Exploration and prioritization of lean techniques in a hotel supply chain

Article *in* International Journal of Lean Six Sigma · July 2018

DOI: 10.1108/IJLSS-10-2017-0119

2 authors:

Raid Al-Aomar
Abu Dhabi University
97 PUBLICATIONS **1,266** CITATIONS
SEE PROFILE

Matloub Hussain
Abu Dhabi University
93 PUBLICATIONS **2,715** CITATIONS
SEE PROFILE

Exploration and prioritization of lean techniques in a hotel supply chain

Raid Al-Aomar
College of Engineering, Abu Dhabi University, Abu Dhabi, United Arab Emirates, and
Matloub Hussain
Abu Dhabi University, Abu Dhabi, United Arab Emirates

Received 21 October 2017
Revised 30 December 2017
Accepted 14 January 2018

Abstract

Purpose – The purpose of this paper is to develop a framework for identification, categorization and prioritization of lean techniques adopted in a hotel supply chain.

Design/methodology/approach – A survey tool is used for the identification of lean techniques that are relevant to a hotel supply chain. The targeted sample includes experts from 50 four- and five-star hotels in the United Arab Emirates (UAE) that confirmed experience in implementing lean practices across hotels supply chain. A Supplier-Inputs-Process-Outputs-Customers (SIPOC) chart and experts' opinion are used to allocate and categorize the identified lean techniques across the construct of the hotel supply chain. Finally, analytical hierarchy process (AHP) is used to prioritize the criteria and sub-criteria of adopted lean techniques.

Findings – Study results have identified six main categories of lean practices and 19 specific lean techniques as relevant to a hotel supply chain. The identified categories include JIT, Kaizen, Quality, Inventory, Maintenance and Standardization. The study found that JIT and Kaizen take the top priority among the identified categories of lean practices. In line with that, on-time service to customers, effective improvement system and on-time delivery from suppliers were found to be the three most relevant lean techniques to a hotel supply chain.

Research limitations/implications – The study has targeted a representative sample of hotels with experience in implementing lean practices. Study findings have several implications to researchers and practitioners for effective adoption of lean techniques within a hotel supply chain. However, the accuracy and credibility of results obtained from this research including SIPOC allocation and lean categorization are highly dependent on the accuracy and credibility of collected empirical data from surveyed hotels within the study context. Results of AHP prioritization also depend on the credibility of judgements made by the hotels' supply chain experts.

Practical implications – The study provides the hospitality industry with a structured approach that can help in a prioritized adoption of most relevant lean techniques across the hotel supply chain to reduce wastes, create value, increase efficiency and improve the service level. Study findings can be used by hotel management to direct and focus the effort of lean capacity building, resources allocation and implementation plans.

Originality/value – Limited research is available on lean management in the context of a hotel supply chain. Also, most of the previous research is focused on lean impacts, while academics and practitioners agree that the identification and prioritization of most relevant lean techniques is crucial to the successful implementation of lean management for waste reduction and value creation. This research addresses this important issue in hotel supply chains and proposes a structured approach for effective lean adoption.

Keywords Analytical hierarchy process, Lean management, Waste reduction, Hotel supply chain, SIPOC analysis

Paper type Research paper

1. Introduction

The rapid pace of change in the hospitality management especially those related to sustainability, technology, service costs, regulations and guest behavior present tremendous

International Journal of Lean Six Sigma

2040-4166
DOI 10.1108/IJLSS-10-2017-0119

challenges to this growing service industry. The impact of these changes is not limited to hotel services, but it also extends to the overall industry supply chain (Xu and Gursoy, 2015; Zhang *et al.*, 2009). Over the past few years, therefore, hotel supply chains have undergone fundamental changes and adopted variety of process improvement strategies to face the challenges, address reported wastes and inefficiencies, and increase operational effectiveness (Huang *et al.*, 2012). Among the reported process improvement strategies, "lean thinking" and "lean management" are increasingly adopted by the operations and supply chain managers of hotels to reduce wastes and create value so that "more could be achieved with less" (Poksinska, 2010).

The philosophy and tools of lean management have initially come from manufacturing and were pioneered by Toyota. In the past two decades, lean has already enjoyed tremendous success in improving quality and efficiency in various applications and its scope has extended to cover the industry supply chains (United States EPA, 2000; Baudin, 2004). Lean has also migrated to service industry and the supply chains of services such as health care, food, retail industry and public sector (de Vries and Huijsman, 2011; Hussain and Malik, 2016; Manzouri *et al.*, 2013; Arlbjørn *et al.*, 2011), and the lean concept of "waste minimization" for process improvement is no longer limited to manufacturing companies (Friedman, 2008; Mollenkoph *et al.*, 2010).

In case of hotel supply chains, there is little doubt that lean thinking can better eliminate or reduce the wastes (Vlachos and Bogdanovic, 2013). This includes tangible wastes (water, energy, solid wastes, defectives, materials, etc.) as well as intangible wastes (errors, delays, low efficiency, underutilization of resources, etc.). Such wastes are applicable to hotels, and their elimination requires a systematic way such as "lean management". However, related literature indicated that lean concepts and techniques are still emerging in hotel industry (Rauch *et al.*, 2016; Bonaccorsi *et al.*, 2011; Sua¨rez, 2013), and a limited research has been carried out to explore and investigate their adoption (Shah and Gnagi, 2017; Thomas *et al.*, 2017).

Hussain and Malik (2016) also argued that the identification and prioritization of lean improvement opportunities that can deliver rapid and observable gains are crucial to the successful implementation of lean. Vlachos and Bogdanovic (2013) also pointed out that this important aspect has not received enough attention in the context of hotel supply chains, despite its strong links to a better lean deployment and improved productivity. As outlined by Rauch *et al.* (2016), the key questions to answer in this regard are "what lean techniques are more relevant to a hotel supply chain?" and "which techniques have more priority when implementing lean practices?" Providing answers to such key questions is expected to contribute to the outlined research gap related to lean hotel supply chains and will encourage and guide hotel management in adopting lean techniques to reduce various wastes and inefficiencies across the supply chain of hotels and, consequently, face the increasing challenges of the industry. Thus, the main objectives of this research are:

- to identify lean techniques that are most relevant to the supply chain of hotels;
- to categorize the identified lean techniques into the standard groups of lean practices; and
- to prioritize the identified lean practices and their sub-categories for effective lean implementation across the supply chain of hotels.

To achieve the above objectives, this paper provides a structured approach of a mixed research method. A survey tool is first used to collect empirical data from hotels and identify relevant lean techniques. A Supplier-Input-Process-Output-Customer (SIPOC) chart is then

used to allocate lean techniques across the hotel supply chain. Lean theory and experts' opinions are used to categorize lean techniques into their standard lean practices. Finally, analytical hierarchy process (AHP) is used to prioritize lean categories and techniques based on their weights of relative importance. The combined SIPOC-AHP approach is set to provide a framework for identification, categorization and prioritization of lean techniques in hotels supply chain. The framework is developed based on a pilot study conducted in selected hotels in the United Arab Emirates (UAE). In addition to the highlighted research contribution, the results of this study have implications for the UAE hotel industry which is estimated to be worth at US$14.6bn and growing at 16 per cent annually (Gulf News, 2015). As the targeted hotels are branches of global chains, the developed framework and study findings can be also used by hotel industry in other countries.

The remainder of this paper is organized as follows: Section 2 provides a survey of relevant literature, Section 3 presents the research methodology and Section 4 outlines the details the proposed framework. The analyses of study results are carried out in Section 5 followed by a discussion of study implications.

2. Literature review

A supply chain is often viewed as a network of critical links that connects organizations (stakeholders and partners) together and links each organization's inputs to its outputs. Managing such network often involves the set of activities and relationships that contribute to customer value and achieve a sustainable competitive advantage. For a service supply chain, as defined by Ellram *et al.* (2004), this includes the management of information, processes, capacity, service performance and funds from the earliest supplier to the ultimate customer. Conversely, services supply chains are often characterized with high customer involvements, less structured processing and intangible products that may not be standardized or stored (Hussain *et al.*, 2016). The hotel supply chain is a typical example of service supply chain. It is a network of organizations engaged in delivering different hotel services to customers. Such network functions through the flow of information (e.g. reservations), monetary transactions (e.g. payments and charges) and physical items (e.g. food and drinks) (Al-Amor and Hussain, 2017). Figure 1 depicts the main components of a hotel supply chain.

