

Waste Analysis and Categorization in the Construct of Hotels Supply Chain

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Abstract—This paper aims at analyzing and categorizing the wastes across the supply chain of the hotel industry. Literature search showed a need for empirical studies that explore the construct of hotels supply chains, analyze wastes across the supply chain construct, and address sustainability practices. The paper provides a structured approach that can be used to assist the analysis and categorization of different types of wastes across the supply chain of hotels and support future research. To this end, the study first develops a SIPOC-based construct of a hotel supply chain and identifies the types of waste at various construct elements. Second, the study categorizes hotel supply chain wastes using lean principles and provides guidelines for waste reduction using lean techniques and green practices. The emphasis is on reducing the identified types of wastes in a hotel supply chain to increase its operational and economic effectiveness and improves the overall service quality. This also contributes to the effort of incorporating sustainability in the supply chains of hotels and services in general. The study is conducted in selected hotels in Abu Dhabi (AD) area in the UAE.

Keywords— Hotel Industry, Lean Thinking, Supply Chain Sustainability, Waste Analysis.

I. INTRODUCTION

Sustainability has been of great interest in the last decade for academia and industry due to pressures from various stakeholders to embrace a commitment to sustainability practices. In sustainable organizations, the environmental and social criteria need to be fulfilled by operations managers, while maintaining competitiveness and meeting customer needs and related economic criteria [1]. This implies that organizations have to satisfy multiple and conflicting objectives such as maximizing profits while reducing operating costs, minimizing the environmental impacts and maximizing the social well-being [2, 3].

A supply chain is often viewed as a network of critical links that connects organizations (stakeholders) together and links each organization's inputs to its outputs. As defined by Bowersox and Closs [4], the supply chain refers to all those

activities associated with the transformation and flow of goods and services, including money and information flows, from the sources of materials to end users. For example, a hotel supply chain is a network of organizations (suppliers, logistics partners, and stakeholders) 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). Further details of supply chain components and functions can be found in [5]. Figure 1 depicts the main components of a service supply chain.

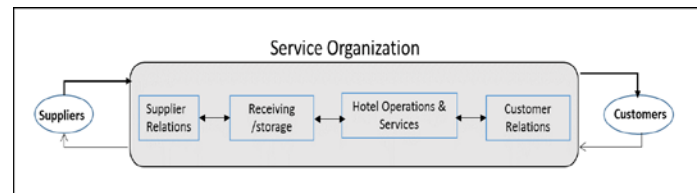


Fig. 1 the main components of a service supply chain

The term of “reverse logistics” is also used to indicate the flow of material backward from customer to sources through recycling, repair, rework, reuse, refurbishment, and so on. Such flow is also gaining ground in hotel industry especially in terms of recycling and reuse. Reverse logistics is considered a strategy for developing sustainable supply chains.

Supply chain sustainability has attracted a growing attention from researchers and practitioners and in various sectors of the economy across the world. That is mainly due to the growing cost of supply chain operations, the increase in stricter environmental regulation and legislations, and the growing competition based on cutting costs and reducing wastes. There is also an agreement among researchers that the concept and techniques of sustainability in services in general are still in the development compared to those in the manufacturing companies.

Sustainable supply chain aims to deliver quality products and services across the supply chain while increasing effectiveness, reducing waste and costs, and being environmentally responsible [6]. The typical challenge that faces organizations in this regard is how to be productive and profitable while being sustainable.

However, few researchers have actually analyzed the wastes of the hotels supply chains and the application of lean techniques and green practices for waste reduction. For example, Vlachos and Bogdanovic [7] presented a survey-

This work was supported by the Office of Research and Sponsored Programs (ORSP) at Abu Dhabi University (ADU) through an internal research incentive fund.

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based study on the lean thinking in European hotel industry. Green practices in hotel industry are relatively more common across the supply chain. An approach known as “triple bottom line” is commonly used to assess supply chain sustainability based on social, environmental, and economic performance [8].

Thus, there is a need for the research on hotels supply chain to analyze and categorize wastes and to link the identified wastes to lean techniques and green practices. Most existing research is mainly focused on assessing and modeling the environmental and economic impacts of the hotel supply chains and prescribing action plans and policies to reduce such impact. This paper presents an exploratory study of hotels supply chain construct and wastes. The study is conducted in selected hotel in Abu Dhabi area in the UAE.

