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Lean in service industries: A literature review

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Abstract Lean service is an amalgamation of tools and practices which, if applied appropriately, would definitely improve the existing quality of operations and ensure the generation of a large amount of favourable financial and economic outcomes and improve the behaviour of the workforce. As a result, it assumes of great significance in the fiercely competitive modern world. This article presents a comprehensive bibliographic study about the various lean service practices through a variety of approaches like service improvement, manufacturing, supply chain, market and retailing approaches, etc. Thus it gives a clear view on how the lean services are implemented in various sectors and the contribution of lean service towards improving the quality in the services provided while reducing the costs.

Keywords: *Lean applications; Service sector; Lean in services; Lean approaches*

1. Introduction

The Japanese developed the philosophy of 'Lean' in the mid 1950's. Lean is concerned with stabilising and standardising the work processes so that the critical problems become clearly visible and the workforce develops critical thinking capability so that they are able to solve the problems and improve the work flow. Lean practices have been efficiently utilized in manufacturing industries for the past two decades (Alsmadi et al. 2012). Lean implementation has been very much successful in the manufacturing sector. Of late, service industries are gaining lots of importance. These service industries are, at present, adopting lean methodology to enhance their efficiencies in delivering top quality services.

Lean thinking involves understanding the philosophy of continuously finding ways to reduce waste by applying lean tools and techniques for customer satisfaction (Schiele and McCue, 2011). Service firms need to meet the specific requirements of each and every customer so that they can always stay ahead of their competitors. This literature survey delineates the different approaches that lead to the successful implementation of the lean philosophy with the objective of accomplishing improved quality in the service industries. This study is organised as follows: Section 2 describes the approaches that have been followed in individual disciplines; Section 3 consists of observations and recommendations of lean in services; section 4 consists of limitations and directions for future research and section 5 provides overall conclusions.

2. Individual Approaches

2.1 Service improvement approach

Comm (1998) observed that leanness was becoming more prominent in most of the industries particularly in manufacturing as it reduces wastes and maximizes efficiency. This study explains how lean could be implemented and developed further in the service sector. Richerson (1999) studied lean practices at Boeing, where a new procedure called 'accelerated improvement workshop' was deployed



successfully to implement the lean practices. Maleyeff (2006) explained that the internal service systems possess many structural characteristics that include the flow of information, process flow across functions; categorization of wasteful activities; and synthesis and exploration. He provides insights into the management of the internal service systems from the perspective of Lean management. Gray (2007) studied the service redesign and service improvement initiatives in the fields of social and health care. Jorgensen et al. (2007) observed that even though 'lean' is growing rapidly, it has pitfalls which affect companies' long term success by paving the path for many difficulties. Two main things are required for sustainable lean implementation viz. performance improvement, and capability development. Kung et al. (2008) implemented the lean concepts in improve workflow in construction processes. They developed a unique queuing theory model with lean concepts for waste water disposal system in excavations involved in construction projects. Lee et al. (2008) discussed the lean and agile application to the service enterprises. Barraza et al. (2009) followed a case study approach and concluded that lean thinking is applied in order to improve the services given to the public through the local councils. They conducted their empirical studies in specific Spanish contexts. Piercy and Rich (2009b) opined that cost reduction and service quality are the most expected aspects of service businesses. Despite the authentication of application of lean approaches in the product-service context, their use in the pure service environment remains largely untested. The main aim of the study is to assess the appropriateness of the application of lean production techniques in a service context.

Barraza et al., (2010) undertook a case study on implementation of Lean-Kaizen approach in human resource service process in a public service organization in Mexico. The organization adopted the Lean-Kaizen approach to solve its problem of delay in human resource hiring process. The approach helped it to reduce cycle time of hiring process.

