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Is lean service promising? A socio-technical perspective

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Abstract

Purpose – This research contributes to the ongoing debate about the effectiveness of lean practices in the service sector.

Design/methodology/approach – This paper examines the impact of lean service on firm operational and financial performance. Exploratory factor analysis is used to reduce the data and identify the underlying dimensions of lean service, and partial least squares structural equation modelling (PLS-SEM) is used to test the developed model.

Findings – The results indicate that the social bundles of lean service had an independent positive impact on firm operational and financial performance. Furthermore, while the technical bundles had an independent positive effect on only the operational performance, they interacted with the social bundles to improve both the operational and financial performance. The findings suggest that service managers must follow a systematic approach when implementing lean service practices without focusing on one side of the system at the expense of the other.

Practical implications – The paper highlights the importance of implementing lean service as a socio-technical system if service firms are to achieve the best possible benefits from their implementation. The motivation factor (social side) and the customer value factor (technical side) are capable of improving all operational performance dimensions and profit margin even if implemented alone. Therefore, service managers with limited resources are encouraged to start lean service implementation with practices within these factors. However, they can also expect improved operational and financial performance from implementing other factors as they positively interact to further improve performance.

Originality/value – Viewing lean service as a socio-technical system, this paper incorporates a larger set of lean practices than previous studies and demonstrates empirically their capability of improving service firms' operational and financial performance. It contributes significantly to the emerging literature on lean service by empirically testing the mechanism through which lean service affects firm performance.

Key words: Lean service technical practices; Lean service social practices; Socio-technical systems theory; Firm performance, Partial least squares (PLS-SEM).

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1. Introduction

The lean system is a multi-dimensional management system which rests on a set of principles and practices that aim to improve customers' value by eliminating non-value adding activities (NVA) (Wiengarten et al., 2015; Shah and Ward, 2003). The system's reputation in helping Japanese manufacturers outperform their Western counterparts has captured the attention of scholars and practitioners around the world (Hadid and Mansouri, 2014). This is evident from the increasing number of studies examining its effectiveness in improving the performance of non-Japanese contexts (e.g. Wiengarten et al., 2015; Talib et al., 2013). However, the literature is under-developed which compromises our understanding of whether the lean system is capable of improving the performance of all adopting firms.

Firstly, most studies have assumed that lean components work in isolation to improve performance (e.g. Agarwal et al., 2013). This ignores the potential performance enhancing interaction between these components, and hence the full potential of the lean system (Hadid and Mansouri, 2014). Secondly, previous studies have tended to investigate improvement capability at the operational level (e.g. Dabhilkar and Åhlström, 2013). However, given the importance of the financial dimension to for-profit organisations, understanding the impact of the lean system, including the interaction among its components, on financial performance is vital for managers (Arlbjørn and Freytag, 2013). Thirdly, most researchers have examined the lean-performance relationship in the manufacturing context (Arlbjørn and Freytag, 2013), with much less attention to its effectiveness in the service context, prompting calls for more research (e.g. Hadid and Mansouri, 2014; Malmbrandt and Åhlström, 2013).

Empirical investigations of the lean-performance association in the service context are important for two reasons. First, the service sector contributes significantly more than manufacturing to the gross domestic product in most developed economies (Malmbrandt and

Åhlström, 2013). Therefore, verifying anecdotal evidence on the effectiveness of lean practices in services can have a dramatic effect at the economy level (Suárez-Barraza et al., 2012). If rigorous research validates the usefulness of lean practices in the service context, then service managers can, and must, be encouraged to adopt them and maximise their benefits (Fullerton and Wempe, 2009). Otherwise, the potential adopters can stop experimenting with them, saving time, effort and implementation resources (Arlbjørn and Freytag, 2013).

Second, differences between the service and manufacturing contexts are acknowledged in the literature, especially in terms of intangibility, simultaneity, heterogeneity, perishability, labour intensity and the presence of customers during service delivery (Sampson and Froehle, 2006; Bowen and Youngdahl, 1998). Such unique characteristics expose service operations managers to difficulties not encountered by manufacturers. As most services are intangible, service quality is usually difficult to measure and quantify compared to manufactured products (Mefford, 1993). Service processes are quite labour intensive and thus more variable since the performance of humans is less predictable than that of machines (Mefford, 1993). Moreover, the convergence between the production and consumption of services resulting from the presence of customers adds to that variability (Sampson and Froehle, 2006). Labour intensity may also increase the resistance to change accompanying the introduction of lean in the service environment (Antony et al., 2007). Given the resources needed to address such resistance (De Leeuw and van den Berg, 2011), adopting lean practices can prove more costly in services. Furthermore, to implement lean practices, employees should be trained to be able to implement lean practices (Staats et al., 2011). The cost of training, estimated to be as high as $50,000 (Swink and Jacobs, 2012), can be another inhibitor.

These arguments leave service managers unclear whether lean manufacturing practices can be equally as valid for service-based processes, and substantiate the need for further research on lean system in the service context (Hadid and Mansouri, 2014; Staats et al., 2011). In response, this study seeks to answer the following question:

> Do lean system practices have an additive and/or non-additive (interaction) impact on operational and/or financial performance of for-profit service firms?

This study, therefore, overcomes shortcomings of the existing literature, firstly by extending earlier studies which focused primarily on the independent (additive) performance impact of lean bundles by introducing the possible interaction among those bundles - interventions which are expected to further enhance performance. Secondly, as suggested by Patterson et al. (2004), a larger set of practices is included in the analysis to better represent each bundle and more precisely examine their performance impact. This also provides an opportunity for the empirical refinement and validation in the service-context of a set of manufacturing-originated practices claimed as being universally applicable across sectors[1]. Thirdly, archival measures of financial performance are also incorporated along with measures of operational performance to capture more precisely the full impact of lean bundles.

Section 2 of the paper presents the relevant literature. The research hypotheses are reported in section 3. The methodological approach is introduced in section 4 followed by the analysis and

[1] We focus on medium and large, for-profit service companies. There is a growing literature examining the applicability and effectiveness of lean system in the public sector (e.g. Radnor and Johnston, 2013; Radnor, 2010). However, for-profit companies may not have similar behaviours and focus to companies in the public sector. Therefore, we decided to exclude firms in the public sector and examine the impact of lean system on for-profit service firms which share the same aim (i.e. profit maximisation) with manufacturing firms (Auzair and Langfield-Smith, 2005). By doing so, heterogeneity resulting from the inclusion of organisations with different focus and aim has been reduced. This also justifies our reliance on some relevant lean manufacturing literature to support parts of our argument when literature on lean service was not available.

results in section 5. Section 6 is devoted to the discussion of the results while section 7 concludes the paper, outlines limitations of the study and identifies directions for future research.

2. Theory

2.1 Theoretical background

A careful review of the lean literature reveals a growing interest in the mechanisms through which lean practices affect firm performance and the extent of this effect (Secchi and Camuffo, 2016; Bamford et al., 2015; Arlbjørn and Freytag, 2013). This body of literature can be divided into three streams.

