Lean Production: Literature Review

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Key Words:

1.Lean Production
2. Agile Production

Abstract

This paper reviews the literature on lean production and concludes that a careful choice of lean tools, appropriate design and operation of lean systems and due attention to contextual factors may overcome the limitations of lean production. It recommends that lean production be used in conjunction with agile production so as to secure efficiencies resulting from lean and flexibility resulting from agile production

Introduction

The concept of lean production was pioneered by Toyota in the 1950s. It has since been adopted in different countries like the USA, UK, Belgium, France, Netherlands, China, Srilanka, Taiwan, Iran and India. (Alsmadi et. al., 2012) state that implementation of lean production is found in firms all over the world and have also benefitted from the same. In India, the concept of lean production is getting much attention and thus the adoption of lean production is likely to be high. It is in this context that a literature review of lean production achieves importance. The literature reviewed were classified into seven themes namely definition and tools of lean production, measurement of leanness, functional issues in lean production implementation, adoption of lean production, applications of lean production, comparative studies and limitations of lean production. The paper is organized as follows: part one briefly discusses the method, part two discusses the review of literature and part three consists of conclusion.

Method

Papers published in journals and conferences as well as books and PhD dissertation were referred for review of literature. Published and presented papers were accessed on the electronic databases with lean production and manufacturing as key words. Some databases had only abstracts and not full papers. A list was prepared of such abstracts that included the names of authors, titles of papers, name of the journal, volume number, issue number and year of publication or presentation. This list was submitted to a reputed library with a request to provide full text papers. This library provided the same to the author. On review of literature, the same was categorized into seven themes namely definition and tools of lean production, measurement of leanness, functional issues in lean production implementation, adoption of lean production, applications of lean production, comparative studies and limitations of lean production.

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Definition and tools of lean production

(Womack and Jones, 2003) define lean production as a series of activities that minimize waste and non-valued added operations and improve the value added process. (Nicholas, 2011) defines lean production as "management that focuses the organization on continuously identifying and removing sources of waste so that processes are continuously improved." (Hopp and Spearman, 2004) consider lean production as production of goods and services that minimizes buffering costs associated with excess lead times, inventories or capacity. (Abdulmaleka and Rajgopal, 2007) consider lean production as the process of identification of all types of wastes in a value stream of supply chain and also the implementation of tools required to eliminate them for minimizing lead time. TPS identifies different types of wastes as overproduction, waiting, conveyance, over processing, excess inventory, unnecessary movement, defects and un-used empooyee creativity (Karim and Arif-Uz-Zaman, 2013). Lean manufacturing is based on six principles – waste elimination, pull production, zero defects, streamlining of

ISSN : 2229-6514 (Print),2230-8237(Online)