II. STUDY FRAMEWORK

The hotel supply chain is a typical example of service supply chain that is amenable to sustainability practices. Different aspects of hotel supply chains have been explored in body of literature. However, the complete hotel supply chains have not been exclusively investigated yet [9, 10]. Thus, this research will first focus on identifying the construct of the hotel industry supply chain, analyzing pertinent wastes across the supply chain, identifying existing lean and green practices, then assessing the extent of adopting lean and green techniques. As shown in Figure 2, the key elements of the research framework include:

- Supply chain construct
- Waste analysis
- Lean practices (sustainability focus)
- Green practices (sustainability focus)

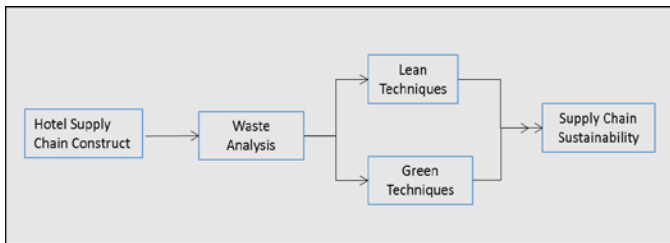


Fig. 2 study framework for hotel supply chain sustainability

A. Construct of Hotel Supply Chain

Before incorporating lean and green practices into the hotel supply chain, it is crucial to understand the construct of the hotel procurement system as well as key hotel operations [11]. As shown in Figure 1, as a service industry, the hotel supply chain is made of the typical elements of Supplier Relationship Management (SRM), logistics, storage, organizational processes and service operations, and of Customer Relationship Management (CRM). These elements which vary from one hotel to another are developed based on the requirements of key hotel services such as:

- Lodging and accommodation
- Restaurants and food services

- Hotel amenities and guest services
- Meetings, events, and conferences

These services require tangible inputs from suppliers and different service providers such as culinary material and other in-bound logistics to ensure efficient delivery of daily hospitality services [12]. Other services in the hotel such as reservation, reception, check-in, check-out, and customer service may not need tangible material as inputs but they need internal and external support and inputs from partners and suppliers such as information, technical support, payment system, security, and so on. Almost all hotel services can be oriented around the hotel guest. As an output, hotel provide services such as catering, events management, and accommodation.

The Supplier-Input-Process-Output-Customer (SIPOC) chart is used in this research to provide the hotel supplies and operations manager with a platform to list the relevant information regarding the hotel supply chain construct, wastes, and the currently used lean and green practices. Figure 3 shows a template of the used SIPOC chart.

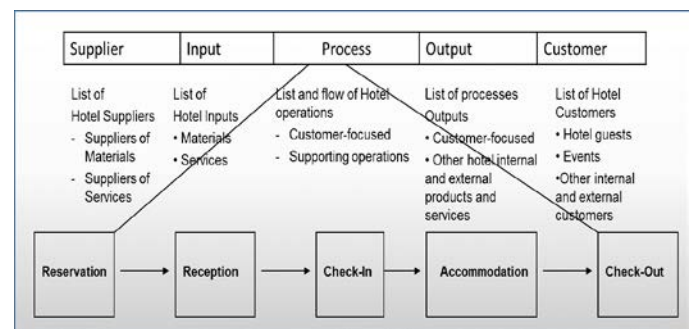


Fig. 3 SIPOC chart of the hotel supply chain construct

B. Waste Analysis

Wastes management is a key business function in most hotels at different star level. This is mainly due to the increased amount of tangible and intangible wastes that are created as a result of hotel services such as accommodation, dining, laundry, and hosted events. This includes food, materials, papers, and so on. The list of wastes in a hotel can also include wastes related to key resources such as water, electricity and energy, and pollution. The list becomes overwhelming when you add to it intangible wastes such as delays, cancellations, complains, errors, and over capacity. As these wastes affect the direct and indirect operational cost, hotels management typically value and support the deployment lean and green techniques that are expected to lead to the reduction or even elimination of different types of wastes. Thus, it is important for any hotel supply chain sustainability framework to analyze the different types of wastes in hotel procurement system and operations and at different stages of the hotel supply chain.