In the first stream, researchers viewed the lean system as a set of separate practices where each can generate improvement in isolation. However, inconclusive findings were reported. Fullerton and Wempe (2009), based on data from 121 manufacturing executives, found that three lean practices (setup reduction, cellular manufacturing and quality improvement) only indirectly affect profitability measured by return on sales. Samson and Terziovski (1999) increased the sample size (1024 manufacturers) and the number of lean practices to assess their impact on operational performance. They studied the influence of six lean practices (leadership, people management, customer focus, strategic planning, information analysis, and process management) on operational performance operationalised as customer satisfaction, employee morale, productivity, quality of output, and delivery. They found a positive impact of the HRM-based practices. However, strategic planning and process management had no impact while information analysis negatively affected the operational performance. In contrast, Bonavia and Marin's (2006) study of 76 manufacturers and eleven lean practices revealed no systematic relationship between the extent of use of lean practices and improvement in operational performance measured as internal quality, productivity, total stock and lead time. Out of the practices studied, total preventive maintenance (TPM) was positively associated with productivity. Setup time reduction was negatively associated with lead time and the level of inventory, while standardisation had a positive relation with the level of inventory. Surprisingly, none of the soft practices (multi-functional employees and group suggestions programme) were found to be capable of improving any of the operational performance indicators.

In summary, in this stream of literature, a different and (relatively) limited number of practices and performance indicators were used. Researchers provided confusing evidence on the relationship between the technical practices (e.g. setup reduction, information analysis, process management) and the soft practices of a lean system (e.g. leadership, customer focus, multi-functional employees) and firm performance.

To overcome these limitations, some researchers decried the narrow focus on isolated practices and pointed out that lean practices are interrelated, and thus understanding their true impact on performance requires studying them as a system of practices (Shah and Ward, 2007; 2003). Consequently, in the second stream of literature, the focus on the potential impact of "lean bundles" became the main concern.[2] In this body of literature, the study of Cua et al. (2001) focused on three lean bundles, namely total quality management (TQM), just in time (JIT) and TPM and their impact on a set of operational performance indicators (unit cost, quality, delivery and flexibility). Seventeen practices were classified into those unique to each bundle, and those common among all bundles. As a result, TQM, JIT and TPM were represented by four, five and three practices respectively and five practices were found common among them. The common practices included committed leadership, strategic planning, cross-functional training, employee involvement, information and feedback. Using data from 163 manufacturing plants, Cua et al. (2001) found that plants applying a combination of unique practices from the three bundles had higher performance than plants focusing on only one bundle. More importantly, they reported

[2] A lean bundle is a set of interrelated and internally consistent practices (Shah and Ward, 2003).

that firms with higher manufacturing performance were associated with a higher level of joint implementation of both the common and unique practices, thus highlighting the importance of the common practices. Similarly, Shah and Ward (2003) surveyed 1757 manufacturers on the effect of four lean bundles (JIT, TQM, TPM and HRM) represented by 22 practices. They found a positive effect for each of the bundles on operational performance although the HRM bundle with only two practices had the weakest impact on performance. Pont et al.'s (2008) survey of 266 plants also found a direct positive effect on operational performance by the JIT and TQM bundles. However, and in contrast to the findings of Cua et al. (2001) and Shah and Ward (2003), the HRM bundle had only an indirect effect on performance via the other two bundles. Bonavia and Marin-Garcia (2011) investigated the ability of four HRM practices and a composite measure of seven lean technical practices to discriminate between the performance of 76 manufacturing firms based on nine operational performance indicators. The authors found that the HRM practices were positively associated with productivity and lower stock levels. However, the composite of lean technical practices was not related to any of the nine performance indicators. Most recently, Agarwal et al. (2013), using data from 152 manufacturers, confirmed the influence of a lean index on only some of the operational and financial indicators studied (including sales, profit and profit margin).

Studies in the second literature stream have clearly improved our knowledge about the lean-performance association and limitations of studying lean practices individually. However, the main focus was limited to operational performance. Furthermore, while the mixed results in relation to the performance impact of the technical and soft (HRM) practices could be attributed to differences between the above studies in terms of sample size, operationalisation of variables and analysis methods, they may also suggest potential interactions between lean bundles, where the performance impact of one bundle is enhanced by the presence of another.

The notion of interaction between lean bundles is not totally new. Shah and Ward (2003) proposed that lean bundles complement each other and interact to improve the operations of adopters although without formally testing this notion. The findings of Cua et al. (2001) corroborate the interaction premise as they found that plants with higher performance implemented both common and unique practices of TQM, JIT and TPM bundles. To date, despite the large number of publications on the lean system, there has been a very limited number of studies addressing the possible interaction effect and they have provided mixed results. In this emerging third stream, Challis et al. (2002) with data from 1024 manufacturers studied the performance impact, and potential interactions, of three lean technical bundles (advanced manufacturing technology (AMT), TQM and JIT) on employee and manufacturing performance. All three improved employee performance, however only JIT and TQM had a significant positive impact on manufacturing performance. More importantly, only the interaction between AMT and TQM was positively related to both employee and manufacturing performance. Patterson et al. (2004) extended Challis et al.'s (2002) work by adding a HRM bundle (represented by two practices); however no positive interaction was detected among any of the four bundles. More recently, Furlan et al. (2011) investigated the role of HRM in the interaction between JIT and TQM to improve operational performance. Data from 266 manufacturing firms showed that without the HRM bundle the interaction between JIT and TQM had no significant effect. However, a positive interaction was documented under high levels of HRM. Finally, Dabhilkar and Åhlström (2013) found a positive interaction between a composite measure of lean technical practices and a composite measure of HRM practices on operational performance of manufacturing firms. The overall paucity of research and inconclusive findings concerning the interaction between lean bundles highlights an important and immediate need for more research to clarify the full capability of the lean system to improve firm performance.

2.2 Lean service

Despite the inconclusiveness surrounding the effectiveness of lean manufacturing practices, organisations in the service sector have been encouraged to use them, leading to the emergence of the lean service concept (Hadid and Mansouri, 2014). Lean service (the implementation of lean manufacturing practices in services) was formally introduced into the literature by Bowen and Youngdahl (1998) with a growing interest among academics and practitioners (Hadid and Mansouri, 2014). Prior research has discussed the validity of lean practices to different service industries but mainly through conceptual and case-based studies (Suárez-Barraza et al., 2012). Although this body of literature has improved our knowledge of different aspects of lean service, many researchers have stressed the importance of providing evidence from large-scale survey studies on the effectiveness of lean service in improving performance (e.g. Hadid and Mansouri, 2014; Malmbrandt and Åhlström, 2013). To date, modest efforts have been made in this regard, notably Alsmadi et al. (2012). However, these studies share similar limitations of the empirical studies on lean manufacturing in terms of the narrow focus on the independent effect of isolated practices while ignoring their potential interaction (e.g. Talib et al., 2013).

