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A Conceptual Model for Evaluating Product-Service Systems Leanness in UK Manufacturing Companies

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Abstract

The purpose of this paper is to present a conceptual model that can be used in measuring the degree of Product-Service System (PSS) leanness in UK manufacturing companies. The model will assess Product-Service System leanness based on five lean enablers (supplier relationship, management leanness, workforce leanness, process excellence, and customer relationship), 21 criteria (supplier delivery, culture of management, process optimisation, etc.) and finally 73 attributes. This proposed model will be the base of developing an index used as quantitative measure of the degree of Product-Service System leanness in manufacturing companies.

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1. Introduction

In today's competitive market, manufacturing companies are more focused on the improvement of core competitiveness. Manufacturing companies try to improve and develop their ability for competition through modern manufacturing initiatives and from these initiatives are lean manufacturing and Product-Service System (PSS). Lean and PSS can lead to dematerialisation through reducing the creation of wastes and the consumption of raw materials, improving customers' satisfaction by meeting customers' needs better and improving competitiveness through increasing customers' value.

In manufacturing companies the trend of servitisation of products is obvious. Through PSS companies can add value to customers, enhance their competitiveness and provide new business opportunities. PSS can be defined as a mix of tangible products and intangible services, designed and combined to be competitive, satisfy customer needs and have lower environmental impact. The idea beyond PSS is the 'sale of use' rather than the 'sale of product', so customers pay for using the product rather than its purchase.

Besides PSS, lean manufacturing was developed from the Toyota Production System (TPS). With the publication of the book *The* Machine That Changed the World, lean manufacturing practices have found acceptance in many manufacturing operations over more traditional mass production techniques. The main goal of Lean operations is the elimination of wastes occurring in the manufacturing process, thereby facilitating cost reduction [1]. There are seven types of wastes prone to occur in any manufacturing process. The seven wastes are overproduction, waiting, transport, inappropriate processing, unnecessary inventory, unnecessary motion and defects [2]. Literature on lean concentrates mostly on the manufacturing sector and especially in the automotive industry where it started. But recently because of the possible benefits gained by applying lean, other types of sectors such as service sector (insurance companies, banks and fast food restaurant) [3,4,5,6,7], public sector (NHS, court system and government councils) [8,9,10] and education sector [11,12,13] have recently taken up the concept of lean and introduced it to their own management activities. According to Womack et al [14] lean thinking is not a manufacturing tactic only, but a management strategy that is

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applicable to all organizations because it has to do with improving processes.

Despite the vast research published on lean either on manufacturing or service, the concept of leanness is immature because it lacks a holistic and unifying measure [15]. The term leanness refers to the degree of the adoption and implementation of lean philosophy in the organisation [16]. Few researchers focused on measuring leanness in the manufacturing sector and fewer attempted to measure leanness in the service sector. But very limited researchers contributed to the approach of measuring leanness in PSS. So the aim of this paper is to present a conceptual model that can be used in measuring the degree of PSS leanness.

2. Related research

Although many companies have applied lean concepts across their operations, more than 90% of them failed to recognise measurable improvement in performance [17]. This was because: (a) lean is often loosely defined in terms of its objectives, and (b) lean lacks a holistic, unifying measure.

Developing a standard measure that integrates the results of the lean practices into one scalar becomes necessary for a successful lean implementation [4]. Several researchers examined leanness in organisations through some measures.

Karlsson and Ahlström (1996) used a set of measures in a form of checklist to assess the extent of leanness. The nine variables that they have used are: elimination of waste, continuous improvement, zero defects, JIT deliveries, pull of materials, multifunction teams, decentralisation, integration of functions, and vertical information system [18]. Based on Karlsson and Ahlström variables, Soriano-Meier and Forrester (2002) developed a model to assess the leanness levels of 30 UK ceramic tableware manufacturers.

The Lean Enterprise Self-Assessment Tool (LESAT) a model presented by Nightingale and Mize (2002) assessed the state of a company's leanness and measured its readiness to change by evaluating three groups of processes; life-cycle processes, enabling infrastructure processes and enterprise leadership processes [19].

