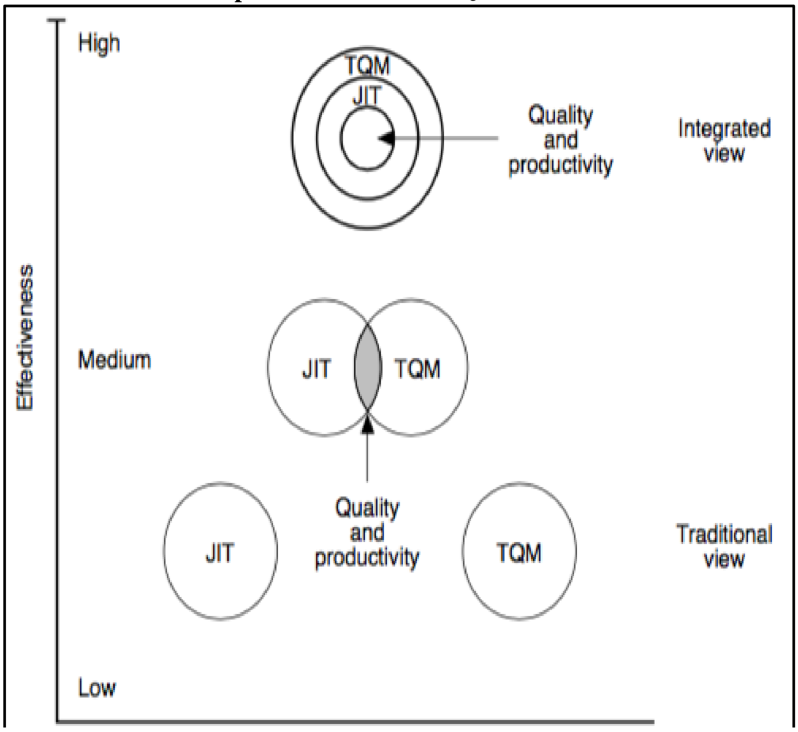
Red – Signifies the person's case is full, the person needs to work on them and forwarded it to the next person in the chain.

Green - Signifies a free case and that the next person in the chain needs to attend to his case.
The observed challenge was to ensure that the papers dint stay too long in the offices just because a person did not see the new ones coming. This resulted in reduced wasted time and movement towards improved supplier relationships. Therefore, bring the challenge of Supply chain one step closer JIT.

II. TOTAL QUALITY MANAGEMENT

JIT and TQM are two revolutionary approaches developed by the Japanese. JIT was integrated into TQM by the Japanese however it was the other way around for the Western countries. Thus, traditionally, JIT and TQM were viewed as two separate approaches, with manufacturing quality control, being the only linkage between them. Those companies which have employed both, JIT and TQM have immensely benefited from them including Ford Motor Company, Hewlett Packard, Toyota Motor Corporation, etc. Operational performance has been found to have improved by implementing both JIT and TQM. JIT is based on two broad principles, Elimination of waste, and Full utilization of people, equipment, materials and parts. JIT is constituted in multifunctional employees, reduced setup times, group technology, quality circles, total preventive maintenance, uniform plant loading, Focused factory, total Kanban, quality control and JIT purchasing. JIT is more suitable to repetitive production backed by steady demand. TQM is an integrative management philosophy. It aims at continuously improving the quality of products and processes to achieve customer satisfaction. TQM is applicable to all types of industries, ie repetitive, customized, and high and low volume production. JIT focuses more on improving the manufacturing efficiencies, ie minimizing inventory, parts and components standardization, use of quality resources, etc. TQM focuses on improving the overall effectiveness of an organization, defines the responsibility of the top management, offers clear directions to improve quality and productivity, ensures lucid interdepartmental interaction, and aims at continuous improvement in all activities directly and indirectly related to manufacturing. Since JIT focuses on inventory minimization, quality, and arrival time of raw material and the final product becomes important. Thus, operational objectives must be set clearly. TQM includes organized development and deployment of quality improvement strategies. TQM is supported through the creation of a supportive environment, ie interactive functions, training and development, and reward system and supporting infrastructure, ie quality information systems, benchmarking and customer feedback systems. For example Zero inventory and expectation of employees to confirm to tight schedules without appropriate supporting infrastructure reduce the long-term productivity. Thus, there is a synergistic effect of implementing TQM and JIT simultaneously, neither of them should be implemented in isolation and an integrated business strategy must be implemented in which JIT is treated as a natural component of the TQM philosophy of overall organizational performance improvement.

Graph 9: Evolution of TQM and JIT



III. CONCLUSION

Just in Time productionhas its own benefits and challenges including, the challenge of eliminating or neutralizing Safety Stock, Improper methods of production, Industry specific success factors of JIT, Reduced Setup time, Batch Production, Lot Size and Supply Chain Management, is not a good fit for all industries, types andvolume of production. Thus, the benefits and challenges ofJIT need to be measured and optimized to be able to make the most ofJIT.Essential Safety stock can be kept in bare minimal quantity to avoid unfavorablesituations. Prevailing methods of production can be based on 'pull' mechanism of manufacturing and the production methodology can be built around it. Implementation and execution of JIT may be altered to suit Industry specific success factors. The Internal processes must be strengthened to be able to cope with reduced Setup time. JIT may not me suitable for Batch production. JIT emphasizes accurate estimation of Demand and Supply of associated factors tonail the Lot size delivery efficiently and effectively. Delivery timing is the foremost challenge that concerns Production managers. Simple and Temporary strategies have been suggested to rectify delivery delay. JIT requires a certain environment for it to be able to perform to its capacity. Total Quality Management is a broader philosophy which is complementary to JIT. Thus, JIT should be implemented simultaneously with TQM as they together produce synergized benefits.

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