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The lean-performance relationship in services: a theoretical model

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Abstract

Purpose – The extant literature on lean service reveals a noticeable lack of theoretical models establishing the core constructs of lean service, their interrelation and impact on organizational performance. The purpose of this paper is to address this gap by proposing a theoretical model in which lean constructs are identified and operationalized to establish their interrelation and impact on organizational performance.

Design/methodology/approach – This paper synthesizes information drawing on a systematic review of the literature on lean service, other relevant academic literature to develop a theoretical model and a set of propositions. Drawing on the universal theory, socio-technical systems theory and contingency theory (CT), the paper highlights and clarifies the potential impact of lean service on operational and financial performance.

Findings – This study identifies a comprehensive set of lean technical practices, lean supportive practices, inhibitors and expected outcome of lean service. Expected relationships among those constructs are established by developing a conceptual framework with several propositions based on the relevant literature and the socio-technical system theory, the universal perspective and the CT, when relevant. Moreover, six influential contextual variables on the lean-performance relation are identified based on a review of the management accounting literature, organizational strategy literature and diversification literature to overcome limitations of previous studies.

Originality/value – This paper covers a gap in the literature by identifying and operationalizing lean service constructs and offering a theoretical model with several propositions that establish relationships between lean constructs and overcome limitations in previous studies by identifying six contextual variables that are important factors in the lean-performance associations.

Keywords Inhibitors, Financial performance, Contextual variables, Operational performance, Lean supportive practices, Lean technical practices

Paper type Conceptual paper

1. Introduction

Globalization and increasing competition have forced companies in different sectors to reconsider their operations and strategies (Karmarkar, 2004). However, the manufacturing sector was exposed to these challenges before other sectors (van Biema and Greenwald, 1997). Manufacturing companies reacted to such severe challenges by seeking new methods of production and management, such as lean system, that are believed to eliminate waste and improve the effectiveness and efficiency of their operations while simultaneously focussing on customers' needs (Abdi *et al.*, 2006). Allway and Corbett (2002, p. 45) defined lean system as "an approach focusing on eliminating non-value-added activities from processes by applying a robust set of performance change tools, and emphasize excellence in operations to deliver superior customer services." The expected benefits from lean system have led to an increasing level of popularity in practice and

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academic literature (Atkinson, 2004). Maskell and Kennedy (2007) report that around 50 percent of American manufacturing companies strive to achieve some levels of lean system in their plants. In addition, Taylor and Taylor (2009) find that lean methods of production and service delivery are one of the eight topics that have the most recent focus in operations management research.

Service providers, in contrast, were to some extent immune against the effect of globalization and competition (van Biema and Greenwald, 1997). In addition, the unique characteristics of service processes (i.e. intangibility, heterogeneity, perishability, simultaneity, labor intensive and the presence of customers during the production process of most services) highlighted by several researchers (e.g. Nie and Kellogg, 1999; Bowen and Youngdahl, 1998) have delayed the spread of and even questioned the applicability of lean practices to various service industries (Nie and Kellogg, 1999). However, the recent rising level of competition facing service companies (Karmarkar, 2004), and the argument that lean system is designed to focus on processes rather than products along with the fact that all companies, manufacturing and non-manufacturing, are a compilation of processes that are used to provide customers with their needs of products and/or services (Allway and Corbett, 2002), have led several researchers to stress the need and applicability of lean practices to services (Kosuge *et al.*, 2010; Endsley *et al.*, 2006; Jones *et al.*, 1999).

Despite the rising level of interest in lean service among academics and service companies (Kosuge *et al.*, 2010; Abdi *et al.*, 2006; Endsley *et al.*, 2006), recent literature reviews by Holm and Ahlstrom (2010b) and Suárez-Barraza *et al.* (2012) uncover a noticeable lack of adopting the survey methodology to explore different aspects of lean service. This is accompanied by the lack of suitable theoretical frameworks to establish the concept of lean service and probe its impact on performance. The critical importance of the change needed to adopt lean service (Scherrer-Rathje *et al.*, 2009; Atkinson, 2004) and the escalating importance of service firms to most developed economies (Chase and Apte, 2007; Ellram *et al.*, 2004) further signify this need. This unproven association between lean service and performance may hinder the development and spread of lean service across industries (Staats *et al.*, 2011; Woehrle and Abou-Shady, 2010; Fullerton and Wempe, 2009). Consequently, there is a serious need for theoretical models that pave the way for rigorous deductive research examining the various aspects of lean service and in particular, its impact on performance.

This paper aims to address this gap by synthesizing information obtained through a systematic literature review of lean service with information from lean manufacturing and other relevant academic service literature (i.e. management accounting literature, organizational strategy literature and diversification literature) to develop a theoretical model that highlights and clarifies the potential effect of lean service on operational and financial performance. More specifically, in this paper, lean service is viewed as a socio-technical system consisted of two constructs, namely lean technical practices (LTPs) and lean supportive practices (LSPs). The model will operationalize lean constructs, underline interrelations among them, highlight their roles in improving performance, and identify contextual variables that may confound the lean-performance association if not taken into consideration in any respective survey study. Our model and related propositions are backed up by three different theories, namely the universalistic theory, the socio-technical systems theory and the contingency theory (CT). The universal theory (UT) simply implies a direct relationship between a dependent (e.g. performance) and independent variables (e.g. LTPs and LSPs) and helps formulate propositions concerning the main effect of our independent variables on performance. The socio-technical theory (STS)

implies that a better performance can be achieved by a simultaneous emphasis on both the technical (LTPs) and social (LSPs) subsystems. The CT assumes that the impact of a predictor variable on an outcome variable varies based on the level of a third variable called a moderator variable.

Section 2 points to the current status of lean service literature. In Section 3, we develop our conceptual framework and generate several propositions regarding the lean-performance association. Section 4 is devoted for the identification of contextual variables vital to be accounted for. Finally, research implications and conclusion are presented in Sections 5 and 6, respectively.

2. Lean system and service industries

Lean service is a recent concept compared to the widely known lean manufacturing. Womack and Jones (1996) formally introduced the term lean thinking that expanded lean manufacturing to include non-manufacturing processes indicating applicability of lean system to other processes than manufacturing. However, the term lean service was introduced explicitly in the academic literature in a pioneering article written by Bowen and Youngdahl (1998) two years after the term lean thinking was reported (Suárez-Barraza *et al.*, 2012). The literature discussing lean service although dominant by conceptual and case studies (Holm and Ahlstrom, 2010b), it covers a wide range of service industries and rapidly develops over time. Figure 1 presents the classification of 214 articles identified in our systematic literature review based on industry type. As shown in the figure, healthcare and office operations were the most popular application areas for lean practices in service sector. The trend of publications on lean service since 1993 is illustrated in Figure 2. The figure reveals an increasing interest in lean service among the academic community with around 30 publications in each of 2011 and 2012.

The conceptual studies in this literature emphasize the applicability of lean practices to service operations and potential outcome expected from it (e.g. Allway and Corbett, 2002; Bowen and Youngdahl, 1998). The case-study part of this literature, however, focusses on reporting how specific and a limited number of lean practices have been successful in improving some performance indicators of various service firms (e.g. Staats *et al.*, 2011; Staats and Upton, 2011; Swank, 2003; Arbos, 2002). This body of literature although collectively indicates applicability of lean practices to a wide range of service industries with promising results, it first does not provide us with as a comprehensive list of lean practices as possible. Such list is needed so that practitioners and researchers are aware of what practices are available for them to implement and study. Second, it does not, to a large extent, differentiate between LTPs and LSPs despite their importance as will be shown later in this paper.

The only-found survey study that touched the lean-performance relationship in services was conducted by Alsmadi *et al.* (2012). Using a sample of 278 UK manufacturing and service firms, the authors reveal that the ten lean practices studied are employed similarly by service and manufacturing firms except for three, namely supplier feedback, set up time reduction and total productive maintenance. These practices are implemented more in the manufacturing context while employee and customer involvement are found to be implemented more in the service firms. Moreover, lean practices individually and collectively are found to have a significant association with the performance of manufacturing firms. For service firms, lean practices as a whole are significantly correlated with performance while individually only three (i.e. supplier development, set up time reduction and total productive

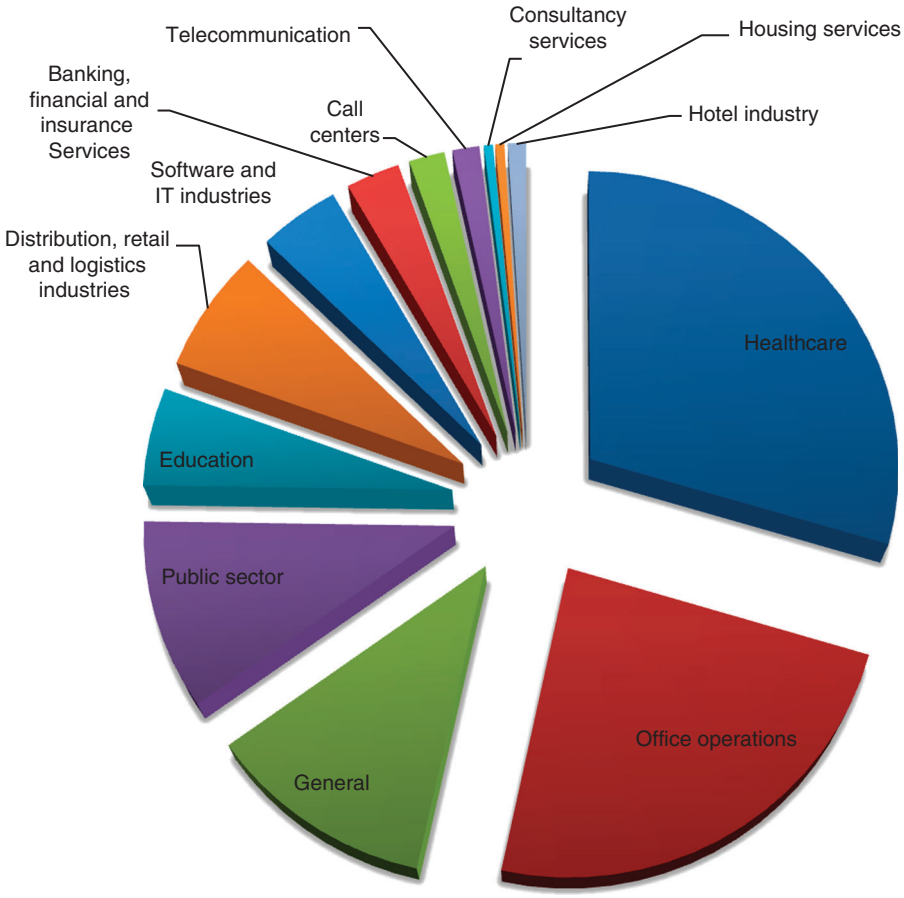

Figure 1.
The classification of lean service literature per industry type

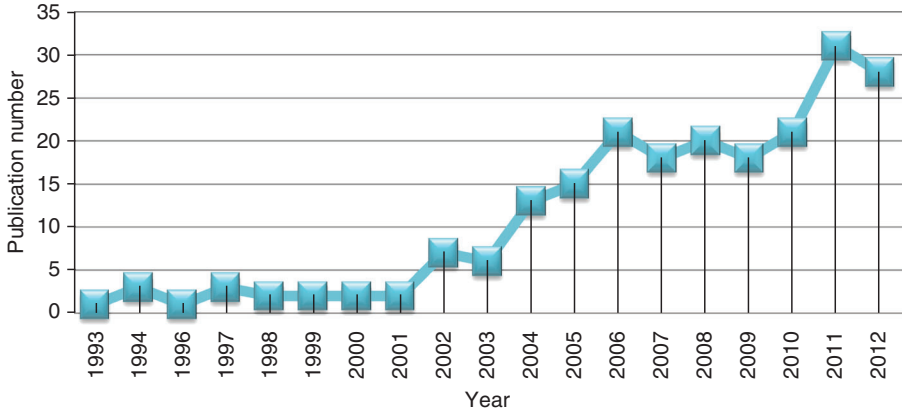

Figure 2.
The trend of lean service publications

maintenance) out of ten practices do not have a significant relationship with performance. This study, however, uses a limited number of lean practices where employing a larger set of practices will provide a clearer picture on the lean-performance relationship. In addition, the authors ignore the effect of LSPs, inhibitors hindering LTPs and other contextual variables that usually play an important role in performance studies.

3. Conceptual framework and propositions development

3.1 Methodology

Given the focus of this research on lean system in services, it is important to establish the definition of services. We consider service firms as any organization which is not involved in manufacturing, agriculture, mining and construction industries. Keeping in mind this definition, a systematic search for lean service publications begins by surveying publications in five well-known databases using key words including "lean," "process improvement," "system thinking" and "more with less." Those databases include: Business Source Premier, ABI/INFORM Research, Emerald, Science Direct and Scopus. All articles reporting any of the aforementioned key words in the title, abstract or key words are collected for further examinations. The title and abstract of each article are examined to distinguish between articles on lean manufacturing and lean services. After identifying publications on lean services, references listed at the end of each article are traced to collect all possible relevant articles. Through this process, 221 articles have been found (up to the end of May 2013) and used to extract required information (i.e. lean practices, inhibitors and outcome) for constructing the model.

