An Integrated Approach to Design and Analysis of Lean Manufacturing System: A Perspective of Lean Supply Chain

THESIS

Submitted in partial fulfillment
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

by

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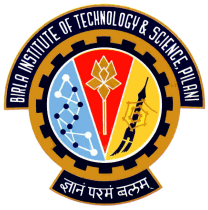

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE
PILANI (RAJASTHAN) INDIA

2009

SYNOPSIS

The objective of this research is to emphasize a need for an integrated approach to the lean manufacturing system in order to achieve total leanness along the supply chain to gain significant competitive advantages. The research focuses on the following five key dimensions.

i. Pricing, investment and order quantity decisions in a supply chain between a manufacturer and a retailer: The relation between the optimal configuration of investment, price and order quantity from the perspective of manufacturer and retailer are discussed. The collaboration between manufacturer and retailer for setting a maximum-profit price is recommended.

ii. Just-in-time (JIT) inventory analysis for a buyer and vendor considering the quality improvement, setup cost and lead time reductions: The integrated joint buyer-vendor optimal policy compared to independent buyer-vendor optimal policy is recommended with the objective of minimum total cost. Buyer integration with high quality vendor is preferred due to lower total costs. Constraints on the quality improvement yields higher total relevant cost for buyer and vendor coordination. Investment on quality results in small lot size, which is a hallmark of JIT system. JIT integrated inventory model is investigated with the objective of simultaneously optimizing the order quantity, setup cost, process quality, number of deliveries and lead time. The investments in setup cost reduction, quality improvement and lead time reduction, results in reduction of total cost, order quantity and number of deliveries.

iii. Optimal cycle length and number of inspections considering the setup cost reduction and quality improvement: Investment in setup cost reduction will result in reduction in primarily the optimal production run length means small lot size, while the investments in quality improvement results in number of inspections undertaken to be unity during each production run. The investment in setup cost reduction and quality improvement in (a) imperfect production process and (b) imperfect production process with inspection and restoration are considered using both time-varying lot sizes approach and common cycle approach. The time-varying lot sizes approach is recommended with the objective of minimizing the total cost.

iv. Optimal batch size in a single-stage production system with inspection errors and optimal number of kanbans in a multi-stage JIT production-delivery system with rework consideration: The effect of process inspection and restoration in the imperfect production process with inspection errors considering the following three different scenarios are investigated: (a) single lot of raw material - multiple lot of finished product - multiple delivery of the product, (b) single lot of raw material - multiple lot of finished product - single delivery of the product, and (c) single lot of raw material - single lot of finished product - single delivery of the product. The analysis shows that incorporating the inspection and restoration in the imperfect production process results in larger batch sizes and lower total costs. Modeling aspects of rework process is developed for the following cases: (i) economic order quantity and production run length for a single-stage production system, and (ii) the optimal batch quantity and number of kanbans in a multi-stage production system. The rework policy consideration results in higher total cost.

v. Analysis of lean manufacturing tools for supply chain performance: This study focuses on distinguishing and analyzing the lean tools in achieving reduced lead time, minimum rework, less inspections, low inventory, less setup cost, optimal cycle time, optimal batch size, quality improvements and JIT production-delivery. Fourteen lean tools are identified and investigated with their percentage importance by providing insight into organizations designing lean supply chains through secondary data collected from the Industry Week's best plant award winners. The study reaffirms that adopting a lean supply chain in any manufacturing organization is significant in increasing the productivity gains. Six major lean tools emerged from this work (a) kaizen, (b) 5S, (c) JIT, (d) value stream mapping, (e) kanban, and (f) six sigma are recommended for the commitment to lean manufacturing by industries at the supply chain level coupled with the employee involvement to realize the benefits of lean.