3. Hypotheses development

3.1 The socio-technical system theory

The hypotheses in this study are developed from the lens of the socio-technical system theory (STS) (Trist and Bamforth, 1951). STS assumes that organisations comprise two components; technical and social. The technical system includes equipment, tools, techniques and processes, while the social system comprises people and relationships among them (Trist, 1981). The social and technical sides are separate but interdependent in that improving one side will require improving the other side in order to obtain the best performance (Trist, 1981). In other words, emphasising the technical side of a system by investing more in its practices and neglecting the social system (by investing less in its practices), or vice-versa, will not lead to the optimal performance (Fox, 1995). This implies that the technical and social sides are likely to positively interact, leading to better performance (Dabhilkar and Åhlström, 2013). With this in mind, the STS perspective is gaining increasing attention in the operations management literature and has been used to understand and explain the performance impact of modern improvement systems. For instance, STS was relied on by Manz and Stewart (1997) to explicate how positive outcomes from TQM could be attained. The authors emphasised that the technical and social sides of TQM are individually able to add value, but better performance can be expected when they are implemented together through interactions with each other.

The STS has also attracted interest in the lean literature. Shah and Ward (2003) referred to the possible complementarity between lean bundles. In a later study, Shah and Ward (2007) formally defined lean system as a socio-technical system. Huber and Brown (1991) discussed the implementation of cellular manufacturing (lean system) from the STS perspective, explaining theoretically how its effectiveness can be enhanced by complementing it with six HRM practices (HRM planning, employee relations, job analysis and design, selection, reward structure, and training and development). The results of Cue et al. (2001) also support the perception of lean system as a socio-technical system when plants with higher performance were found to implement both common (social) and unique (technical) practices of JIT, TQM and TPM bundles. The conflicting results highlighted in subsection 2.1 regarding the performance impact of the technical bundles (TQM, JIT and TPM) and the social bundle (HRM) provide an additional motivation to examine the mechanism of the STS in the lean context. Consequently, our hypotheses focus on the independent effect of each side of lean service on performance, but importantly, also on the impact of the potential interaction between practices from the two sides. Accordingly, this research contributes to the literature on STS by empirically measuring and explicitly testing the independent and combined impact of the social and technical sides of lean service on operational and financial performance in the service context. This offers a direct empirical examination and validation of the mechanism (interaction) of the STS which has been lacking in the lean service literature (Hadid and Mansouri, 2014).

Prior research on lean service has made good progress in terms of identifying and classifying its practices into technical practices and social practices. Among the most recent work is that of Hadid and Mansouri (2014) and Malmbrandt and Åhlström (2013). While the latter study identified a set of lean service practices and developed an instrument to measure the progress of their implementation, Hadid and Mansouri's (2014) study, based on a systematic literature review, extended this list by reporting 54 practices which were classified into technical practices (37) (e.g. 5Ss, automation, group technology) and social practices (17) (e.g. training, employee involvement and customer involvement)[3].

3.2 Lean technical practices and performance

Lean technical practices help and encourage adopting firms to use less space, capital, and labour to deliver services which better match customers' expectations and demands (Swank, 2003). The technical practices follow a systematic approach in improving performance. The starting point of lean technical practices is the identification of customer value, based on which activities can be classified as value-adding and non-value adding (NVAs) (Hadid and Mansouri,

[3] The full lists and definitions are presented in Hadid and Mansouri (2014).

2014). To improve customer value, lean technical practices seek to eliminate NVAs for example by modifying processes and/or the physical structure of organisations (Yasin et al., 2003). By doing so, some scholars argued that the implementation of lean technical practices can lead to several benefits for both customers and the adopting service firms.

For instance, mapping processes and visualising their constituent activities are essential as they have helped firms identify bottlenecks in the service delivery process which led to customer dissatisfaction (Piercy and Rich, 2009). This is critical information, needed by managers to improve the flow of processes and hence increase customer satisfaction (Swank, 2003). Staats et al. (2011) reported case-based evidence indicating that some of the technical practices (such as visualisation, standardisation and process mapping) were very effective in improving processing time and labour productivity in a software service firm. Piercy and Rich (2009) found that the elimination of NVAs through lean technical practices freed staff time, decreased lead and cycle time, reduced costs, and thus improved customer value. Moreover, by emphasising the need to perform tasks right first time, lean technical practices have helped firms to improve service quality and reduce points of failure and their associated costs (Swank, 2003; Piercy and Rich, 2009). These benefits are expected, in turn, to increase the profitability of the adopting service firms (Hadid and Mansouri, 2014). Accordingly, the following hypotheses are formulated:

H1a: There is a direct positive relationship between lean technical practices (LTPs) and operational performance.

H1b: There is a direct positive relationship between lean technical practices (LTPs) and financial performance.

3.3 Lean social practices and performance

Early work on the lean system and Toyota production system emphasised the importance of the human aspect of the system (Sugimori et al., 1977). Shah and Ward (2003) formally included

HRM practices in the lean system and championed their role in improving firm operational performance. Research on lean in the service context has also noted the vital role of HRM practices and several researchers have explained their performance impact (e.g. Alsmadi et al., 2012; Staats et al., 2011).

Samson and Terziovski's (1999) study of manufacturing firms found a positive relationship between leadership, people management and customer focus, and operational performance. Shah and Ward (2003) proposed and verified the direct and positive association between the HRM bundle and operational performance. While these studies argued for and found a direct relationship between the social practices of lean system and performance, others were not able to, and instead adopted an alternative perspective in which the social practices were expected to relate indirectly to performance. For instance, in Pont et al.'s (2008) study, while the JIT and TQM practices had a direct positive impact on operational performance, the impact of the HRM bundle was found to occur through the other two bundles.

Despite these partly contrasting results, in this study we expect a direct impact of the social practices on firm performance, supported by evidence from the HRM literature on the ability of the social practices to have an independent, direct impact on firm performance (e.g. Delaney and Huselid, 1996). Furthermore, recent service sector evidence provides support for this position. Specifically, Talib et al. (2013), based on data from 172 service firms, demonstrated that practices such as training and education, quality culture and teamwork were critical to increase quality performance. Similarly, Alsmadi et al. (2012) revealed that service firms were likely to pay more attention to the social practices of lean service than to the technical practices, and these were found to directly impact the operational and financial performance of 135 service firms. Accordingly:

H2a: There is a direct positive relationship between lean social practices (LSPs) and operational performance.

H2b: There is a direct positive relationship between lean social practices (LSPs) and financial performance.

3.4 The interaction effect of lean technical and social practices on performance

So far, the potential independent performance effect of each set of practices (technical and social) has been explained. However, Shah and Ward (2003) argue that the impact of lean goes beyond the sum of the impact of its individual bundles, pointing to the possible interaction effect among lean bundles. This argument is supported by the STS theory. From the STS perspective, the technical practices and social practices of lean service are distinct yet interdependent, in that each influences the impact of the other on firm performance (Hadid and Mansouri, 2014).