processes, quality at source and continuous improvement. (Shah and Ward, 2003)view lean production as an integrated system consisting of a wide variety of management practices such as just-in-time, quality systems, work teams, cellular manufacturing and supplier management etc. Lean manufacturing concerns itself with economising; it may take the form of waste elimination, cost reduction or even better materials management (Seth and Gupta, 2005). (Sun, 2011)identified three characteristics of lean production as aggressive customer satisfaction effort, lean operations throughout the delivery system and close integration of resource network. (Upadhye et. al., 2009) in their study of manufacturing firms and educational institutes, studied the perceptions towards lean manufacturing. The same include cost reduction and utilization of resources, single piece flow, just-in-time production, combination of processes, effective, powerful tool, route to manufacturing excellence, suitable for non-variable and constant demand products, process-optimization, includes all parts of an organization, means to meet global challenges in quality and price, avoid wastage, judicious mix of manual and automatic processes, smooth flow of inventory and reduction in break-downs, moving up the value chain. They also identified key issues associated with lean manufacturing like inventory, lead time, rejections, warranty claims, transportation costs, break-down maintenance, house keeping, product design, process selection, supplier relations, vendor relations, material handling, information system, small batch production, set-up time reduction, nearby suppliers, nearby customers, direct on-line suppliers, process control, vendor development, level of automation, measurement of quality, spare parts management, cleanliness, application of total productive maintenance philosophy and workers' participation. (Vinodh and Joy, 2012) state that Total Productive Maintenance, Total Quality Management, Failure Mode and Effect Analysis, 5S, Quality Function Deployment, Kaizen, Kanban and Value Stream Mapping are the important tools and techniques of implementation of lean manufacturing. They also developed five dimensions of leanness practice – management responsibility leanness, manufacturing management leanness, manufacturing strategy leanness and technology and workforce leanness and concluded that manufacturing management leanness, manufacturing strategy leanness and manufacturing responsibility leanness are important drivers of lean manufacturing. Manufacturing cell is a specific unit of the manufacturing system. (Saurin et.al., 2011) conducted a study on assessing the use of lean production practices in manufacturing cells and identified 18 attributes of lean production practices. They concluded that seven practices namely multi-functionality and cross-training, workplace housekeeping, visual management of production control, one-piece flow, visibility and information exchange , layout size and shape and organization by the dominant flow are fully used while three practices namely workers' autonomy, standardized work and lean performance metrics are partially used. Eight practices – teamwork and leadership, continuous improvement, pull production, smoothed production, total productive maintenance, visual monitoring of quality control, quick setups and equipment automation were not used in cell manufacturing. (Upadhye et. al., 2010) in their study on lean manufacturing for sustainable development, reviewed various tools and techniques of lean manufacturing such as value stream mapping, 5 S, Kaizen, Pull system, Cellular manufacturing system, Inventory management, PokaYoke, Single minute exchange of die, Standardized work, total productive maintenance and total quality management and statistical quality control or statistical process control. (Yu et.al, 2012) introduced a soft-window mechanism wherein vendors can deliver within a certain time window and argued that it enables decision-makers to incorporate time-based performance metrics for vendor evaluation in the context of lean production implementation. They claim that this mechanism helps the buyers adjust the window-width according to the urgency or need for parts delivery. (Jayaram et.al., 2008) explored the relationship perspective as a facilitator of lean manufacturing and lean design. Relationship envisages supplier development, supplier partnering and closer customer relationship. They claimed that lean manufacturing did not show any relationship with financial performance although it may have positive relationship manufacturing performance. They finally concluded that relationship building is beneficial to lean manufacturing and lean design. (So and Sun, 2011) argue that implementing lean production in electronic-enabled manufacturing supply chain improves the operating efficiency of manufacturers by integrating end-to-end supply chain information flow. They also state that implementing of lean production principles such as restructuring supply strategy, pull production, streamlining manufacturing process and empowerment of work force will improve the bottom line of the manufacturers. (Abdulmalek and Rajgopal, 2007) studied the impact of lean production in a process context with value stream mapping as the tool. They concluded that in case of push-pull hybrid production system, total productive maintenance can have significant contribution in reducing the lead-times as well as work in process inventory.

ISSN : 2229-6514 (Print),2230-8237(Online)

Measurement of leanness

(Amin and Karim, 2013) developed a mathematical model to measure the contribution of lean strategies selected to reduce wastes. They also developed a methodology to select appropriate lean strategies so that they help achieve maximum benefit by minimising wastes. (Achanga et. al., 2012) developed a fuzzy logic advisory system to assess the impact of lean manufacturing in SME sector. It can also be used by companies to assess their lean-readiness. (Ghosh, 2013) used the survey method to measure the degree of lean production implementation in manufacturing sector in India. He also studied the impact of lean practices on various operational metrics; lean practices studied included supplier feedback, customer need, pull system, setup time, TPM, SPC and cross department problem solving while the operating metrics included productivity, lead time, first-pass correct output, cost reduction, inventory reduction and space reduction. He argued that out of the above six operating metrics, first-pass correct output, reduction in lead time and productivity increase were the drivers of lean implementation. (Duque and Cadavid, 2007) in their conceptual paper, considered four lean tools namely detect and remove obstacles to flow, pull links and standardization for impact on five dimensions - waste elimination, continuous improvement, continuous flow and pull-driven systems, multi-functional teams and information systems. For each of these dimensions, metrics were suggested. They claim that these metrics would be helpful in monitoring the progress of lean implementation, continuous monitoring and benchmarking. (Karim and Arif-Uz-Zaman, 2013) developed a methodology based on lean principles to identify wastes, select lean tools, identify performance indicators, achieve performance improvement and establish lean culture. (Behrouzi and Wong, 2011) in their study on lean supply chain performance in Iran, identified 28 performance measures scattered into four groups. These groups were quality, cost, flexibility and delivery and reliability. Measures like supplier rejection rate, percentage of standardized processes, customer complaints, customer rejection rate, defect rate of raw materials, percentage of rework and defect rate of production were grouped under quality. Labour value added productivity, percentage of total value added time, average freight cost per unit, total inventory, manufacturing cost per unit, warranty costs and cost of energy were grouped under the cost factor. Supplier delivery flexibility, manufacturer delivery flexibility, supplier volume flexibility, supplier product-mix flexibility, manufacturer volume flexibility and manufacturer product-mix flexibility were grouped under flexibility factor. Delivery and reliability factor included customer delivery lead time, set up unscheduled and idle time, on-time delivery to customers, on-time delivery by suppliers, perfect order fulfilment by suppliers, supplier delivery lead time, on-time production and perfect order fulfilment to customers.