C. Lean Techniques

Lean thinking which was started to reduce or eliminate

production wastes in Toyota has recently developed into a management philosophy that focuses on increasing the effectiveness of the organization. Womack *et al.* [13] describe waste as any activity which uses resources, but creates no value. This includes over production, excess processing, inventory, rework, motion, transport and material handling, defects, failures, setup and underutilizing skills and resources.

The lean supply chain is an approach that is focused on streamlining the flow of goods and information across the supply chain and reducing the supply chain cost by eliminating non-value-added activities through the adoption of lean techniques. To this end, lean principles and tools are applied to the supply chain elements and functions (supplier selection, purchases, shipping, order management, warehousing, manufacturing/processing, transportation, distribution, etc.) to transform it into a value chain. Examples include Kaizen, error-proofing (poke-yoke), flow analysis, line balancing, inventory control, quality-at-the-source, JIT, 5S, etc.

D. Green Practices

The main objective of green SCM is to extend the traditional supply chain to deal with the effects of products and processes. Extended supply chain models often include recycling and remanufacturing operations along with measures to reduce emissions and conserve energy. As an outcome, green SCM can reduce waste, minimize pollution, save energy, conserve natural resources, and reduce carbon emissions. Details on adding the “Green” component to the supply chain management can be found in [14].

In the hotel industry, the application of green technology is expanding as a result of strict regulations and the growing customer awareness of environmental concerns. It is therefore important for a hotel sustainability framework to include specific green practices that can be deployed and lead to conservation of resources, reduction of energy and emissions, and efficient recycling. Examples include environmental standards, safety standards, pollution reduction, recycling, reuse, take-back, energy efficiency, water conservation, green technology, green suppliers, clean transport, hazardous material treatment, etc.

III. STUDY RESULTS

The study has adopted a survey-based industry research to collect empirical data from the hotel industry in Abu Dhabi (AD) of the UAE. It is an exploratory study of the construct and waste types in the hotel supply chain along with an analysis of and categorization of wastes. To this end, a survey is designed and distributed to about thirty 3, 4, and 5 stars hotels in AD area. The survey has collected basic hotel information and identified the types of waste currently exist in the hotel supply chain. The results of the survey were studied and analyzed to answer the following two research questions:

- RQ1: What is the construct of the supply chain of hotels?
- RQ2: What types of waste exist in the supply chain of hotels?

The study results were obtained from the surveys collected

from 30 hotel in AD area. The survey has targeted only the 3, 4, 5-star rated hotels in the Emirate of AD in the UAE. A total of 50 surveys were distributed and 30 were qualified. Key descriptive summary is as follows:

- The rating of the surveyed hotels is as follows; 20 five star, 8 four stars, and 2 three stars. The reason for focusing on 5-star hotels and is getting better response is due to the fact that they have well-established systems and standards (including green and environmental) and more focus of effectiveness (lean practices).
- Hotel size is assessed in terms of hotel employee and rooms for guest accommodation. Number of employee ranges from 45 to 1500. The rooms' number ranges from 95 to 823.
- The level of management is distributed between mid and top level (18 mid-level and 12 top-level). This indicates the interest and the organization seriousness when it comes to such practices.

A. Answers to Research Questions

To answer the first research question, a SIPOC chart is developed to present the construct of AD hotels supply chains based on the collected information from the surveyed hotels. The chart lists hotel suppliers, inputs supplied and used by hotel's main processes, the products and services of these processes, and their customers. Each column in the chart lists the items indicated by each surveyed hotel. For example, the Suppliers column list almost all types of suppliers who provide the hotels with products, parts, food, drinks, materials, and services (IT, security, landscaping, entertainment, repair, etc.). The chart provides a comprehensive view of the hotel supply chain construct.

The main hotel processes and operations represent the core of the construct. These processes takes key inputs and produce key outputs in terms of products and services to guests and hotel internal and external customers. Table 1 provides a summary of main hotel processes along with their inputs and outputs. Suppliers list is not included for confidentiality and customers are limited to hotel guests.