A number of scholars have attempted to empirically examine the STS interaction premise. Flynn et al. (1995) studied the possible performance effect of the interaction between a set of technical practices (similar to those usually included in the JIT and TQM bundles of the lean system) and a set of social practices (termed common practices). Their findings demonstrated the presence of such interaction, leading to a greater performance improvement in quality and cycle time. Similarly, Das and Jayaram (2007) used the STS perspective to examine the interaction between four lean technical practices (kanban, group technology, JIT supply, TPM) and three HRM practices (cross-trained employees, operator teams, decentralised decision-making). Their findings also substantiated the expected positive interaction effect on operational performance. Nevertheless, these studies adopted a narrow focus by examining the interaction effect at the practice level. It is however commonly accepted that lean practices are interrelated and thus should be studied in the form of bundles (Shah and Ward, 2007; 2003). With this in mind, some scholars have argued for extending the interaction analysis to the bundle level (Dabhilkar and Åhlström, 2013; Furlan et al., 2011).

Specifically, Patterson et al. (2004) reported on the interaction impact of four bundles (AMT, TQM, JIT and HRM) on firm productivity and profits, but could not verify the assumed positive interaction. Similarly, Dabhilkar and Åhlström (2013) demonstrated the presence of a positive interaction between an index of lean technical practices and the HRM bundle on operational performance indicators. Furlan et al. (2011) found evidence for the interaction between the JIT and TQM bundles, albeit only at high levels of HRM. While evidently some disagreement, there is clearly a paucity of empirical examination, most noticeably absent in the service-domain. In line with Shah and Ward's (2003) argument, the STS perspective and Furlan et al. (2011), this study hypothesises a positive interaction between the technical and social bundles to improve firm performance:

H3a: There is a positive interaction between lean technical practices (LTPs) and lean social practices (LSPs) in improving operational performance.

H3b: There is a positive interaction between lean technical practices (LTPs) and lean social practices (LSPs) in improving financial performance.

<<Figure 1>>

4. Research methods

4.1 Measures and survey instrument

The data was gathered via a self-administered questionnaire from UK for-profit service firms. The questionnaire was pre-tested by two academics and 13 professionals from the service sector to ensure face and content validity of the items. Necessary modifications were made to improve the instrument. All measures are presented in Appendix.

4.1.1 Lean service technical practices

To measure the technical practices, the works of Hadid and Mansouri (2014) and Fullerton et al. (2003) were adopted. Based on their systematic review of the lean service literature, Hadid and Mansouri (2014) identified 37 lean technical practices along with the frequency of each practice in the lean service literature. To ensure high relevance, only practices that were mentioned by at least five articles were considered, and hence 23 technical practices were included in our study[4]. Following Fullerton et al. (2003), participants were asked to declare the level of implementation of each practice on a six-point scale as follows: 1-no implementation, 2-considering, 3-beginning, 4-partially, 5-substantially and 6-fully. In addition, the initiation year of lean service was also requested.

4.1.2 Lean service social practices

Similarly, Hadid and Mansouri (2014) reported 17 social practices, of which 10 practices were mentioned by at least five lean service articles. To measure the implementation level of each, the measurement scale developed by Yasin et al. (2003) was used. Respondents were asked to indicate the level of effort spent on each, with anchors 1=no effort, to 6=highest level of effort.

4.1.3 Firm performance

To measure the performance impact of lean service, both subjective and objective data were used, at operational and financial levels. Combining the questionnaire's subjective data with secondary data reduces the bias that can arise when a questionnaire is the only source of information, thereby enhancing validity (Swink and Jacobs, 2012). Hadid and Mansouri (2014)

[4] See Appendix for a list of those practices along with the frequency of each practice taken from the study of Hadid and Mansouri (2014)

identified 19 operational performance indicators, of which 13 indicators were reported by at least five articles. Based on the measurement scale of Yasin et al. (2003), respondents were requested to indicate the level to which lean practices were effective in bringing each of the 13 benefits (anchors: 1=strongly disagree, to 6=strongly agree). Financial performance was measured through objective data collected from the FAME database, using two indicators commonly used in the literature; profit margin (PM) and turnover per employee (TURN/E) (e.g. Agarwal et al., 2013; Patterson et al., 2004). In measuring the financial performance, the year in which lean service was implemented was taken into account. Responses showed that lean service had been implemented, on average, for three years. This is not surprising as lean service is an emerging concept (Malmbrandt and Åhlström, 2013). Based on the implementation year, financial data were collected on all available years since the implementation year[5]. For each firm an industry-adjusted median value was computed and used in the main analysis to control for the effect of industry-specific factors (Swink and Jacobs, 2012).

Furthermore, to enhance the robustness of the findings, the effect of past financial performance was accounted for (Swink and Jacobs, 2012; Patterson et al., 2004). Data on the two performance indicators (PM and TURN/E) from the three preceding years were collected and an industry-adjusted median value was calculated for each firm and used in the main analysis[6].

4.1.4 Control variables

To control for the effect of contextual variables on the implementation and effectiveness of lean service, firm age and firm size (Hadid and Mansouri, 2014) were considered, which were

[5] By using financial data on the three years following the implementation of an innovation system (e.g. lean service), the issue of reverse causality is partially addressed (Guest et al., 2003).
[6] Accounting for the effect of past performance also helps control for the possibility that past performance led to the implementation of lean service (Guest et al., 2003).

measured by objective data obtained from FAME; age by the number of years past inception, and size by the average total number of employees in the last three years.

4.2 Sample selection and description

A sample of 1000 UK for-profit service firms was identified using the FAME database[7]. To be included, a firm should have full unconsolidated information in the last three available years on turnover, and employ more than 50 employees. Limiting the sample frame to medium and large firms stems from the expectation that small firms are less likely to implement lean practices (Shah and Ward, 2003). Each respondent received the questionnaire, a pre-stamped envelope and an introductory letter explaining the aim of the research and instructions. To ensure consistent interpretation of the technical practices, a glossary sheet developed by Hadid and Mansouri (2014) was provided. The questionnaires were addressed personally to operations director/manager, chairman, CEO, or finance director, since these individuals are expected to have the knowledge needed to accurately respond. All non-respondents received a reminder letter after three weeks. Finally, a telephone call was made to all non-respondents to motivate them to participate. 186 questionnaires were returned yielding an initial response rate of 20%, and 70 were returned to the sender due to wrong addresses[8]. The 186 questionnaires were further reduced to 105 as 81 were returned empty for different reasons, as reported in table 1. Six more questionnaires were removed due to missing data, leaving 99 usable questionnaires. Similar response rates are not uncommon in survey studies, for example the 10.6% recently reported by Kim et al. (2012).