Functional management issues in implementing lean production

(Forrester, 1995) in her study on the implications of lean manufacturing on human resources claims that lean manufacturing results in employees becoming more involved and flexible. She also claims that lean manufacturing requires the development of a number of interrelated policies covering every aspect of personnel policy and practice. (Spithoven, 2001) in his study in Netherlands on lean production and disability, claimed that lean production improved the speed of work and resulted in the rise of number of disabled people. (Sim and Rogers, 2009) in their study on implementing lean production systems in eastern USA conclude that communication plays an important role in the maintenance and effectiveness of continuous improvement initiatives. (Cagliaono et. al., 2006) applied the lean concept to supply chain integration that is integrating information flows and integrating physical flows. (Fullerton et. al., 2013) claim that implementation of lean production results in simplified internal accounting reporting system, eliminates inventory tracking and overhead allocations as well as increases use of value stream costing. (Apreutesei and Arvinte, 2010) identified various financial models used in lean manufacturing as full absorption, direct variable, ABC method, TPC method and order activity. They also claimed that standard costs can be eliminated in favour of value stream costs. (Meade et. al., 2006) argue that the impact of rapid inventory reduction on net profit is significant and the negative impact on net profit continues till the time inventories are reduced. They finally conclude that a more aggressive and successful lean program will result in greater negative impact on financial performance measures till the reduction in inventory level ceases.

Adoption of lean production

(Gurumurthy and Kodali, 2011) used value stream mapping and simulation in the context of a firm manufacturing doors and windows in India and claimed that the use of lean manufacturing tools like line balancing, multi-machine activity and 5S etc. enhanced the productivity and significant reduction in inventory, cycle time, floor space and manpower etc. (Perera and Kulasooriya, 2011) studied a firm in food-processing in Sri Lanka where lean production was implemented. They concluded that leanness of the process was below expectation. They identified areas in

ISSN : 2229-6514 (Print),2230-8237(Online)

which lean principles can be applied to obtain the benefits of lean production system. . (Panizzolo et. al., 2012) claimed that the level of diffusion of lean manufacturing is very high in automotive sector, high in electronics sector and medium to low in machine tools, fast moving consumer goods, aerospace and process industry sectors. (Subashini and Mohan Kumar, 2013) studied implementation of lean production on nine themes – waste elimination, continuous improvement, just in time, pull, multi-functional team, decentralized responsibilities, integrated functions and vertical information systems in the kitchenware industry in India and observed that all kitchenware industries practice most of the lean principles. (Chowdary and George, 2012) applied lean production in the pharmaceutical firm in India and concluded that wastes such as unnecessary inventory and storage area can be eliminated, total cycle time can be reduced and production flow can be improved. (Panizzolo et. al., 2012) studied four firms from different sectors in the Indian context and concluded that all the four firms benefitted from the implementation of lean production. However the extent of benefits differed from firm to firm on various parameters. Improvement was observed by them on parameters such as lead time, on-time delivery, quality, accuracy of order fulfilment, cycle time of order fulfilment, customer complaints or returns, work in process, inventory rotation index, manufacturing throughput time, manufacturing process time, set-up time and scrap and rework. (Mehta et. al., 2012) studied the impact of lean implementation in the context of automotive ancillary manufacturing firm in India and concluded that implementation of lean production resulted in reducing different types of wastes – wastages due to over-processing by 23%, wastages inventory by 19%, wastages in movement by 18%, wastages in waiting by 16%, wastage in transportation by 10%, wastage due to over-production by 8%wastages due to defects by 6%. They also identified lack of interest of management and employees, lack of trained manpower, lack of training, lack of research, financial constraints, lack of supervision and inter-departmental conflicts as impediments in implementing lean production. (Ramesh et. al., 2008) studied the implementation of total productive manufacturing in a tyre manufacturing firm in India and concluded that it reduces cycle time and equipment breakdown, productivity and builds confidence among the personnel.