The identification of lean practices is not a trivial task given the confusion surrounding the concept (Lewis, 2000). For instance, the human-based practices are emphasized and argued to be crucial for any improvement system where lean is not an exception (Höök and Stehn, 2008). Based on that, some authors include explicitly or implicitly the human-based practices such as education/training, employees' involvement and empowerment, multi-skilled/multi-function employees and teamwork in the lean toolbox (e.g. Staats *et al.*, 2011; Holden, 2010; Kuriger *et al.*, 2010; Poksinska, 2010; Manos *et al.*, 2006). Shah and Ward (2003) involve HRM practices in the lean toolbox to conclude that lean system comprises four bundles namely, JIT, TQM, TPM and HRM practices, each of which has its own items. In contrast, other researchers adopt a different perspective believing that HRM practices are important to a successful lean implementation and consequently they are a prerequisite for lean system (e.g. Suarez-Barraza and Ramis-Pujol, 2010; Ehrlich, 2006; Comm and Mathaisel, 2005a). Pettersen (2009) reports that the findings of his study contradict those of Shah and Ward (2003). He finds that HRM is not a basic characteristic of lean although it is important to present. Pont *et al.* (2008) consider HRM practices as one of the lean bundles and report the importance of their implementation first in the lean journey. That, however, implicitly supports the need to differentiate between HRM and other lean bundles. Fullerton and Wempe (2009) separate employees' involvement from other lean tools namely, cellular manufacturing and quality improvement. Finally, studying the impact of JIT practices on plants performance, Sakakibara *et al.* (1997) and Ahmad *et al.* (2003) perceive similar practices as supportive and infrastructure practices necessary for an effective JIT system. Consequently, in this study, we follow Shah and Ward (2007) in viewing lean service as a socio-technical system that has two distinctive sets of practices. HRM practices, however, discussed above and other practices identified in the literature will represent the social side (LSPs in this paper) of the system.

This differentiation is highly important given that some companies may not adopt all practices (technical and social). Therefore, if the aforementioned activities are combined with LTPs in one comprehensive group, they may not be considered for implementation leading to a less successful overall outcome and consequently distorting the reputation of lean service.

Changing the facility layout (CFL) is another controversial point. For instance, some researchers view CFL as a requirement for moving away from a department-based organization to a process-based organization (Yasin *et al.*, 2003) which is needed for the group technology concept. In contrast, others consider CFL to be one of the lean techniques that could be employed to attack one or more of waste elements (Holden, 2010; Holm and Ahlstrom, 2010a; Poksinska, 2010; Manos *et al.*, 2006; Tonya, 2004; Allway and Corbett, 2002). Theoretically and regardless of leading to a complete process-based layout, the layout of an organization can be modified so that any unnecessary movements of employees and/or inefficient use of space can be eliminated (Hameri, 2010). Therefore, CFL will be included in the LTPs that an organization can use to eliminate waste.

3.2 The findings

3.2.1 LTPs, LSPs and benefits. Given the argument presented above, our systematic literature review determines 37 LTPs (reported in Table I) and 17 LSPs (reported in Table II) that, we argue, have several roles in the case of lean service. Practices reported in Table I collectively represent the first construct in our model that is LTPs. Similarly, practices reported in Table II represent LSPs construct. Similar approach is used, however, for all other constructs (inhibitors and outcome) so that the effect of a construct is used in our generated propositions. To clarify the terms used in Table I, definitions for the LTPs have been provided in Appendix 1. Furthermore, given that lean concept revolves around identifying and eliminating non-value adding activities (waste) from operations, the definition of each LTP was used to classify the 37 LTPs based on their role in the waste identification and elimination process. The seven types of waste (i.e. overproduction, over-processing, motion, transportation, inventory, waiting and defects) introduced by Ohno (1988) which are adapted to service processes by several researchers (e.g. Malladi *et al.*, 2010; Taubitz, 2010) were used as criteria for classification. To start the classification process using the definition of each practice, an answer was sought to the following question: does the implementation of a specific practice directly identify any type of waste, eliminate any type of waste, lead to both identification and elimination of waste or none of the aforementioned? Employing this methodology, three groups emerged as shown in Appendix 2, namely waste identification practices, waste elimination practices and complementary practices.

The waste identification practices identify and expose problems and waste in a process but they cannot eliminate them. Value stream mapping (VSM) has been used to understand the as-is process and bring to light inherent waste in the process but it is not capable of eliminating such waste where that is mainly the role of practices in the second group. The second set of practices, waste elimination practices, directly attack highlighted waste to eradicate it or at least reduce it. For instance, if unnecessary movements by some employees were highlighted through VSM, the CFL practice can be effectively used to eliminate this type of waste. As demonstrated in the table, some practices can perform the two aforementioned tasks simultaneously. Among the four practices of this type, Tatikonda (2007) explained how using quality function deployment can identify and eliminate waste by linking students' needs to the design

Table I.
Lean technical practices

No.	Technical practices	References
1.	5Ss	Ehrlich (2006), Holden (2010), Poksinska (2010), Arlbjørn *et al.* (2011), Burgess and Radnor (2010), Manos *et al.* (2006), Fillingham (2007), Esain *et al.* (2008), Emiliani (2004), Bushell *et al.* (2002), Suarez Barraza *et al.* (2009), Wayne (2005), Brewton (2009), Tiplady (2010), Finigan and Humphries (2006), Maguad (2007), Julien and Tjahjono (2009), Haque and James-Moore (2004), Keen (2011), Pedersen and Huniche (2011), Wenchao Song *et al.* (2009), Kaplan and Patterson (2008), Markovitz (2012), Chadha *et al.* (2012), Radnor *et al.* (2012), Schulze and Störmer (2012)
2.	A3 report	Holden (2010), Jimmerson *et al.* (2005), Doman (2011), Qudrat-Ullah *et al.* (2012)
3.	Automation	Holden (2010), Poksinska (2010), Bortolotti and Romano (2010), Manos *et al.* (2006), Ahluwalia *et al.* (2004), Lodge and Bamford (2008), Wayne (2005), Julien and Tjahjono (2009), Åhlström (2004), Carter *et al.* (2011), Wenchao Song *et al.* (2009), Bortolotti and Romano (2012)
4.	Change management	Manos *et al.* (2006)
5.	Continuous improvement	Dickson *et al.* (2009), Ehrlich (2006), Poksinska (2010), Piercy and Rich (2009a), Manos *et al.* (2006), Emiliani (2004), Alagaraja (2010), Maguad (2007), Kuriger *et al.* (2010), Yavas and Yasin (2001), Hagan (2011), Qudrat-Ullah *et al.* (2012)
6.	Eliminating loop-backs	Swank (2003)
7.	Group technology	Piercy and Rich (2009b), Ehrlich (2006), Holden (2010), Swank (2003), Arlbjørn *et al.* (2011), Nielsen and Edwards (2010), Burgess and Radnor (2010), Manos *et al.* (2006), Arbos (2002), Ben-Tovim *et al.* (2007), Alagaraja (2010), Hyer and Wemmerlöv (2002), Tatikonda (2007), Cuatrecasas (2004), Middleton *et al.* (2005)
8.	Changing the facility layout	Allway and Corbett (2002), Holden (2010), Poksinska (2010), Holm and Ahlstrom (2010a), Manos *et al.* (2006), Tonya (2004), Cuatrecasas (2004), Nelson-Peterson and Leppa (2007)
9.	Just in Time	Cooper and Mohabeersingh (2008a, b), Holden (2010), Poksinska (2010), Arlbjørn *et al.* (2011), Manos *et al.* (2006), Emiliani (2004), Alagaraja (2010), Åhlström (2004), Cuatrecasas (2004), Nelson-Peterson and Leppa (2007), Chadha *et al.* (2012)
10.	Kaizen blitz	Dickson *et al.* (2009), Holden (2010), Arlbjørn *et al.* (2011), Burgess and Radnor (2010), Hines and Lethbridge (2008), Suarez-Barraza and Ramis-Pujol (2010), Suarez Barraza *et al.* (2009), Kress (2008), Papadopoulos and Merali (2008), Montabon (2005), Graban and Swartz (2012), Papadopoulos (2012), Radnor *et al.* (2012)
11.	Kanban	Holden (2010), Poksinska (2010), Arlbjørn *et al.* (2011), Manos *et al.* (2006), Alagaraja (2010), Reinertsen (2005), Hagan (2011), Nelson-Peterson and Leppa (2007)

(*continued*)

Table I.

No.	Technical practices	References
12.	Mistakes proofing/Poka-Yoke	Ehrlich (2006), Cooper and Mohabeersingh (2008a, b), Holden (2010), Poksinska (2010), Manos *et al.* (2006), Alagaraja (2010), Finigan and Humphries (2006), Maguad (2007), Kuriger *et al.* (2010), Mirehei *et al.* (2011), Hagan (2011), Doman (2011)
13.	Model cell, roll out	Swank (2003), Graban and Swartz (2012)
14.	Outsourcing	Comm and Mathaisel (2005b)
15.	Point of use storage	Manos *et al.* (2006)
16.	Policy deployment/ Hoshin Kanri	Poksinska (2010), Swank (2003), Emiliani (2004), Alagaraja (2010), Pejsa and Eng (2011), Ball and Maleyeff (2003), Wayne (2005), Qudrat-Ullah *et al.* (2012)
17.	Process redesign	Piercy and Rich (2009a), McQuade (2008), Suarez-Barraza and Ramis-Pujol (2010), Yavas and Yasin (2001), Carter *et al.* (2011), Edwards *et al.* (2012), Chadha *et al.* (2012), Bortolotti and Romano (2012)
18.	Production levelling/Heijunka	Poksinska (2010), Emiliani (2004), Staats *et al.* (2011), Pedersen and Huniche (2011)
19.	Pull system	Ehrlich (2006), Cooper and Mohabeersingh (2008a, b), Poksinska (2010), Holm and Ahlstrom (2010a), Arlbjørn *et al.* (2011), Manos *et al.* (2006), Petersen and Wohlin (2010), Kuriger *et al.* (2010), Reinertsen and Shaeffer (2005), Reinertsen (2005), Kress (2008), Mirehei *et al.* (2011), Hagan (2011), Ball and Maleyeff (2003), Schulze and Störmer (2012)
20.	Quality circles	Swank (2003), Searcy (2009b)
21.	Quality function deployment	Emiliani (2004), Alagaraja (2010), Tatikonda (2007), Wang *et al.* (2012), Schulze and Störmer (2012)
22.	Quick set up time	Arlbjørn *et al.* (2011), Manos *et al.* (2006), Arbos (2002), Finigan and Humphries (2006), Maguad (2007)
23.	Root cause analysis	Ehrlich (2006), Holden (2010), Poksinska (2010), Jones *et al.* (1999), Petersen and Wohlin (2010), Searcy (2009b), Villarreal *et al.* (2009), Haque And James-Moore (2004), Yavas and Yasin (2001), Wang *et al.* (2012), Collar *et al.* (2012), Schulze and Störmer (2012)
24.	Segregating complexity	Holm and Ahlstrom (2010a), Swank (2003), Nielsen and Edwards (2010), King *et al.* (2006)
25.	Self-inspection	Manos *et al.* (2006), Maguad (2007)
26.	Simplification	Bortolotti and Romano (2010), Bortolotti and Romano (2012)
27.	Single piece flow	Poksinska (2010), Staats *et al.* (2011), Alagaraja (2010), Kuriger *et al.* (2010), Haque and James-Moore (2004), Kress (2008), Mirehei *et al.* (2011), Nelson-Peterson and Leppa (2007), Chadha *et al.* (2012), Bortolotti and Romano (2012)
28.	Small lots	Ehrlich (2006), Swank (2003), Manos *et al.* (2006), Arbos (2002), Brewton (2009), Kuriger *et al.* (2010), Reinertsen and Shaeffer (2005), Reinertsen (2005), Kress (2008)

(*continued*)

Table I.

