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Review of Lean Manufacturing Implementation in Textile Industry

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ABSTRACT
The purpose of this review paper is to discuss the lean implementation and its quantified benefits for the textile industry. Both current and future state maps of the organization's shop floor scenarios are discussed using lean techniques in order to highlight improvement areas and to bridge the gap between the existing state and the future state of shop floor of the textile industry. After an exhaustive review it is being found that lean implementation has many benefits at organizational and operational level. It has been concluded that, still many of the Indian textile industry have not adopted lean and it may be beneficial for them.

Introduction

The manufacturing industry has experienced an unprecedented degree of change in the last few decades, involving drastic changes in management approaches, product and process technologies, customer expectations, supplier attitudes as well as competitive behavior (Ahuja et al., 2006). In today's highly dynamic and rapidly changing environment, the global competition among organizations has lead to higher demands of the manufacturing organizations (Miyake and Enkawa, 1999). The global marketplace has witnessed an increased pressure from customers and competitors in manufacturing as well as service sector (Basu, 2001; George, 2002).

Compared to widespread implementation of Lean techniques across almost all areas of the manufacture of assembled products, Lean improvement efforts lag within the process industries. Manufacturing operations that produce paints, salad dressings, synthetic fibers, plastics, ceramics, and pharmaceuticals are quite different from operations that assemble refrigerators, automobiles, cell phones, lawn mowers, and medical instruments. The differences are significant enough that manufacturing engineers working in a process environment face challenges unique to those operations, and must adapt traditional Lean tools to apply them successfully. Lean as a concept has evolved over time, and will continue to do so. As a result of this development, significant confusion about what is lean, and what is not has arisen – a fact clearly observable at both academic and practitioner conferences in logistics and operations management.

This present paper is mainly focused on review of implementing lean manufacturing techniques in a textile industry, mainly dealing with fabrication of cloths. The companies are equipped with dying, weaving and processing divisions. The attention of this present research paper is on the review of textile division globally.

In this division the basic raw material yarn is converted into fabric. The textile division has many more departments like; planning, raw material storage, warping, sizing, drawing, weaving, quality control and rework.

Literature Review

Manufacturing industry has shown a significant growth through increasing productivity and product quality while reducing product lead times utilizing variety of strategies which are based on technology, employees, process, product, material and management (Kumar 2006). The improvements are achieved through process management strategies such as reduction of human efforts, space, engineering hours, lead times and inventory while increasing the quality, product variety and the flexibility of manufacturing operations (Diekmann et al., 2004). Different philosophies were also introduced to the manufacturing industry, namely total quality control (TQC), total quality management (TQM), theory of constraints (TOC), just-in-time (JIT), lean manufacturing, total productive maintenance (TPM) and six sigma. A critical review on these strategies by Stamm et al. (2009) concludes that aforementioned strategies have a common core aim of eliminating waste or variability using different approaches. Furthermore, Hines et al. (2004) mentioned that the other manufacturing strategies can easily be integrated into lean without contradicting the strategic objective of lean, to provide customer value.

Lean Manufacturing

Lean manufacturing philosophy is at the forefront in today's operations management and quality improvement practices. It is characterized by its goal of maximizing productivity (Brown et al., 2008). Its primary focus is to minimise wastage, reduce variation in standards and to improve production quality (Nave, 2002). It also reduces cycle time, increases flexibility, and improves productivity (Hobbs, 2004). Essentially, knowledge is distributed in lean

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manufacturing because reduction in waste is regarded as common responsibility for all employees in the organisation. It covers aspects of just-in-time (JIT) (Brown et al., 2008; Zhu and Meredith, 1995), workflow management, culture of minimum waste as well as continuous improvement. The driving force of lean manufacturing is the process of continuous improvement through the elimination of waste or non-value adding activities (Burton and Boeder, 2003). Eight types of waste categories that include defects were introduced in Burton's study.