The study by Ritchie and Angelis (2010) provides a description of what Lean means in a service context. It focuses on the energy sector. It covered processes such as TQM, Six Sigma and benchmarking and Kaizen initiatives. They observed that only a core of Lean manufacturing attributes are carried through into services: waste removal, responding to customer demand and increased breadth of communications in the firm. The study also finds that Lean is often confused with Six Sigma, but this does not adversely affect the Lean implementation. Staats et al. (2011) examined the applicability of lean concepts to knowledge work by investigating the implementation of a lean production system at an Indian software services firm. They combined a detailed case study and an empirical analysis and found that lean software projects perform better than non-lean software projects.

Based on the Value stream of lean service, the following types of wastes have been identified by Qu et al.,(2011) (Table-1). This study also concludes that the waste analysis of lean service is absolutely necessary.

Table 1. Type of wastages from Services (Qu et al. 2011)

Sl.no.	Type of wastes in service	Significances
1	Service Design waste	no response to customer needs and resulting unnecessary excess features
2	Service Item waste	flaws in service process
3	Service Ability waste	does not make full use of service capacity
4	Service Process waste	low efficiency work
5	Service Delay waste	phenomena that waiters or customers wait

The field research by Laganga (2011) in outpatient service operations examined original quantitative data on appointments and analysed a lean process improvement project that was conducted to increase capacity to admit new patients into a healthcare service operation system. The project resulted in substantial increase in service capacity to intake new patients and reduction in the no-show rate as a result of the transformation of service processes.

Alsmadi et al. (2012) observed that Lean is now more and more applied to service operations and empirically analysed the difference in Lean practices as well as their relationship to firm performance between manufacturing and service sectors in the UK. The empirical results confirm that service firms are interested in the soft practices of Lean such as people and customer involvement while they are found underperforming in manufacturing-related practices such as total productive maintenance, set-up time and supplier feedback. Moreover, the results show a positive relationship between Lean practices and firm performance in both sectors. Besides, the degree of effect on performance was found to be identical between the two sectors.

Ming-Te et al. (2013) used data mining techniques to investigate whether lean production and service can enhance the entire performance of production and service. They set up lean service performance model and Employee Characteristic Analysis model using data mining techniques. The results showed that lean production and service can enhance the performance of entire production and service.

Azevedo and Sholiha (2015) observe that Product service system (PSS) or particularly industrial product service system has started gaining importance as innovative strategy to face the fiercely competitive global market. Cost dimension is one of the important aspects to be considered here. They feel that traditional costing system is no longer able to facilitate a company's transformation and propose a new assessment framework to address the needs of IPS environment. According to them, Lean accounting with its value stream costing (VSC) will be able to provide comprehensive cost information to support a company's transformation into a successful IPS company. Bertoni et al. (2015) suggest that the methods and tools that were developed in Value Driven Design have the potential to be applied in the initial design stages in Lean Product Service Development.

Bhasin, (2015) points out that the tertiary sector has often unique operational characteristics with most of the work virtually enabled within globally dispersed information technology systems. The major focus is hence on the critical success factors for implementing Lean to sustain continuous improvement culture in a long run. Asnan et al. (2015) observe that Government agencies adopt lean management to improve efficiencies and deliver quality services to their customers. They focused on lean implementation in Government agencies and found that service organizations are unable to fully implement and sustain lean. Resistance to change is one of the challenges during lean implementation in service. They call attention to change management during the transition phase to lean. Bhasin, (2015) emphasised the significance of performance measurement in implementing lean and highlighted the importance of utilising indices that transcend finance. Thus there is a need for a balanced portfolio of metrics to address all dimensions. It does not easily lend itself to the traditional accounting systems. Sassanelli et al. (2015) point out that success of Product Service Systems (PSS) depends on the decisions taken during the initial lifecycle stages, when PSSs are conceptualized, designed, developed and engineered and the adoption of lean techniques in the early stages of products development. They describe the evolution of lean thinking from product manufacturing to design phases. They also uncover the limitations of the methods suggested by existing literature and point out the way to new opportunities and challenges through many further research and industrial projects paving the path for further research and industrial projects.