No.	Technical practices	References
29.	Standardization	Allway and Corbett (2002), Ehrlich (2006), Holden (2010), Poksinska (2010), Holm and Ahlstrom (2010a), Sprigg and Jackson (2006), Swank (2003), Bortolotti and Romano (2010), Kosuge *et al.* (2010), Nielsen and Edwards (2010), Manos *et al.* (2006), Emiliani (2004), Bushell *et al.* (2002), Staats *et al.* (2011), Alagaraja (2010), Haque And James-Moore (2004), LaGanga (2011), Hagan (2011), Wenchao Song *et al.* (2009), Kaplan and Patterson (2008), Nelson-Peterson and Leppa (2007), Middleton *et al.* (2005), Doman (2011), Carlborg *et al.* (2013), Wang *et al.* (2012), Qudrat-Ullah *et al.* (2012), Chadha *et al.* (2012), Bortolotti and Romano (2012), Jaca *et al.* (2012)
30.	Takt time	Allway and Corbett (2002), Poksinska (2010), Holm and Ahlstrom (2010a), Swank (2003), Arlbjørn *et al.* (2011), Arbos (2002), Emiliani (2004), Haque and James-Moore (2004), Reinertsen (2005), Kress (2008), Cuatrecasas (2004), Middleton *et al.* (2005)
31.	Total preventive maintenance	Poksinska (2010), Arlbjørn *et al.* (2011), Manos *et al.* (2006), Arbos (2002), Emiliani (2004), Finigan and Humphries (2006), Maguad (2007), Åhlström (2004)
32.	Total quality	Kuriger *et al.* (2010), Mirehei *et al.* (2011)
33.	Use of new technologies	Jones *et al.* (1999), Hines and Lethbridge (2008), Comm and Mathaisel (2005b), Tischler (2006)
34.	Value stream mapping	Dickson *et al.* (2009), Piercy and Rich (2009b), Ehrlich (2006), Holden (2010), Poksinska (2010), Arlbjørn *et al.* (2011), Bortolotti and Romano (2010), Piercy and Rich (2009a), Nielsen and Edwards (2010), Burgess and Radnor (2010), King *et al.* (2006), Jimmerson *et al.* (2005), Ahluwalia *et al.* (2004), Fillingham (2007), Jones *et al.* (1999), Lodge and Bamford (2008), Bushell *et al.* (2002), McQuade (2008), Suarez-Barraza and Ramis-Pujol (2010), Hines *et al.* (2008), Ben-Tovim *et al.* (2007), Suarez Barraza *et al.* (2009), Staats *et al.* (2011), Alagaraja (2010), Tonya (2004), Wayne (2005), Searcy (2009b), Tiplady (2010), Maguad (2007), Villarreal *et al.* (2009), Julien and Tjahjono (2009), Haque And James-Moore (2004), Keen (2011), Kress (2008), LaGanga (2011), Pedersen and Huniche (2011), Papadopoulos and Merali (2008), Wenchao Song *et al.* (2009), Tischler (2006), Chaneski (2005), Doman (2011), Wang *et al.* (2012), Chadha *et al.* (2012), Bortolotti and Romano (2012), Schulze and Störmer (2012), Vlachos and Bogdanovic (2013)
35.	Vertical information system	Holm and Ahlstrom (2010a), Åhlström (2004)
36.	Visualization	Holden (2010), Poksinska (2010), Arlbjørn *et al.* (2011), Manos *et al.* (2006), Fillingham (2007), Emiliani (2004), Bushell *et al.* (2002), Staats *et al.* (2011), Alagaraja (2010), Wayne (2005), Brewton (2009), Finigan and Humphries (2006), Haque And James-Moore (2004), Keen (2011), Wenchao Song *et al.* (2009), Tischler (2006), Kaplan and Patterson (2008), Nelson-Peterson and Leppa (2007)
37.	Work load balancing	Swank (2003), Brewton (2009), Kuriger *et al.* (2010), Cuatrecasas (2004), Mirehei *et al.* (2011), Wenchao Song *et al.* (2009), Middleton *et al.* (2005)

Table II.
Lean supportive practices

No.	Supportive practices	References
1.	An appropriate rewarding system	Piercy and Rich (2009b), Ehrlich (2006), Holden (2010), Wayne (2005), Jaca *et al.* (2012)
2.	Customer involvement	Holm and Ahlstrom (2010a, b), Suarez-Barraza and Ramis-Pujol (2010)
3.	Effective Communication System	Allway and Corbett (2002), Holden (2010), Swank (2003), Manos *et al.* (2006), Hines and Lethbridge (2008), Suarez-Barraza and Ramis-Pujol (2010), Hines *et al.* (2008), Comm and Mathaisel (2005a), Pejsa and Eng (2011), Jaca *et al.* (2012)
4.	Employee empowerment	Holden (2010), Jones *et al.* (1999), Comm and Mathaisel (2005a), Graban and Swartz (2012), deHaan *et al.* (2012), Bortolotti and Romano (2012), Collar *et al.* (2012)
5.	Employees commitment	Dickson *et al.* (2009), Poksinska (2010), Carter *et al.* (2011), Bortolotti and Romano (2012), Schulze and Störmer (2012)
6.	Employees involvement	Piercy and Rich (2009b), Ehrlich (2006), Holden (2010), Swank (2003), Bortolotti and Romano (2010), Manos *et al.* (2006), Suarez-Barraza and Ramis-Pujol (2010), Hines *et al.* (2008), Tonya (2004), Julien and Tjahjono (2009), Kress (2008), Graban and Swartz (2012), deHaan *et al.* (2012), Bortolotti and Romano (2012), Collar *et al.* (2012), Schulze and Störmer (2012), Jaca *et al.* (2012)
7.	Establishing a long-term relation with suppliers	Swank (2003), Wang *et al.* (2012), Qudrat-Ullah *et al.* (2012)
8.	Establishing environment for change	Comm and Mathaisel (2005a), Graban and Swartz (2012)
9.	Having multifunctional employees	Dickson *et al.* (2009), Ehrlich (2006), Arbos (2002), Tonya (2004), Moayed and Shell (2009), Cuatrecasas (2004), LaGanga (2011), Chadha *et al.* (2012)
10.	Improving teamwork spirit	Suarez-Barraza and Ramis-Pujol (2010), Graban and Swartz (2012), Jaca *et al.* (2012)
11.	Leadership	Allway and Corbett (2002), Swank (2003), Suarez-Barraza and Ramis-Pujol (2010), Comm and Mathaisel (2005a), Jaaron and Backhouse (2011), Keen (2011), Qudrat-Ullah *et al.* (2012), Schulze and Störmer (2012)
12.	Modifying the terminology to suit services	Hines *et al.* (2008)
13.	Obtaining management support	Dickson *et al.* (2009), Allway and Corbett (2002), Piercy and Rich (2009b), Poksinska (2010), Holm and Ahlstrom (2010a), Swank (2003), Bortolotti and Romano (2010), Piercy and Rich (2009a), Burgess and Radnor (2010), King *et al.* (2006), Jimmerson *et al.* (2005), Hines and Lethbridge (2008), Suarez-Barraza and Ramis-Pujol (2010), Tischler (2006), Towne (2006), Graban and Swartz (2012), Papadopoulos (2012), Jaca *et al.* (2012)

(*continued*)

Table II.

No.	Supportive practices	References
14.	Performance measurement system	Piercy and Rich (2009b), Ehrlich (2006), Swank (2003), Burgess and Radnor (2010), Suarez-Barraza and Ramis-Pujol (2010), Bhasin (2008), Comm and Mathaisel (2005a), Comm and Mathaisel (2005b), Kennedy *et al.* (2007), Kress (2008), Bortolotti and Romano (2012)
15.	Posting performance results	Swank (2003), Middleton *et al.* (2005)
16.	Providing justifications for implementing the practices	Jaaron and Backhouse (2011)
17.	Training	Dickson *et al.* (2009), Piercy and Rich (2009b), Ehrlich (2006), Holden (2010), Poksinska (2010), Holm and Ahlstrom (2010a), Piercy and Rich (2009a), Burgess and Radnor (2010), Manos *et al.* (2006), King *et al.* (2006), Jimmerson *et al.* (2005), Suarez-Barraza and Ramis-Pujol (2010), Hines *et al.* (2008), Staats *et al.* (2011), Comm and Mathaisel (2005a), Comm and Mathaisel (2005b), Tonya (2004), Wayne (2005), Searcy (2009b), Keen (2011), Kress (2008), Cuatrecasas (2004), Mirehei *et al.* (2011), Carter *et al.* (2011), Tischler (2006), Graban and Swartz (2012), Schulze and Störmer (2012), Jaca *et al.* (2012)

of teaching course. Similarly, Staats *et al.* (2011) reported on how a software service provider could utilize visualization to spotlight any increase in the work in process inventory (waste) while eliminating waiting and movement waste resulting from poor communication between team members. Finally, the third group of LTPs (called complementary practices) consists of practices that directly neither identify nor eliminate waste, but yet they still contribute to that process. A3 report, as an example, does nothing except addressing a specific pre-defined problem or one type of waste systematically. This will be achieved by containing sufficient information on the nature of the problem and what and how practices can be used to eliminate it (Doman, 2011). That, however, ensures that any attempt to solve a problem or eliminate any sort of waste will achieve its aim. In addition, applying the continuous improvement practice does not seem to play a direct role in the identification and elimination of waste. It rather helps instill the need and possibility to continuously improve a process into employees mind so that seeking ways for improvements becomes gradually the norm in an organization (Emiliani, 2004).

The classification scheme reported above highlights the different roles of each group of LTPs in improving service operations through increasing the value-adding activities at the account of the non-value adding ones. Such increase is expected to lead to several benefits as indicated in the literature reviewed and reported in Table III.

Adopting the UT that simply implies a direct relationship between a dependent and independent variables (Delery and Doty, 1996), the contemporary literature of lean service advocates that LTPs reported in Table I are capable of producing several benefits for all service firms as shown in Table III. The first couple of propositions can then be formulated:

P1.1. There is a positive impact of the implementation of LTPs on operational performance.

P1.2. There is a positive impact of the implementation of LTPs on financial performance.

Examining the impact of LTPs on operational and financial performance separately is important due to at least one reason. In manufacturing, even a successful lean attempt may result in deterioration in net profit corresponding to liquidating high levels of inventory stored prior to implementing lean manufacturing (Meade *et al.*, 2010). Liquidating inventory transfers the capitalized value of inventory to expenses charged to the year in which lean system requires reducing the amount of inventory acquired. Therefore, although lean system is successfully attacking one type of waste (inventory) to improve processes, it may lead to a reduction in net profit until the level of inventory has stabilized, and then an increase in profit can be expected (Meade *et al.*, 2010). However, in most service industries there is no or low levels of inventory (Apte and Goh, 2004). But the argument here is about whether operational improvements obtained from lean service can overcome any costs (e.g. training sessions, CFL) associated with the adoption of lean service. Consequently, having no materialized financial benefits should not be the only indication of lean failure. Operational benefits should be considered as well before doubting the successfulness of lean service.

Given the view of lean service as having two sides (i.e. LTPs and LSPs), the impact on performance does not seem to be restricted to LTPs only. LSPs are mainly focussed on human resource aspects. These practices are also argued to have a positive effect

Table III.
Benefits of lean service implementation

No.	Benefits	References
1.	Freeing staff time	Piercy and Rich (2009b), Ehrlich (2006), Jimmerson *et al.* (2005), Searcy (2009a, b), Hagan (2011), Papadopoulos (2012), Markovitz (2012), Bortolotti and Romano (2012)
2.	Identification and elimination of waste	Ehrlich (2006), Swank (2003), Hines and Lethbridge (2008), McQuade (2008), Comm and Mathaisel (2005a), Maguad (2007), Julien and Tjahjono (2009), Kaplan and Patterson (2008), Nelson-Peterson and Leppa (2007), Chadha *et al.* (2012), Bortolotti and Romano (2012), Collar *et al.* (2012), Schulze and Störmer (2012)
3.	Improvement in capacity	Holden (2010), Poksinska (2010), Nielsen and Edwards (2010), Burgess and Radnor (2010), King *et al.* (2006), Ben-Tovim *et al.* (2007), LaGanga (2011), Hagan (2011), Chadha *et al.* (2012)
4.	Improvement in customer perception of product/service quality	Piercy and Rich (2009b), Ehrlich (2006), Bortolotti and Romano (2010), Arbos (2002), Hyer and Wemmerlöv (2002), Hagan (2011), Nelson-Peterson and Leppa (2007)
5.	Improvement in customer satisfaction	Piercy and Rich (2009b), Ehrlich (2006), Poksinska (2010), Bortolotti and Romano (2010), Piercy and Rich (2009a), Jimmerson *et al.* (2005), Emiliani (2004), Hines and Lethbridge (2008), Suarez-Barraza and Ramis-Pujol (2010), Hines *et al.* (2008), Yavas and Yasin (2001), Pejsa and Eng (2011), Kaplan and Patterson (2008), Carlborg *et al.* (2013), Edwards *et al.* (2012), Bortolotti and Romano (2012)
6.	Improvement in employees satisfaction and their performance	Piercy and Rich (2009b), Poksinska (2010), Swank (2003), Nielsen and Edwards (2010), Burgess and Radnor (2010), Jimmerson *et al.* (2005), Fillingham (2007), Hines *et al.* (2008), Pejsa and Eng (2011), Kaplan and Patterson (2008), deHaan *et al.* (2012), Edwards *et al.* (2012), Jaca *et al.* (2012)
7.	Improvement in employees understanding of the process	Swank (2003), Burgess and Radnor (2010), Esain *et al.* (2008), Bushell *et al.* (2002), Maguad (2007), Radnor *et al.* (2012)
8.	Improvement in operational efficiency	Cooper and Mohabeersingh (2008a, b), Bortolotti and Romano (2010), Malladi *et al.* (2010), Comm and Mathaisel (2005a), Carlborg *et al.* (2013), Collar *et al.* (2012)
9.	Improvement in process flexibility	Bortolotti and Romano (2010), Kosuge *et al.* (2010), Chadha *et al.* (2012)
10.	Improvement in productivity	Allway and Corbett (2002), Bortolotti and Romano (2010), Arbos (2002), Bhatia and Drew (2007), Staats *et al.* (2011), Pejsa and Eng (2011), Carlborg *et al.* (2013), Bortolotti and Romano (2012), Jaca *et al.* (2012)
11.	Improvement in the organization of work areas	Poksinska (2010), Manos *et al.* (2006), Suarez Barraza *et al.* (2009), Radnor *et al.* (2012)
12.	Reduction in costs	Piercy and Rich (2009b), Ehrlich (2006), Cooper and Mohapeersingh (2008b), Poksinska (2010), Swank (2003), Bortolotti and Romano (2010), Piercy and Rich (2009a), Nielsen and Edwards (2010), Jimmerson *et al.* (2005), Jones *et al.* (1999), Arbos (2002), McQuade (2008), Ben-Tovim *et al.* (2007), Cooper and Mohabeersingh (2008b), Bhatia and Drew (2007), Malladi *et al.* (2010), Villarreal *et al.* (2009), Julien and Tjahjono (2009), Hagan (2011), Kaplan and Patterson (2008), Bortolotti and Romano (2012)