A Brief History of Lean

The origins of lean thinking can be found on the shop-floors of Japanese manufacturers and, in particular, innovations at Toyota Motor Corporation (Shingo, 1981, 1988; Monden, 1983; Ohno, 1988). These innovations, resulting from a scarcity of resources and intense domestic competition in the Japanese market for automobiles, included the just-in-time (JIT) production system, the kanban method of pull production, respect for employees and high levels of employee problem-solving/automated mistake proofing. This lean operations management design approach focused on the elimination of waste and excess from the tactical product flows at Toyota (the Toyota "seven wastes") and represented an alternative model to that of capital-intense mass production (with its large batch sizes, dedicated assets and "hidden wastes"). Much of the early work at Toyota was applied under the leadership of Taiichi Ohno to car engine manufacturing during the 1950s, later to vehicle assembly (1960s), and the wider supply chain (1970s). It was only at this latter point that supplier manuals were produced and the "secrets" of this lean approach were shared with companies outside Toyota for the first time. These manuals were written in Japanese, and it took almost another decade before the first English literature was available (e.g. Shingo, 1981; Schonberger, 1982; Hall, 1983; Monden, 1983; Sandras, 1989)

Lean manufacturing has been the buzzword in the area of manufacturing for past few years. The concept originated in Japan after the Second World War when Japanese realized they could not afford the massive investment required to build facilities similar to those in the USA. The goal of lean manufacturing is to reduce waste in human effort, inventory, time to market and manufacturing space to become highly responsive to customer demand while producing quality products in the most efficient and economical manner. Nicholas (1998) found that waste takes many forms and can be found at any time and in any place. Waste consumes resources but does not add any value to the product. Russell and Taylor (1999) define waste as anything other than the minimum amount of equipment, effort, materials, parts, space, and time that are essential to add value to the product. Lean manufacturing combines the best features of both mass and craft production: the ability to reduce costs per unit and dramatically improve quality while at the same time providing an ever wider range of products and more challenging work (Womack et al., 1990). It is a far more focused and contingent view of the value adding (VA) process. Lean manufacturing uses tools like one-piece flow, visual control, Kaizen, cellular manufacturing, inventory management, Poka yoke, standardized work, workplace organization, and scrap reduction to reduce manufacturing waste (Russell and Taylor, 1999; Monden, 1993) suggested a new scheme of classifying operations into three generic categories as non-VA, necessary but non-VA and VA. This scheme proved to be more generic and was extended to different areas.

Over the years, many lean manufacturing tools to support value stream have been developed and many more are being proposed every day (Womack et al., 1990; Barker, 1994; Cusumano and Nobeoka, 1998; Childerhouse et al., 2000; Taylor and Brunt, 2001).

Lean Methodology in Textile Industry

Lean methodology is one of those concepts introduced to the apparel sector with the objective of increasing productivity, improving product quality and cycle time, reducing inventory, reducing lead times and eliminating manufacturing waste. All these objectives will ultimately formulate one core objective of providing an enhanced customer satisfaction while eliminating the waste activities of manufacturing. Lean manufacturing is yet to be spread widely in the textile industry. The theory of lean manufacturing needs to be adapted accordingly to suit the particular industry in concern. This is because; it is difficult and misleading to use the lean experience (activities and performance indicators) in another industry as a reference point. The economic, cultural and social background of the Toyota Company, where lean manufacturing was developed and is practiced extensively, is largely different from that of companies.

A recent study on benefits of lean methodology by McGrath (2007) indicates that the main driver for becoming lean for most of the companies is to make profits either directly by reducing costs or indirectly by improving productivity. This may be the likely reason that many industries including apparel manufacturers opt to use the lean methodology in being competitive. Liker and Morgan (2006), state that even though many companies adopted some type of lean initiative, most of such efforts represent quick fixes to reduce lead time and costs and to increase quality which almost never created a true learning culture. Implementation of new manufacturing practices has not always been successful as the focus had been mostly on technical factors with little concern for soft issues like organisational culture which has been often ignored (Nahm et al., 2004). Furthermore, Forrester (1995) states that the change in culture to lean manufacturing is a profound one. Therefore studying both of these facets, namely technical performance and cultural impact, are critical in lean implementation.