The literature on the wastes across the supply chain of hotels and the need of this service industry to adopt lean practices is explored in this section. This section also reviews the literature on methods used for categorizing and prioritizing lean techniques with a focus on AHP.

2.1 Wastes across hotel supply chain

Different types of waste, anything which is not adding value, are growing across hotel supply chains similar to other services and hospitality sectors. The hotel industry, because of the nature of its functions, characteristics and services, consumes substantial quantities of energy, water and non-durable products, and generates harmful emissions into the air, water and soil (Mensah, 2005; Trung and Kumar, 2005). Thus, Vlachos and Bogdanovic (2013)

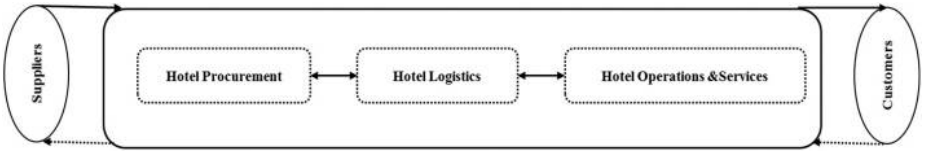


Figure 1.
An outline of a hotel supply chain

pointed out that waste is not new in hotels, but its elimination requires a systematic way of thinking. Edorgan and Baris (2007) explored waste management in hotels through a survey of Ankara hotels. They grouped the different types of hotel wastes into five categories. They found that the greatest amount of waste produced by hotels is in the category of paper and food waste. Gray and Bebbington (2001) also pointed out that hot water, grey water, food packaging, food and other waste are the most common observed wastes in hotel industry. Finally, Chung and Parker (2010) mentioned that hotels also impact local communities through their occupation of space, use of infrastructure and relationships with local business and government.

The list of hotel wastes becomes overwhelming when considering intangible wastes such as delays, cancellations, complains, errors and over capacity. Such wastes can be also related to the seven standard types of wastes in production and service systems (Womack *et al.*, 2007). These wastes affect the direct and indirect operational cost as well as the effectiveness of the overall hotel supply chain. The hotel industry has, therefore, faced increasing pressure to pay more attention to waste minimization and environmental issues. Consequently, the adoption of lean techniques in hotels has been aimed at the reduction or even the elimination of different types of wastes (Edorgan and Baris, 2007; Psychogios *et al.*, 2012).

2.2 Lean in hotel supply chains

Lean methodology has its origin in Toyota in Japan where the success of Toyota Production System was hailed as "the machine that changed the world" (Womack *et al.*, 2007). At the core of lean production is the concept of systematic elimination of "waste" or non-value adding activities that are not desired or are not necessary to fulfill a customer request across the supply chains of both manufacturing and service systems (Cudney and Elrod, 2011; Shah and Ganji, 2017). Lean optimizes value and non-value adding activities which can have a dramatic effect on productivity, cost and effectiveness. Lean has also gained further popularity when combined with Six Sigma quality standard. Further details on implementing lean and Six Sigma across the supply chain can be found in Cudney and Kestle (2010).

Though the service sector differs on various counts, lean methods for optimizing value-adding and non-value adding activities, ensuring built in quality, standardizing and simplifying processes are equally valid for services process improvement (Tortorella *et al.*, 2017; Psychogios *et al.*, 2012; Cudney and Elrod, 2011). This is mainly driven by the fact that lean methodology is focused on the process itself and not on the process's output (Damrath, 2012). Abdi *et al.* (2006) examined five lean principles of identification of customer value, the value stream mapping, smoothing the process flow, pull demand and the perfection pursuit for potential applications in services and concluded that lean is applicable to service operations. Similarly, Ahlstrom (2004) opined that lean would be applicable to services if the contingencies stemming from the characteristics of services were taken into consideration. Bonaccorsi *et al.* (2011) highlighted the tailoring of lean tools/concepts of value stream mapping, takt time and pitch to the specific requirements of services as one of the challenges to the successful implementation of lean resulting in significant operational improvements. Wang and Chen (2010) found that the adoption of lean tools in the US banking sector led to the reduction of waiting times and costs while improving the process capacity. Lean tools have also been applied to other services such as the airline industry (Psychogios and Tsironis, 2012) and public services (Leseure *et al.*, 2010).

Lean application has also extended for improving the efficiency of the supply chain for both service and production firms. Singh and Pandey (2015) presented a state-of-the-art

review of lean supply chain literature. Martínez-Jurado and Moyano-Fuentes (2014) also presented a summary of the research on the links between lean management, supply chain management and sustainability. Examples of specific lean supply chain applications include logistics and distribution (Baudin, 2004; Reichhart and Holweg, 2007) and warehousing (Dharmapriya and Kulatunga, 2011).

Lean in hotel supply chain management has also generated a great deal of interest given the improvement potential. The industry leaders agree that the sustainable prosperity of hotel businesses calls for the inclusion of efficient use of resources in every phase of their business venture, from the preparation and application of site plans and business programs and policies to daily routine practices (Thomas *et al.*, 2017). This has led to an increase in the utilization of lean practices across hotels supply chains as several managers started to believe that long-term economic sustainability and growth depend upon the effective adoption of lean practices. However, as explained earlier, there is scarce evidence of lean application to hotels and lack of studies that outline the most relevant lean techniques (Rauch *et al.*, 2016; Vlachos and Bogdanovic, 2013). The key challenge in this regard is how to identify and prioritize the deployment of these emerging techniques within the supply chains of hotels.

2.3 Analytical hierarchy process

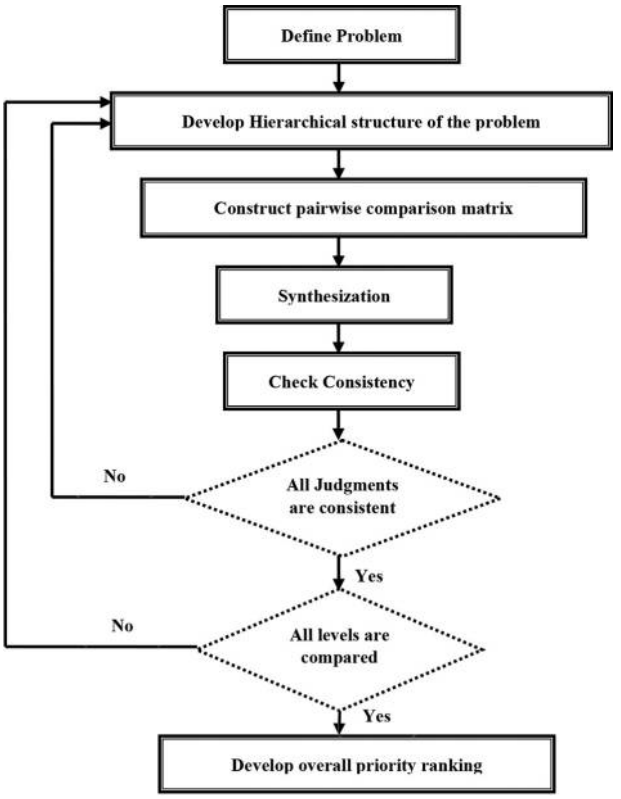
AHP was proposed by Saaty (1980) as a multi-criteria decision-making method that provides a means of ranking and prioritizing the various elements in a constructed decision hierarchy, thereby helping governments and industry practitioners to focus on the most important matters (Cheng and Li, 2001). AHP aids managerial decision-making in a structured way to generate priorities as shown in Figure 2.

Through a set of pairwise comparisons at each level of the hierarchy, a matrix can be developed, where the entities indicate the strength with which one element dominates another with respect to a given criterion. AHP is a principle of measurement through pair-wise comparisons and relies on the judgment of experts to derive the priority scales. These scales measure the intangibles in relative terms. The comparisons are made using a scale of absolute judgment that represents how much more one element dominates another with respect to a given attribute. The main concern of AHP is dealing with inconsistencies arising with the judgment and improving this judgment (Saaty, 2008). AHP judges and selects the elements/concepts which have a greater influence on predetermined objective. AHP has been used to accurately evaluate the influence of the criteria in terms of goals.