(*continued*)

No.	Benefits	References
13.	Reduction in inventory	Poksinska (2010), Bortolotti and Romano (2010), Manos *et al.* (2006), Jones *et al.* (1999), Kaplan and Patterson (2008)
14.	Reduction in lead time and cycle time	Piercy and Rich (2009b), Ehrlich (2006), Cooper and Mohapeersingh (2008b), Holden (2010), Poksinska (2010), Swank (2003), Bortolotti and Romano (2010), Piercy and Rich (2009a), Nielsen and Edwards (2010), King *et al.* (2006), Fillingham (2007), Arbos (2002), Lodge and Bamford (2008), McQuade (2008), Suarez-Barraza and Ramis-Pujol (2010), Hines *et al.* (2008), Ben-Tovim *et al.* (2007), Cooper and Mohabeersingh (2008b), Bhatia and Drew (2007), Suarez Barraza *et al.* (2009), Staats *et al.* (2011), Hyer and Wemmerlöv (2002), Yavas and Yasin (2001), Hagan (2011), Tischler (2006), Nelson-Peterson and Leppa (2007), Papadopoulos (2012), Edwards *et al.* (2012), Radnor *et al.* (2012)
15.	Reduction in reworks	Jones *et al.* (1999), Hyer and Wemmerlöv (2002)
16.	Reduction in staff turnover and absenteeism	Piercy and Rich (2009b), deHaan *et al.* (2012)
17.	Reduction in the number of human errors	Poksinska (2010), Swank (2003), Jimmerson *et al.* (2005), Searcy (2009a), Hyer and Wemmerlöv (2002), Hagan (2011)
18.	Reduction in work in process	Piercy and Rich (2009b), Ehrlich (2006), Swank (2003)
19.	Savings in space	Nielsen and Edwards (2010), Manos *et al.* (2006), Suarez Barraza *et al.* (2009)
20.	Profitability	Allway and Corbett (2002), Ehrlich (2006), Bhatia and Drew (2007), Pejsa and Eng (2011)

Table III.

on performance (Delaney and Huselid, 1996; Huselid, 1995). For instance, investing in training programs is believed to advance the quality of employees by improving their current skills and helping acquire new skills so that they become multi-functional employees able to perform various tasks and serve in different locations when needed (Delaney and Huselid, 1996; Huselid, 1995). Consequently, a multi-skilled employee can smooth operations processes when a bottleneck appears at any point of a process by helping other employees working in that part of the process. However, having multi-skilled employees may not lead to the purported improvement if such employees are not motivated and empowered to utilize their skills (Delaney and Huselid, 1996; Huselid, 1995). Therefore, an appropriate rewarding system that can align the interest of employees with that of an organization along with decentralization in the decision-making process will be effective in motivating employees to achieve pre-specified goals (Delaney and Huselid, 1996; Huselid, 1995). Improvements obtained from such practices were subject to empirical tests by several authors, most of which reported a positive impact on operational and financial performance of adopters (Shah and Ward, 2007; Cua *et al.*, 2001; Yasin *et al.*, 2003; Delaney and Huselid, 1996; Huselid, 1995). Therefore, based on the above argument and adopting the UT (Delery and Doty, 1996) the following propositions can be confidently formulated:

P2.1. There is a positive impact of LSPs on operational performance.

P2.2. There is a positive impact of LSPs on financial performance.

These propositions are highly important in the case of lean service for managements who get excited about the benefits that can be achieved from LTPs so that they rush to implement LTPs without realizing the role of LSPs in independently improving performance.

3.2.2 The synergistic effect of LTPs and LSPs on performance. In addition to the independent positive impact of LTPs and LSPs on performance, there is yet another expected improvement to performance resulting from the expected synergy between the LTPs and LSPs. Here, we are claiming that the effectiveness of each set of practices on performance is expected to be enhanced by the other. Adopting this perspective implies that each set moderates the form of relationship between the other set and performance, and therefore the traditional moderation perspective cannot be adopted here as it is not possible to determine which set represents the independent variable and which one represents the moderator variable (Sharma *et al.*, 1981). The synergy perspective is supported by the mechanism of the STS shown in Figure 3. The STS indicates that the best outcome of any socio-technical system can only be achieved by simultaneous emphasis on implementing practices from both subsystems (Kull *et al.*, 2013; Trist, 1981). This notion can be illustrated by the following example. For instance, in the case of lean service, the VSM can be applied to identify non-value adding activities and bottlenecks. Some of these can be eliminated by untrained employees. It could be argued that trained and multi-skilled employees can eliminate more of those activities if they are empowered to do so. However, if the non-value adding activities were not detected through VSM, trained and multi-skilled employees would carry out all activities, including non-value adding efficiently. The gain achieved in each of the forgoing cases will be less than the gain obtained in a third case where a company applies VSM and has trained and multi-skilled employees to improve

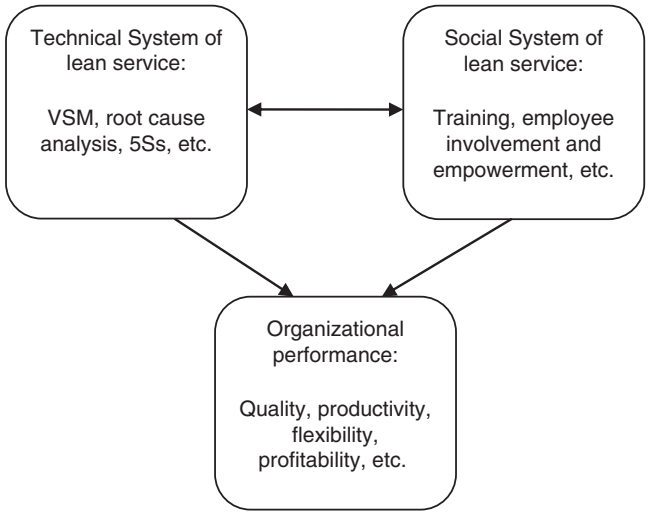

Figure 3.
The mechanism of the socio-technical theory in lean service.

its processes. Based on this example backed up by the mechanism of the STS, we can propose the following:

P3.1. There is a synergy between LTPs and LSPs in improving operational performance.

P3.2. There is a synergy between LTPs and LSPs in improving financial performance.

3.2.3 Inhibitors, LSPs and LTPs. One important but usually neglected construct in the lean literature is the inhibitors construct. Like any other change philosophy, service companies attempting lean system are argued to encounter several inhibitors (Eswaramoorthi *et al.*, 2011; Suarez Barraza *et al.*, 2009). The literature of lean service indicates the existence of six inhibitors as reported in Table IV.

The previously presented inhibitors in Table IV, if not taken into consideration, can significantly lead to preventing an organization from implementing or widely disseminating one or more of LTPs. For instance, lean service seeks identification and elimination of waste present in a whole process rather than focussing on individual parts of it (Allway and Corbett, 2002). Therefore, adopting LTPs can be more difficult to achieve with the presence of functional hierarchical management structure due to the expected lack of coordination among different functions that form the targeted process (Bayo-Moriones *et al.*, 2008). Moreover, human errors in the implementation process may lead to disappointment among employees and consequently hinder the implementation of other practices. More important is that resisting the change resulting from the introduction of lean service slows down the implementation process of lean practices and may turn the implementation to be a failure (Del Val and Fuentes, 2003). Furthermore, the adoption of multiple improvement programs may confuse employees as to whether LTPs are more effective than others to focus on, which may lead to reluctance to implement them (Burgess and Radnor, 2010). However, this negative impact of inhibitors on the level of LTPs implementation is not expected to be the same across all adopters of service firms.

No.	Inhibitors	References
1.	Employees resistance to change	Allway and Corbett (2002), Poksinska (2010), Swank (2003), Souza *et al.* (2011), Nielsen and Edwards (2010), Burgess and Radnor (2010), Hines and Lethbridge (2008), Lodge and Bamford (2008), Suarez-Barraza and Ramis-Pujol (2010), Hines *et al.* (2008), Ben-Tovim *et al.* (2007), Suarez Barraza *et al.* (2009), Pedersen and Huniche (2011)
2.	Functional hierarchical management structure	Poksinska (2010), Souza *et al.* (2011), Burgess and Radnor (2010), Suarez-Barraza and Ramis-Pujol (2010), Graban and Swartz (2012)
3.	Human errors in the implementation process	Suarez Barraza *et al.* (2009)
4.	Implementation of multiple improvement programs	Burgess and Radnor (2010)
5.	Lack of knowledge of the practices	Poksinska (2010), Arlbjørn *et al.* (2011)
6.	Their origin in manufacturing	Souza *et al.* (2011), Manos *et al.* (2006), Pedersen and Huniche (2011)

Table IV.
Inhibitors of lean technical practices

It seems plausible to expect a varying impact of inhibitors on LTPs as a result of investing in LSPs. We argue that investing in LSPs can mitigate the negative effect of inhibitors. For example, empowering, involving and training employees to participate in the implementation and decision-making process will counteract the negative consequences of resistance to change and errors occurred during the implementation process. In addition, justifying the use of LTPs to achieve improvements and developing an effective communication system ensure all employees are aware of the need and importance of adopting LTPs. That is expected to alleviate the effect of employee resistance and reduce ambiguity about the effectiveness of such practices (Comm and Mathaisel, 2005a). Furthermore, encouraging team work and introducing a rewarding system that links rewards to team goals can improve coordination among employees in different functions that is important for adopting LTPs at a process level (Piercy and Rich, 2009b).

From a contingency perspective operationalized as a moderation effect, when the relationship between a dependent and independent variables varies across the level of a third variable, the third variable is said to moderate that relationship (Venkatraman, 1989). Given this argument, we contend that LSPs moderate the impact of inhibitors on LTPs. In this circumstance, we expect that impact to be weaker for companies investing highly in LSPs and stronger for companies with lower levels of investment in LSPs:

P4. The negative impact of inhibitors on LTPs will be stronger under low levels of LSPs than it is under high levels of LSPs.

4. Contextual factors

There can be several factors that may affect either companies' performance (Capon *et al.*, 1990) or lean adoption or both. several researchers in the literature of lean manufacturing have stressed the importance of contextual variables in determining the lean-performance association such as the nature of process, firm size, age and industry

(Shahrukh, 2011; Malladi *et al.*, 2010; Pont *et al.*, 2008; Shah and Ward, 2003; Cua *et al.*, 2001; Christopher, 2000). Not fully taking into account the effect of such contextual variables might have been behind inconsistent empirical results concerning the lean-performance relationship (Staats *et al.*, 2011; Shah and Ward, 2003). Therefore, to overcome shortcomings in previous similar empirical literature and construct a model that provides a valid examination of the lean-performance relation in services, we stress the importance of the contextual variables identified in this study. In the case of this research, the literature of lean service fails to provide sufficient information on important contextual variables. Therefore, to identify the key potential contextual variables, the literature of lean manufacturing and research focussing on the performance of service sector are searched. Our search identified six contextual variables that need to account for their effect to accurately isolate the impact of lean practices on performance. These variables are reported below.

4.1 Size

The size of companies can play an important role in the implementation of lean practices whether in manufacturing or service companies (Ahmed *et al.*, 1991; Moch, 1976). However, the argument of the size effect can be developed in favor of both enhancing and hindering lean adoption. Large companies usually have a complicated structure that has a negative effect on flexibility of work which leads to rigidity (Hannan and Freeman, 1984). From this point, introducing any change program such as lean system is painful, costly and not easy to accept (Hannan and Freeman, 1984). Similarly, given the feeble coordination between functions and employees in large firms, combined with higher levels of interdependency needed between functions and employees for lean system, large firms seem to be less valid for the adoption of lean system (Bayo-Moriones *et al.*, 2008). In contrast, large companies enjoy economies of scale and have a higher level of financial and human resources that enable them to invest in innovations (Bayo-Moriones *et al.*, 2008; Hannan and Freeman, 1984). Therefore, they are more likely to implement innovative systems such as lean system. Furthermore, despite the inconsistent empirical results in relation to the effect of size, researchers in the manufacturing and service industries usually control for its potential effect (e.g. Bayo-Moriones *et al.*, 2008; Capar and Kotabe, 2003; Jennings *et al.*, 2003; Shah and Ward, 2003). This discussion underpins the need to control for the effect of size in research reporting on lean-performance relationship.