[7] Healthcare services are mainly part of the UK public sector and they were excluded from our study (see footnote1).

[8] Returning questionnaires due to wrong address is not uncommon in survey studies. See, for instance, the study of Kroes and Ghosh (2010) (469 questionnaires out of 1973).

Information on the sample is provided in table 2. The mean (median) general experience of respondents are 18 (17) years and 9 (6) years at their current firm. This gives positive assurance in relation to the credibility of the data collected.

<<Table 1 >>

<<Table 2 >>

Non-response bias was tested using two methods. ANOVA analysis was performed on age and turnover, commonly used variables for this purpose (e.g. De Leeuw and van den Berg, 2011). A random sample of 99 non-respondents was drawn from the non-respondents and used in this test (Hair et al., 2010). The findings revealed no significant differences between the two groups (P-value (turnover) = 0.47, P-value (age) = 0.79), implying non-response bias was not a threat. The commonly adopted wave method was also used (e.g. Kim et al., 2012; De Leeuw and van den Berg, 2011), where late respondents and non-respondents are believed to share the same characteristics (Hoque, 2000). Accordingly, data provided by early respondents was compared with that from late respondents. ANOVA analysis checked for differences on all items in the questionnaire and no significant differences were detected, further confirming that non-response bias was not a threat to validity.

Harman’s single-factor test was conducted to test for common method bias (Podsakoff et al., 2003). All items were entered into a factor analysis and the unrotated solution examined. Twelve factors were extracted with an eigenvalue greater than one and the first factor explained only 17% of the total variance. Accordingly, single-source bias is not believed to have any significant effect.

4.3 Data preparation and reduction

To reduce the data and identify lean service bundles, exploratory factor analysis (EFA) using the principal component method with varimax rotation was used[9]. Kaiser-Meyer- Olkin (KMO) test for sampling adequacy was used at a scale and individual item level with a minimum value of 50% being acceptable. A communality value for each item of at least 50% and loading of >= 55% were required given the sample size of approx. 100 observations (Hair et al., 2010). Items that cross-loaded significantly and/or did not satisfy the previous criteria were eliminated. The reliability of each factor was assessed using Cronbach's alpha with a minimum value of 60% (Nunnally, 1978).

Before running the EFA, the data were tested against the assumptions of parametric tests. Six technical lean practices had a significantly skewed distribution (P<.001). Their distributions could not be improved by different transformations and consequently they were deleted.

Table 3 presents the results of the EFA of the 17 lean technical practices. Four factors were extracted, explaining 62% of the variance. One practice (mistake proofing) did not adequately load on any factor and therefore was deleted. The alpha values ranged from 0.68 to 0.83. The four factors were named process factor, physical structure factor, customer value factor and error prevention factor[10].

<<Table 3 >>

The factor solution for the 10 lean social practices indicated that two factors were appropriate and extracted 75% of the total variance (table 4). One practice (multifunctional employees) was

[9] This study includes a larger set of lean practices compared to previous research, some of which (e.g. automation, visualisation and value stream mapping) have not been examined in earlier empirical research. Therefore, the use of exploratory factor analysis is appropriate here in order to establish groups of similar practices.

[10] Kaizen blitz has been included in the customer value factor as shown in table 3. Some may argue (from a content point of view) that it fits in the error prevention factor. However, Kumar and Harms (2004) articulated how a company used Kaizen blitz events to introduce employees to the value stream mapping technique (both practices loaded one the same factor in our study) and the objective was to identify NVA (from the customer perspective) and then suggest ways to eliminate them. This implies that Kaizen events can have a link with other practices that focus directly on customer value. Based on this argument and the statistical evidence, Kaizen blitz was included in the customer value factor.

dropped due to low communality. Alpha values were 0.90 and 0.91. The factors were named motivation factor and human factor.

<<Table 4 >>

The 13 operational benefits loaded on three factors, explaining 68% of the total variance, and alphas ranged from 0.71 to 0.83. ‘Reduction in inventory’ was dropped due to low sampling adequacy (< .5) and ‘improvement in capacity’ was dropped because of low communality (< .5) (table 5). The three factors were labelled internal and external customer satisfaction, waste elimination and process time reduction.

<<Table 5 >>

5. Analysis

Partial least squares structural equation modelling (PLS-SEM) was used to test the research model. Like covariance-based SEM (CB-SEM), PLS-SEM has two components: measurement (outer) model and structural (inner) model (Hair et al., 2011). However, PLS-SEM has some advantages which make it superior to CB-SEM under specific conditions (Hair et al., 2011). First, while modelling formative latent constructs is limited in CB-SEM, PLS-SEM can unrestrictedly handle both reflective and formative latent constructs (Hair et al., 2012). Second, PLS-SEM relaxes the multivariate normality assumption which is essential for CB-SEM (Hair et al., 2011). Third, whilst obtaining a sufficient sample size required for CB-SEM is troublesome in empirical research, PLS-SEM is capable of estimating models with small sample sizes (Hair et al., 2012).

Given these advantages, PLS-SEM is receiving increasing attention in many fields including operations management (e.g. Blomea et al., 2014; Calvo-Mora et al., 2014). PLS-SEM was selected in the current study for the following reasons: (1) its capability to handle non-normally distributed data such as financial data, (2) the complexity of the model, and (3) its superiority in producing accurate estimates with relatively small sample size.

5.1 Validity and reliability

To evaluate the validity and reliability of each construct, the recommendations of Hair et al. (2011) were followed by examining the factor loadings, composite reliability, and average variance extracted (AVE) (table 6). Two operational performance indicators (i.e. customer perception of product/service quality and operational efficiency) loaded significantly on other constructs and thus were deleted. A construct is reliable if its composite reliability value is greater than 0.70 for advanced research (Hair et al., 2011). Table 6 shows that the composite reliability value for all constructs exceeded considerably 0.70, and the majority of items loaded on their respective factor at higher than 0.70.

To ensure convergent validity, the value of the AVE of that construct should be 0.5 or higher (Hair et al., 2011). Discriminant validity is evident if the square root of AVE of a construct is greater than its correlations with other constructs in the model (Hair et al., 2012). From table 6 it can be seen that the AVE for all constructs is greater than 0.5 demonstrating their convergent validity, and the results presented in table 7 support discriminant validity.

<<Table 6 >>

<<Table 7 >>

5.2 Hypotheses testing

The second stage of PLS-SEM is to examine whether the structural model supports the research hypotheses. PLS-SEM seeks to estimate model parameters that maximise the variance of the dependent latent constructs explained by the latent independent constructs. Therefore, R^2 and path coefficients (β) along with their significance should be the primary assessment criteria (Hair et al., 2012). The significance of path coefficients is evaluated using resampling techniques such as bootstrapping which produces t-statistics (Lee et al., 2011). Hair et al. (2011) point out that the larger the number of samples used during the bootstrapping process, the more robust the findings will be. Instead of relying on the default number of 200 for bootstrapping in Smartpls 2.0, the bootstrapping process was applied on 1000 samples (Hair et al., 2011). The predictive capability of the model was evaluated by the Stone-Geisser Q^2 value (Geisser, 1974; Stone, 1974). The Q^2 value is calculated using the blindfolding technique (Hair et al., 2011). A Q^2 value of larger than zero implies that the exogenous constructs have predictive relevance for the endogenous constructs included in the model.