Recently, there has been renewed interest in the AHP as an emerging solution to the complex real world and multi-criteria decision-making problems (Yang and Shi, 2003; Ishizaka *et al.*, 2012; Drake *et al.*, 2013). The AHP has been successfully implemented in various fields, and it is widely used in various industry settings (Korpela *et al.*, 2001; Çebi and Bayraktar, 2003; Hussain *et al.*, 2016; Malik *et al.*, 2015; Ngai and Chan, 2005). AHP is also applied to support studies on lean implementation in services and manufacturing [e.g. assessing an overall lean index quantitatively and qualitatively (Oleghe and Salonitis, 2015) and measuring the leanness and agility of an enterprise (Soltan and Mostafa, 2015)].

3. Research methodology

The surveyed literature has emphasized the need for developing an effective framework for adopting lean techniques to integrate sustainability into the supply chains of different industries. As indicated in the literature review, a key requirement for an applicable lean adoption framework is to set priorities for the lean techniques that are most relevant to the particular industry (Al-Aomar and Weriakat, 2012; Jasti and Kurra, 2017; Hussain and Malik, 2016). In the context of a hotel supply chain, such requirement is of a higher value



Source: Hussain *et al.* (2016)

Figure 2.
An outline of AHP method

given the limited research on lean adoption. This paper, therefore, focuses on identifying, categorizing and prioritizing lean techniques across a hotel supply chain. The objective is to facilitate lean adoption in this growing service industry.

A mixed research method is used to fulfil the defined research objectives, and the empirical data were collected in two phases. First, in the exploratory phase, a survey tool is designed and used to collect data from selected hotels in the UAE and to identify the commonly used lean techniques (i.e. most relevant from an industry perspective). The surveyed hotels operating in the UAE market are part of international firms (a global chain) which provides insight to the global hotel industry. A SIPOC chart (a commonly used tool for process mapping) is used to allocate the identified lean techniques across the hotel supply chain. Such allocation helps the industry in focusing the lean implementation plan and in assigning the effort to different parties across the hotel supply chain. Existing literature and hotels' experts' opinion are then used to categorize the identified lean techniques into their relevant standard lean practices. In the second phase, AHP is used to prioritize lean techniques to facilitate their implementation. The following subsections explain and rationalize the used research methods. Figure 3 depicts the integrated structure (framework) of the used research methodology.

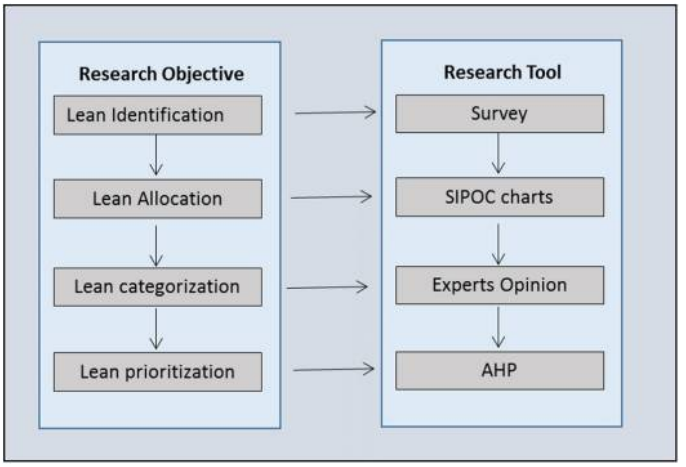


Figure 3.
The proposed research methodology

3.1 The research context

The UAE Government regularly encourages both manufacturing and service sectors to raise the awareness of efficient use of resources and to become more eco-friendly. The country has also a strategic objective of shifting the economy from oil-based to a knowledge/service economy. The goal is to be globally competitive in the service economy and to become a global hub for tourism. The hospitality industry is considered to be in the heart of the tourism service sector. With the growth in the number of international tourists coming to the UAE, there is an urging need for UAE hotels to be more efficient and competitive.

As discussed in the literature review, lean management has been increasingly considered by hotels globally and in the UAE to be an effective approach for increasing the efficiency and minimizing the waste and costs. However, as little research has explored lean implementation in hotel supply chains, hotels in the UAE and globally have a growing need for studies that identify relevant lean techniques and prioritize their implementation. This study was conducted in international hotels within the UAE context to contribute to this need. The selected UAE hotels confirmed that they have partial or full experience in implementing lean or at least knowledge of lean concepts and techniques. As the study is of an exploratory nature, such experience/knowledge was found to be sufficient.

3.2 Survey tool and lean expertise

To identify relevant lean techniques, this exploratory study has adopted a survey-based industry research to collect empirical data from the hotel industry. The survey was developed to first collect basic hotel information including familiarity with lean practices and the experience of the person filling the survey. The second section of the survey is an extended SIPOC table that requires the experts to list the lean techniques that are of most relevance to various SIPOC columns (supply chain construct). The survey was distributed to 50 hotels in the UAE mainly branches of international brands. Selection of hotels was based on the following criteria:

- The hotel must be implementing lean methods as highlighted in their annual review report submitted to National Bureau of Statistics of UAE.
- Selected hotels should not belong to same corporation or brand.
- Selected hotels must be either four or five stars.

The experts were then identified by the selected hotels as of most experience in lean implementation. Target population was senior managers and directors (with more than 10-year experience in hotel industry) and of different departments including operations, supply chain, customer relations, procurement/purchasing and strategic management. Initially, 70 senior managers and directors across selected hotels were randomly shortlisted. The shortlisted respondents were then contacted by telephone and briefed on the content of the survey and research objectives. Only 45 prospective respondents (supply chain and procurement experts in the surveyed hotels) have agreed to complete the survey. After two weeks, a gentle reminder was sent and within four weeks 35 filled surveys were received. Only 30 filled surveys were qualified based on completeness and content. Given the exploratory nature of the study and the mentioned selection criteria, 30 complete surveys were found sufficient to identify commonly used lean techniques and allocate them across hotel supply chain.

3.3 Supplier-Inputs-Process-Outputs-Customers analysis

Analyzing the theory of a service supply chain in general and for hotels in particular faces several challenges that mainly stem from the nature of the hospitality industry. To simplify the analysis, SIPOC chart was used in this research as a platform for the surveyed experts to allocate relevant lean techniques across the hotel supply chain. SIPOC is a widely used tool for process diagnostic and improvement in business planning, re-engineering and continuous improvement (Rasmusson, 2006). In this research, SIPOC is extended to depict the supply chain construct from hotel suppliers to customers. Figure 4 shows a generic template of the SIPOC chart used within the context of a hotel supply chain. The chart does not include all supplier tiers and various network topologies. It is only focused on the main structure of a hotel supply chain. The hotel operations represent the core of the SIPOC chart. Hotel suppliers provide inputs to these processes, and their outcomes are delivered to hotel guests and customers. As a common graphical and process mapping tool, the details of SIPOC chart development are not discussed for brevity.

Hotel experts based on their experience with lean implementation used the SIPOC chart to allocate the used lean techniques at each SIPOC stage. Many of the identified lean techniques were commonly used by multiple hotels. The study did not check the impact of applying these techniques on the hotel supply chain performance. Results from surveyed hotels are used as inputs to construct the SIPOC chart using the common lean techniques at

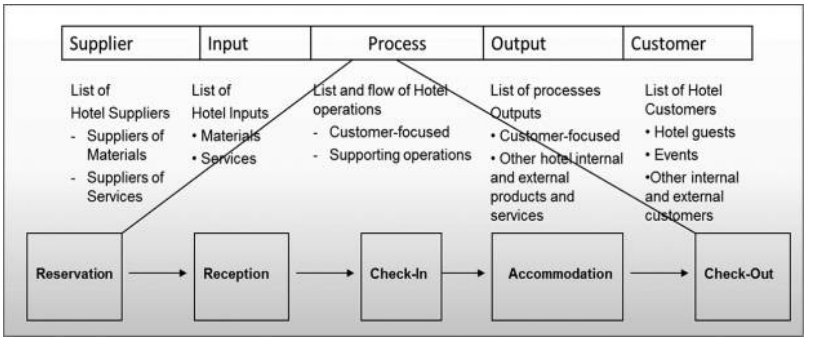


Figure 4.
A SIPOC chart of a generic hotel supply chain

each SIPOC stage (column). The identified lean techniques and their SIPOC allocation are summarized in Table I.