4.2 Age

Like the effect of size, the effect of age of companies is often argued to be important and can be developed in two directions, positive and negative. Older companies usually enjoy more resources in terms of money and experience that make the adoption of innovative systems such as lean system more feasible (Galende and de la Fuente, 2003). In contrast, some researchers highlight a negative effect of age that in old companies, employees are used to doing tasks in a specific way. Therefore, introducing a major change system such as lean system (Kennedy and Widener, 2008) is more likely to be resisted (Shah and Ward, 2003). Consequently, age of companies may have its word in the success of lean implementation and should be accounted for.

4.3 Internationalization

Internationalization as defined by Capar and Kotabe (2003, p. 345) is "a firm's expansion beyond the borders of its home country across different countries and

geographical regions." The importance of controlling for the effect of such variable stems from the use of internationalization as a growth strategy that may have a considerable effect on performance (Hitt *et al.*, 2006). Manufacturing and service companies alike seem to expand abroad for similar reasons among which labor costs, market access and resources (Contractor *et al.*, 2003). Some empirical results suggest that there is a positive linear relationship between internationalization and firm financial performance (Hitt *et al.*, 2006). However, unlike manufacturing companies expanding abroad by exporting their physical products without a significant need to establish a new facility in the host country (Boddewyn *et al.*, 1986), service firms suffer from intangibility and inseparability that prevent or limit the possibility of exporting their services without investing in a local facility in the host country (Venzin *et al.*, 2008; Boddewyn *et al.*, 1986). Therefore, given these disadvantages of service firms that necessitates some initial investing costs for expanding abroad, Capar and Kotabe (2003) report empirical evidence of a *U*-shaped relationship between internationalization and service firm performance. While Contractor *et al.* (2003) find an *S*-shape relationship between internationalization and financial performance and their results prove that knowledge-work firms experience all three stages while capital-intensive firms experience only the first two that is decrease followed by increase in their financial performance. Based on the above argument, controlling for the effect of international diversification is important for isolating the effect of lean system on performance.

4.4 Process type

The heterogeneity among service processes makes it difficult for researchers to treat them alike. This leads to significant differences in the organizational structure of various service firms (Auzair and Langfield-Smith, 2005; Silvestro *et al.*, 1992). Therefore, several attempts have been made to combine various services into fewer groups based on the most important factors for services (e.g. Chase, 1978; Silvestro *et al.*, 1992). Among others, the classification scheme introduced by Silvestro *et al.* (1992) based on empirical data (Verma, 2000; Cook *et al.*, 1999) is highly acknowledged in the literature (Shafti *et al.*, 2007; Auzair and Langfield-Smith, 2005). This scheme classifies service processes into three categories (i.e. professional services, mass services and service shops) based on six service dimensions and the number of customers served by an individual service unit per day. Professional services are characterized by having relatively long contact time with customer, most value added in front office, with relatively few transactions, highly customized service offerings, focus on process, considerable level of freedom for staff to meet customer needs. Mass services are the exact reverse of professional services while service shops fall between the other two categories.

Auzair and Langfield-Smith (2005) reveal that the management control system utilized by companies classified as professional services is significantly different to that used by companies classified as mass services. Furthermore, Silvestro (2001) shows that TQM practices are not equally relevant among the three service types indicating that service process types can impact the implementation process of lean system and should be taken into consideration as recommended by Cua *et al.* (2001).

4.5 Business strategy

Business strategy can be thought of as the plan through which companies compete in the market. The most commonly cited classification scheme is Porter's (1980) scheme (Leitner and Guldenberg, 2010; Bordean *et al.*, 2010). Porter (1980) classified companies

into three categories: cost leadership, differentiators and focusses. Porter (1980) argued that there should be no superiority for either strategy on the other. However, companies that fail to adopt fully one of these strategies will stuck in the middle and achieve inferior performance.

Bordean *et al.* (2010) supported the model introduced by Porter (1980) and the results of their study indicated that Romanian hotels followed such model. Auzair and Langfield-Smith (2005) and Chenhall and Langfield-Smith (1998) report that firms adopting cost strategy are significantly different in structure and priorities from those adopting differentiation strategy. The differentiation strategy, however, is found to be more compatible with lean system (Kennedy and Widener, 2008). In terms of the effect on performance, White (1986) found that, in general, pure cost leadership strategy leads to achieving a higher rate of return on investment (ROI) than pure differentiation strategy while this result is reversed with regard to sales growth. A mix of cost and differentiation strategy leads to the highest ROI compared to both pure cost and differentiation strategy while having an intermediate position regarding the sales growth. Similar results were achieved by Leitner and Guldenberg (2010). The authors found that companies following a combination strategy of cost leader and differentiation have higher performance than companies focussing on only one strategy. Based on such empirical results some researchers criticized Porter's classification scheme that excludes the stuck in the middle category (Chrisma *et al.*, 1988). The aforementioned argument highlights the importance of controlling for the strategy effect in any lean-performance empirical research.

4.6 Cost and management systems

Cost and management accounting systems can be another factor that needs to be accounted for because of its potential association with both the implementation of lean system and performance.

Most, if not all, service companies cannot inventory their services and a major portion of their costs is fixed and does not relate to the volume of services produced at least in the short term (Carenys and Sales, 2008; Dearden, 1978). Therefore, if a sale transaction is not made, the associated revenue is lost forever and the time-based overhead costs of the period is added to that loss (Schlissel and Chasin, 1991). In addition, service companies are facing extensive competition (Karmarkar, 2004). Therefore, service companies are less able to charge customers arbitrary prices for their services as it was the case several years ago (Yu-Lee, 2011). Consequently, the cost information is then more important than ever for service companies to measure resources used, evaluate operating performance, planning, make informed decisions, pricing and more important for survival (Martinson, 2002; Hegde and Nagarajan, 1992; Anania, 1987). Such information if utilized efficiently may have a direct impact on firms' performance (Pizzini, 2006). Pizzini (2006) provides evidence on such effect by studying the relationship between cost-design systems, managers' beliefs about the relevance and usefulness of cost data and financial performance using a sample of 277 US hospitals. The results indicate that managers consider cost data to be relevant and useful if it is provided with greater detail, classified according to behavior and reported more frequently. In addition, reporting cost data with greater detail is proved to be associated with financial indicators namely, operating margin, cash flow and administrative expense.

The importance of cost and management systems is more emphasized when the implementation of lean system is considered. Given the thrive of lean system to

improve values delivered to customers by eliminating waste and unnecessary costs from processes (Kennedy and Widener, 2008), having valid and timely information on waste and associated cost cannot be overstated for the success of lean system (Li *et al.*, 2012). For instance, Al-Omiri and Drury (2007) in a survey study of 176 UK manufacturing and service firms highlight a positive relationship between the implementation of lean system and the level of cost system sophistication. From the aforementioned facts, it seems that cost and management systems can impact the implementation of lean practices as well as the overall performance and that necessitate accounting for their effect in any potential survey studies of lean-performance relationship.

The argument developed in this paper regarding the impact of lean service on performance and the interrelations between lean construct is depicted graphically in Figure 4.

5. Implications

5.1 Research implications

This study has important implications for researchers on lean service. Our systematic literature review of lean service highlighted an increasing interest in lean service although rigorous research focussing on the lean-performance association is still lacking. However, researchers intending to examine that association should not merely focus on the improvement anticipated from lean service on the financial performance. As mentioned before, reporting no improvement at a financial level should not lead to the conclusion that lean service is a failure because the cost associated with adopting the system may offset gains from lean initially. Moreover, lean service was viewed as a socio-technical system with two distinctive sides that work independently and together to improve firm performance. Therefore, it is important for researchers to measure and include the level of adoption of practices in both sides to capture precisely the effectiveness of lean service in advancing firm performance. In addition, given the synergy proposed by the STS between the two sides of lean service, researchers should be aware that assuming LSPs moderate the LTPs-performance relation or the reverse can only capture one part of the whole picture. We found that each side (rather than one specific side) positively moderates the effect of the other side on performance. Furthermore, inhibitors of LTPs were found to have a negative impact on the adoption and dissemination of LTPs. Therefore, incorporating inhibitors into a model to examine the lean-performance relation will help better understand the magnitude of their effect and uncover another role of LSPs in moderating that effect on LTPs. Finally, although taking into account all possible contextual variables is almost impossible, this study brought to light the possible confounding role played by six contextual variables in the lean-performance association. Consequently, further

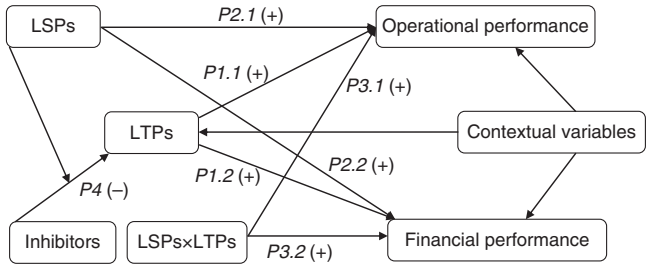

Figure 4.
Conceptual framework of lean service

research is needed to examine the possible effect of those contextual variables where that assists in isolating the impact of lean service on firm performance.

5.2 Management implications

Services managers currently implementing or seeking to implement lean service will also benefit from the current research. The research provides a valuable indication on the positive effect of lean service on firm performance. Moreover, the paper portrays lean service as a socio-technical system that has two sides. This perspective assists service leaders to be cognizant of the different roles of each side in improving firm performance. LTPs and LSPs were found to independently improve firm performance. However, our argument supported by the STS (Figure 3) indicates that the improvement achieved from LTPs will be enhanced by simultaneously adopting LSPs and vise versa. The practical implications would be that service managers should not devote their efforts and resources to fully adopt LTPs or LSPs at the expense of the other. Rather, the best outcome can be expected from adopting practices from both sides together. Furthermore, within the technical side (LTPs), different practices play different roles in achieving the aim of increasing the ratio of value-adding activities to non-value-adding activities. The simple classification scheme of LTPs indicates that managers cannot expect to achieve the purported outcome by blindly picking up a few of LTPs to implement. Those managers are advised first to understand the role that can be assigned to each practice. For instance, waste cannot be eliminated by adopting VSM only because this practice can only uncover waste in a process. On the other hand, automation can be used to target pre-identified waste but cannot find waste itself to eliminate. Therefore, full understanding of the contribution of each set of practices proposed in the classification scheme developed in the paper is essential for services managers. Finally, service managers adopting LTPs or seeking to adopt them should not surrender to the negative impact of inhibitors (Table IV) on their adoption process. Investing in the LSPs can be an effective remedy that mitigates such a negative impact. This, however, highlights another important role of LSPs in addition to their aforementioned roles of improving performance and enhancing the effectiveness of LTPs.

6. Conclusion and recommendations

In this study we developed a conceptual framework that primarily provides insights for managers of service organizations to embark on a successful lean effort. Moreover, it assists researchers in conducting rigorous survey studies to report empirical evidence on the impact of lean service on firm performance. In our model, lean service was viewed as a socio-technical system that has two distinctive sets of practices (i.e. LTPs and LSPs). Through a systematic review of lean service literature, we operationlized the two sides of lean service and proposed several propositions that highlight their roles in improving firm performance. LTPs were found to have two main roles by independently improving performance and enhancing the impact of LSPs on performance. On the other hand, LSPs were proved to play three different roles. First, they independently improve performance. Second, they enhance the impact of LTPs on performance. Third, given the identification of potential inhibitors with their expected negative effect on LTPs, LSPs were believed to moderate that negative impact of inhibitors on LTP.

Furthermore, the management accounting literature, organizational strategy literature and internationalization literature in services were searched to overcome encountered problems in previous empirical studies by identifying contextual variables that are

relevant in the case of lean service. Six contextual variables that can have a profound effect on the lean-performance relationship were identified and reported. These include: firm size, firm age, internationalization, process type, business strategy and cost and management system. This research was an attempt to improve the available limited knowledge on the lean-performance relationship in the service context and pave the way for thoroughly designed survey studies that report precise evidence that will add to the limited knowledge on the impact of lean service on firm performance.

Based on the results of this research, future research should focus on providing more empirical evidence on the impact of lean system on performance in the service context. Such empirical research is invited to use the theoretical model developed in this study to test its validity and consequently, raise our knowledge of the lean-performance relationship in the service context. In addition, Figure 1 shows a lack of attention given to the application of lean service into some service industries such as hotel industry, consultancy services, telecommunications industry, etc. Therefore, more work should be conducted on those currently neglected industries. Moreover, interesting results can be obtained by examining whether specific sets of lean practices are more applicable to specific service industries than others. In addition, empirical evidence on which lean practices can better improve what performance indicators will have a significant implication for both academics and practitioners. Another important direction for future work on lean service can be the investigation of whether a specific sequence of implementing lean practices can be more effective than others in improving firm performance.

References

Abdi, F., Shavarini, S.K. and Hoseini, S.M.S. (2006), "Glean Lean: how to use lean approach in service industries?", *Journal of Services Research*, Vol. 6, Special Issue, pp. 191-206.

Åhlström, P. (2004), "Lean service operations: translating lean production principles to service operations", *Int. J. Services Technology and Management*, Vol. 5 Nos 5-6, pp. 545-564.