Haque and Chaudhuri (2016) observe that Human Resources Management is an unexplored field for implementation of lean, He explains in detail the lean service implementation in Human Resource Management. The seven major lean principles have the potential of being applied for significant improvement in organizational performance and creation of congenial environment in the organization. Out of the seven principles, elimination of waste resulting in the creation of value-added service is one of the major strategic imperatives in the present scenario.

2.2 Operational strategic approach

Chougule et al. (2011) observe that in the present globalised market, there is always a consistent pressure on the original equipment manufacturers to improve and sustain the improvement in the service processes that directly relate to the customer satisfaction. Vilkas et al. (2015) claim that the objective of lean production systems is to enable the provision of a wide variety of goods and services at competitive prices. Lean production is expected to promote agility and facilitate fast introduction of new products and cost effective mass customization.

2.3 Modelling Approach

Jadhav et al. (2014) have proposed that the competitive edge purely determines the success or survival of any company. Lean practice is one of the best tools that enable a company to achieve competitive edge. However, nearly 2/3rd of the lean implementations result in failures and less than 1/5th of those implemented have lasting results. The aim of their study was to develop an outline for sustainable lean execution using Interpretive Structural Modelling approach.

2.4 Lean in Public Service Sectors

Allway and Corbett (2002) observe that the “lean” approach has become well-known in improving operations and profitability of manufacturing companies and can be successfully adopted in many service-sector firms. They explain a rigorous five-phase process and point out how an insurance company successfully adopted the lean approach through this process. This model has yielded positive results in industries ranging from banking to health care. McNary (2008) explains the quality management framework in the Columbus Consolidated Government through the development and implementation of one particular project team working on an issue in the Office of the Tax Assessor.

Arlbjorn et al. (2011) investigate lean practices in the municipal sector in a service supply chain management (SCM) context. They analyzed lean implementation in Danish municipalities. They proposed a model that illustrates the conditions under which lean is most appropriate according to the type of service delivered. The results show that lean is mainly implemented as “toolbox lean,” such as with value stream mapping, kaizen and information boards. In addition, the analyses show that the lean philosophy can be used by the public sector to be more effective in terms of cost reduction and service improvements if the assumptions for implementing lean exist.

2.5 Lean in Marketing Strategy

Piercy and Rich (2009a) examine the application of lean production improvement techniques to the pure-service context and evaluate the contribution of lean production techniques to services marketing improvement. They find that service call centres can achieve operational cost reduction and increased customer service quality through the adoption of lean service tools.

Qian (2014) proposed a market-based strategy for joint decisions on price, delivery time, service level, and supplier selection. He suggests that a firm's operation characteristics and market characteristics must be matched for better profitability. Besides, concepts of lean manufacturing and flexible or agile manufacturing should be combined based on market characteristics. He also suggests that operation characteristics of the supplier chosen should match market characteristics.

2.6 Lean in Retailing

Hsieh et al. (2010) explained that the concept of lean service can be built into the whole lean demand chain, and lean marketing may be used to expand and develop the overall sales by enhancing motivation of the customer's consumption. Noda (2015) found that lean can be successfully applied to retailing and stable pricing is a driver for successful implementation of lean operation. He explains how lean operation and stable pricing can be used for developing an alternative business model to successfully achieve competitive advantage.

2.7 Lean in Service Supply Chain

Staudacher (2010) conducted interviews in three third party logistic companies and seven companies of the financial services sector. They observed that these companies are implementing lean in high volume low variety processes and focus on back office activities that resemble manufacturing. Susano et al. (2014) use the Gaps Model of Service Quality and relate it with lean principles of waste from a supply chain perspective. They propose a methodology for assessing the internal failures contributing to each gap. They develop an approach for joint analysis of gap's structure and supply chain's failures that allow the assessment of the importance of each failure from a service quality perspective. Moreover, they explain how these failures can be associated to lean wastes, thus providing a framework for "leanness" assessment. Tritos et al. (2014) explicate a general approach for ranking lean supply chain management initiatives in healthcare service operations. The ranking purely depends upon relative potential of various initiatives on a range of performance measures. Based on several literature reviews, nearly 24 lean supply chain management initiatives are identified and Q-sort method is used to divide them into four categories viz., continuous process improvement; enterprise alignment/integration; waste elimination; and flow management/JIT.