Lean Principles

Hodge et.al. (2011) determined which lean principles are appropriate for implementing in textile industry. This paper investigates the different tools and principles of lean and the use of lean manufacturing in the textile industry was examined by the researchers by considering plant tours and case studies. From this case study the researchers came to a conclusion that lean manufacturing is a strategy that does not require large investment in automation or IT and it can be implemented in both small and large companies where all employees can be involved in improving operations to meet customer needs.

Overall, Lean is a powerful tool, when adopted it can create superior financial and operational results. But in many cases, the confusion about how to start lean, from where to begin is also a problem for new practitioners. In some cases, the company tries to implement lean but it does not give effective results and stops in-between. All these are due to lack of clarity before implementing lean and lack of top management commitment. So to avoid the chances of failure one has to prepare in advance for the outcomes of the lean and should involve all employees on improvement programs. Lean is not just about the implementation of tools but also the development of its employees to adopt these tools.

So, regular training and upgrading of employee skill is the most important factor for the success of lean. The major five principles of Lean are as follows (Burton T. and Boeder, 2003):

Principle 1: Accurately specify value from customer perspective for both products and services.

Principle 2: Identify the value stream for products and services and remove non-value-adding waste along the value stream.

Principle 3: Make the product and services flow without interruption across the value stream.

Principle 4: Authorize production of products and services based on the pull by the customer.

Principle 5: Strive for perfection by constantly removing layers of waste.

KIND OF WASTES: According to David Magee, (Magee, 2007) different kinds of wastes in a process can be categorized in following categories. These wastes reduce production efficiency, quality of work as well as increase production lead time.

Overproduction – Producing items more than required at given point of time i.e. producing items without actual orders creating the excess of inventories which needs excess staffs, storage area as well as transportation etc.

Waiting – Workers waiting for raw material, the machine or information etc. is known as waiting and is the waste of productive time. The waiting can occur in various ways for example; due to unmatched worker/machine performance, machine breakdowns, lack of work knowledge, stock outs etc.

Unnecessary Transport – Carrying of work in process (WIP) a long distance, insufficient transport, moving material from one place to another place is known as the unnecessary transport.

Over processing – Working on a product more than the actual requirements are termed as over processing. The over processing may be due to improper tools or improper procedures etc. The over processing is the waste of time and machines which does not add any value to the final product.

Excess Raw Material - This includes excess raw material, WIP, or finished goods causing longer lead times, obsolescence, damaged goods, transportation and storage costs, and delay.

Unnecessary Movement – Any wasted motion that the workers have to perform during their work is termed as unnecessary movement.

Defects – Defects in the processed parts is termed as waste. Repairing defective parts or producing defective parts or replacing the parts due to poor quality etc. is the waste of time and effort.

Unused Employee Creativity – Loosing of getting better ideas, improvement, skills and learning opportunities by avoiding the presence of employee is termed as unused employee creativity (Liker, 2003).

Waste Reduction Techniques

Some of the waste reduction tools include zero defects, setup time reduction, and line balancing. The goal of zero defects is to ensure that products are fault free all the way, through continuous improvement of the manufacturing process (Karlsson and Ahlstrom, 1996). Human beings almost invariably will make errors. When errors are made and are not caught then defective parts will appear at the end of the process. However, if the errors can be prevented before they happen then defective parts can be avoided. One of the tools that the zero defect principle uses is Poka Yoke. Poka-Yoke, which was developed by Shingo, is an autonomous defect control system that is put on a machine that inspects all parts to make sure that there are zero defects. The goal of Poka-Yoke is to observe the defective parts at the source, detect the cause of the defect, and to avoid moving the defective part to the next workstation (Feld, 2000).