The research hypotheses were tested in two steps. The first examined the independent effect of the technical bundles and social bundles of lean service on operational and financial performance (H1a,b and H2a,b). Therefore, the structural model included the four technical bundles, the two social bundles and the two control variables as the independent variables, and the three operational performance components and the two financial indicators as the dependent variables. In the second step, the expected interaction effect proposed in H3a,b was tested by adding eight interaction terms using the feature available in SmartPLS.

Table 8 presents the outcome of the hypotheses testing. All R^2 values are above the minimum recommended value of 0.10 necessary to ensure practical and statistical significance (Lee et al., 2011). Further, the cross-validated redundancy value for all dependent constructs is larger than zero which verifies the predictive capability of the model (Hair et al., 2012). In relation to the research hypotheses, panel A in table 8 provides some support to H1a, H2a and H2b. The evidence suggests that the technical side of lean service has an independent positive association with operational performance but not with financial performance. This supports H1a but not H1b (all standardised βs in panel A which relate the process factor, the physical structure factor, the customer value factor and the error prevention factor to both profit margin and turnover per employee are not significant at $p > 0.1$). In addition, there is an indication that the social side of lean service also has an independent positive relationship with operational performance and financial performance. Consequently, H2a and H2b are supported. As proposed by the STS, panel B in table 8 reveals that the technical and social sides of lean service positively interact to improve firm operational and financial performance. Accordingly, H3a and H3b are both supported.

<<Table 8 >>

6. Discussion and implications

Viewing lean service as a socio-technical system, it was proposed in this research that each of the two sides of lean service would have a positive association with operational and financial performance. In addition, it was expected that the two sides would support each other and interact to further improve firm performance.

The results indicated that three of the four lean technical factors were associated with better operational performance. Specifically, lean service technical practices included in the process factor, the customer value factor and the error prevention factor were positively related to internal and external customer satisfaction and processing time. However, the technical side of the lean service did not significantly relate to financial performance. In contrast, the social side of the system was found to improve both operational and financial performance. These findings are important as they empirically validate the proposition in the lean service literature that lean service practices improve firm performance despite the challenging characteristics of service operations (Hadid and Mansouri, 2014). In relation to the human factor and physical structure factor, no significant relationship was detected with operational and financial performance although all respective coefficients were positive. This, however, does not imply that they are not important components of lean service. Lean service is considered a long-term improvement system, and therefore its practices are not likely all to be implemented simultaneously. Furthermore, there will be a period of time after implementation of a specific practice before its benefits materialise. The lack of association may be due to recent implementation of practices within these factors by the respondent firms, in which case insufficient time will have elapsed for their benefits to be realised or reflected financially. Examining the data on the implementation level of the different lean service practices, we found an indication supporting this notion. The sample firms implemented lean practices on average in 2009 with more focus on the practices included in the motivation factor, the process factor and the customer value factor, all of which did prove effective in improving performance.

Furthermore, the findings of this study revealed that different performance dimensions were improved by different sets or 'bundles' of lean service practices. This implies that service firms should not focus on a limited number of lean service practices as that is likely to hinder the achievement of better performance (Cua et al., 2001). This is emphasised by the results reported in panel B (table 8) on the possible interaction between lean service factors to improve firm performance. The performance impact of lean bundles was not limited to their independent effect. Rather, these bundles complement each other so that the presence of one bundle enhances the performance impact of the others. The findings in panel B provide empirical verification of the positive interaction between lean technical and social bundles to improve the performance of adopting firms. Interestingly, while the independent effect of the lean technical bundles on financial performance was not evident as shown in panel A, panel B indicated that these bundles (especially the process factor and the physical structure factor) had a positive impact on profit margin through their interaction with the two social bundles. Based on this empirical evidence, service firms are strongly encouraged to adopt a systematic approach when implementing lean service practices. While focusing merely on either the technical bundles or the social bundles of lean service is likely to improve firm performance, the optimal improvement should be achieved through the simultaneous implementation of bundles from the two sides. These findings extend previous work which suggested and found positive interactions at the practice level (e.g. Das and Jayaram, 2007). This knowledge can be very critical for helping service managers to make informed decisions about how to best utilise their scarce resources among lean service bundles in order to maximise performance outcomes (Dabhilkar and Åhlström, 2013).

7. Conclusions

The current study set out to understand the mechanism through which lean service impacts firm performance. To do so, lean service was viewed as a socio-technical system. Using EFA, the technical side was found to be represented by four bundles and the social side by two bundles, and these bundles were expected to have an independent positive effect on firm performance as well as a combined effect through their interaction. Using data from 99 UK service firms, it was found that three out of the four lean technical bundles (i.e. process, customer value, and error prevention) had an independent positive association with operational performance, but not financial. In contrast, while one of the social bundles (i.e. the human bundle) did not have a significant relationship with either facet of performance, the motivation bundle had a significant positive association with operational and financial performance. More importantly, the results suggested that these bundles interacted positively to further enhance firm operational and financial performance, over and above their independent effect. These findings contribute to the current lean literature by improving our knowledge on how lean bundles (rather than individual practices) can improve firm performance, and moreover in the service context where relatively little research on the effectiveness of the lean system has been carried out.

Like most studies, this study has some limitations. Its cross-sectional nature prevents definitive statements about causality between the dependent variables (DVs) and the independent variables (IVs). Incorporating the time factor through longitudinal studies can address the causality issue, and moreover would help to understand the time needed for the benefits of lean service to materialise. Another limitation arises from using subjective single-item measures and single informants. Despite that, subjective measures whether single-item or multiple-item have and continue to be widely used in operations management literature (e.g. Shah and Ward, 2007; 2003), and we included objective measures of financial performance to avoid sole reliance on subjective measures. In addition, the data in this study was collected from senior level managers who were believed to be able to acquire information on all variables included in this study. While this is the most common method in the literature and widely adopted by similar studies (e.g. Gligor et al., 2015; Chavez et al., 2013), there is some emerging evidence suggesting that senior managers may not always have detailed information on the practices used on a daily basis in their organisations (Leyer and Moormann, 2013). Furthermore, the sample size in this research is relatively small and the effect of its size on generalisation of findings should be noted. Our sample includes only medium and large service firms and therefore the results may not be applicable to small service firms.