2.8 Lean in Manufacturing Services

Kehoe (2007) explain how getting rid of shop clutters may reduce wastes, improve efficiency and create a culture of discipline and pride. Xue-gang and Er-shi (2010) clearly explain the theoretical source of lean thinking and also the difficulties faced at the current stage by China's manufacturing sector. The background and conceptual evolution of modern manufacturing services are also explained. Then, at the end, with the help of an example, the application of lean thinking in the transition of manufacturing-services is elucidated. Hong et al. (2014) provide practical insight on how to integrate service-driven value creation and delivery for achieving both cost effectiveness and quality performance outcomes which have so far been restricted only to manufacturing firms. Andres-Lopez et al. (2015) provide some valuable insights into redefining value and waste concepts, focused on the inherent characteristics of service: intangibility, perishability, inseparability, variability and lack of ownership.

2.9 Case Study and Exploration through Literature

Barraza et al. (2009) demonstrated through a case study approach how lean thinking is applied in order to improve the services provided to the public by local councils in specific Spanish contexts. Wei, (2009) suggested that the lean principles can shed new lights on current service theories. This is done by doing several reviews on the theoretical underpinning of services in the operations management

and service marketing literature. Seddon et al.(2011) trace the evolution of 'lean' literature . They observe that the better way to design and manage service organizations is to understand and manage the organization as a system. They developed a systems archetype for managing service in such a way as to see and remove waste continuously.

Stone (2012) presents a systematic review of four decades of scholarly lean literature and identifies four phases of lean viz. the Discovery phase, Dissemination phase, Implementation phase, Enterprise phase, and the Performance phase. The review covers the areas of lean manufacturing, lean production, lean thinking, lean and review, lean and Toyota Production System, lean assessment, lean culture, lean transformation. Jadhav et al.(2014) identify eight significant Lean practice bundles (groups of inter-related and internally consistent Lean practices) based on literature review and opinion of experts. The bundles are:

- Waste elimination practice bundle
- Conformance quality practice bundle
- Delivery reliability practice bundle
- Volume flexibility practice bundle
- Low cost practice bundle
- Human resource management practice bundle
- Health and safety practice bundle and
- Creativity and innovation practice bundle

3. Observations and recommendations

In this paper, 51 journal articles that appeared from 1999 to 2015 have been reviewed. They analyse the lean parameters in service organisations and their effectiveness in improving the quality of service. The approaches were thoroughly studied and some observations based on these journal articles are made here:

- Flat structures of a management system with shared goals and values, de-layered management structure (cross-skilling), measuring the value at the delivery point to customers, reducing system failures, rewarding through group incentives are vital to attain leanness transformation in a pure service environment(Piercy and Rich 2009b).
- The lean practices of the manufacturing service firms leading to improved performances are influenced strongly by good supplier relationship (suppliers feedback response), JIT delivery of goods, selecting suppliers based on proximity, commitment towards cost reduction as well as ensuring good relationship with the customers, continuous flow of goods based on Group Technology principle (Alsmadi et al. 2012)
- Customer relations are heavily impacted by having backlog of service requests. A method called Accelerated Improvement Workshop (AIW) is used in a few service companies to implement lean techniques. The defects % in kickback queue and the cycle time with work volume are calculated and tabulated. Then the backlogs are identified so that they can be reduced to meet customer satisfaction(Richerson, 1999).
- The lack of standard procedures, longer processing time, communication breakdowns with customer, inaccurate training, staffing, inadequate support from other functions are some of the reasons in the internal service systems. Upon avoiding all these lean principles can be implemented in the service organisations(Maleyeff, 2006).
- In the public service sectors, lean can be implemented only when the change management is adopted successfully. Strong top management commitment in addition to the employee involvement during the change management implementation is needed to develop lean organisation (Asnan et al., 2015).