It can be seen from Table I that each SIPOC stage has several common lean techniques identified by experts. For example, at suppliers end, six lean techniques are selected to be of most relevance to improve the efficiency of supplies (reliable delivery in terms of time, content and quality). These are mainly related to JIT, Kaizen and efficient processing of hotel orders. Similarly, at the customer end, four lean techniques can be practiced by customers to reduce errors, delays and wastes leading to efficient customer service. These are mainly related to accurate reservations, on-time arrival and check-out and reducing waste during the guest stay at the hotel. Table I also shows that the majority of the identified lean techniques are most relevant to the I-P-O construct of the hotel supply chain. The implementation of lean techniques within these three elements is within the direct control of the hotel management. These mainly represent practices that efficiently use hotel inputs and effectively operate hotel processes that lead to high quality services. As shown in Table I, the I-P-O lean techniques mainly include problem-solving, standardization and continuous improvement practices that some hotels may not officially label as lean technique. They also include standard lean practices such as JIT, quality-at-the-sources, Kaizen, inventory reduction and error-proofing.

The SIPOC lean techniques in Table I are listed collectively by the surveyed hotels and necessarily practiced by at least one hotel. They serve as roadmap for a hotel to implement lean techniques that are most relevant to different stages of the hotel supply chain. Finally, and as it may be overwhelming for a hotel to adopt a high number of lean practices, the roadmap should include a priority ranking of lean techniques. To this end, the identified lean techniques are categorized and structured in an AHP model.

3.4 Analytical hierarchy process model

The purpose of developing the AHP model is to prioritize the identified lean practices to facilitate their implementation. The hierarchal structure of AHP includes main criteria and sub-criteria. Thus, the identified lean techniques through SIPOC chart were first categorized

Suppliers	Inputs	Processes	Outputs	Customers
JIT shipment	Accurate Orders	Drop off points	JIT services	Correct reservation
Kaizen events	Zero defects	Efficient processing	JIT food	On-time arrival
Problem-solving	Inventory reduction	Error-free (fool-proofing)	JIT amenities	On-time checkout
Efficient processing	Free resources	Kaizen events	JIT deliveries	Waste reduction
Standardization	Stock leveling	Problem-solving	Zero defects	
Training programs	Resource allocation and scheduling	Work-standards (SOPs)	Shorter processing (fast services)	
	Goals cascading	E-ordering and computerized operations	Demand-based pull system (per customer request)	
	Quality-at the sources	Efficient work-flow	Simplified services	
		Team-work	Waste reduction	
			High-quality services	

Table I. A SIPOC Chart of identified lean techniques

into six main lean criteria: JIT, Kaizen, Quality improvement, Inventory control, Productive maintenance and Standardization. This is mainly based on the nature of each lean practice, the commonalities among the identified lean techniques in SIPOC chart and the integral components of the lean theory. For example, looking at Table I, several lean techniques were related to JIT as a main lean practice (e.g. JIT shipment of supplies as inputs and JIT delivering hotel services as outputs). The attainment of JIT within a hotel context is set to be function of three sub-criteria (on-time deliveries, on-time services and using Kanban). These sub-criteria were selected based on standard lean techniques in lean theory and the initial survey of hotels' experts. Similarly, zero defects in hotel inputs and outputs along with error-free hotel services were related to "Quality Improvement" as a main criterion (lean practice). The attainment of "Quality Improvement" within a hotel context is approached using quality-at-the-source, quality management systems and quality measurement. The same approach is sued for the other lean categories.

Relevancy of the lean technique varies across industries. Manufacturing industry applies different lean techniques from services industries such as health care and hospitality. Conversely, all lean techniques are integral components of lean theory. Thus, the classification of lean practices was related to standard types of lean practices in lean theory (JIT, Kaizen, etc.) and to their specific lean techniques. Furthermore, the classification was experimented for content validity using interviews with the senior managers of operation, supply chain, quality control and customer relationship management departments in three hotels. Based on the results of the conducted reviews, few lean techniques were reshuffled from one category to another.

The multi-criteria lean attributes were organized in a hierarchical structure with the highest level of the hierarchy being the overall goal, i.e. to prioritize lean technique. The six categories of lean techniques were represented as the main criteria in Level 2 of AHP. Finally, the specific lean techniques within each category were represented by Level 3 (sub-criteria). Level 4 refers to the used rating scale, while Level 5 refers to the surveyed UAE hotels. The AHP model with five-level hierarchical structure is constructed as shown in Figure 5. However, it should be made clear that the developed AHP model is not intended to be used for comparing the surveyed hotels (selecting amongst decision alternatives). It is only intended to generate weights of relative importance for the main lean categories (criteria) and their specific lean techniques (sub-criteria). These weights are used to set priority and guidance for effective lean implementation within the context of a hotel supply chain.

3.5 Lean priority assessment

Based on the AHP model in Figure 5, lean priority assessment means assessing the relative importance of the identified lean criteria and sub-criteria based on experts opinion. The population comprises top management of the following hotel departments; operations, supply chain, customer relations, procurement/purchasing and strategic management. Data have been collected only from four- and five-stars hotels. This is mainly due to their better understanding of the concerned topic and their management capacity to provide pairwise comparisons of lean criteria and sub-criteria. The respondents were selected through purposive sampling to ensure nationality, discipline and experience and gender diversity. Expert opinion of 25 respondents from nine different hotels was collected through in-depth interviews. According to Cheng and Li (2001) and Zamberi and Hussain (2017), small sample size is acceptable from the AHP methodology perspective and, thereafter, the sample size of 25 respondents is considered to be satisfactory (Drake *et al.*, 2013; Hussain *et al.*, 2016).

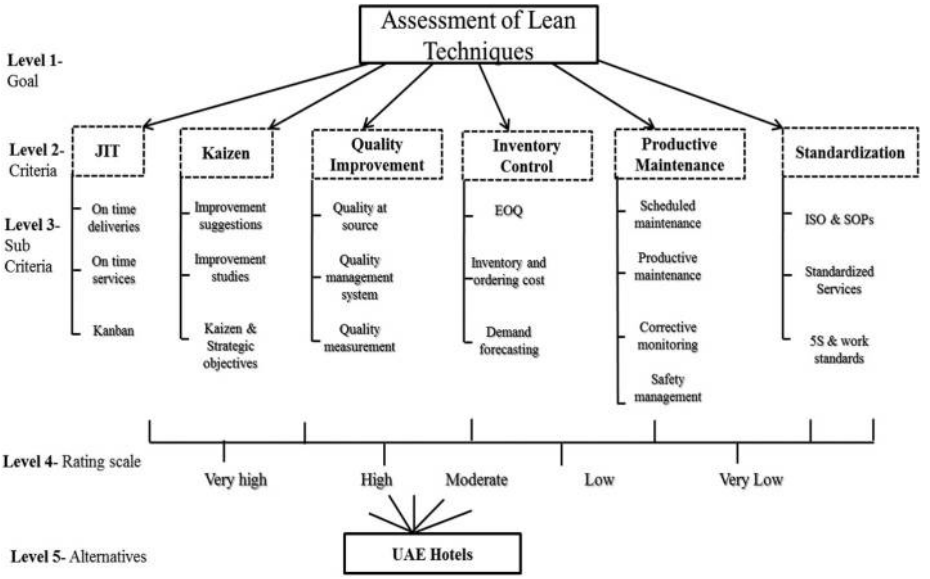


Figure 5.
AHP model for prioritizing lean techniques

The AHP solves the survey fatigue problem by only asking experts to compare the importance of two items at a time. These comparisons are called judgments. The judgements in making pairwise comparisons integrate logical thinking with specific knowledge and experience. Thus, the questionnaire was developed using Saaty's 1-9 scale as shown in Table II and pairwise comparisons of lean criteria and sub-criteria were then made by the 25 experts. For example, if a respondent identifies that the JIT is moderately more important than Kaizen, then the former is rated "3" and the latter as "1/3". The other lean criteria and sub-criteria are rated in a similar manner.