Typically such construct operates through a logistic system that flows material, information, and money across the supply chain. The logistic system includes procurement, transportation, material handling, warehousing, and distribution. Such system is managed through an integrated database and network or an Enterprise Resource Planning (ERP) system.

To answer this question, a SIPOC chart is developed to categorize and summarize the hotel wastes based on the developed construct. As shown in Table 2, the chart lists wastes created by suppliers and customers and observed in the inputs used by hotel processes, within the processes, and their produced outputs. Suppliers produce wastes as well as customers. SRM and CRM can work with both ends of the supply chain on waste reduction.

Table 1 summarized I-P-O construct of the hotel supply chain

Inputs/supplies	Main Processes	Outputs/services
Online bookings Phone reservations Booking website Reservation software	Reservation and booking	Confirmed reservations Events schedule Facilities planning
Guests arrivals Stationary and Office equipment Newspapers and magazines Printing and promotional items	Reception	Check-In Room assignment Payment Check-out Concierge service
Room furniture Entertainment system Linens, towels, bedsheets, robes, etc. Tea, Coffee and Coffee Machines Room amenities Bathroom amenities Room accessories and room decoration Tissues and disposable cleaning papers Promotional items	Room accommodation	Guest comfortable stay Room services
Food and drinks Fruits and vegetables Cooking materials Cooking equipment Cookware and glassware Kitchen furniture Energy and electricity Hardware supplies Cleaning materials Grocery Items (Cereals, Pulses, Spices, canned vegetables, jams, etc.)	Restaurants culinary and cooking	Meals Buffets Rooms catering External catering Room services Events catering Others food services
Maintenance repair and operating supplies. Plumbing and sensor water taps, electrical and lighting fittings, lamps, etc. HVAC system and equipment Security equipment and software Lifts and escalators	Maintenance	Available water and electricity Functional lightening system Functional HVAC system Functional plumbing system Functional security system Functional lifts and escalators

Awareness plans to customers, visitors, and guests and sourcing decisions to select eco-friendly and reliable suppliers (e.g., green suppliers) are initiatives that can achieve such objectives. However, the I-P-O waste reduction is within the control of the hotel management system. That is where most of the effort of engineering and operational excellence should be directed.

Table 2 SIPOC summary of hotel supply chain wastes

Suppliers	Inputs	Processes	Outputs	Customers
Delivery delay Wrong delivery Transportation delay Wrong material Broken items Wrong mix Shortage	Packaging materials wrongly received Item Defects Excessive inventory Improper storage Damaged material Wrong resource allocation	Garbage waste Used Oil Paper/cardboard/ plastics/ Organic waste Raw food Unclear communication Defects: pipes, lamps, hardware Over-processing Under-utilization Waiting, idle time Excessive multitasking	Cooked food waste Amenities waste Delay in guest services Wrong invoicing Misinformation Over Production of food Delay	Wrong reservations Late arrivals Cancellations No shows Late changes Cans Food leftovers Wrong orders Excessive use of water Excessive use of AC Keeping lights on Damaging room furniture and accessories Leaving and spreading dirt Delay in check-out

As seen in Table 2, the wastes across the supply chain can be categorized as tangible (material, item shortage, bad food, defects, etc.) and intangible (delays, errors, bad scheduling, etc.). Hotel supply chain wastes can be also related to the seven wastes or non-value-added (NVA) of lean philosophy.

Table 3 categorizes of the identified wastes in the hotel supply chain into the seven common types of waste according to lean principles and thinking.

Table 3 lean-based categorization of wastes in hotels supply chain

Lean Waste	Waste examples in hotel supply chain
Defects	Broken items, spoiled or expired food and milk, invoicing errors, reservation errors, scheduling conflicts, wrong material, damaged materials, damaged amenities, rejects, return, rework, repair, nonconforming items, parts, devices, and equipment, etc.
Delay/waiting	Late delivery, late shipment, late arrival, services delay, check-in/out delay, customer waiting time, work idle time, unclear communication, resources underutilization, etc.
Overproduction	More than needed supplies, excessive food cooking and catering, garbage, water waste, energy waste, etc.
Overprocessing	Exceeding standards, using expensive equipment, complex operations, complex services, overqualified resources, wrong resource allocation, excessive multitasking
Inventory	Keeping large amount of raw food and drinks, improper storage, excessive storage of cleaning materials, spare parts, tools, equipment, etc.
Transportation	Long distance supplies and shipments, less than full trucks, returns, excessive material handling, back and forth movements, etc.
Motion	Failure to follow standard operating procedures, lack of labor training and skills, excessive worker motion in cooking, housekeeping, and other hotel services and operations.