Future researchers are encouraged to employ larger samples and rely on multiple-item measures from more than one participant per firm. In addition, our results revealed that a relatively large number of service firms (22% of non-respondents) indicated irrelevancy of the questionnaire to their firms. This points to the high reluctance of service managers to experiment with lean service practices despite the increasing literature encouraging them to do so. Future work is recommended to improve our knowledge of the reasons for such reluctance. In addition, it was beyond the scope of our study to examine whether there was a specific sequence in the implementation of lean technical and social practices that led to the improved performance. More work needs to be done to establish better planning or sequencing of lean system implementation. Finally, this study focused mainly on the direct impact of lean service practices on firm operational and financial performance. More insights, for instance, can be obtained by adopting appropriate methodologies to understand the possible indirect effect of those practices on financial performance acting through other variables including the different dimensions of operational performance. Such research will contribute to our understanding of the mechanism through which lean service influences the performance of adopting firms.

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Tables

Table 1: Reasons for declining to participate

Reason	Total
No time	21
The intended person is no longer available	20
The questionnaire does not apply to their industry	18
Company policy	9
Small company	8
Confidential information	3
High demand for participation in research studies	2
Total	**81**

Table 2: Sample distribution

Industry	Number of respondents
Banks	13
Education	9
Hotels & restaurants	16
Insurance companies	7
Other services	24
Post & Telecommunications	8
Transport	6
Wholesale & retail trade	16
Total	**99**

Table 3: Lean technical factors

Practices	Factor loadings				Communality
	1	2	3	4	
Automation	**0.702**	0.170	0.003	-0.178	0.554
Just in Time	**0.620**	0.441	0.006	-0.118	0.593
Pull system	**0.760**	0.024	0.175	0.306	0.703
Work load balancing	**0.731**	0.066	0.231	0.179	0.624
Quick set up time	**0.708**	0.067	0.256	0.296	0.659
Small lots	**0.643**	0.352	0.158	-0.209	0.606
5Ss	0.063	**0.706**	0.146	0.189	0.560
Group technology	0.231	**0.768**	0.211	0.090	0.696
Improving facility layout	0.177	**0.820**	0.080	0.217	0.757
Visualisation	0.166	**0.607**	0.354	0.052	0.524
Kaizen blitz	0.402	0.135	**0.607**	0.096	0.557
Policy deployment/Hoshin Kanri	0.155	0.098	**0.799**	0.109	0.684
Quality function deployment	0.167	0.201	**0.697**	0.200	0.594
Value stream mapping	-0.025	0.308	**0.598**	-0.272	0.527
Root cause analysis	-0.026	0.202	0.167	**0.736**	0.612
Total preventive maintenance	0.127	0.177	-0.020	**0.831**	0.738
Measure of sampling adequacy (Whole model)	0.777				
Variance extracted by the model	62.417				
Cronbach's alpha	0.832	0.81	0.711	0.677	

Table 4: Lean social factors

Practices	Factor loadings		Communality
	1	2	
Reward system	**0.837**	0.064	0.705
Communication system	**0.845**	0.121	0.729
Management support	**0.867**	-0.046	0.753
Performance measurement system	**0.875**	0.111	0.779
Training	**0.822**	0.167	0.704
Employee empowerment	0.034	**0.873**	0.763
Employee commitment	0.066	**0.886**	0.789
Employee involvement	0.120	**0.887**	0.801
Leadership	0.117	**0.853**	0.742
Measure of sampling adequacy (Whole model)	0.848		
Variance extracted by the model	75.156		
Cronbach's alpha	0.907	0.902	

Table 5: Operational performance factors

Indicators	Factor loadings			Communality
	1	**2**	**3**	
Customer perception of product/service quality	**0.789**	0.290	0.193	0.745
Customer satisfaction	**0.848**	0.232	0.051	0.776
Employees satisfaction and their performance	**0.834**	0.132	0.229	0.765
Employees understanding of the process	**0.709**	0.248	0.274	0.639
Identification and elimination of waste	0.108	**0.668**	0.323	0.562
Operational efficiency	0.394	**0.703**	0.095	0.658
Productivity	0.250	**0.712**	0.276	0.645
Reduction in costs	0.182	**0.812**	-0.071	0.697
Freeing staff time	0.309	0.225	**0.742**	0.696
Lead time and cycle time	0.077	-0.002	**0.814**	0.668
Human errors	0.211	0.228	**0.781**	0.707
Measure of sampling adequacy (Whole model)	0.823			
Variance extracted by the model	68.712			
Cronbach's alpha	0.828	0.708	0.768	

Table 6: Validity and reliability analysis of the measurement model

Construct	Loading	Composite reliability	AVE
Process Factor		0.87	0.52
Automation	0.70		
Just in Time	0.69		
Pull system	0.79		
Quick set up time	0.73		
Small lots	0.71		
Work load balancing	0.78		
Physical Structure Factor		0.88	0.64
5Ss	0.77		
Group technology	0.86		
Improving facility layout	0.86		
Visualisation	0.69		
Customer Value Factor		0.82	0.54
Kaizen blitz	0.77		
Policy deployment/Hoshin Kanri	0.78		
Quality function deployment	0.73		
Value stream mapping	0.64		
Error prevention factor		0.86	0.76
Root cause analysis	0.88		
Total preventive maintenance	0.86		
Motivation Factor		0.93	0.73
Reward system	0.84		
Communication system	0.85		
Management support	0.89		
Performance measurement system	0.82		
Training	0.86		
Human Factor		0.93	0.77
Employee empowerment	0.84		
Employee commitment	0.88		
Employee involvement	0.89		
Leadership	0.90		
Internal and external customer satisfaction		0.90	0.74
Customer satisfaction	0.76		
Employees satisfaction and their performance	0.92		
Employees understanding of the process	0.89		
Waste elimination		0.83	0.63
Productivity	0.88		
Reduction in costs	0.79		
Identification and elimination of waste	0.69		
Process time reduction		0.87	0.68
Freeing staff time	0.83		
Lead time and cycle time	0.78		
Human errors	0.88		

*Deleted practices due to high skewness measures were: Continuous improvement, Kanban, Process redesign, Single piece flow, Standardization, and Takt time

Table 7: Correlations matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Firm age	**1***												
2 Motivation factor	-0.14	**0.85**											
3 Human factor	-0.11	0.19	**0.88**										
4 Process factor	-0.04	0.13	0.26	**0.72**									
5 Physical structure factor	-0.17	0.21	0.18	0.46	**0.80**								
6 Customer value factor	-0.04	0.20	0.24	0.44	0.49	**0.74**							
7 Error prevention factor	-0.14	0.13	0.16	0.15	0.33	0.22	**0.87**						
8 Internal and external customer satisfaction	-0.06	0.20	0.07	0.30	0.30	0.37	0.08	**0.86**					
9 Waste elimination	0.10	0.20	0.10	0.15	0.14	0.08	0.10	0.48	**0.79**				
10 Processing time reduction	0.03	0.28	0.02	0.30	0.32	0.35	0.25	0.46	0.39	**0.83**			
11 Profit margin	-0.03	0.33	0.16	0.18	0.24	0.15	0.04	0.01	0.03	0.14	**1.00**		
12 Firm size	0.31	-0.14	-0.04	-0.08	0.12	0.07	0.01	-0.03	-0.03	0.03	-0.07	**1.00**	
13 Turnover/employee	-0.08	0.14	0.07	0.06	0.06	0.10	0.00	0.03	0.03	0.03	-0.08	-0.31	**1.00**

* Values in the diagonal represent the square root of AVE for each construct.