Applications of lean production

Lean production has been applied to other areas extensively. As cited by (Leon and Farris, 2011) (Haque and James-Moore, 2002) applied lean principles like waste removal, customer pull and pursuit of perfection to product development. (Oppenheim, 2004) in their study on lean product development flow, endorsed their work. (Morgan, 2002) in his doctoral work on system approach to lean product development developed value stream mapping version tailored to lean product design. (Lee et. al., 2008) used the concept of lean production in the service sector – a third party logistics firm. They surveyed fourteen ERP vendors who confirmed that their product supported at least one lean manufacturing feature. Lean manufacturing features included by the ERP vendors are demand smoothing, mathematical models to synchronise daily production to demand, Kanban and exception reporting. They reviewed information technologies and systems that benefitted retailing and claim that IT is an important enabling tool in lean systems. Lean production has been applied to various services such as healthcare (Black,),insurance, governmental agencies, IT operations, retail buying groups and publishing houses (Alsmadi et. al., 2012). (Buzby et. al., 2002) recommend the use of electronic solutions such as electronic quotations and electronic reminders. These solutions reduce the cost of quotation and repetitive tasks involved in preparing quotations. The ideas of lean production have been introduced to construction industry in 1993. (Conte, 2002) in his study in the Brazilian context concludes that lean production principles can be applied to construction of buildings and that saving in construction time and cost can be obtained. (Pheng and Chual, 2001) concluded that precast concrete industry in Singapore is ready to successfully adopt just-in –time delivery. (Jekiel, 2011) applied lean production to human resources. He recommended the use of seven lean production principles like keep customer in mind, learn from mistakes and improve, generate ideas and identify concerns, understand the entire process, solve problem with wisdom, judgment and creativity, work against goals that are visibly measured and demonstrate personal leadership to avoid wastage of human talent. (Filho and Menezes, 2002) claim that lean production principles can be implemented in construction by modifying them in light of construction peculiarities. (Pasqualini and Zawislak, 2005) concluded that value stream mapping essentially a lean production tool can be applied to construction to reduce costs, improve speed of work as well as quality. (Gabriel, 1997) applied lean production concept to project management involving difficult buildings and concluded that it avoids duplication and also reduces risk to the client. (Lapinski et. al., 2006) studied the project delivery process of Toyota Real Estate and Facilities – a firm that constructs corporate offices, parts and vehicle distribution centres, logistical support training and financial facilities, executive housing and

ISSN : 2229-6514 (Print),2230-8237(Online)

airport hangars. They used lean production concept and identified five process wastes such as inconsistent flow, complex activity and process sequences, lack of process transparency, segregated departmental structure and inconsistent feedback and improvement. They also identified the elements of lean in the delivery process of the firm that benefitted it such as identification of unique environmental opportunities, determination of likely LEED certification, assignment of sustainable features with project budgets, selection of project team with sustainable experience, generation of ecostatement, conducting design ecocharette, revise ecostatement, monitoring on-site sustainable programmes, education of maintenance staff and occupants and monitoring operational performance.