Ahluwalia, R.S., Srinivasan, A. and Irani, S.A. (2004), "Evidence of lean", *Industrial Engineer*, Vol. 36 No. 12, pp. 35-40.

Ahmad, S., Schroeder, R.G. and Sinha, K.K. (2003), "The role of infrastructure practices in the effectiveness of JIT practices implications for plant competitiveness", *Journal of Engineering and Technology Management*, Vol. 20 No. 3, pp. 161-191.

Ahmed, N.U., Tunc, E.A. and Montagno, R.V. (1991), "A comparative study of US manufacturing firms at various stages of just-in-time implementation", *International Journal of Production Research*, Vol. 29 No. 4, pp. 787-802.

Alagaraja, M. (2010), "Lean thinking as applied to the adult education environment", *Int. J. Human Resources Development and Management*, Vol. 10 No. 1, pp. 51-62.

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.

Al-Omiri, M. and Drury, C. (2007), "A survey of factors influencing the choice of product costing systems in UK organizations", *Management Accounting Research*, Vol. 18 No. 4, pp. 399-424.

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 and Business Excellence*, Vol. 23 Nos 3-4, pp. 381-396.

Anania, L. (1987), "Services: low productivity high cost", *Review of Business*, Vol. 9 No. 1, pp. 21-23.

Apte, U.M. and Goh, C.H. (2004), "Applying lean manufacturing principles to information intensive services", *Int. J. Services Technology and Management*, Vol. 5 Nos 5-6, pp. 1-20.

Arbos, L.C. (2002), "Design of a rapid response and high efficiency service by lean production principles: methodology and evaluation of variability of performance", *International Journal of Production Economics*, Vol. 80 No. 2, pp. 169-183.

Arlbjørn, J.S., Freytag, P.V. and Haas, H. (2011), "Service supply chain management: a survey of lean application in the municipal sector", *International Journal of Physical Distribution and Logistics Management*, Vol. 41 No. 3, pp. 277-295.

Atkinson, P. (2004), "Creating and implementing lean strategies", *Management Services*, Vol. 48 No. 2, pp. 18-21.

Auzair, S.M. and Langfield-Smith, K. (2005), "The effect of service process type, business strategy and life cycle stage on bureaucratic MCS in service organizations", *Management Accounting Research*, Vol. 16 No. 4, pp. 399-421.

Ball, D.R. and Maleyeff, J. (2003), "Lean management of environmental consulting", *Journal of Management in Engineering*, Vol. 19 No. 1, pp. 17-24.

Bayo-Moriones, A., Bello-Pintado, A. and Merino-Díaz-de-Cerio, J. (2008), "The role of organizational context and infrastructure practices in JIT implementation", *International Journal of Operations and Production Management*, Vol. 28 No. 11, pp. 1042-1066.

Ben-Tovim, D.I., Bassham, J.I., Bolch, D., Martin, M.A., Dougherty, M. and Szwarc, M. (2007), "Lean thinking across a hospital: redesigning care at the Flinders Medical Centre", *Australian Health Review*, Vol. 31 No. 1, pp. 10-15.

Bhasin, S. (2008), "Lean and performance measurement", *Journal of Manufacturing Technology Management*, Vol. 19 No. 5, pp. 670-684.

Bhatia, N. and Drew, J. (2007), "Applying lean production to the public sector", *The McKinsey Quarterly*, No. 6, June, pp. 1-5.

Boddewyn, J.J., Halbrich, M.B. and Perry, A.C. (1986), "Service multinationals: conceptualization, measurement and theory", *Journal of International Business Studies*, Vol. 17 No. 3, pp. 41-57.

Bordean, O.N., Borza, A.I., Nistor, R.L. and Mitra, C.S. (2010), "The use of Michael Porter's generic strategies in the Romanian hotel industry", *International Journal of Trade, Economics and Finance*, Vol. 1 No. 2, pp. 173-178.

Bortolotti, T. and Romano, P. (2010), "Enabling lean management adoption in the pure service sector: when to implement automation and information systems?", *Proceedings of the 17th International Annual EurOMA Conference, June*, pp. 1-10.

Bortolotti, T. and Romano, P. (2012), "Lean first, then automate: a framework for process improvement in pure service companies", *A Case Study. Production Planning and Control: The Management of Operations*, Vol. 23 No. 7, pp. 513-522.

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.

Brewton, J. (2009), "The lean office: develop lean administrative procedures", *Cost Management*, Vol. 23 No. 2, pp. 40-47.

Burgess, N. and Radnor, Z. (2010), "Lean paradox: can lean influence healthcare?", *Proceedings of the 17th International Annual EurOMA Conference*, *June*, pp. 1-10.

Bushell, S., Mobley, J. and Shelest, B. (2002), "Discovering lean thinking at progressive healthcare", *Journal for Quality and Participation*, Vol. 25 No. 2, pp. 20-25.

Capar, N. and Kotabe, M. (2003), "The relationship between international diversification and performance in service firms", *Journal of International Business Studies*, Vol. 34 No. 4, pp. 345-355.

Capon, N., Farley, J.U. and Hoenig, S. (1990), "Determinants of financial performance: a meta-analysis", *Management Science*, Vol. 36 No. 10, pp. 1143-1159.

Carenys, J. and Sales, X. (2008), "Costing the banking services: a management accounting approach", *Journal of Money, Investment and Banking*, Vol. 6 No. 6, pp. 35-53.

Carlborg, P., Kindström, D. and Kowalkowski, C. (2013), "A lean approach to service productivity improvements: synergy or oxymoron?", *Managing Service Quality*, Vol. 23 No. 4, pp. 1-25.

Carter, B., Danford, A., Howcroft, D., Richardson, H., Smith, A. and Taylor, P. (2011), "'All they lack is a chain' lean and the new performance management in the British Civil Service", *New Technology, Work and Employment*, Vol. 26 No. 2, pp. 83-97.

Chadha, R., Singh, A. and Kalra, J. (2012), "Lean and queuing integration for the transformation of health care processes", *Clinical Governance: An International Journal*, Vol. 17 No. 3, pp. 191-199.

Chaneski, W.S. (2005), "Stories from the lean office", *Modern Machine Shop*, Vol. 78 No. 7, pp. 44-46.

Chase, R.B. (1978), "Where does the customer fit in a service operation?", *Harvard Business Review*, Vol. 56 No. 6, pp. 137-142.

Chase, R.B. and Apte, U.M. (2007), "A history of research in service operations: what's the big idea?", *Journal of Operations Management*, Vol. 25 No. 2, pp. 375-386.

Chenhall, R.H. and Langfield-Smith, K. (1998), "The relationship between strategic priorities, management techniques and management accounting an empirical investigation using a systems approach", *Accounting, Organizations and Society*, Vol. 23 No. 3, pp. 243-264.

Chrisma, J.J., Hofer, C.W. and Boulton, W.R. (1988), "Toward a system for classifying business strategies", *Academy of Management Review*, Vol. 13 No. 3, pp. 413-428.

Christopher, M. (2000), "The agile supply chain competing in volatile markets", *Industrial Marketing Management*, Vol. 29 No. 1, pp. 37-44.

Collar, R.M., Shuman, A.G., Feiner, S., McGonegal, A.K., Heidel, N., Duck, M., McLean, S.A., Billi, J.E., Healy, D.W. and Bradford, C.R. (2012), "Lean management in academic surgery", *Journal of the American College of Surgeons*, Vol. 214 No. 6, pp. 928-936.

Comm, C.L and Mathaisel, D.F.X. (2005a), "A case study in applying lean sustainability concepts to universities", *International Journal of Sustainability in Higher Education*, Vol. 6 No. 2, pp. 134-146.

Comm, C.L and Mathaisel, D.F.X. (2005b), "An exploratory study of best lean sustainability practices in higher education", *Quality Assurance in Education*, Vol. 13 No. 3, pp. 227-240.

Contractor, F.J., Kundu, S.K. and Hsu, C.C. (2003), "A three-stage theory of international expansion: the link between multinationality and performance in the service sector", *Journal of International Business Studies*, Vol. 34 No. 1, pp. 5-18.

Cook, D.P., Goh, C.H. and Chung, C.H. (1999), "Service typologies: a state of the art survey", *Production and Operations Management*, Vol. 8 No. 3, pp. 318-338.

Cooper, R.G. and Mohabeersingh, C. (2008a), "Lean thinking in healthcare system – innovative roles", *Journal of Pre-Clinical and Clinical Research*, Vol. 2 No. 1, pp. 88-89.

Cooper, R.G. and Mohapeersingh, C. (2008b), "Lean thinking for medical practices", *Journal of Pre-Clinical and Clinical Research*, Vol. 2 No. 2, pp. 110-117.

Cua, K.O., McKone, K.E. and Schroeder, R.G. (2001), "Relationships between implementation of TQM, JIT, and TPM and manufacturing performance", *Journal of Operations Management*, Vol. 19 No. 6, pp. 675-694.

Cuatrecasas, L. (2004), "A lean management implementation method in service operations", *Int. J. Services Technology and Management*, Vol. 5 Nos 5-6, pp. 532-544.

Dearden, J. (1978), "Cost accounting comes to service industries", *Harvard Business Review*, Vol. 56 No. 5, pp. 132-140.

DeHaan, J., Naus, F. and Overboom, M. (2012), "Creative tension in a lean work environment: implications for logistics firms and workers", *International Journal of Production Economics*, Vol. 137 No. 1, pp. 157-164.

Del Val, M.P. and Fuentes, C.M. (2003), "Resistance to change: a literature review and empirical study", *Management Decision*, Vol. 41 No. 2, pp. 148-155.

Delaney, J.T. and Huselid, M.A. (1996), "The impact of human resource management practices on perceptions of organizational performance", *Academy of Management Journal*, Vol. 39 No. 4, pp. 949-969.

Delery, J.E. and Doty, D.H. (1996), "Modes of theorizing in strategic human resource management: tests of universalistic, contingency, and configurational performance predictions", *Academy of Management Journal*, Vol. 39 No. 4, pp. 802-835.

Dickson, E.W., Anguelov, Z., Vetterick, D., Eller, A. and Singh, S. (2009), "Use of lean in the emergency department: a case series of 4 hospitals", *Annals of Emergency Medicine*, Vol. 54 No. 4, pp. 504-510.

Doman, M.S. (2011), "A new lean paradigm in higher education: a case study", *Quality Assurance in Education*, Vol. 19 No. 3, pp. 248-262.

Edwards, K., Nielsen, A.P. and Jacobsen, P. (2012), "Implementing lean in surgery – lessons and implications", *International Journal of Technology Management*, Vol. 57 Nos 1-23, pp. 4-17.

Ehrlich, B.H. (2006), "Service with a smile: lean solutions extend beyond the factory floor", *Industrial Engineer*, Vol. 38 No. 8, pp. 40-44.

Ellram, L.M., Tate, W.L. and Billington, C. (2004), "Understanding and managing the services supply chain", *Journal of Supply Chain Management*, Vol. 40 No. 4, pp. 17-32.

Emiliani, M.L. (2004), "Improving business school courses by applying lean principles and practices", *Quality Assurance in Education*, Vol. 12 No. 4, pp. 175-187.

Endsley, S., Magill, M.K. and Godfrey, M.M. (2006), "Creating a lean practice", *Family Practice Management*, Vol. 13 No. 4, pp. 34-38.

Esain, A., Williams, S. and Massey, L. (2008), "Combining planned and emergent change in a healthcare lean transformation", *Public Money and Management*, Vol. 28 No. 1, pp. 21-26.

Eswaramoorthi, M., Kathiresan, G.R., Prasad, P.S.S. and Mohanram, P.V. (2011), "A survey on lean practices in Indian machine tool industries", *The International Journal of Advanced Manufacturing Technology*, Vol. 52 Nos 9-12, pp. 1091-1101.

Fillingham, D. (2007), "Can lean save lives?", *Leadership in Health Services*, Vol. 20 No. 4, pp. 231-241.

Finigan, T. and Humphries, J. (2006), "Maintenance gets lean", *Industrial Engineer*, Vol. 38 No. 10, pp. 26-31.

Fullerton, R.R. and Wempe, W.F. (2009), "Lean manufacturing, non-financial performance measures, and financial performance", *International Journal of Operations and Production Management*, Vol. 29 No. 3, pp. 214-240.

Galende, J. and de la Fuente, J.M. (2003), "Internal factors determining a firm's innovative behaviour", *Research Policy*, Vol. 32 No. 5, pp. 715-736.

Graban, M. and Swartz, J.E. (2012), "Change for health", *Management Services*, Vol. 56 No. 2, pp. 35-39.

Hagan, P. (2011), "Waste not, want not leading the lean health-care journey at Seattle Children's Hospital", *Global Business and Organizational Excellence*, Vol. 30 No. 3, pp. 25-31.

Hameri, A.P. (2010), "Production flow analysis-cases from manufacturing and service industry", *International Journal of Production Economics*, Vol. 129 No. 2, pp. 233-241.

Hannan, M.T. and Freeman, J. (1984), "Structural inertia and organizational change", *American Sociological Review*, Vol. 49 No. 2, pp. 149-164.

Haque, B. and James-Moore, M. (2004), "Applying lean thinking to new product introduction", *Journal of Engineering Design*, Vol. 15 No. 1, pp. 1-31.