Table 8: The results of the structural analysis

	Operational performance			Financial performance	
	Internal and external customer satisfaction	Waste elimination	Processing time reduction	Profit margin	Turnover/ employee
	Standardised coefficient (β)				
Panel A					
Firm age	0.03	0.21**	0.11	-0.06	0.08
Firm size	-0.01	-0.19**	0.01	-0.07	-
Past performance-PM				0.43***	
Past performance-TURN/E					0.84***
Motivation factor (S)	0.14	0.22**	0.25**	0.23**	0.003
Human factor (S)	0.03	0.02	0.15	0.13	0.01
Process factor (T)	0.13	0.11	0.18*	0.002	0.01
Physical structure factor (T)	0.15	0.11	0.13	0.07	-0.05
Customer value factor (T)	0.28**	0.06	0.21**	0.08	0.04
Error prevention factor (T)	0.07	0.13	0.19*	-0.01	0.03
Panel B					
Process factor *Motivation factor	0.21**	0.19*	0.17	0.17*	-0.07
Process factor *Human factor	0.06	0.22*	0.17	0.19*	-0.03
Physical structure factor *Motivation factor	0.05	0.35***	0.16	0.15	0.01
Physical structure factor *Human factor	0.01	0.07	0.08	0.25**	0.09
Customer value factor *Motivation factor	0.24**	0.22**	0.02	0.12	0.08
Customer value factor *Human factor	0.18	0.06	0.1	0.07	-0.05
Error prevention factor *Motivation factor	0.26**	0.33***	0.22*	0.04	0.11
Error prevention factor *Human factor	0.04	0.12	0.01	0.13	-0.04
R^2	0.41	0.38	0.44	0.58	0.79
Cross-validated redundancy	0.27	0.22	0.30	0.58	0.77

* $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$; (T) = a lean technical factor; (S) = a lean social factor

Figures

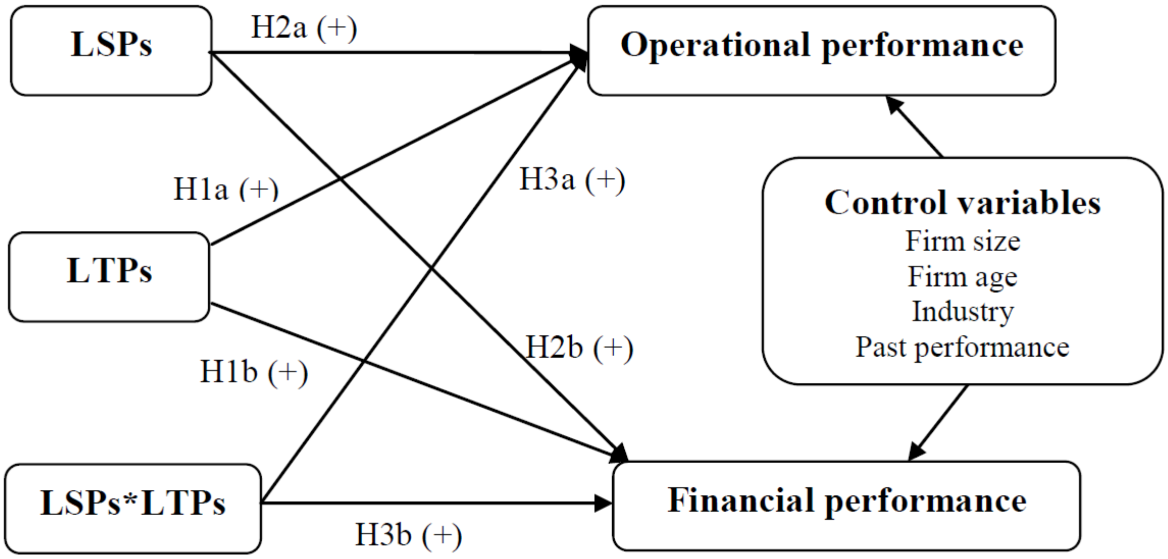

Figure 1: Conceptual framework of lean service

Appendix

1. Indicate the extent to which your firm has implemented the following practices: (**tick one option**) (**Check the glossary sheet for a definition of each expression if needed**)

Scale: (1) No implementation (2) Considering (3) Beginning (4) Partially (5) Substantially (6) Fully

Frequency of each practice*	Practices
26	5Ss
12	Automation
15	Group technology
8	Improving facility layout
11	Just in Time
13	Kaizen blitz
8	Policy deployment/Hoshin Kanri
15	Pull system
5	Quality function deployment
12	Root cause analysis
8	Total preventive maintenance
46	Value stream mapping
18	Visualisation
7	Work load balancing
12	Mistakes proofing/Poka-Yoke
5	Quick set up time
9	Small lots
12	Continuous improvement
8	Process redesign
29	Standardisation
8	Kanban
10	Single piece flow
12	Takt time

*The number of articles in which each practice was mentioned in the lean service literature. This information was taken from table 1 in the study of Hadid and Mansouri (2014).

2. Indicate your level of agreement with achieving each of the listed benefits by your firm as a direct consequence of the implementation of the practices reported in **question (1)**: (**tick one option**)

Scale: (1) Strongly disagree (6) Strongly agree

Frequency of each benefits*	Benefits
8	Freeing staff time
13	Identification and elimination of waste
9	Improvement in capacity
7	Improvement in customer perception of product/service quality
16	Improvement in customer satisfaction
13	Improvement in employees satisfaction and their performance
6	Improvement in employees understanding of the process
7	Improvement in operational efficiency
9	Improvement in productivity
21	Reduction in costs
5	Reduction in inventory
29	Reduction in lead time and cycle time
6	Reduction in the number of human errors

*The number of articles in which each benefit was mentioned in the lean service literature. This information was taken from table 3 in the study of Hadid and Mansouri (2014).

3. How much effort, in terms of monetary, human and other resources, did your firm extend on each of the activities listed below as a direct consequence of implementing the practices reported in **question (1)**? (**tick one option**)

Scale: (1) No effort (6) Highest level of effort

Frequency of each practice*	Practices
5	An appropriate rewarding system
10	Effective Communication System
7	Employee empowerment
5	Employee commitment
17	Employee involvement
8	Having multifunctional employees
8	Leadership
18	Obtaining management support
11	Performance measurement system
28	Training

*The number of articles in which each practice was mentioned in the lean service literature. This information was taken from table 2 in the study of Hadid and Mansouri (2014).