Comparative studies

This section deals with three types of comparative study; first type of comparative study deals with of implementation of lean production in different types of manufacturing set up, the second one deals with comparison between lean manufacturing and agile manufacturing and the third type of study deals with the comparison of lean production between manufacturing and service sectors. (Deflorin and Scherrer-Rathje, 2012) in their comparative study of lean production in craft producer and mass producer argue that different choices of manufacturing process influence the lean transformation process and its implementation. They conclude that craft producers and mass producers face different challenges during transformation to lean. The differences are in terms of people involvement, process standardization, changes in behaviour, problem-solving, mistake handling and work tasks. Lean production principles were applied to product development by many researchers. In a comparative study of lean manufacturing and agile manufacturing (Castro et. al., 2012) in the context of research and development programmes concluded that agile manufacturing is a better solution in supply chain management owing to its flexibility and responsiveness. (Yusuf and Adeleye, 2002) concluded that firms should adopt both the lean as well as agile philosophies so as to achieve internal efficiencies and also supply-chain based responsive adaptation. (Bruce et. al., 2004) in their study in the UK context on SCM in textiles argue that textiles and clothing industry use a combination of lean and agile production principles. (Greene et. al., 2008) in their study consisting of four firms from different sectors and different geographical locations, also concluded that lean production and agile production are not mutually exclusive and that firm should adopt both the philosophies. Lean production would enable a firm to eliminate waste while agile production will enable it to become flexible and also respond well to market fluctuations. (Alsmadi et. al., 2012) in their study in UK consisting of 278 manufacturing and service firms concluded that service sector is interested in the soft lean practices like relationship with customers and HR management whereas the manufacturing sector is more interested in the hard lean practices like TPM and set-up time reduction.

Limitations of lean production

There are some reservations on the results of implementation of lean production. (Karim and Arif-Uz-Zaman, 2013) claim that selection of suitable strategies, applied at the right time and for the right purpose are important for the success of lean production. They also argue that organizational contexts play an important role in the success of lean production. (Shah and Ward, 2003) in their study on relationship between contextual factors and extent of implementation, **c**onclude that plant size, unionization and plant age are important for the implementation of lean production and that applying synergetic bundles of lean practices concurrently make a meaningful contribution to operational performance. (Conti et. al. 2006) in their study on the effects of lean production on workers, find the lean production is not inherently stressful but depends upon the design and operation of the lean systems adopted by the adopting firm. (Lewis, 2000), in his study in the UK, claims that becoming lean, does not on its own improve financial performance. He also claims that every firm has its own and unique lean production process. (Yusuf and Adeleye, 2002) in their comparative study involving more than 100 manufacturing firms in the UK, identified some limitations of lean production like it being unique to Japan, ruthless on workers, suitable for products of mass appeal. They further argue that competing on the basis of cost and quality a focus of lean production is unlikely to be sustainable in the long run.

Conclusion

Implementation of lean production has some limitations. However, a careful choice of lean tools, appropriate design and operation of lean systems and due attention to contextual factors may overcome the limitations and enable implementation of lean production make significant contribution to profitability enhancement for the firm implementing it. It is advisable to implement lean production in conjunction with agile production so as to secure efficiencies resulting from lean and flexibility resulting from agile production

References

Alsmadi, Majed., Almani, Ahmad., and Jerisat, Rula. 2012. A

ISSN : 2229-6514 (Print),2230-8237(Online)

comparative analysis of lean practices and performance in the UK manufacturing and service sector firms. Total Quality Management, 23(4), 381 – 396.

Abdulmalek, Fawaz A., and Rajgopal, Jayant. 2007. Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. International Journal of Production Economics, 107, 223 – 236.

Achanga, Pius., Shehab, Essem., Roy, Rajkumar., and Nelder, Geoff. 2012. A fuzzy-logic advisory system for lean manufacturing within SMEs. International Journal of Computer Integrated Manufacturing, 25(9), 839 – 852.

Amin, Md. Al., and Karim, M.A. 2013. A time- based quantitative approach for selecting lean strategies for manufacturing organizations. International Journal of Production Research, 51(4), 1146 – 1167.

Apreutesei, Mihai., and Arvinte, Roxana. 2010. Financial models and tools for managing lean manufacturing. Journal of Economics and Engineering, 4, 4-7.

Behrouzi, Farzad., and Wong, Kuan Yew. 2011. An investigation and identification of lean supply chain performance measures in the automotive SMEs. Scientific Research and Essays, 6(24), 5239 – 5252.

Black, John. 2008. Toyota way to healthcare excellence: Increase efficiency and improve quality with lean, Health Administration Press, Chicago, 1 – 26.

Bruce, Margaret., Daly, Lucy., and Towers, Neil. 2004. Lean or agile: A solution for supply chain management in the textiles and clothing industry. International Journal of Operations and Production Management, 24(1/2), 151v-170.

Buzby, Conan M., Gerstenfeld, Arthur., Voss, Lindsay E., and Zeng, Amy Z. 2002. Industrial Management and Data Systems, 102(8/9), 513 – 520.