The role of lean and green techniques will be focused on eliminating/reducing these types of wastes. Such classification can be used by hotel management to select the most effective lean and green techniques that result in the most reduction of wastes across the supply chain. That explains the need for lean and green techniques in the next research question.

Some hotels have developed plans for classifying and recycling different types of hotel wastes. These wastes are assumed to remain after implementing lean and green practices. Table 4 presents an example of wastes classification. Some wastes are treated by private recycling contractors, some are treated internally in the hotel, and some are sent for disposal.

Table 4 example of plan for hotel classification of wastes

Waste Type	Source	Recyclable	Hazardous	Treatment/ Disposal plan
Cardboard/ papers	Rooms offices	Yes	No	ABC company
Food	restaurants	No	No	Disposal
Cans	Restaurants, Rooms, Offices	Yes	No	ABC company
Metals	Rooms, Offices	Yes	No	ABC company
Oils	Restaurants	No	Yes	Disposal
Glass	Restaurants, Rooms	Yes	Yes	ABC Company
Used water	All	Yes	No	Hotel facility
General waste	All	No	No	Disposal

IV. DISCUSSION AND CONCLUSION

The study has explored the hotel supply chain construct and identified, categorized, and analyzed the wastes across the supply chain of hotel industry. Results provided guidelines for assessing and analyzing sustainability practices in hotels supply chains. In general, the study found that the sustainability concept in terms of lean and green practices is relatively new to the hotel industry in AD. Many surveyed

hotels view sustainability as adhering to environmental standards and audits rather than technical lean and green practices. Results showed that 5-star hotels have relatively better sustainability practices across the supply chain in terms of well-established systems and standards (including green and environmental) with more focus of the chain effectiveness (lean practices).

The SIPOC chart is found to be a good platform for analyzing the construct of hotels supply chain based on the collected information from the surveyed hotels. The chart lists hotel suppliers, the inputs supplied and used by hotel's main processes, the products and services of these processes, and their customers. The construct showed the size and diversity in in some cases the complexity of hotels supply chains when analyzed with a comprehensive view from sources of inputs to the flow of services and operations towards hotel customers and guests. The main hotel processes and operations represent the core of the developed construct. These processes take key hotel inputs and produce key outputs in terms of products and services to guests and hotel internal and external customers. Typically such construct operates through a logistic system (procurement process) that flows material, information, and money across the supply chain.

A SIPOC chart is also developed to categorize and summarize the hotel wastes based on the developed construct. The chart listed wastes created by suppliers and customers and those observed in the inputs used by hotel processes, within the processes, and their produced outputs. The wastes across the hotel supply chain were then categorized as tangible (material, item shortage, bad food, defects, etc.) and intangible (delays, errors, bad scheduling, etc.). Wastes were also related to the seven types of wastes or non-value-added (NVA) of lean philosophy.

Such categorization can help the hotel management in identifying and directing effective green practices and lean techniques to reduce the identified types of wastes. For example, recycling and reuse green practices can target tangible wastes and JIT and Kaizen techniques can target the intangible delays and errors. Similarly, each type of lean waste can be targeted by specific lean technique (e.g., defects by quality at the source, overproduction by pull JIT system, excessive inventory by inventory control systems, and so on).

The study recommended that SRM and CRM fronts of the hotel can work with both ends of the supply chain on waste reduction through awareness plans to customers, visitors, and guests and proper sourcing decisions to select eco-friendly and reliable suppliers. However, the hotel sustainability practices should be focused on the I-P-O waste reduction (i.e., with the hotel forward flow and reverse logistics). That is where most of the effort of engineering and operational excellence should be directed.

ACKNOWLEDGMENT

The researchers would like to thank the ORSP office, the students who helped in collecting research data, and the hotel industry in the Emirate of Abu Dhabi of the UAE.

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