Goodson (2002) evaluated companies' leanness with a rapid plant assessment tool (RPA), using a tool kit that aided experts to decide if factories are truly lean [20]. Shah and Ward (2007) developed a multi-dimensional measure of lean production. They mapped the various conceptual measures of lean manufacturing. Some of the measures of lean production include; setup time reduction, simplicity in product design, customer focus, workforce management, etc [2]. Bayou and De-Korvin (2008) compared the leanness of General Motors and Ford Motor Company. They found that Ford's system is 17% leaner than General Motors's system over a period of three years. They argued that the systematic measure of leanness has seven characteristics: relative, dynamic, long-term fuzzy logic, objective, integrative and comprehensive [15]. Bhasin (2011) used a total of 104 indices, which are grouped within 12 distinctive categories to measure the leanness of 20 manufacturing organisations in the UK [17]. Vinodh and Chintha (2011) developed an index for measuring leanness by using multi-grade fuzzy approach. They have used a measurement system that consists of three levels. The first level consists of five leanness enablers; the second level consists of 20 lean criteria, and the third level consists of several lean attributes. By using this system they have specified the degree of leanness and the areas for leanness improvements [16]. Also Vimal and Vinodh (2013) used their previous system, but they have applied artificial neural network with fuzzy logic in the leanness assessment process [21].

All the previous researches focused mainly on the manufacturing sector. The question now is whether or not manufacturing and service operations can be managed based on the same concepts. Some stress the significance of distinctive service features. Grönroos (1990) claimed that there are four basic characteristics used in identifying services, namely: services are more intangible, services are activities or a series of activities rather than things, services are at least to some extent produced and consumed simultaneously and finally customers participate in the production process at least to some extent [22].

On the other hand, there are many authors who argued that the distinctive features of services should not be an excuse for avoiding manufacturing concepts as a means of increasing the efficiency of service operations. For example, Bowen and Youngdahl (1998) argued that lean ideas transfer well from manufacturing to services provided they were employed with minor alterations [3]. Additionally Allway and Corbett (2002) claimed that lean principles can be applied to many service sector firms, with equally the impressive results achieved in the manufacturing sector [23]. In 2006 Radnor asserted that lean is transferable to the public sector and can be used to develop more seamless processes, improve flow, reduce waste and develop an understanding of customer value [9]. He found that lean is a suitable methodology for improving performance and embedding a continuous improvement culture in the public sector. Similarly Swank [5], Piercy and Rich [6], Delgado and Ferrerira [7] confirmed that lean approach can be applied to services.

There are some authors who suggested that services can benefit and gain the same advantages achieved through lean manufacturing, if the lean concept and tools are adapted and adjusted to cope with the organizational context. For example, Ahlstrom (2004) claimed that the principles of lean manufacturing can be applied in service operations, but with contingencies [24].

Apart from this debate, there are some existing instruments for evaluating lean in the service sector.

Kollberg *et al*. (2007) developed a model called "flow model". This model used to explore lean thinking initiatives in the Swedish health care. The main focus of the model was not measuring lean, but to measure lead times and their improvement in health care [25]. Also Sanchez and Perez (2004) assessed the changes towards leanness in services. Their model was implemented in Spanish service companies [26]. Furthermore Cuatrecasa (2004) assessed lean adoption in a hotel check-out service. Cuatrecasa established a methodology used in measuring the operations efficiency for the hotel check-out service [27]. Finally, Apte and Goh (2004)

built a model for evaluating the performance of lean adoption in the insurance claims handling process [28].

3. Research methodology

Starting from existing literature on lean manufacturing assessment and lean service assessment as shown in Figure 1, the initial model for assessing PSS leanness was developed. After conducting literature review, semi-structured interviews with five academic researchers involved in lean projects were conducted. Each interview was held independently and ranged from 45 to 60 minutes. In each interview an explanation of the model, its items, and how it will be used in calculating the leanness of PSS were presented. Every researcher was asked about his opinion in the model in order to validate the model and assess its feasibility. These interviews ended up with the second version of the model.

The second version of the model was refined using semi-structured interviews with a number of experts working in different UK manufacturing industries (trucks and buses, transportations, document management and aerospace), involved in lean and continuous improvement projects, and with working experience ranged from 15 years to 30 years. Each interview took about 60 minutes discussing the model and examining its items, its structure, and its ability to measure PSS leanness. These interviews resulted in refining the second version of the model by adding and removing some items as well as changing the names of other items.