Cagliaono, Raffaella., Caniato, Federico., and Spina, Gianluca. 2006. The linkage between supply chain integration and manufacturing improvement programmes. International Journal of Operations & Production Management, 26(3), 282 – 299.

Castro, Helio., Putnik, Goran D., and Shah, Vaibhav. 2012. A review of agile and lean manufacturing as issues in selected national and international research and development programs and roadmaps. The Learning Organization, 19(3), 267 – 289.

Chowdary, Boppanna., and George, Damian. 2012. Improvement of manufacturing operations at a pharmaceutical company. Journal of Manufacturing Technology Management, 23(1), 56 – 75.

Conti, Robert., Angelis, Jannis,. Cooper, Cary., and Gill, Colin. 2006. The effects of lean production on worker job stress. International Journal of Operations and Production Management, 26(9), 1013 – 1038.

Deflorin, Patricia., and Scherrer – Rathje, Maike. 2012. Challenges in the transformation to lean production from different manufacturing-process choices: A path-dependent perspective. International Journal of Production Research, 50(14), 3956 – 3973.

Duque, D F M., and Cadavid, L R. 2007, Lean manufacturing measurement: The relationship between lean activities and lean metrics. Estudgerenc, 23(105), 69 – 83.

Filho, Antonio N. and Menezes, Emilio Araujo. 2002. Development of an operational parameter measuring system; Proceedings IGLE – 10 Aug. 2002, Gramado, Brazil.

Fullerton, Rosemary R., Kennedy, Frances A., and Widener, Sally K. 2013. Management accounting and control practices in a lean manufacturing environment. Accounting, Organizations and Society, 38, 50 – 71.

Gabriel, Eric. 1997. The lean approach to project management. International Journal of Project Management, 15(5), 205 – 209.

Ghosh, Manimay. 2013. Lean manufacturing performance in Indian manufacturing plants. Journal of Manufacturing Technology Management, 24(1), 113 – 122.

Greene, Christopher M., Ellis, Brandon., and Waller, Mathew. 2008. Can lean and agile exist simultaneously? Comparative analysis through literature case studies. IIE Annual Conference, 217 – 222.

Gurumurthy, Anand., and Kodali, Rambabu. 2011. Design of lean manufacturing systems using value stream mapping with simulation. Journal of Manufacturing Technology Management, 22(4), 444 – 473.

Haque, Badr., and James – Moore, Michael. 2011. Measures of performance for lean product introduction in the aerospace industry. Proceedings of the Institution of Mechanical Engineers, 218:10 (October, 2004), 1387 – 1398.

Hopp, W. J., and Spearman, M. L. 2004. To pull or not to pull: What is the question?. Manufacturing and Service Operations Management, 6(2), 133 – 148.

Jayaram, J., Vickery, S., and Droge, C. 2008. Relationship building, lean strategy and firm performance: An exploratory study in the automotive supplier industry. International Journal of Production Research, 46(20), 5633 – 5649.

Jekiel, Cheryl M. 2011. Lean human resources. CRC Press, Ney York, 3- 9.

Karim, Azharul., and Arif-Uz-Zaman, Kazi. 2013. A methodology for effective implementation of lean strategies and its performance evaluation in manufacturing organizations. Business Process Management Journal, 19(1), 169 – 196.

Lapinski, Anthony R., Horman, Michael J., and Riley, David R. 2006. Lean processes for sustainable project delivery. Journal of Construction Engineering and Management, 132(10), 1083–1091.

Lee, Sang M., Olson, David L., Lee, Sang-Heui., Hwang, Taewon., and Shin, Matt S. 2008. Entrepreneurial applications of lean approach to service industries. The Service Industries Journal, 28(7), 973 – 987.

Leon, Hilda C Martinez., Farris, Jennifer A. 2011. Lean product development research: Current state and future directions. Engineering Management Journal, 23(1), 29 – 51.

Lewis, Michael A. 2000. Lean production and sustainable

competitive advantage. International Journal of Operations and Production Management, 20(8), 959 -977.

Meade, David J., Kumar, Sameer., and Houshyar, Abdolazim. 2006. Financial analysis of a theoretical lean manufacturing implementation using hybrid simulation modelling. Journal of Manufacturing Systems, 25(2), 137 – 152.