- Volume, variety, process focus, operators' discretion and customisation of the products are the main characteristics of the process that are affected by the lean implementation (Portioli-Staudacher, 2010)
- Leadership commitment, building value stream mapping of customers, collecting data and metrics of lean and the continuous practising of lean by leaders when they preach about lean are critical success factors of lean transformation (Bujak et al., 2012).
- Lean settlement, lean related function, lean application, monitoring and follow up, integration and feedback alongside with the continuous improvement are stages of lean service implementation (Andres-Lopez et al., 2015).
- Three vital techniques 5S, Gemba Kaizen workshops (reducing wastes) and process mapping are required to improve the processes and the quality of the services offered by the public service organisations. This refers to lean-Kaizen public service (Barraza et al., 2009).

4. Limitations and directions for future research

The main focus of this section is confined to lean implementation in service areas.

In certain areas like installation services of water and sewer, lean is limited in scope as the environment is sensitive in nature and quantification of improvements cannot be done in such situations (Kung et al., 2008). In majority of the papers, the sample size is very low to draw a good statistical inference to define the success (Teo et al., 2007). This literature survey is generally confined to the terms like lean practice, kaizen and service sector improvements, lean in manufacturing industries, lean performance measurements and continuous improvements through lean.

This literature survey of lean in service sectors deals with several lean practices in the service industries, the way lean is implemented in these industries and the frameworks that they have followed for the successful implementation of lean. There is very little work on the assessment of lean implementations and the performance of the same. Future work may focus on various methods of assessment of lean practices in service sector and the ways of overcoming the drawbacks and pitfalls associated with the measurement of the performance of lean service.

5. Conclusion

Generally there is a misperception that lean practices can be effectively implemented only in the manufacturing sector. But this literature survey reveals that lean practices can be successfully implemented in service sector also leading to proven beneficial financial results and excellent customer satisfactions. Leanness is not only restricted to the tools but also it embraces the involvement of an active workforce. Through distinct approaches, many proposals have been made to improve the workflow through the application of lean methodologies to remove the non-value added activities. Lean practice needs a reengineering heart and motivation on the part of organisation to use lean to its full potential to obtain good returns economically as well as satisfactorily.

References

Andres-Lopez, E., Gonzalez-Requena, I. & Sanz-Lobera, A., 2015. Lean Service: Reassessment of Lean Manufacturing for Service Activities. *Proc., Engineering*, 132, pp.23–30.

Alsmadi, M., Almani, A, and Jerisat, R., 2012. A comparative analysis of Lean practices and performance in the UK manufacturing and service sector firms. *Total Quality Management & Business Excellence*, **23**(4), pp.381–396.

Allway, M. and Corbett, S., 2002. Shifting to lean service: Stealing a page from manufacturers' playbooks, *Journal of Organizational Excellence*, 21(2), pp.45–54.

Arlbjorn, J.S., Freytag, P.V., Haas, H.D., (2011). Service supply chain management: A survey of lean application in the municipal sector, *Int., Journal of Physical Distribution & Logistics Management*, **41**(3), pp.277 – 295.

Asnan, R., Nordin, N. & Othman, S.N., 2015. Managing Change on Lean Implementation in Service Sector. *Proc., - Social and Behavioral Sciences*, **211**, pp.313–319.

Azevedo, A and Maratus Sholiha, M, 2015. Innovative Costing System Framework in Industrial Product-service System Environment, *Proc., Manufacturing*, **4**, pp.224-230.

Barraza, M.F.S, Smith, T, Dahlgaard-Park, S.M, (2009). Lean-kaizen public service: an empirical approach in Spanish local governments, *The TQM Journal*, **21**(2), pp.143 – 167.