Hegde, G.G. and Nagarajan, N.J. (1992), "Incentives for overhead cost reduction: setup time and lot size considerations", *International Journal of Production Economics*, Vol. 28 No. 3, pp. 255-263.

Hines, P. and Lethbridge, S. (2008), "New development: creating a lean university", *Public Money and Management*, Vol. 28 No. 1, pp. 53-56.

Hines, P., Martins, A.L. and Beale, J. (2008), "Testing the boundaries of lean thinking: observations from the legal public sector", *Public Money and Management*, Vol. 28 No. 1, pp. 35-40.

Hitt, M.A., Bierman, L., Uhlenbruck, K. and Shimizu, K. (2006), "The importance of resources in the internationalization of professional service firms: the good, the bad, and the ugly", *The Academy of Management Journal*, Vol. 49 No. 6, pp. 1137-1157.

Holden, R.J. (2010), "Lean thinking in emergency departments: a critical review", *Annals of Emergency Medicine*, Vol. 57 No. 3, pp. 265-278.

Holm, M. and Ahlstrom, P. (2010a), "Assessing lean service integration", *Proceedings of the 17th International Annual EurOMA Conference, June*, pp. 1-10.

Holm, M. and Ahlstrom, P. (2010b), "Lean service – a literature review", *Proceedings of the 17th International Annual EurOMA Conference, June*, pp. 1-10.

Höök, M. and Stehn, L. (2008), "Lean principles in industrialized housing production: the need for a cultural change", *Lean Construction Journal*, pp. 20-33.

Huselid, M.A. (1995), "The impact of human resource management practices on turnover, productivity, and corporate financial performance", *Academy of Management Journal*, Vol. 38 No. 3, pp. 635-672.

Hyer, N.L. and Wemmerlöv, U. (2002), "The office that lean built", *Industrial Management*, Vol. 44 No. 5, pp. 36-43.

Jaaron, A. and Backhouse, C.J. (2011), "A methodology for the implementation of lean thinking in manufacturing support services", *Int. J. Services and Operations Management*, Vol. 9 No. 4, pp. 389-410.

Jaca, C., Santos, J., Errasti, A. and Viles, E. (2012), "Lean thinking with improvement teams in retail distribution a case study", *Total Quality Management and Business Excellence*, Vol. 23 Nos 3-4, pp. 449-465.

Jennings, D.F., Rajaratnam, D. and Lawrence, F.B. (2003), "Strategy-performance relationships in service firm: a test for equifinality", *Journal of Managerial Issues*, Vol. 15 No. 2, pp. 208-220.

Jimmerson, C., Weber, D. and Sobek, D.K. (2005), "Reducing waste and errors: piloting lean principles at IHC", *Joint Commission Journal on Quality and Patient Safety*, Vol. 31 No. 5, pp. 249-257.

Jones, C., Medlen, N., Merlo, C., Robertson, M. and Shepherdson, J. (1999), "The lean enterprise", *BT Technology Journal*, Vol. 17 No. 4, pp. 15-22.

Julien, D.M. and Tjahjono, B. (2009), "Lean thinking implementation at a safari park", *Business Process Management Journal*, Vol. 15 No. 3, pp. 321-335.

Kaplan, G.S. and Patterson, S.H. (2008), "Seeking perfection in healthcare: a case study in adopting Toyota production system methods", *Healthcare Executive*, Vol. 23 No. 3, pp. 17-20.

Karmarkar, U. (2004), "Will you survive the services revolution?", *Harvard Business Review*, Vol. 82 No. 6, pp. 100-107.

Keen, M. (2011), "Office skills", *Management Services*, Vol. 55 No. 1, pp. 20-22.

Kennedy, F., Owens-Jackson, L., Burney, L. and Schoon, M. (2007), "How do your measurements stack up to lean?", *Strategic Finance*, Vol. 88 No. 11, pp. 33-41.

Kennedy, F.A. and Widener, S.K. (2008), "A control framework: insights from evidence on lean accounting", *Management Accounting Research*, Vol. 19 No. 4, pp. 301-323.

King, D.L., Ben-Tovim, D.I. and Bassham, J. (2006), "Redesigning emergency department patient flows: application of lean thinking to health care", *Emergency Medicine Australasia*, Vol. 18 No. 4, pp. 391-397.

Kosuge, R., Modig, N. and Ahlstrom, P. (2010), "Standardization in lean service: exploring the contradiction", *Proceedings of the 17th International Annual EurOMA Conference, June*, pp. 1-10.

Kress, N.J. (2008), "Lean thinking in libraries: a case study on improving shelving turnaround", *Journal of Access Services*, Vol. 5 Nos 1-2, pp. 159-172.

Kull, T.J., Ellis, S.C. and Narasimhan, R. (2013), "Reducing behavioral constraints to supplier integration: a socio-technical systems perspective", *Journal of Supply Chain Management*, Vol. 49 No. 1, pp. 64-86.

Kuriger, G.W., Wan, H.D., Mirehei, M., Tamma, S. and Chen, F.F. (2010), "A web-based lean simulation game for office operations: training the other side of a lean enterprise", *Simulation and Gaming*, Vol. 41 No. 4, pp. 487-510.

LaGanga, L.R. (2011), "Lean service operations: reflections and new directions for capacity expansion in outpatient clinics", *Journal of Operations Management*, Vol. 29 No. 5, pp. 422-433.

Leitner, K.H. and Guldenberg, S. (2010), "Generic strategies and firm performance in SMEs: a longitudinal study of Austrian SMEs", *Small Business Economics*, Vol. 35 No. 2, pp. 169-189.

Lewis, M.A. (2000), "Lean production and sustainable competitive advantage", *International Journal of Operations and Production Management*, Vol. 20 No. 8, pp. 959-978.

Li, X., Sawhney, R., Arendt, E.J. and Ramasamy, K. (2012), "A comparative analysis of management accounting systems' impact on lean implementation", *International Journal of Technology Management*, Vol. 57 Nos 1-3, pp. 33-48.

Lodge, A. and Bamford, D. (2008), "New development: using lean techniques to reduce radiology waiting times", *Public Money and Management*, Vol. 28 No. 1, pp. 49-52.

McQuade, D. (2008), "New development: leading lean action to transform housing services", *Public Money and Management*, Vol. 28 No. 1, pp. 57-60.

Maguad, B.A. (2007), "Lean strategies for education overcoming the waste factor", *Project Innovation*, Vol. 128 No. 2, pp. 248-255.

Malladi, S., Dominic, P.D.D. and Kamil, A. (2010), "Lean principles in IT services: a case study on implementation and best practices", *Int. J. Business Information Systems*, Vol. 8 No. 3, pp. 1-22.

Manos, A., Sattler, M. and Alukal, G. (2006), "Make healthcare lean", *Quality Progress*, Vol. 39 No. 7, pp. 24-30.

Markovitz, D. (2012), "Information 5S", *Management Services*, Vol. 56 No. 1, pp. 8-11.

Martinson, O.B. (2002), "A look at cost accounting in the service industry and the federal government", *The Journal of Government Financial Management*, Vol. 51 No. 1, pp. 18-25.

Maskell, B.H. and Kennedy, F.A. (2007), "Why do we need lean accounting and how does it work?", *Journal of Corporate Accounting and Finance*, Vol. 18 No. 3, pp. 59-73.

Meade, D.J., Kumar, S. and White, B. (2010), "Analysing the impact of the implementation of lean manufacturing strategies on profitability", *Journal of the Operational Research Society*, Vol. 61 No. 5, pp. 858-871.

Middleton, P., Flaxel, A. and Cookson, A. (2005), "Lean software management case study: Timberline Inc", *Lecture Notes in Computer Science*, Vol. 3556, pp. 1-9.

Mirehei, S.M., Kuriger, G., Wan, H.D. and Chen, F.F. (2011), "Enhancing lean training for the office environment through simulation and gaming", *Int. J. Learning and Intellectual Capital*, Vol. 8 No. 2, pp. 206-221.

Moayed, F.A. and Shell, R.L. (2009), "Comparison and evaluation of maintenance operations in lean versus non-lean production systems", *Journal of Quality in Maintenance Engineering*, Vol. 15 No. 3, pp. 285-296.

Moch, M.K. (1976), "Structure and organizational resource allocation", *Administrative Science Quarterly*, Vol. 21 No. 4, pp. 661-674.

Montabon, F. (2005), "Using kaizen events for back office processes: the recruitment of frontline supervisor co-ops", *Total Quality Management and Business Excellence*, Vol. 16 No. 10, pp. 1139-1147.

Nelson-Peterson, D.L. and Leppa, C.J. (2007), "Creating an environment for caring using lean principles of the Virginia mason production system", *The Journal of Nursing Administration*, Vol. 37 No. 6, pp. 287-294.

Nie, W. and Kellogg, D.L. (1999), "How professors of operations management view service operations?", *Production and Operations Management*, Vol. 8 No. 3, pp. 339-355.

Nielsen, A.P. and Edwards, K. (2010), "Implementing lean in healthcare: barriers and opportunities", *Proceedings of the 17th International Annual EurOMA Conference, June*, pp. 1-10.

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

Papadopoulos, T. (2012), "Continuous innovation through lean thinking in healthcare: the role of dynamic actor associations", *International Journal of Technology Management*, Vol. 60 Nos 3-4, pp. 266-280.

Papadopoulos, T. and Merali, Y. (2008), "Stakeholder network dynamics and emergent trajectories of lean implementation projects: a study in the UK national health service", *Public Money and Management*, Vol. 28 No. 1, pp. 41-48.

Pedersen, E.R.G. and Huniche, M. (2011), "Negotiating lean the fluidity and solidity of new management technologies in the Danish public sector", *International Journal of Productivity and performance management*, Vol. 60 No. 6, pp. 550-566.

Pejsa, P. and Eng, R. (2011), "Lean strategy deployment delivers customer satisfaction at GE Healthcare", *Global Business and Organizational Excellence*, Vol. 30 No. 5, pp. 45-55.

Petersen, K. and Wohlin, C. (2010), "Software process improvement through the lean measurement (SPI-LEAM) method", *The Journal of Systems and Software*, Vol. 83 No. 7, pp. 1275-1287.

Pettersen, J. (2009), "Defining lean production: some conceptual and practical issues", *The TQM Journal*, Vol. 21 No. 2, pp. 127-142.

Piercy, N. and Rich, N. (2009a), "High quality and low cost: the lean service center", *European Journal of Marketing*, Vol. 43 No. 11, pp. 1477-1497.

Piercy, N. and Rich, N. (2009b), "Lean transformation in the pure service environment: the case of the call service center", *International Journal of Operations and Production Management*, Vol. 29 No. 1, pp. 54-76.

Pizzini, M.J. (2006), "The relation between cost-system design, managers' evaluations of the relevance and usefulness of cost data and financial performance an empirical study of US hospitals", *Accounting, Organizations and Society*, Vol. 31 No. 2, pp. 179-210.

Poksinska, B. (2010), "The current state of lean implementation in health care: literature review", *Quality Management in Health Care*, Vol. 19 No. 4, pp. 319-329.

Pont, G.D., Furlan, A. and Vinelli, A. (2008), "Interrelationships among lean bundles and their effects on operational performance", *Operations Management Research*, Vol. 1 No. 2, pp. 150-158.

Porter, M. (1980), *Competitive Strategy*, Free Press, New York, NY.

Qudrat-Ullah, H., Seong, B.S. and Mills, B.L. (2012), "Improving high variable-low volume operations: an exploration into the lean product development", *International Journal of Technology Management*, Vol. 57 Nos 1-23, pp. 49-70.

Radnor, Z.J., Holweg, M. and Waring, J. (2012), "Lean in healthcare: the unfilled promise?", *Social Science and Medicine*, Vol. 74 No. 3, pp. 364-371.

Reinertsen, D. (2005), "Let it flow", *Industrial Engineer*, Vol. 37 No. 6, pp. 40-45.

Reinertsen, D. and Shaeffer, L. (2005), "Making R&D lean", *Research Technology Management*, Vol. 48 No. 4, pp. 51-57.

Sakakibara, S., Flynn, B.B., Schroeder, R.G. and Morris, W.T. (1997), "The impact of just-in-time manufacturing and its infrastructure on manufacturing performance", *Management Decision*, Vol. 43 No. 9, pp. 1246-1257.

Scherrer-Rathje, M., Boyle, T.A. and Deflorin, P. (2009), "Lean, take two! Reflections from the second attempt at lean implementation", *Business Horizons*, Vol. 52 No. 1, pp. 79-88.

Schlissel, M.R. and Chasin, J. (1991), "Pricing of services an interdisciplinary review", *The Service Industries Journal*, Vol. 11 No. 3, pp. 271-286.

Schulze, A. and Störmer, T. (2012), "Lean product development – enabling management factors for waste elimination", *International Journal of Technology Management*, Vol. 57 Nos 1-23, pp. 71-91.

Searcy, D.L. (2009a), "Developing a lean performance score", *Strategic Finance*, Vol. 91 No. 3, pp. 34-39.

Searcy, D.L. (2009b), "Using cost management and lean tools to improve AMG's rental operations", *Cost Management*, Vol. 23 No. 6, pp. 24-33.