Method Study: Method study focuses on how a task can (should) be accomplished. Whether controlling a machine or making or assembling components, how a task is done makes a difference in performance, safety, and quality. Using knowledge from ergonomics and methods analysis, methods engineers are charged with ensuring quality and quantity standards are achieved efficiently and safely. Methods analysis and related techniques are useful in office environments as well as in the factory. Methods techniques are used to analyze the Movement of individuals or material, Activity of human and machine and crew activity, Body movement (primarily arms and hands) (Heizer et al., 2000).

Time Studies: The classical stopwatch study, or time study, originally proposed by Federic W. Taylor in 1881, is still the most widely used time study method. The time study procedure involves the timing of a sample of worker's performance and using it to set a standard. A trained and experienced person can establish a standard by following these eight steps (Heizer et al., 2000). Define the task to be studied (after methods analysis has been conducted), Divide the task into precise elements, Decide how many times to measure the task (the number of cycles of samples needed), Record elemental times and rating of performance, compute the average observed cycle time. The average observed cycle time is the arithmetic mean of the times for each element measured.

Normal Time = (average observed cycle time) x (performance rating factor).

$$Standard\ Time = \frac{Total\ Normal\ Time}{1 - Allowance\ Factor}$$

Personal time allowances are often established in the range of 4% to 7% of total time, depending upon nearness to rest rooms, water fountains, and other facilities. Fatigue allowances are based on our growing knowledge of human energy expenditure under various physical and environmental conditions.

Work Sampling: It is an estimate of the percentage of time that a worker spends on particular work by using random sampling of various workers. This can be conducted by the following procedures (Heizer et al., 2000). Take a preliminary sample to obtain an estimate of the parameter value (such as percent of time worker is busy). Compute the sample size required, Prepare a schedule for observing the worker at appropriate times, The concept of random numbers is used to provide for random observation, Observe and record worker activities, Determine how workers spend their time (usually as percentage).

Layout Design: Layout is one of the key decisions that determine the long-run efficiency of operations. Layout has numerous strategic implications because it establishes an organization's competitive priorities in regard to the capacity, processes, flexibility and cost as well as quality of work life, customer contact and image. An effective layout can help an organization to achieve a strategy that supports differentiation, low cost, or response (Heizer et al., 2000). The layout must consider how to achieve the higher utilization of space, equipment, and people, Improved flow of information, material or people, Improved employee morale and safer working conditions, Improved customer/client interaction, Flexibility (whatever the layout is now, it will need to change).

Cycle Time: Cycle time is defined as how frequently a finished product comes out of our production facility (Rother et al., 2008). Cycle time includes all types of delays occurred while completing a job. So cycle time can be calculated by the following formula.

Total Cycle Time = processing time + set up time + waiting time + moving time + inspection time + rework time + other delays to complete the job

Facility Layout: Ongoing production process layout of jute industry is studied and a new layout will be developed based on the systematic layout planning pattern theory to reduce production cost and increase productivity. The number of equipment and travelling area of material in yarn production have been analyzed. The detailed study of the plant layout such as operation process chart, activity relationship chart and relationship between equipment and area has been investigated. The new plant layout has been designed and compared with existing plant layout. The new plant layout shows that the distance and overall cost of material flow from stores to dispatch area are significantly decreased. (Riyad, 2014).

Total Productive Maintenance (TPM)

TPM is a methodology originating from Japan to support its lean manufacturing system, since dependable and effective equipment are essential pre-requisite for implementing Lean manufacturing initiatives in the organizations (Sekine and Arai, 1998). While Just-In-Time (JIT) and Total Quality Management (TQM) programs have been around for a while, the manufacturing organizations off late, have been putting in enough confidence upon the latest strategic quality maintenance tool as TPM.