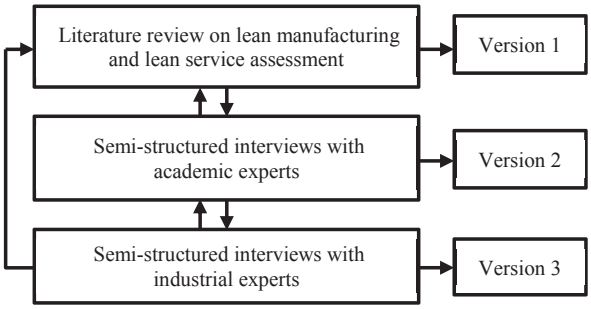


Fig. 1. Research methodology

4. The proposed model for assessing PSS leanness

The proposed model for PSS leanness assessment has been developed based on the model presented by Vinodh and Chintha [16], which assessed the degree of production leanness. The assessment model consists of three levels as presented in Fig. 3. The first level consists of five enablers; the second level consists of 21 lean criteria; and the third level consists of 73 attributes.

As a sample, supplier relationship enabler has been explained. The major criteria of supplier relationship are: supplier quality, supplier cost, supplier responsiveness, supplier delivery, supplier feedback and finally supplier development. The supplier cost criterion consists of attributes such as: price competitiveness and flexibility in payment.

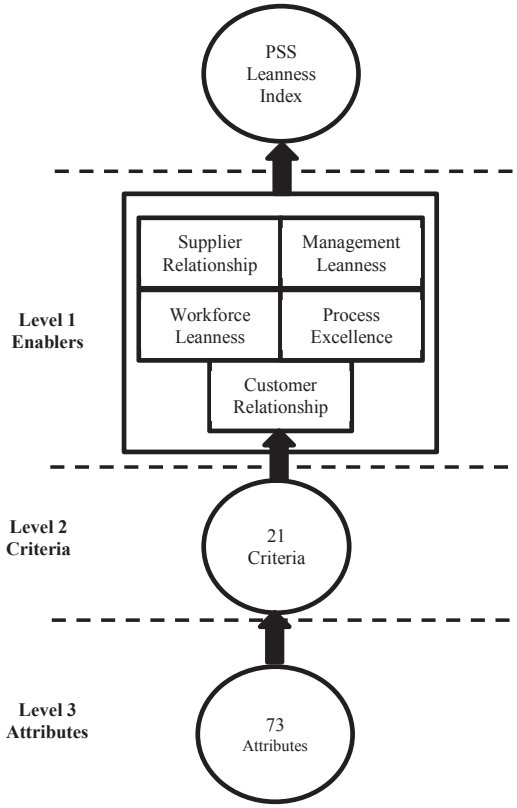


Fig. 2. Summary of the model

4.1. Supplier relationship

The relationships between suppliers and customers are crucial to achieving leanness. Womack et al. (1990) emphasised the strategic role that suppliers have to play and outlined the characteristics of lean supply [29]. Some features of lean suppliers are:

- Lean suppliers are expected to be responsive to quality problems so defects can be prevented.
- Lean suppliers need effective telecommunications networks with their customers to get information on orders and to track and manage material flows and inventories.
- Lean suppliers need to deliver frequently, in small quantities, as required at the point of use with total quality guaranteed to eliminate the need for incoming inspection.

Furthermore, there should be long-term commitment and closer relationships between supplier and customer.

4.2. Management leanness

Without management commitment to lean, lean implementation often fails and virtually never achieves the