In line with suggestions from Saaty (2008), the geometric mean approach was preferred over the arithmetic mean to combine the individual pairwise comparison judgments and to obtain the consensus pairwise comparison judgment matrices for the entire team. To check the consistency of the comparisons, the Consistency Index (CI) is applied. Saaty (1990) defined consistency as follows:

Intensity of importance	Definition	Explanation
1	Equal importance	Two criteria contribute equally to the objective of waste reduction
3	Moderate importance	Judgment slightly favor one over another
5	Strong importance	Judgment strongly favor one over another
7	Very strong importance	A criterion is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	Importance of one over another affirmed on the highest possible order
2,4,6,8	Intermediate values	Used to represent compromise between the priorities listed above

Table II.
The 1 to 9 scale for AHP pairwise comparison

$$CI = (\lambda_{max} - n)/(n-1) \quad (1)$$

where λ_{max} is the maximum eigenvalue of the matrix of the importance ratios and n is the number of factors. Then, the consistency ratio (CR) is used to assess whether or not a matrix is sufficiently consistent. This is the ratio of the CI to the random index (RI):

$$CR = CI/RI \quad (2)$$

Random pairwise comparisons have been simulated to produce average random indices for different sized matrices. The values of RI are given in Table III (Saaty, 1990). According to Saaty (1990), if the value of CR is smaller or equal to 0.10, the inconsistency is acceptable.

4. Analytical hierarchy process results

Using Saaty's scale in Table II, hotel experts have conducted pairwise comparison among the main lean criteria. Table IV presents the geometric means of pairwise comparison for the six main lean criteria. The relative priorities of the criteria (the final column of Table IV) is then computed as "Priority Vectors". Saaty (1990) introduced a "Consistency Principle" for calculating priority vectors. Consistency principle indicates that $a_{ik} = a_{ij} \,.\, a_{jk}$ and subsequent arguments for using the special case of the consistency matrix is formed by elements $a_{ik} = w_i/w_j$, where w_i and w_j are the elements of the priority weight vector corresponding to criteria i and j, respectively.

Table IV reveals that the JIT is considered as the most relevant group/criterion of lean techniques used in UAE hotel supply chains with a priority weight of 40 per cent followed by Kaizen, with a priority weight of 24 per cent. Maintenance, quality, standardization and inventory were ranked 3rd, 4th, 5th and 6th, respectively (i.e. JIT and Kaizen constitute 64 per cent of lean criteria' relative importance). Results also show that the consensus responses of hotel experts used in Table IV fulfil the acceptable consistency ratio (CR) requirement of AHP.

Table III. Random index

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.48

Note: Where n is number of factors

Table IV. Geometric means of pairwise comparison of main criteria and the resulting priority

Criteria	JIT	Kaizen	Quality	Inventory	Maintenance	Standardization	Priority vector
JIT	1.00	3.10	6.88	7.25	7.25	7.50	0.40
Kaizen	0.32	1.00	5.00	7.38	6.40	7.13	0.24
Quality	0.15	0.20	1.00	7.50	0.17	7.25	0.11
Inventory	0.14	0.14	0.13	1.00	5.70	0.13	0.06
Maintenance	0.14	0.16	6.00	0.18	1.00	7.00	0.11
Standardization	0.13	0.14	0.14	8.00	0.14	1.00	0.08

Note: CR Value: 0.08 < 0.10 (consistent)

To gain a better understanding of the priorities reported in Table IV, a pairwise comparison of the sub-criteria within each main lean criterion was also undertaken based on the consensus responses of hotel experts. Results are shown in Tables V to X.

Table V shows the priority listing of the consensus pairwise comparison for the JIT sub-criteria. Surveyed UAE hotels are giving the highest priority to on-time services (52 per cent) followed by on-time delivery (40 per cent). A very low priority is given to using Kanban (8 per cent) within the hotel context. The JIT sub-criteria weights assessment also meets the AHP consistency requirement.

Table VI shows the pairwise comparison of the three sub-criteria within the Kaizen criterion. Results show that improvement suggestions has the highest priority weight (69 per cent) followed by improvement studies (24 per cent). Strategic objectives regarding

Criteria	On time delivery	On time services	Kanban	Priority vector
On time delivery	1	0.5	7.2	0.40
On time services	2	1	4.5	0.52
Kanban	0.14	0.2	1	0.08

Note: CR value: 0.03 < 0.10 (consistent)

Table V. Pairwise comparison of JIT sub-criteria

Criteria	Improvement suggestions	Improvement studies	Kaizen and strategic objectives	Priority vector
Improvement suggestions	1	5.8	7.1	0.69
Improvement studies	0.17	1	6.7	0.24
Kaizen and strategic objectives	0.14	0.1	1	0.07

Note: CR value: 0.04 < 0.10 (consistent)

Table VI. Pairwise comparison of kaizen sub-criteria

Criteria	Quality at source	Quality management	Quality measurement	Priority vector
Quality at source	0.16	0.02	0.68	0.28
Quality management	0.78	0.11	0.04	0.31
Quality measurement	0.06	0.87	0.28	0.41

Note: CR value: 0.08 < 0.10 (consistent)

Table VII. Pairwise comparison of quality Sub-criteria

Criteria	EOQ	Forecasting	Inventory cost	Priority vector
EOQ	0.07	0.10	0.04	0.07
Forecasting	0.43	0.61	0.65	0.56
Inventory cost	0.50	0.29	0.31	0.37

Note: CR value: 0.03 < 0.10 (consistent)

Table VIII. Pairwise comparison of inventory control sub-criteria

Kaizen has the least application (7 per cent) within surveyed hotels. The Kaizen sub-criteria weights assessment also meets the AHP consistency requirement.

Table VII shows the priority listing of the consensus pairwise comparison for the quality sub-criteria. The highest priority was given to quality measurement (41 per cent) followed by quality management systems (31 per cent) and quality-at-the-source (28 per cent). The quality sub-criteria weights assessment meets the AHP consistency requirement.

Table VIII shows the priority listing of the consensus pairwise comparison for the inventory sub-criteria. The highest priority is given to using demand forecasting techniques (56 per cent) followed by controlling inventory cost (37 per cent). However, hotels experts gave the lowest priority to using the EOQ model for inventory control (7 per cent). The inventory sub-criteria weights assessment meets the AHP consistency requirement.

Table IX shows the priority listing of the consensus pairwise comparison for the Productive Maintenance sub-criteria. The highest priority is given to safety measurement (47 per cent). Medium priority is given to scheduled maintenance (23 per cent) and preventive maintenance (19 per cent). The lowest priority is given to corrective maintenance (11 per cent). The productive maintenance sub-criteria weights assessment meets the AHP consistency requirement.

Finally, Table X shows the priority listing of the consensus pairwise comparison for the standardization sub-criteria. UAE hotels are giving almost equal priority to the three sub-criteria. The standardization sub-criteria weights assessment meets the AHP consistency requirement.

5. Results discussion

Study results from the initial survey have identified 19 lean techniques being used across the supply chain of surveyed hotels. SIPOC was used as a platform to allocate the identified lean techniques across hotels supply chain (Table I). Lean techniques were categorized into six main practices based on lean theory and experts' validation. An AHP model was

Table IX. Pairwise comparison of productive maintenance sub-criteria

Criteria	Scheduled maintenance	Preventive maintenance	Safety management	Corrective maintenance	Priority vector
Scheduled maintenance	0.17	0.33	0.12	0.32	0.23
Preventive maintenance	0.08	0.16	0.16	0.36	0.19
Safety management	0.69	0.47	0.48	0.21	0.47
Corrective maintenance	0.06	0.05	0.24	0.11	0.11

Note: CR value: 0.04 < 0.10 (consistent)

Table X. Pairwise comparison of standardization sub-criteria

Criteria	ISO and SPO	5S & work standards	Standardized system	Priority vector
ISO and SPO	0.14	0.74	0.02	0.30
5S and work standards	0.04	0.24	0.88	0.38
Standardized system	0.82	0.03	0.10	0.32

Note: CR value: 0.09 < 0.10 (consistent)

developed and used to prioritize lean categories and sub-categories (Figure 5). The results of AHP prioritization of the six main categories of lean practices were presented in Table IV. The prioritization of lean techniques within each main category of lean practices was summarized in Tables 5 to 10. In line with study results, Rauch *et al.* (2016) confirmed that not all lean management methods are suitable or equally applicable to a hotel. However, they emphasized that lean management holds additional potential for the tourism and hospitality sector in the future and lean methods should be adapted to the special requirements of the hotel sector.