Nakajima (1989), a major contributor of TPM, has defined TPM as an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns, and promotes autonomous maintenance by operators through day-to-day activities involving the total workforce (Conway and Perry, 1999, Bhadury, 2000). The emergence of TPM is intended to bring both production and maintenance functions together by a combination of good working practices, team-working and continuous improvement (Cooke, 2000). Willmott (1994) portraits TPM as a relatively new and practical application of TQM and suggests that TPM aims to promote a culture in which operators develop “ownership” of their machines, learn much more about them, and in the process realize skilled trades to concentrate on problem diagnostic and equipment improvement projects. TPM is not a maintenance specific policy; it is a culture, a philosophy and a new attitude towards maintenance (Chowdhury, 1995). TPM is a system (culture) that takes advantage of the abilities and skills of all individuals in an organization (Patterson et al. 1995). An effective TPM implementation program provides for a philosophy based upon the empowerment and encouragement of personnel from all areas in the organization (Davis and Willmott, 1999). The rapidly changing needs of modern manufacturing and the ever increasing global competition has emphasized upon the re-examination of the role of improved maintenance management towards enhancing organization’s competitiveness (Riis, 1997). Confronted with such reality, organizations are under great pressure to enhance their competencies to create value to customers and improve the cost effectiveness of their operations on a continuous basis. In the dynamic and highly challenging environment, reliable manufacturing equipment is regarded as the major contributor to the performance and profitability of manufacturing systems (Kutucuoglu et al., 2001). Its importance is rather increasing in the growing advanced manufacturing technology application stages (Maggard and Rhyne, 1992). Therefore, equipment maintenance is an indispensable function in a manufacturing enterprise (Ahmed et al., 2005). The recent competitive trends and ever increasing business pressures have been putting maintenance function under the spotlight as never before (Garg and Deshmukh, 2006). For maintenance to make its proper contribution to profits, productivity, and quality, it must be recognized as an integral part of the plant production strategy (Kumar et al., 2004). Thus achieving excellence in maintenance issues has to be treated as a strategic issue for manufacturing organizations to create world-class-manufacturers (Brah and Chong, 2004).

Scope of Lean Manufacturing

Singh et al. (2010) discussed the scope of lean implementation in Indian industries and identified many lean implementation issues in consultation to Indian managers. They also grouped these issues by using principal component analysis. Chitturi et al. (2007) explored practical issues like how to calculate TAKT time, where to place supermarket, where can we use continuous flow processing, what process improvements can be done and how to handle different product families while mapping job shop operations.

Chauhan and Singh (2012) aimed to identify the measuring the associated parameters of lean. There is a broad scope to focus on the elimination of different forms of wastes from manufacturing system for the lean manufacturing in India. Green et.al (2010) wants to implement lean in a material handling system for petroleum drill bit manufacturing company. They addressed that the operational group with a tool to assist in defining the objectives of lean manufacturing has been developed by many of the authors. At the end, it is concluded that a special solution was developed from the process of implementing the project. The methodology was developed using lean manufacturing concepts and the material handling issues and the author identified through assessing the cells selected for the implementation of lean manufacturing in material handling operations. Review based on leanness assessment is presented in Vinodh & Vimal (2012). They presented the 30 criteria based leanness assessment methodology using fuzzy logic. Fuzzy logic has been used to overcome the disadvantages with scoring method such as impreciseness and ambiguity. In this paper, a conceptual model for lean assessment has been designed. Then the fuzzy lean index which indicates the lean level of the organization and fuzzy performance importance index which helps in identifying the obstacles for leanness has been analyzed. The results indicate that the model is capable of effectively assessing leanness and has practical significance. Taj (2005) presented a spreadsheet-based assessment tool to evaluate nine key areas of manufacturing namely, inventory team approach, processes, maintenance, layout/handling, suppliers, setups, quality, and scheduling/control. The results are then displayed in the score worksheet and finally a lean profile chart is created to display the current status of the plant and the gap from their specific lean targets. It is found from the results that lean assessment tool have revealed significant gap from the lean manufacturing target, and also identified opportunities for improvement.