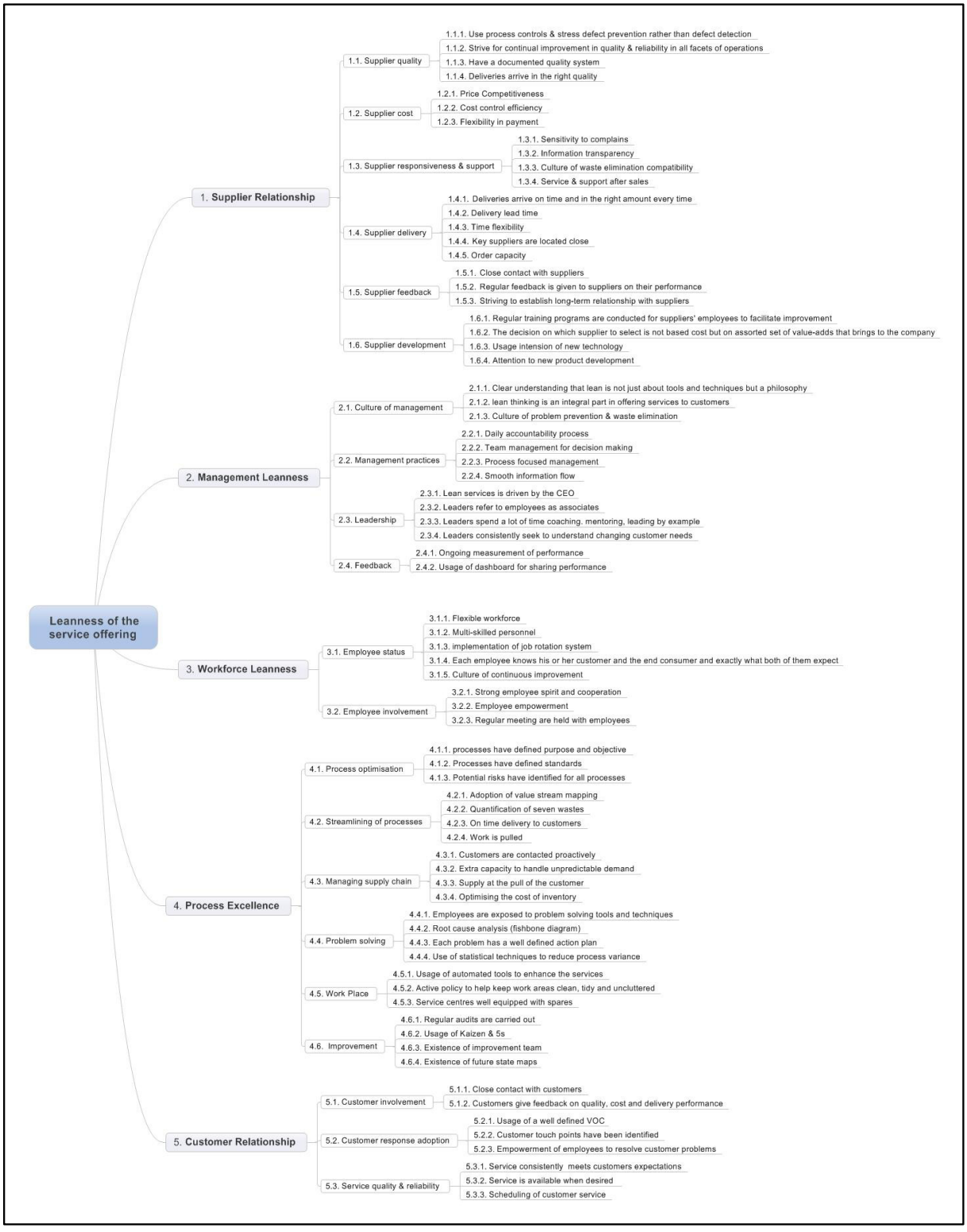


Fig. 3. PSS leanness assessment model

required objectives. To achieve management commitment, managers should clearly understand lean philosophy and feels enthusiastic for it. Womack (2008) argued that every organization must address the 3Ps: purpose, processes and people. He believes that most organizations struggle because the purpose is not clearly defined, the processes are not clearly specified and the people are not fully engaged.
Also, managers should act as leaders to create a sustainable motivation for implementing lean among employees. The successful implementation of lean requires strong leadership and management commitment. Many lean implementation plans have failed because the leaders did not have the courage and character to make difficult decisions and the lack of support and involvement of firms managers [30]. The role of leadership is critical; they have to prepare people for the required changes and the consequences that may occur. Furthermore, there should be clear communication between managers and employees. This communication can be done by regular meetings, exchanging information, and regular feedbacks. Management should: have a clear understanding that lean is not just about tools and techniques but a philosophy, have culture of problem prevention and waste elimination, and act as leaders not as managers.