AHP results found JIT to be of most priority among lean practices in hotels supply chain followed by Kaizen. Both JIT and Kaizen represent 64 per cent of the total relative priority. SIPOC analyses have also found JIT to be relevant to all elements within the construct of the hotel supply chain. Kaizen as a method of continuous improvement was found to be a common practice for hotel suppliers and operations. This can be attributed to the nature of hotel services which are mainly time-sensitive and guest-centered (Cudney and Elrod, 2011; Abdi *et al.*, 2006; Ahlstrom, 2004). JIT techniques typically improve the hotel capability for providing on-time services (has the highest priority amongst JIT sub-criteria with 52 per cent). Study results have also confirmed that providing on-time services to hotel guests is not attainable without on-time deliveries from suppliers (has the second priority amongst JIT sub-criteria with 40 per cent). Finally, the study found that specific production-based techniques such as Kanban have received the lowest priority (i.e. 8 per cent) among JIT lean sub-criteria. This is understandable given the nature of hotel operations and services which do not have the continuous material flow requirements of production systems.

The study has also found Kaizen to be of high priority as a lean practice within hotels supply chains. As discussed in Thomas *et al.* (2017), Kaizen improvement studies are increasingly used in service sector and hotels to improve performance and solve reported problems not only within the hotel but also at both suppliers and customers. Based on AHP results of the Kaizen sub-criteria, "Kaizen Improvement Suggestions" received the highest weight (69 per cent). This was expected in the context of a hotel supply chain where most Kaizen exercises are often conducted in response to the suggestions made by internal or external customers and guests. Suggestion boxes and employee suggestion systems often support such practices. The second Kaizen sub-criteria in priority is "Kaizen improvement studies" with 24 per cent. This was logical as responding to improvement suggestions is typically easier for hotel management compared to the effort needed to identify improvement opportunities. Nevertheless, hotels have started to give more attention to practicing internal Kaizen studies that target continuous improvement towards excellence. Finally, the study found that linking Kaizen to the hotel strategic objectives has marginal priority (7 per cent). As Kaizen studies apply incremental improvements to hotel operations, supply chain mangers still do not view them as initiatives or programs to attain the hotel's strategic objectives which are typically provide long-term directions.

AHP results showed that the implementation of "Quality" and "Productive Maintenance" lean practices have a similar priority with 11 per cent. Indeed, the two lean practices are quite related as management often views maintenance as a means to provide the required level of systems' availability that facilitates a high level of service quality at the hotel. The fact that both lean practices were ranked after JIT and Kaizen also reveals that hotel management is mainly focused on implementing JIT and Kaizen as the two standard pillars of lean. This shows that not all hotel supply chain managers are apparently aware of the direct and indirect impact of quality and maintenance on lean performance.

The study also found that hotels supply chain mangers have a comprehensive view of the quality criterion. All the three quality sub-criteria have received close values of priority

weights with some advantage to quality measurement (41 per cent). This illustrates the hotels' growing interest in measuring service quality through guests feedback and complaints and in tracking other quality indicators such as service errors and invoicing mistakes. Quality management (31 per cent) in general was found important to the quality of a hotel supply chain, as it sets the infrastructure that supports quality programs and methods. Most surveyed hotels have already obtained ISO9001 quality management certification. Quality-at-the-source has a relatively lower priority (28 per cent), as most hotel managers still consider this technique to be more relevant to the production systems and their physical products and flow processes. Indeed, within the context of a hotel supply chain, quality-at-the-source can be still relevant to assure the quality of hotel supplies as well as internal hotel operations that lead to the delivery of hotel services.

Similar results were obtained from the productive maintenance priorities. The study found that hotels supply chain mangers have a comprehensive view of the maintenance criterion. Among the four maintenance sub-criteria, "Safety Management" has received the highest priority (47 per cent). This highlights the importance of safety for hotels, as it is essential service element for such context. Most surveyed hotels have also obtained ISO18001 safety management certification in addition to many other safety standards. Scheduled and Preventive Maintenance are almost of similar importance as they are both related. The lowest rank is given to Corrective Maintenance (11 per cent). This shows that the practices of hotel managers do not support the reactive mode of fixing reported failures in hotel systems, as it may result in negative consequence on hotel services and operations such as delays and interruptions.

Finally, AHP results showed that lean practices related to both "Inventory" and "Standardization" are of lowest importance to hotels (6 and 8 per cent, respectively). Unlike production firms, inventory was not viewed by hotel management as a priority when implementing lean initiatives. In contrast to hotel supply chains, inventory and transportation have been highly ranked in health-care supply chains (Hussain *et al.*, 2016). However, the low ranking of "Standardization" as a lean practice was somehow a surprising result. Hotels are typically known with their strict standard operating procedures for almost all activities from cooking and cleaning to standard guest services. The three standardization sub-criteria were almost of equal weights which was a good indication. However, at the inventory criterion, hotels gave most of the weight to forecasting (56 per cent) and inventory cost (37 per cent) and only a marginal weight was given to using inventory control models such as EOQ (7 per cent). Again, the majority of hotel managers still believe that such models are more applicable to a production environment with standard inventory control systems.

After setting the priority for main lean criteria, effective implementation of lean within the context of a hotel supply chain requires the right priority of specific lean techniques within all criteria (i.e. developing an overall relative priority for the 19 lean techniques). This can be simply attained by multiplying the sub-criteria weights with the main criteria priority matrix. The resulting priority weights are ranked to facilitate an effective implementation of lean practices across the hotel supply chain. A Pareto chart of the final priority of the 19 identified lean techniques is shown in Figure 6.

As shown in Figure 6, the three vital few lean techniques include on-time service, improvement system and on-time delivery. These three lean techniques are viewed by hotel experts as the most relevant to hotel supply chain. Therefore, their implementation is expected to lead the most improvement in terms of waste reduction and increased efficiency. The time-sensitive nature of hotel services explains the high priority of on-time services and on-time delivery. They are both related to JIT lean practice. Similarly, the need for

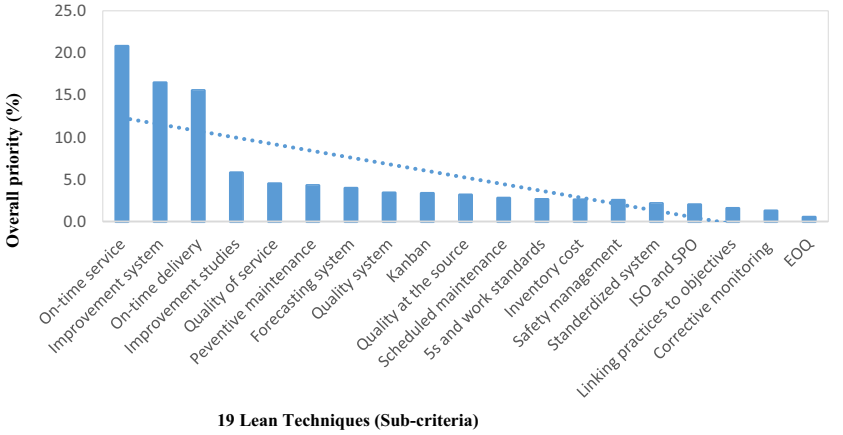


Figure 6.
The overall priority of the 19 lean techniques (sub-criteria)

improvement across the construct of hotel supply chain explains the focus of lean adoption in the hotel industry on developing Kaizen improvement systems. The implementation plan should first focus on adopting these three lean techniques. The remaining lean techniques are considered trivial many at this stage; they should be gradually implemented but not ignored.