Author provides a practical and easy way to use assessment tool to help manufacturing managers to make their manufacturing operations more productive. There is a lot of scope to implement this tool in other industrial sector for achieving leanness. In this background the scope of this paper is to quantify leanness in a textile industry.

Conclusions

In conclusion, it has been found that the implementation of lean manufacturing at the organizational level and operational level is crucial to understanding as a whole in order to apply the right tools and strategies to productivity improvement. Much of the discussion in textile industry and others still centers on the shop-floor, which exhibits a limited understanding of what contemporary lean approaches are about. It has been made an attempt to summaries how the lean concept has evolved from industries and it can be utilized for the benefit in the fabric or yarn industries as well. The resulting lean value system encompasses a value-adding network of operations across companies, with the goal of providing a series of contingent lean techniques.

Most of the firms in the Indian textile industry are small. Even so, there are differences in their working culture. In any event, implementation of lean techniques deployment in the textile industry is generally low. Quality control and TPM have a high degree of implementation, but other practices (group technology, kanban, set-up time reduction, multi-function employees and graphs or panels for visual factory) are uncommon. We are of the opinion that variations in operational performance are hard to explain in this sector. The use of Lean techniques practices as described in the present study may have important determinants of high performance. The economies of scale associated with high manufacturing volumes lead to high levels of efficiency in many industries.

References

Ahmed, S., Hassan, M.H. and Taha, Z. (2005), “TPM can go beyond maintenance: excerpt from a case implementation”, Journal of Quality inMaintenance Engineering, Vol. 11 No. 1, pp. 19-42.

Ahuja, I.P.S. and Khamba, J.S. (2007), “An evaluation of TPM implementation initiatives in an Indian manufacturing enterprise”, Journal of Quality in Maintenance Engineering, Vol. 13 No. 4, pp. 338-52.

Ahuja, I.P.S. and Khamba, J.S. (2008a), “An evaluation of TPM initiatives in Indian industry for enhanced manufacturing performance”, International Journal of Quality & Reliability Management, Vol. 25 No. 2, pp. 147-72.

Ahuja, I.P.S. and Khamba, J.S. (2008b), “An assessment of maintenance management initiatives in Indian manufacturing industry”, International Journal of Technology, Policy, Management, Vol. 8 No. 3, pp. 250-78.

Ahuja, I.P.S. and Khamba, J.S. (2008c), “Strategies and success factors for overcoming challenges in TPM implementation in Indian manufacturing industry”, Journal of Quality in Maintenance Engineering, Vol. 14 No. 2.

Ahuja, I.P.S., Khamba, J.S. and Choudhary, R. (2006), “Improved organizational behavior through strategic total productive maintenance implementation”, ASME International Mechanical Engineering Congress and Exposition (IMECE), Chicago, IL, November 5-10, pp. 1-8.

Ahuja, I.P.S., Singh, T.P., Sushil, M. and Wadood, A. (2004), “Total productive maintenance implementation at Tata Steel for achieving core competitiveness”, Productivity, Vol. 45 No. 3, pp. 422-6.

Barker, R.C. (1994), “The design of lean manufacturing systems using time based analysis”, International Journal of Operations & Production Management, Vol. 14, pp. 86-96.

Burton, Terence T., and Boeder, Steven M. (2003). Lean Extended Enterprise : Moving Beyond the Four Walls to Value Stream Excellence. Boca Raton, FL, USA: J. Ross Publishing Inc. p. 122.

Chowdhury, C. (1995), “NITIE and HINDALCO give a new dimension to TPM”, Udyog Pragati,Vol. 22 No. 1, pp. 5-11.

Coetzee, J.L. (1999), “A holistic approach to the maintenance problem”, Journal of Quality in Maintenance Engineering, Vol. 5 No. 3, pp. 276-80.

Cooke, F.L. (2000), “Implementing TPM in plant maintenance: some organizational barriers”, International Journal of Quality & Reliability Management, Vol. 17 No. 9, pp. 1003-16.