4.3. Workforce leanness

The chance of a successful lean implementation will increase if there are committed workers and cooperative labor-management relations.

A lean workforce is a workforce with the right number of workers, with the right skill sets for the job at hand, working safely and productively without errors. Workforce leanness requires the development of best practices and training on how to perform each job, the implementation of the job rotation system, strong employees' spirit and cooperation, and employees' empowerment. Workforce leanness can lead to:

- Elimination of wasted time and effort improves productivity, thus reducing costs and improving services.
- Self-motivated and accountable workers with higher morale will provide better and more responsive customer service. This improves customer satisfaction and loyalty.
- Proper workforce. This will reduce overtime and the need for temporary help.

4.4. Process excellence

There are three types of activities in a process: value-added activities, business value-added activities, and non-value-added activities [31].

Value-added activities are those activities for which the customer is willing to pay. These activities help to bring about a transformation in the product or service being provided by the organisation and add a feature or trait that the customer values and is willing to pay for [31].

Business-value-added activities are those activities in a process for which the customer is not willing to pay but cannot be avoided. They necessarily need to be present in the process and cannot be eliminated from the process [31].

Non-value-added activities are those activities in a process for which the customers are not willing to pay and can be avoided. Management focus should be on eliminating these non-value-added activities, which do not enhance the customer's image of the product or service and do not support the business process [31].

Process excellence can be achieved by process optimization, streamlining of processes, managing demand and applying problem solving techniques.

4.5. Customer relationship

Understanding and precisely identifying customer needs is a mandatory step for a successful lean implementation process [29]. The full identification of customer demand allows managers to leverage the knowledge of their customer preferences and hence improve the accuracy of forecast plans and service quality level. Also customer demand management is important to increase customer value and service level. Improving customer relationship can be achieved by: using well-defined voice of the customer, identifying customer touch points, and empowerment of employees to resolve customer problems. According to the model customer relationship enabler will depend on some criteria such as: customer involvement, customer response adoption and service quality and reliability.

5. Conclusions

The aim of this paper is to develop and validate a model for assessing PSS leanness in UK manufacturing companies. The assessment model contains three levels. The first level consists of five lean enablers. These five enablers will be used in measuring the leanness of PSS.

The second level consists of 21 criteria. These criteria will be used in evaluating the performance of lean enablers.

Finally, the third level which consists of 73 attributes. These attributes will be used in measuring the performance of the criteria.

The model development process included in-depth interviews with industrial experts and academics. The model was found to be applicable and feasible. Furthermore, this model will be the foundation for developing a PSS leanness index. This index will provide companies with a quantitative measure of PSS leanness.

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References

[1] Soriano-Meier, H. and Forrester, P. L. (2002), "A model for evaluating the degree of leanness of manufacturing firms", Integrated Manufacturing Systems, vol. 13, no. 2, pp. 104-109.

[2] Shah, R. and Ward, P. T. (2007), "Defining and developing measures of lean production", Journal of Operations Management, vol. 25, no. 4, pp. 785-805.

[3] Bowen, D. E. and Youngdahl, W. E. (1998), ""Lean" service: in defense of a production-line approach", International Journal of Service Industry Management, vol. 9, no. 3, pp. 207-225.

[4] Goland, A., Hall, J. and Devereaux, C. (1998), "First national Toyota", The McKinsey Quarterly, vol. 4, pp. 59-66.

[5] Swank, C. K. (2003), "The lean service machine", Harvard business review, vol. 81, no. 10, pp. 123-130.

[6] Piercy, N. and Rich, N. (2009), "Lean transformation in the pure service environment: the case of the call service centre", International Journal of Operations & Production Management, vol. 29, no. 1, pp. 54-76.

[7] Delgado, C., Ferreira, M. and Branco, M. C. (2010), "The implementation of lean Six Sigma in financial services organizations", Journal of Manufacturing Technology Management, vol. 21, no. 4, pp. 512-523.

[8] Krings, D., Levine, D. and Wall, T. (2006), "The Use of" Lean" in Local Government", PUBLIC MANAGEMENT-LAWRENCE THEN WASHINGTON-, vol. 88, no. 8, pp. 12.