Mehta, Rajesh Kumar., Mehta, Dhermendra., Mehta, Naveen K. 2012. An exploratory study on implementation of lean manufacturing practices (with special reference to automobile sector industry). Journal of management and economics, 19(2), 289 – 299.

Morgan, J M. 2002. High performance product development: A system approach to a lean product development process. PhD Dissertation, University of Michigan.

Oppenheim, Bohdan W. 2004. Lean product development flow. Systems Engineering, 7(4), 352 – 376.

Nicholas, John. 2011. Lean production for competitive advantage. CRC Press, New York, 3.

Panizzolo, Roberto., Garengo, Patrizia., Sharma, Milind., and Gore, Amol. 2012. Lean manufacturing in developing countries: Evidence from Indian SMEs. Production Planning and Control, 23(10-11), 769 – 788.

Pasqualini, Fernanda. and Zawislak, Paulo. 2005. Value stream mapping in construction: A case study in Brazilian construction company, Proceedings IGLC – 13, July 2005, Sydney, Australia.

Pheng, Low Sui., and Chuaan, Choong Joo. 2001. A study of the readiness of precasters for just-in-time construction; Work Study, 50 (4), 131 – 140.

Perera, HSC., and Kulasooriya, DMA. 2011. Lean manufacturing: A case study of a Sri Lankan manufacturing organization; South Asian Journal of Management, 18(1), 149-158.

Ramesh, V., Sreeni vase Prasad, K V., and Srinivas, T.R. 2008. Implementation of total productive manufacturing concept with reference to lean manufacturing in a processing industry in Mysore: A practical approach. The Icfai University Journal of Operations Management, 7(4), 45 – 57.

Saurin, Tarcisio Abreu., Marodin, Giuliano Almeida., and Ribeiro, Jose Luis Duarte. 2011. A framework for assessing the use of lean production practices in manufacturing cells. International Journal of Production Research, 49(11), 3211 – 3230.

Seth, D., and Gupta, V. 2005. Application of value stream mapping for lean operations and cycle time reduction: An Indian case study. Production Planning and Control, 16(1), 44 – 59.

Shah, Rachana., and Ward, Peter. 2003. Lean manufacturing: Context, practice bundles and performance; Journal of Operations Management, 21, 129-149.

Sim, Khim L., and Rogers, John W. 2009. Implementing lean production systems: Barriers to change. Management Research News, 32(1), 37 – 49.

So, Stuart., and Sun, Hongyi. 2011. An extension of IDT in examining the relationship between electronic-enabled supply chain integration and the adoption of lean production. International Journal of Production Research, 49(2), 447 – 466.

Spithoven, A H G M. 2001. Lean production and disability. International Journal of Social Economics, 28(9), 725 – 741.

Subashini, G.S., and Mohan Kumar S. 2013. An investigation on adoption of lean production principles in kitchenware manufacturing industries. Interdisciplinary Journal Of Contemporary Research In Business, 4(9), 271 – 279.

Sun, Shili. 2011. The strategic role of lean production in SOE's development. International Journal of Business and Management, 6(2), 160 – 168.

Upadhye, Nitin., Deshmukh, S.G., and Garg, Suresh. 2009. Key issues for Implementation of lean manufacturing system; Global Business and Management Research: An International Journal, 1 (3/4), 57 – 68.

Upadhye, Nitin., Deshmukh, S.G., and Garg, Suresh. 2010. Lean manufacturing for sustainable development; Global Business and Management Research: An International Journal, 2 (1), 125 – 137.

Vinodh, S., and Joy, Dino. 2012. Structural Equation modelling of lean manufacturing practices. International Journal of Production Research, 50(6), 1598 – 1607.

Yu, Min-Chun., Goh, Mark., and Lin, Hung-Chung. 2012. Fuzzy multi-objective vendor selection under lean procurement. European Journal of Operational Research, 219, 305 – 311.

Yusuf, Y Y., and Adeleye, E O. 2002. A comparative study of lean and agile manufacturing with a related survey of current practices in the UK. International Journal of Production Research, 40(17), 4545 – 4562.

Womack, J. P., and Jones, D. T. 2003. Lean thinking: Banish waste and create wealth in your corporation, Simon and Schuster, London, 2nd edition, 15 – 90.

ISSN : 2229-6514 (Print),2230-8237(Online)