Barraza, M.F.S., Pujol, J.R, (2010). Implementation of Lean-Kaizen in the human resource service process: A case study in a Mexican public service organisation, *Journal of Manufacturing Technology Management*, **21**(3), 388 – 410.

Bertoni, A., Bertoni, M., Panarotto, M., Johansson, C., Larsson, T. (2015). Expanding Value Driven Design to Meet Lean Product Service Development, *Proc., CIRP*, **30**, pp.197-202.

Bhasin, S, (2015). Lean Management Beyond Manufacturing- A Holistic Approach, *Springer Int., Publishing*, pp. 117-137.

Bujak, A., Carvalho, W., Sriramulu, R., (2012) Lean Management and Operations in the Global Professional Services Industry, *Baumer, U et al. (eds.), in Globalization of Professional Services*.

Comm, C.L., 1998. Marketing Marketing Lean Initiatives in Service Industries. *Journal of Professional Services Marketing*, **18**(2), pp.59–64.

Chougule, R., Rajpathak, D. and Bandyopadhyay, P., (2011). An integrated framework for effective service and repair in the automotive domain: An application of association mining and case-based-reasoning. *Computers in Industry*, **62**(7), pp.742–754.

Gray, J., 2007. A Lean towards service improvement, *Journal of Integrated Care Pathways*, **11**(1), pp.1–10.

Haque, S., and Chaudhuri, S.R., (2016) Framework of Training for Lean Service, *Drishtikon: A Management Journal*, **7**(1), pp.41-56.

Hong, P., Ga (Mark) Yang, M. and D.Dobrzykowski, D., (2014). Strategic customer service orientation, lean manufacturing practices and performance outcomes, *Journal of Service Management*, **25**(5), pp.699-723.

Hsieh, Y.H., Chen, H.C. & Chang, W.L., 2010. The application of lean concept combines demand channel and supply channel in service industry. *IEEM2010 - IEEE Int., Conf., on Industrial Engineering and Engineering Management*, pp.1309–1313.

Jadhav, J.R., Mantha, S.S. and Rane, S.B., (2014). Development of framework for sustainable Lean implementation: an ISM approach. *Journal of Industrial Engineering Int.*, **10**(3), pp.72:1-27.

Jorgensen, F., Mathiessen, R, Nielsen, J., Johansen, J., 2007, in IFIP International Federation for Information Processing, Volume 246, *Advances in Production management Systems*, eds. Olhager, J., Persson, F., (Boston: Springer), pp. 371–378.

Kehoe, K., 2007. Get LEAN in Service, Yard & Garden, **15**, *ABI/INFORM Complete*, pp.18-19.

Kung, D., Alex, D.P., Al-Hussein, M., and Fernando, S. (2008). “Application of lean thinking to improve the productivity of water and sewer service installations.” *Canadian Journal of Civil Engineering*, **35**(4), pp.418-430.

Laganga, L.R., (2011). Lean service operations: Reflections and new directions for capacity expansion in outpatient clinics. *Journal of Operations Management*, **29**(5), pp.422–433.

Lee, S.M., Olson, D., Lee, T., Hwang, T., Shin, M., (2008). Entrepreneurial Applications of the Lean Approach to Service Industries, *Journal of Service Industries*, **28**(7), pp.973-987.

Maleyeff, J., 2006. Exploration of internal service systems using lean principles, *Management Decision*, **44**(5), pp.674–689.

McNary, L.D., 2008. Quality Management in the Public Sector: Applying Lean Concepts to Customer Service in a Consolidated Government Office. *Public Administration Quarterly*, **32**(2), pp.282–301.

Ming-Te, L., Kuo-Chung, M.A. & Pan, W.T., 2013. Using data mining technique to perform the performance assessment of lean service. *Neural Computing and Applications*, **22**(7-8), pp.1433–1445.

Noda, T., (2015). Integration of Lean Operation and Pricing Strategy in Retail. *Journal of Marketing Development & Competitiveness*, **9**(1), pp.50–60.