5.1 Implications of study findings

The SIPOC chart in Table I, AHP results in Table IV and the Pareto chart in Figure 6 provide an insight for researchers and a roadmap for practitioners for an effective implementation of lean techniques across a hotel supply chain. For researchers, the proposed research methodology has addressed a research gap that was not fully investigated in current research; exploring lean techniques (identification, categorization and prioritization) across the entire hotel supply chain. For practitioners, SIPOC provides an allocation of lean techniques based on relevancy to various elements/stages of a hotel supply chain. This allocation was based on the commonly used lean techniques in the surveyed hotels within UAE context. Hotel experts may come up with a different allocation in a different context. However, as selected hotels are members of global hotel chains, it is expected to observe degree of similarity in terms of used practices and their SIPOC allocation.

The second study implication for researchers is the categorization of adopted lean practices based on lean theory. This can help researchers develop a lean implementation frameworks for hotels supply chains. As discussed in the literature review, several frameworks were developed for lean implementation in manufacturing firms. However, less work was done for service firms and for hotels supply chains in particular. For practitioners, linking the different lean techniques to standard lean categories would be very helpful for adopting lean frameworks and initiatives. For example, study results showed that the lean techniques used across the supply chains of surveyed hotels can be categorized into six main standard lean practices and the majority of these techniques are linked to JIT and Kaizen. Such findings can be used by hotel management to direct and focus the effort of lean capacity building, resources allocation and implementation plans.

Finally, the AHP-based priorities of lean practices and techniques can be also used by researchers to customize lean implementation frameworks to the specific needs of the hotel

supply chain. As most researchers agree that lean techniques priority is not identical across service industries, study results provide a pilot assessment for lean implementation priority within a hotel supply chain. For supply chain managers, AHP results outline the priority for adopting lean practices and, for lean implementation teams, the Pareto chart sets the priority of specific lean techniques. While it may not be an easy task for a hotel to implement lean practices at suppliers and guests ends, partnership and collaboration with suppliers along with awareness programs to customers can facilitate lean adoption at these two fronts of supply chain.

In terms of local study implication, the UAE is already among the top five countries in the world for new hotel openings over the past five years and the hotel sector has seen exceptional growth over the past couple of years. With an aim of establishing itself as a preferred destination for tourists and a hub for global tourism, the UAE hotel sector has been under severe pressure to provide high-quality services at a competitive price. Adopting lean methodology and lean management practices are likely to improve both quality and productivity of the UAE hotels especially when implemented across the entire supply chain. However, and as suggested by Weintraub (2011), a careful adaptation of lean to the complex supply chains is recommended. This can be approached by initiating small-scale lean projects restricted to one process/department as a lean "inception" stage for targeted improvements that can deliver quick and visible successes in terms of waste reduction and quality improvement. The idea from that is "the small scale financial and operational gains realized in the inception stage are likely to increase an organization wide awareness and commitment to lean implementation" (i.e. facilitating and broadening lean across the supply chain).

5.2 Limitations and directions for future work

This study has used a mixed research method that can be adapted to explore the lean implementation across the supply chain of hotels in different contexts or even in other service industries. It has used a survey tool designed to extract needed information from the surveyed hotels. Thus, key study limitations can be related to study context, sample size and representation, and the expertise of those who filled the surveys and ranked lean techniques in selected hotels. Surveyed hotels were selected carefully based on their experience in applying lean techniques. The selected UAE hotels confirmed that they have partial or full experience in implementing lean or at least knowledge of lean concepts and techniques. The experts were then identified by the selected hotels as of most experience in lean implementation. In terms of sample size, 70 hotel experts were identifies, shortlisted to 45, and only 30 completed surveys were considered in the study based on completeness and content. Such sample size was found sufficient given the exploratory nature of the study.

The methodology has also extended the SIPOC application to the entire supply chain. Experts from the surveyed hotels used SIPOC to allocate lean techniques based on their experience in implanting lean techniques. Surveyed hotels have confirmed the knowledge of the experts who filled the survey in implementing lean practices across hotel supply chains. Researchers are also encouraged to develop models for assessing the expertise of hotel management in implementing lean techniques within UAE hotels and globally.

AHP was then structured and used to prioritize lean adoption. Based on the commonality of the identified lean techniques and their link to the standard lean practices of lean theory, six categories were used as main lean criteria in AHP. Not all researchers may agree with the used categorization of lean techniques and future research is directed to quantitatively and qualitatively validate the proposed classification (e.g. using structured interviews and Confirmatory Factor Analysis). The same is also recommended for setting the sub-criteria of

specific lean techniques within each main category in the AHP model. For AHP priority ranking, expert opinion of 25 respondents from 9 different hotels was collected through in-depth interviews. The consensus of a small size of experts was found sufficient for AHP pairwise comparison. Researchers are also encouraged to expand the study for a larger sample of hotel experts within UAE market as well as in other contexts.

In summary, and although the study results and findings were primarily derived from a group of selected hotels in the UAE, the research methodology is applicable to different contexts and the study results can be adapted and used by different hotel supply chains around the globe. Study results can also provide further directions for future research. For example, the study did not check the impact of applying lean techniques on the hotel performance. The study was only concerned with the relevance of these techniques to different stages of the hotel supply chain. Through AHP, the relative importance of lean techniques indirectly assesses their impact on the effectiveness of a hotel supply chain. Future research is directed to develop models that can assess the direct impact of lean adoption on the performance and the sustainability of a hotel supply chain.

References

Abdi, F., Shavarini, S.K. and Hoseini, S. (2006), "Glean lean: how to use lean approach in service industries?", *Journal of Services Research*, Vol. 6, pp. 121-136.

Ahlstrom, P. (2004), "Lean service operations: translating lean production principles to service operations", *International Journal of Services Technology and Management*, Vol. 5 Nos 5/6, pp. 545-564.

Al-Amor, R. and Hussain, M. (2017), "An assessment of green practices in a hotel supply chain: a study of UAE hotels", *Journal of Hospitality and Tourism Management*, Vol. 32, pp. 71-81.

Al-Aomar, R. and Weriakat, D. (2012), "A framework for a green and lean supply chain: a construction project application", *Proceedings of the International Conference on Industrial Engineering & Operations Management (IEOM)*, *Istanbul*, pp. 289-299.

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

Baudin, M. (2004), *Lean Logistics: The Nuts and Bolts of Delivering Materials and Goods*, Productivity Press, New York, NY.

Bonaccorsi, A., Carmignani, G. and Zammori, F. (2011), "Service value stream management (SVSM): developing lean thinking in the service industry", *Journal of Service Science and Management*, Vol. 4 No. 4, pp. 428-438.

Çebi, F. and Bayraktar, D. (2003), "An integrated approach for supplier selection", *Logistics Information Management*, Vol. 16 No. 6, pp. 395-400.

Cheng, E.W. and Li, H. (2001), "Analytic hierarchy process: an approach to determine measures for business performance", *Measuring Business Excellence*, Vol. 5 No. 3, pp. 30-37.

Chung, L.H. and Parker, L.D. (2010), "Managing social and environmental action and accountability in the hospitality industry: a Singapore perspective", *Accounting Forum*, Vol. 34 No. 1, pp. 46-53.

Cudney, E. and Elrod, C. (2011), "A comparative analysis of integrating lean concepts into supply chain management in manufacturing and service industries", *International Journal of Lean Six Sigma*, Vol. 2 No. 1, pp. 5-22.

Cudney, E. and Kestle, R. (2010), *Implementing Lean Six Sigma throughout the Supply Chain: The Comprehensive and Transparent Case Study*, Productivity Press, New York, NY.

Damrath, F. (2012), "Increasing competitiveness of service companies: developing conceptual models for implementing lean management in service companies", Thesis at Politecnico di Milano.

De Vries, J. and Huijsman, R. (2011), "Supply chain management in health services: an overview", *Supply Chain Management: An International Journal*, Vol. 16 No. 3, pp. 159-165.

Dharmapriya, U. and Kulatunga, A. (2011), "New strategy for warehouse optimization–lean warehousing", *Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management, IEOM, Kuala Lumpur*, pp. 121-129.

Drake, P., Lee, D. and Hussain, M. (2013), "The lean and agile purchasing portfolio model", *Supply Chain Management: An International Journal*, Vol. 18 No. 1, pp. 3-20.