Shafti, F., Meer, R. and Williams, T. (2007), "An empirical approach to service classification for productivity management studies", *The Service Industries Journal*, Vol. 27 No. 6, pp. 709-730.

Shah, R. and Ward, P.T. (2003), "Lean manufacturing: context, practice bundles, and performance", *Journal of Operations Management*, Vol. 21 No. 2, pp. 129-149.

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.

Shahrukh, I. (2011), "Choosing what works: high-mix, low-volume small manufacturers must supplement the right tools with other strategies", *Industrial Engineer*, Vol. 43 No. 8, pp. 42-47.

Sharma, S., Durand, R.M. and Gur-Arie, O. (1981), "Identification and analysis of moderator variables", *Journal of Marketing Research*, Vol. 18 No. 3, pp. 291-300.

Silvestro, R. (2001), "Towards a contingency theory of TQM in services – how implementation varies on the basis of volume and variety", *International Journal of Quality and Reliability Management*, Vol. 18 No. 3, pp. 254-288.

Silvestro, R., Fitzgerald, L., Johnston, R. and Voss, C. (1992), "Towards a classification of service processes", *International Journal of Service Industry Management*, Vol. 3 No. 3, pp. 62-75.

Souza, D., Brandao, L. and Michael, P. (2011), "Exploring the barriers to lean health care implementation", *Public Money and Management*, Vol. 31 No. 1, pp. 59-66.

Sprigg, C.A. and Jackson, P.R. (2006), "Call centers as lean service environments: job-related strain and the mediating role of work design", *Journal of Occupational Health Psychology*, Vol. 11 No. 2, pp. 197-212.

Staats, B.R. and Upton, D.M. (2011), "Lean knowledge work", *Harvard Business Review*, Vol. 89 No. 10, pp. 100-110.

Staats, B.R., Brunner, D.J. and Upton, D.M. (2011), "Lean principles, learning, and knowledge work: evidence from software services provider", *Journal of Operations Management*, Vol. 29 No. 5, pp. 376-390.

Suarez-Barraza, M.F. and Ramis-Pujol, J. (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*, Vol. 21 No. 3, pp. 388-410.

Suarez Barraza, M.F., Smith, T. and Dahlgaard-Park, S.M. (2009), "Lean-kaizen public service: an empirical approach in Spanish local governments", *The TQM Journal*, Vol. 21 No. 2, pp. 143-167.

Suárez-Barraza, M.F., Smith, T. and Dahlgaard-Park, S.M. (2012), "Lean service a literature analysis and classification", *Total Quality Management & Business Excellence*, Vol. 23 Nos 3-4, pp. 359-380.

Swank, C.K. (2003), "The lean service machine", *Harvard Business Review*, Vol. 81 No. 10, pp. 123-129.

Tatikonda, L. (2007), "Applying lean principles to design, teach, and assess courses", *Management Accounting Quarterly*, Vol. 8 No. 3, pp. 27-38.

Taubitz, M.A. (2010), "Lean, green & safe", *Professional Safety*, May, pp. 39-46.

Taylor, A. and Taylor, M. (2009), "Operations management research: contemporary themes, trends and potential future directions", *International Journal of Operations and Production Management*, Vol. 29 No. 12, pp. 1316-1340.

Tiplady, B. (2010), "Running a lean office", *British Journal of Administrative Management*, No. 72, pp. 22-23.

Tischler, L. (2006), "Bringing lean to the office", *Quality Progress*, Vol. 39 No. 7, pp. 32-38.

Tonya, V. (2004), "Spreading the good word", *Industry Week*, Vol. 253 No. 2, pp. 59-60.

Towne, J. (2006), "Going 'lean' streamlines processes, empowers staff and enhances care", *Hospitals and Health Networks*, Vol. 80 No. 10, pp. 34-35.

Trist, E.L. (1981), "The evolution of socio-technical systems: a conceptual framework and action research program", Occasional Paper No. 2, Ontario Quality of Working Life Centre, Ontario, CA.

Van Biema, M. and Greenwald, B. (1997), "Managing our way to higher service-sector productivity", *Harvard Business Review*, Vol. 75 No. 4, pp. 87-95.

Venkatraman, N. (1989), "The concept of fit in strategy research: toward verbal and statistical correspondence", *Academy of Management Review*, Vol. 14 No. 3, pp. 423-444.

Venzin, M., Kumar, V. and Kleine, J. (2008), "Internationalization of retail banks: a micro-level study of the multinationality-performance relationship", *Management International Review*, Vol. 48 No. 4, pp. 463-485.

Verma, R. (2000), "An empirical analysis of management challenges in service factories, service shops, mass services and professional services", *International Journal of Service Industry Management*, Vol. 11 No. 1, pp. 8-25.

Villarreal, B., Garcia, D. and Rosas, I. (2009), "Eliminating transportation waste in food distribution: a case study", *Transportation Journal*, Vol. 48 No. 4, pp. 72-77.

Vlachos, I. and Bogdanovic, A. (2013), "Lean thinking in the European hotel industry", *Tourism Management*, Vol. 36, June, pp. 354-363.

Wang, L., Ming, X.G., Kong, F.B., Li, D. and Wang, P.P. (2012), "Focus on implementation: a framework for lean product development", *Journal of Manufacturing Technology Management*, Vol. 23 No. 1, pp. 4-24.

Wayne, C. (2005), "Company applies lean techniques in the office", *Modern Machine Shop*, Vol. 78 No. 7, pp. 44-46.

Wenchao Song, W., Tan, K.H. and Baranek, A. (2009), "Effective toolbox for lean service implementation", *International Journal of Services and Standards*, Vol. 5 No. 1, pp. 1-16.

White, R.E. (1986), "Generic business strategies, organizational context and performance: an empirical investigation", *Strategic Management Journal*, Vol. 7 No. 3, pp. 217-231.

Woehrle, S.L. and Abou-Shady, L. (2010), "Using dynamic value stream mapping and lean accounting box scores to support lean implementation", *American Journal of Business Education*, Vol. 3 No. 8, pp. 67-76.

Womack, J.P. and Jones, D.T. (1996), "Beyond Toyota: how to root out waste and pursue perfection", *Harvard Business Review*, Vol. 74 No. 5, pp. 140-158.

Yasin, M.M., Small, M.H. and Wafa, M.A. (2003), "Organizational modifications to support JIT implementation in manufacturing and service operations", *Omega*, Vol. 31 No. 3, pp. 213-226.

Yavas, U. and Yasin, M.M. (2001), "Enhancing organizational performance in banks: a systematic approach", *Journal of Services Marketing*, Vol. 15 No. 6, pp. 444-453.

Yu-Lee, R.T. (2011), "Proper lean accounting: eliminating waste isn't enough; you have to reduce inputs to save money", *Industrial Engineer*, Vol. 43 No. 10, pp. 39-43.

(The Appendix follows overleaf.)

Appendix 1.

Table AI.
Definitions of lean technical practices

Practices	Definition	Reference
5Ss	Sort – sort out what is wanted in an area and what items can be disposed of, reduced or moved, Set in order – place items to be retrieved closest to the area for frequency of use and determine volume of use. Make visible so abnormalities are apparent, Shine – make sure all items are in the best working condition and remain so, Standardize – standardize work routines as well as equipment and material usage, Sustain – ensure standards set are followed and improved	Esain *et al.* (2008)
A3 report	It is a one side of A3 paper size that addresses a specific problem in a systematic manner	Jimmerson *et al.* (2005)
Automation	It is the replacement of manual labor by advanced equipments	Bortolotti and Romano (2010)
Change management	A structured approach to transitioning individuals, teams and organizations from a current state to a desired future state	Manos *et al.* (2006)
Continuous improvement	A philosophy which promotes organizational change based on an ongoing pattern of planning, execution and evaluation of results related to all operations of an organization for the purpose of forever improvement	Emiliani (2004)
Eliminating loop-backs	Methods used to eliminate the possibility of returning work to a previous step for further processing	Swank (2003)
Group technology	Work processes are designed to form work cells which are located close to each other with the object of cutting down on unneeded transport and waiting times	Suarez Barraza *et al.* (2009)
Changing the facility layout	A layout designed according to optimum operational sequence or flow	Suarez Barraza *et al.* (2009)
Just in Time	It is the delivery of what is needed to where they are needed, in the quantity needed, at the time they are requested	Alagaraja (2010)
Kaizen blitz	Short-term process improvement projects that concern a specific area to improve	Suarez Barraza *et al.* (2009)
Kanban	It is an information system that indicates when a subsequent activity within a connected series of activities can start	Manos *et al.* (2006)
Mistakes proofing/ Poka-Yoke	It is a process that helps eliminate the chance for mistakes	Manos *et al.* (2006)
Model cell, roll out	The establishment of a microcosm of business processes in which new improvement practices are implemented to examine their effectiveness and solving mistakes in the implementation process before rolling them out to the entire business	Swank (2003)

(*continued*)

Table AI.

Practices	Definition	Reference
Outsourcing	Hiring a third party business to manage some non-core activities	Comm and Mathaisel (2005b)
Point of use storage	To keep the items used most often in the space where they are used. Therefore, waste of searching for items or walking to get needed items is minimized	Manos *et al.* (2006)
Policy deployment/Hoshin Kanri	A process used to connect corporate strategy to key objectives and resources, including daily activities across functions	Emiliani (2004)
Process redesign	To redesign content, scope, flow and structure of tasks and subtasks within an organization to enhance operational and customer-related performance outcomes such as cost, productivity, quality, service, satisfaction and speed	Yavas and Yasin (2001)
Production levelling/ Heijunka	It is to balance production and delivery of services over a period of time to meet customer demand	Staats *et al.* (2011)
Pull system	To produce and deliver services at the request or pull of the customer or user	Manos *et al.* (2006)
Quality circles	A group of employees that meets regularly to consider ways of resolving problems and improving production in their organization	Swank (2003)
Quality function deployment	Using a cross-functional team approach to reach consensus about final product/service specifications, in accordance with customer requirements	Alagaraja (2010)
Quick set up time	It is the ability to re setup an area for providing a different product/service quickly	Maguad (2007)
Root cause analysis	Methods used to determine the root cause of a problem and identify countermeasures to avoid repeat occurrences. Key tools are "5 Whys" (asking why five or more times until the root cause of the problem is discovered) and fishbone or cause-and effect diagram	Emiliani (2004)
Segregating complexity	It is to cluster tasks of similar levels of difficulty into separate groups with their own performance goals	Swank (2003)
Self inspection	It is having people inspect their own work	Manos *et al.* (2006)
Simplification	To simplify operations by eliminating steps delaying the production and delivery of a product/service	Bortolotti and Romano (2012)
Single piece flow	To pass the work to the next station right after finishing it without making any batches	Mirehei *et al.* (2011)
Small lots	To process transactions/information in the smaller batch possible and passed it along to the next step	Arbos (2002)

(*continued*)

Table AI.

Practices	Definition	Reference
Standardization	It is an agreed-upon set of work procedures that establish the best and most reliable methods and sequences for each process and each worker	Kosuge *et al.* (2010)
Takt time	The rate of customer demand. Used to establish a direct link between marketplace demand and workplace activities	Emiliani (2004)
Total preventive maintenance	A program used to ensure that equipment is in good operating condition and available for use when needed	Mirehei *et al.* (2011)
Total quality	To assign the responsibility of improving and maintaining quality to every employee in the company	Emiliani (2004)
Use of new technologies	It is the use of new methods and practices that have become available and can develop and improve operational processes	Comm and Mathaisel (2005b)
Value stream mapping	A visual picture of material and information flows from supplier to customer: current-state map determines current conditions of flow; future-state map shows opportunities for improvement at some future point	Alagaraja (2010)
Vertical information system	It is a simple information system relying on direct information flows to the relevant decision makers, which allows for rapid feedback and corrective action	Åhlström (2004)
Visualization	Signs and other forms of visual information used to simplify the workplace and make it easy to recognize abnormalities	Emiliani (2004)
Work load balancing	It is the allocation of tasks in a balanced amount between employees so that none will be over or under loaded with tasks	Mirehei *et al.* (2011)

Appendix 2.

Lean practices	Waste identification	Waste elimination	Complementary practices
5Ss	*	*	
A3 report			*
Automation		*	
Change management			*
Continuous improvement			*
Eliminating loop-backs		*	
Group technology		*	
Changing the facility layout		*	
Just in Time		*	
Kaizen blitz			*
Kanban		*	
Mistakes proofing/Poka-Yoke		*	
Model cell, roll out			*
Outsourcing		*	
Point of use storage		*	
Policy deployment/Hoshin Kanri			*
Process redesign		*	
Production levelling/Heijunka		*	
Pull system		*	
Quality circles			*
Quality function deployment	*	*	
Quick set up time		*	
Root cause analysis	*		
Segregating complexity		*	
Self inspection		*	
Simplification		*	
Single piece flow		*	
Small lots		*	
Standardization		*	
Takt time			*
Total preventive maintenance		*	
Total quality	*	*	
Use of new technologies		*	
Value stream mapping	*		
Vertical information system		*	
Visualization	*	*	
Work load balancing		*	

Table AII.
Classification of lean technical practices

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