Piercy, N and Rich, N, (2009b). Lean transformation in the pure service environment: the case of the call service centre, *Int., Journal of Operations & Production Management*, **29**(1), pp.54 – 76.

Piercy, N and Rich, N., (2009a). High quality and low cost: the lean service centre. *European Journal of Marketing*, **43**(11/12), pp.1477–1497.

Portioli-Staudacher, A (2010) Lean Implementation in Service Companies, *Advances in Production Management Systems. New Challenges, New Approaches*, **338**, pp 652-659.

Qian, L., 2014. Market-based supplier selection with price, delivery time, and service level dependent demand, *Int., Journal of Production Economics*, **147**, pp.697–706.

Qu, L., Ma, M. & Zhang, G., 2011. Waste analysis of Lean Service. *Int., Conf., on Management and Service Science*, MASS 2011, Wuhan.

Richerson, M.E., (1999). Applying “lean” techniques to computer support services, Portland *Int., Conf., on Management of Engineering and Technology*, Portland.

Ritchie,R., Angelis,J., (2009). Implementing Lean into a Servicing Environment, Advances in Production Management Systems. New Challenges, New Approaches, Volume 338 of the series *IFIP Advances in Information and Communication Technology*, pp 587-594.

Sassanelli, C., Pezzotta,G., Rossi, M., Terzi, S., Cavalieri,S., (2015).Towards a Lean Product Service Systems (PSS) Design: State of the Art, Opportunities and Challenges, *Proc., CIRP*,**30**, pp. 191–196.

Schiele,J.J and McCue, C.P. (2011), Lean thinking and its implications for public procurements: Moving forward with assessment and implementation, *Journal of Public Procurement*, **11**(2), pp.206-239.

Seddon,J., O’Donovan,B., and Zokaei,K, (2011). Rethinking Lean Service, M. Macintyre et al. (eds.), Service Design and Delivery, *Service Science: Research and Innovations in the Service Economy*.

Staats, B.R., Brunner, D.J. & Upton, D.M., 2011. Lean principles, learning, and knowledge work: Evidence from a software services provider. *Journal of Operations Management*, **29**(5), pp.376–390.

Staudacher, A.P., (2010). Lean implementation in service companies. *IFIP Advances in Information and Communication Technology*, **338**, pp.652–659.

Susano,R, Jaca,C and Rogério Puga-Leal,R.P., (2014). Lean Services: An Approach for Supply Chains Based on the Gaps Model of Service Quality, *Proc., of the Eighth Int., Conf., on Management Science and Engineering Management*, J. Xu et al. (eds.), Advances in Intelligent Systems and Computing,**280**, pp. 533-539.

Stone, K.B., 2012. Four decades of lean: a systematic literature review. *Int., Journal of Lean Six Sigma*, **3**(2), pp.112–132.

Teo, E.A.L., Chan, S.L. and Tan, P.H., (2007) Empirical Investigation into Factors Affecting Exporting Construction Services in SMEs in Singapore. *Journal of Construction Engineering and Management*, **133**, pp.582–591.

Tritos, L., Premaratne, S and Dotun, A., 2014. Prioritizing lean supply chain management initiatives in healthcare service operations: A Fuzzy-AHP approach. *IEEE Int., Conf., on Industrial Engineering and Engineering Management*, pp.236–242.

Vilkas, M, Koreckaja,I, Katiliute,E, Bagdoniene,D, (2015) Adoption of Lean Production: Preliminary Evidence from Lithuania, *Proc., - Social and Behavioral Sciences*, **213**, pp. 884–889.

Wei,J.C., 2009.Theories and principles of designing lean service process, 6th International Conference on Service Systems and Service Management, Xiamen.

Xue-Gang,S., and Er-shi, Q, (2010). The application of lean thinking in transition of manufacturing-services. 2010 *Int., Conf., on Multi Media and Information Technology*, Kaifeng, pp.48–51.