Cua, K.O., McKone, K.E. and Schroeder, R.G. (2001), “Relationships between implementation of TQM, JIT, and TPM and manufacturing performance”, Journal of Operations Management, Vol. 19 No. 6, pp. 675-94.

Chitturi, R.M., Glew, D.J. and Paulls, A. (2007), “Value stream mapping in a jobshop”, IET International Conference on Agile Manufacturing, Durham University, Durham, 9-11 July, pp. 142-7.

David, A.T. (1995), “Japan’s new advantage: total productive maintenance”, Quality Progress, Vol. 28 No. 3, pp. 121-3.

Davis, R. (1997), “Making TPM a part of factory life”, TPM Experience (Project EU 1190, DTI, Findlay, sponsored by the DTI.

Davis, R. and Willmott, P. (1999), Total Productive Maintenance, Alden Press, Oxford.

Feld, M.W., (2000). Lean Manufacturing: Tools, Techniques, and how to use them. Boca Raton, London: The St. Lucie Press.

Garg, A. and Deshmukh, S.G. (2006), “Maintenance management: literature review and directions”, Journal of Quality in Maintenance Engineering, Vol. 12 No. 3, pp. 205-38.

George, M. (2002), Lean Six Sigma: Combining Six Sigma Quality with Lean Speed, McGraw-Hill, New York, NY.

Gits, C. (1992), “Design of maintenance concepts”, International Journal of Production Economics, Vol. 24 No. 3, pp. 217-26.

Gomes, C.F., Yasin, M.M. and Lisboa, J.V. (2006), “Performance measurement practices in manufacturing firms: an empirical investigation”, Journal of Manufacturing Technology Management, Vol. 17 No. 2, pp. 144-67.

Gao L., Norton M. J. T., Zhang Z. and Kin-man To C. Potential Niche Markets for Luxury Fashion Goods in China. Journal of Fashion Marketing and Management Vol. 13 No. 4, 2009, p. 514-526.

Gersten, F. (ed), and Riis, Jens O. (ed)., (2002). Continuous Improvement and Innovation. Bradford, GBR: Emerald Group Publishing Ltd. p. 41.

Hall, R. (1983), Zero Inventories, Dow Jones-Irwin, Homewood, IL.

Hall, R.W., 1983b. Zero inventories crusade—much more than materials management. Production and Inventory Management Journal 24 (3), 1–8.

Hines, P., Holweg, M., Rich, N., 2004. Learning to evolve—a review of contemporary lean thinking. International Journal of Operations & Production Management 24 (10), 994–1011.

Heizer, J., and Render, B. (2000), Principles of Operations Management 4th Edition. Pearson College Div. ISBN-10: 0130271470. p. 336-420.

Huang, S.H., Dismukes, J.P., Shi, J. and Su, Q. (2002), "Manufacturing system modeling for productivity improvement", Journal of Manufacturing Systems, Vol. 21 No. 4, pp. 249-60.

Kumar, P., Wadood, A., Ahuja, I.P.S., Singh, T.P. and Sushil, M. (2004), "Total productive maintenance implementation in Indian manufacturing industry for sustained competitiveness", 34th International Conference on 'Computers and Industrial Engineering', San Francisco, CA, November 14-16, pp. 602-7.

Miyake, D.I. and Enkawa, T. (1999), "Matching the promotion of total quality control and TPM: an emerging pattern for nurturing of well-balanced manufactures", Total Quality Management & Business Excellence, Vol. 10 No. 2, pp. 243-69.

Sharma, R.K., Kumar, D. and Kumar, P. (2005), "FLM to select suitable maintenance strategy in process industries using MISO model", Journal of Quality in Maintenance Engineering, Vol. 11 No. 4, pp. 359-74.

Levitt, J. (1996). Managing factory maintenance. Industrial Press Inc., New York, NY.