Edorgan, N. and Baris, E. (2007), "Environmental protection programs and conservation practices of hotels in Ankara, Turkey", *Tourism Management*, Vol. 28 No. 2, pp. 604-614.

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

Friedman, P. (2008), "Leaning toward green: green your supply chain with lean practices", available at: http://outsourced-logistics.com/operations_strategy/leaning_toward_green_1108/index.html (accessed 1 September 2015).

Gray, R. and Bebbington, J. (2001), *Accounting for the Environment*, 2nd ed., Sage Publications, London.

Gulf News (2015), available at: http://gulfnews.com/business/sectors/tourism/travel-tourism-to-contribute-8-5-per-cent-of-uae-gdp-1.1305826 (accessed 1 October 2015).

Huang, Y., Song, H., Huang, G.Q. and Lou, J. (2012), "A comparative study of tourism supply chains with quantity competition", *Journal of Travel Research*, Vol. 51 No. 6, pp. 717-729.

Hussain, M. and Malik, M. (2016), "Prioritizing lean management practices in public and private hospitals", *Journal of Health Organization and Management*, Vol. 30 No. 3, pp. 457-474.

Hussain, M., Malik, M. and Alneyadi, H.S. (2016), "AHP framework to assist lean deployment in Abu Dhabi public healthcare delivery system", *Business Process Management Journal*, Vol. 22 No. 3, pp. 546-565.

Ishizaka, A., Pearman, C. and Nemery, P. (2012), "AHPSort: an AHP-based method for sorting problems", *International Journal of Production Research*, Vol. 50 No. 17, pp. 4767-4784.

Jasti, N.V.K. and Kurra, S. (2017), "An empirical investigation on lean supply chain management frameworks in Indian manufacturing industry", *International Journal of Productivity and Performance Management*, Vol. 66 No. 6, pp. 699-723.

Korpela, J., Lehmusvaara, A. and Tuominen, M. (2001), "Customer service based design of the supply chain", *International Journal of Production Economics*, Vol. 69 No. 2, pp. 193-204.

Leseure, M., Hudson-Smith, M. and Radnor, Z. (2010), "Transferring lean into government", *Journal of Manufacturing Technology Management*, Vol. 21 No. 3, pp. 411-428.

Malik, M., Abudullah, S. and Hussain, M. (2015), "Assessing supplier environmental performance: applying analytical hierarchical process in the United Arab Emirates healthcare chain", *Renewable and Sustainable Energy Reviews*, Vol. 55, pp. 1313-1321, doi: 10.1016/j.rser.2015.05.004.

Manzouri, M., Rahman, M.N., Saibani, N. and Che Rosmawati, C.M.Z. (2013), "Lean supply chain practices in the Halal food", *International Journal of Lean Six Sigma*, Vol. 4 No. 4, pp. 389-408.

Martínez-Jurado, P.J. and Moyano-Fuentes, J. (2014), "Lean management, supply chain management, and sustainability: a literature review", *Journal of Cleaner Production*, Vol. 85, pp. 134-150.

Mensah, I. (2005), "Environmental management practices among hotels in the greater Accra region", *International Journal of Hospitality Management*, Vol. 25 No. 3, pp. 414-431, doi: 10.1016/j.ijhm.2005.02.003.

Mollenkoph, D., Stolze, H., Tale, W.L. and Ueltschy, M. (2010), "Green, lean, and global supply chains", *International Journal of Physical Distribution & Logistics Management*, Vol. 40 Nos 1/2, pp. 14-41.

Ngai, E. and Chan, E. (2005), "Evaluation of knowledge management tools using AHP", *Expert Systems with Applications*, Vol. 29 No. 4, pp. 889-899.

Oleghe, O. and Salonitis, K. (2015), "Improving the efficacy of the lean index through the quantification of qualitative lean metrics", *Procedia CIRP*, Vol. 37, pp. 42-47.

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.

Psychogios, A.G., Atanasovski, J. and Tsironis, L.K. (2012), "Lean six sigma in a service context", *International Journal of Quality & Reliability Management*, Vol. 29 No. 1, pp. 122-139.

Psychogios, A.G. and Tsironis, L.K. (2012), "Towards an integrated framework for lean six sigma application: lessons from the airline industry", *Total Quality Management and Business Excellence*, Vol. 23 Nos 3/4, pp. 397-415.

Rasmusson, D. (2006), *The SIPOC Picture Book: A Visual Guide to the SIPOC/DMAIC Relationship*, Oriel Incorporated, Wisconsin.

Rauch, E., Damian, A., Holzner, P. and Matt, D.T. (2016), "Lean hospitality: application of lean management methods in the hotel sector", *Procedia CIRP*, Vol. 41, pp. 614-619.

Reichhart, A. and Holweg, M. (2007), "Lean distribution: concepts, contributions, conflicts", *International Journal of Production Research*, Vol. 45 No. 16, pp. 3699-3722.

Saaty, T.L. (1980), *The Analytic Hierarchy Process: Planning, Priority Setting, Resources Allocation*, McGraw, New York, NY.

Saaty, T.L. (1990), "How to make decision: the analytic hierarchy process", *European Journal of Operations Research*, Vol. 48 No. 1, pp. 9-26.

Saaty, T.L. (2008), "Decision making with the analytic hierarchy process", *International Journal of Services Sciences*, Vol. 1 No. 1, pp. 83-98.

Shah, R.S. and Ganji, E.N. (2017), "Lean production and supply chain innovation in baked foods supplier to improve performance", *British Food Journal*, Vol. 119 No. 11, pp. 2421-2447.

Singh, S.C. and Pandey, S.K. (2015), "Lean supply-chain: a state-of-the-art literature review", *Journal of Supply Chain Management Systems*, Vol. 4 No. 3, pp. 33 -46.

Soltan, H. and Mostafa, S. (2015), "Lean and agile performance framework for manufacturing enterprises", *Procedia Manufacturing*, Vol. 2, pp. 476 -484.

Thomas, F., Jiju, A. and Kevin, D., O.G. (2017), "Continuous improvement methodologies and practices in hospitality and tourism", *International Journal of Contemporary Hospitality Management*, Vol. 30 No. 1, pp. 581-600, available at: https://doi.org/10.1108/IJCHM-03-2017-0141

Tortorella, G.L., Miorando, R. and Tlapa, D. (2017), "Implementation of lean supply chain: an empirical research on the effect of context", *The TQM Journal*, Vol. 29 No. 4, pp. 610-623.

Trung, D.N. and Kumar, S. (2005), "Resource use and waste management in Vietnam hotel industry", *Journal of Cleaner Production*, Vol. 13 No. 2, pp. 109-116.

United States EPA (2000), "The lean and green supply chain: a practical guide for materials managers and supply chain managers to reduce costs and improve environmental performance", EPA 742-R-00-001, EPA, Office of Pollution Prevention and Toxics, Washington, DC.

Vlachos, I. and Bogdanovic, A. (2013), "Lean thinking in European hotel industry", *Tourism Management*, Vol. 36, pp. 353-364.

Wang, F.K. and Chen, K.S. (2010), "Applying lean six sigma and TRIZ methodology in banking services", *Total Quality Management*, Vol. 21 No. 3, pp. 301-315.

Womack, J.P., Jones, D.T. and Roos, D. (2007), *The Machine That Changed the World: The Story of Lean Production-Toyota's Secret Weapon in the Global Car Wars That Is Revolutionizing World Industry*, Free Press, New York, NY.

Xu, X. and Gursoy, D. (2015), "A conceptual framework of sustainable hospitality supply chain management", *Journal of Hospitality Marketing & Management*, Vol. 24 No. 3, pp. 229-259.

Yang, J. and Shi, P. (2003), "Applying analytic hierarchy process in firm's overall performance evaluation: a case study in China", *International Journal of Business*, Vol. 7 No. 1, pp. 1-18.

Zhang, X., Song, H. and Huang, G.Q. (2009), "Tourism supply chain management: a new research agenda", *Tourism Management*, Vol. 30 No. 3, pp. 345-358.

Corresponding author
Raid Al-Aomar can be contacted at: raid.alaomar@adu.ac.ae