[9] Radnor, Z., Scotland. Scottish Executive, Scotland. Office of the Chief Researcher and Scotland. Social Research (2006), Evaluation of the Lean approach to business management and its use in the public sector, Scottish Executive Edinburgh.

[10] Zokaei, K., Elias, S., O'Donovan, B., Samuel, D., Evans, B. and Goodfellow, J. (2010), "Lean and Systems Thinking in the Public Sector in Wales", Lean Enterprise Research Centre report for the Wales Audit Office, Cardiff University

[11] William, B. K. (2010), "Lean higher education–increasing the Value and Performance of University Processes", .

[12] Barroso, I. P. M., Santos, S. M. F. and Carravilla, M. A. (2010), "Beyond classroom boundaries: How higher education institutions apply lean", 1st Braziliar Symposium on Services Science, .

[13] Radnor, Z. and Bucci, G. (2011), Analysis of Lean Implementaion in UK Business Schools and Universities , Association of Business Schools, London.

[14] Womack, J. P., Miller, D. and Institute for Healthcare Improvement (2005), Going lean in health care, Institute for Healthcare Improvement.

[15] Bayou, M. and De Korvin, A. (2008), "Measuring the leanness of manufacturing systems—a case study of Ford Motor Company and General Motors", Journal of Engineering and Technology Management, vol. 25, no. 4, pp. 287-304.

[16] Vinodh, S. and Chintha, S. K. (2011), "Leanness assessment using multi-grade fuzzy approach", International Journal of Production Research, vol. 49, no. 2, pp. 431-445.

[17] Bhasin, S. (2011), "Measuring the Leanness of an organisation", International Journal of Lean Six Sigma, vol. 2, no. 1, pp. 55-74.

[18] Karlsson, C. and Åhlström, P. (1996), "Assessing changes towards lean production", International Journal of Operations & Production Management, vol. 16, no. 2, pp. 24-41.

[19] Nightingale, D. J. and Mize, J. H. (2002), "Development of a lean enterprise transformation maturity model", Information, Knowledge, Systems Management, vol. 3, no. 1, pp. 15-30.

[20] Goodson, R. E. (2002), "Read a Plant-Fast", Harvard business review, vol. 80, no. 5, pp. 105-113.

[21] Vimal, K. and Vinodh, S. (2013), "Application of artificial neural network for fuzzy logic based leanness assessment", Journal of Manufacturing Technology Management, vol. 24, no. 2, pp. 274-292.

[22] Grönroos, C. (1990), Service management and marketing: managing the moments of truth in service competition, Lexington Books.

[23] Allway, M. and Corbett, S. (2002), "Shifting to lean service: Stealing a page from manufacturers' playbooks", Journal of Organizational Excellence, vol. 21, no. 2, pp. 45-54.

[24] Ahlstrom, P. (2004), "Lean service operations: translating lean production principles to service operations", International Journal of Services Technology and Management, vol. 5, no. 5, pp. 545-564.

[25] Kollberg, B., Dahlgaard, J.J. and Brehmer, P.-O. (2007), "Measuring lean initiatives in health care services: issues and findings", International Journal of Productivity and Performance Management, Vol. 56 No. 7

[26] Sa´nchez, A.M. and Pe´rez, M.P. (2004), "The use of lean indicators for operations management in services", International Journal of Services Technology and Management, Vol. 5 No. 465.

[27] Cuatrecasas, L. (2004), "A lean management implementation method in service operations", International Journal of Services Technology and Management, Vol. 5 Nos 5/6, p. 532.

[28] Apte, U.M. and Goh, C.-H. (2004), "Applying lean manufacturing principles to information intensive services", International Journal of Services Technology and Management, Vol. 5 No. 488.

[29] Womack, J. P., Jones, D. T. and Roos, D. "The Machine that Changed the World: The Story of Lean Production. 1990", New York: Rawson Associates, .

[30] Wilson, L. (2010) How to implement lean manufacturing, McGraw-Hill.

[31] Sarkar, D. (2007), Lean for service organizations and offices: A holistic approach for achieving operational excellence and improvements, Asq Press.



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