Feld,M.W.,(2000).Lean Manufacturing: Tools, Techniques, and how to use them. Boca Raton, London: The St. Lucie Press

Kumar, S. A. (2008). Production and Operations Management. Daryaganj, Delhi, India: New Age International, p. 217-220.

Larson, A. (2003). Demystifying Six Sigma: A Company-Wide Approach to Continuous Improvement. Saranac Lake, NY, USA: AMACOM Books. p. 46.

Liker, J. K. (2004). The Toyota Way: 14 Management Principles From the World's Greatest Manufacturer. McGraw-Hill, NY.

Liker, J. K. & Morgan, J. M. (2006). The Toyota Way in Services: The Case of Lean Product Development. Academy of Management Perspectives, 5-20.

Liker, J. (2003). Toyota Way. Blacklick, OH, USA: McGraw-Hill Professional Publishing, p. 28-33.

Lucy Daly, M.B. and Towers, N. Lean or Agile: A Solution for Supply Chain Management in the Textile and Clothing Industry. International Journal of Operations & Production Management Vol. 24 No. 2, 2004, p. 151-170.

Magee, D. (2007). How Toyota Became Leadership Lessons from the World's Greatest Car Company. New York, USA: Penguin Group. p. 67.

Monden, Y. (1983), The Toyota Production System, Productivity Press, Portland, OR.

Nakajima, S., 1988. Introduction to TPM: Total Productive Maintenance. Productivity Press, Cambridge, MA.

Ohno, T. (1988), The Toyota Production System: Beyond Large-Scale Production, Productivity Press, Portland, OR.

Riyad et. al., (2014), "Increasing Productivity through Facility Layout Improvement using Systematic Layout Planning Pattern Theory" Global Journal of Researches in Engineering, Volume 14 Issue 7 Version 1.0 Year 2014

Rother, M. and Shook, J. (1998). Learning to See: value stream mapping to create value and eliminate muda. MA USA: Lean Enterprise Institute.

Rother, M. and Harris, R., (2008). Creating Continuous Flow an Action Guide for Managers, Engineers and Production Associates. One Cambridge Center, Cambridge USA: Lean Enterprise Institute. p. 13-1.

Shahidul, M. I. and Syed Shazali, S. T. Dynamics of manufacturing Productivity: Lesson Learnt from Labor Intensive Industries. Journal of Manufacturing Technology Management Vol. 22 No. 5, 2011, p. 664-678.

Shahram, T. and Cristian, M. The Impact of Lean Operations on the Chinese Manufacturing Performance. Journal of Manufacturing Technology Management Vol. 22 No. 2, 2011, p. 223-240.

S. Vinodh & K. E. K. Vimal, "Thirty criteria based leanness assessment using fuzzy logic approach", Int J Adv Manuf Technol (2012) Vol. 60, pp. 1185–1195

Shingo, S. (1981), Study of the Toyota Production Systems, Japan Management Association, Tokyo.

Shingo, S. (1988), Non-Stock Production: The Shingo System for Continuous Improvement, Productivity Press, Cambridge, MA.

Shirose, K., 1992. TPM for Workshop Leaders, Productivity Press, Cambridge, MA.

Sandras, (1989), JIT: Making it Happen. Unleashing the Power of Continuous Improvement, John Wiley & Sons, New York.

Schonberger, R.J. (1986), World Class Manufacturing – The Lessons of Simplicity Applied, The Free Press, New York, NY.

Singh, B., Garg, S.K. and Sharma, S.K. (2010a), "Development of leanness index to measure leanness: a case of an Indian auto component industry", Journal of Measuring Business Excellence, Vol. 14 No. 2.

Van Hoek, R., Harrison, A. and Christopher, M. (2001), "Measuring agile capabilities in the supply chain", International Journal of Operations & Production Management, Vol. 21 No. 1/2, pp. 126-47.

Womack, J., Jones, D.T. and Roos, D. (1990), The Machine That Changed the World, Rawson Associates, New York, NY.