Examining Supply Chain Management Structures and Models in Maintenance and Repair Service Operations

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ABSTRACT

There is a need to conduct research studies on the adoption of supply chain management (SCM) models and structures within the maintenance and repair service sector. This paper explores the SCM best practices, techniques, and theoretical models adopted by organizations operating in the maintenance and repair service sector. It also identifies the key contributors to the building of these models and structures and explores the key success factors. Through the use of an online survey, the primary data were collected from 85 SCM practitioners and managers from organizations operating within the market of a Middle Eastern country. The study revealed the key contributors to the development of SCM models and structures. The use of SCM frameworks still lags behind the theoretical models proposed by the scientific literature. Crucial functions from SCM for the effective management of product–service supply chains, such as service performance, reverse logistics, and research and development, are still not explored to their full potential, therefore preventing local organizations from generating and delivering additional value to the market. Such missed value includes quality control, the management of the product life cycle, and the development of new service solutions for the market. The findings from this study can assist service sector managers in understanding better how best to develop effective SCM models and structures to obtain and sustain significant improvement and efficient performance. Such operations can be obtained and leveraged through the effective management of product–service supply chains and the application of the best practices, functions, and processes inherent in the SCM discipline.

Keywords: Maintenance and repair service operations; Supply chain management; Product–service supply chain; SCM conceptual models; SCM structures; Middle East.

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INTRODUCTION

Supply chains (SCs) are not a new concept, and they have been in use for several decades now. This concept has become a unique term, and it appears in more than two thousand publications every year (Braziotis, Bourlakis, Rogers, & Tannock, 2013). Several definitions of a supply chain have been proposed, but no generic consensus has been reached (Corominas, Mateo, Ribas, & Rubio, 2015). However, perhaps the most commonly used definition is Chopra and Meindl's (2013) description of an SC as a network of enterprises, from the suppliers of raw material to the end customers, including producers, manufacturers, transporters, distributors, retailers, and resellers, involved in and working directly or indirectly to attend to and satisfy the market demand and the customer needs. The amount of research related to SC has increased dramatically over the years, and the terms "supply chain" and "supply network" have been used interchangeably; however, there are key differences between the two, for example on the level of complexity (low or high), design (linear or non-linear shapes), configuration (stable or dynamic structures), and focal point (centered on products or on relationships, respectively) (Cui, 2015; Khalaj, Modarres, & Tavakkoli-Moghaddam, 2014; Modrak & Bednar, 2016; Tsinopoulos & Mena, 2015).

Several models of SCM can be found in the literature. One of these models, which is based on business process integration, is the SCM model introduced by the Global Supply Chain Forum (GSCF) (Lambert, 2014). Another commonly used model is the Supply Chain Operation Reference (SCOR), which focuses on processes, performance, and best practices and is endorsed by the Supply Chain Council (APICS Supply Chain Council, 2015). The origin of this model can be traced to the time when manufacturing sectors needed to develop efficiency and effectiveness in operations and to maximize their business performance as a response to turbulent and complex markets, which enabled continuous growth of competition (Baltacioglu et al., 2007). Competitive advantages can be created and better business performance can be sustained through the adoption of best practices and efficient models of SCM (Anatan, 2014; Grimm, Knemeyer, Polyviou, & Ren, 2015; Jacobs & Chase, 2014; Wisner, Tan, & Leong, 2012). However, there are several potential barriers that organizations may face when implementing supply chain management principles within their operations. These may include a lack of management comprehension and support, process integration challenges, and a lack of available resources and technology.

In the past, academics and practitioners were mainly interested in exploring aspects related to supply chain management within manufacturing settings due to the contribution of this sector to the global economic development (Ellram, Tate, & Billington, 2004). However, the service sector has recently begun to contribute in a remarkable manner to the development of the economies in developed countries. In some developing countries, almost 80 percent of the gross domestic production comes from the service sector (World Bank, 2016). Due to this growing trend, several studies have emerged proposing conceptual models and frameworks for the management of service supply chains (SSCs). For example, a generic model was proposed by Ellram et al. (2004), and another model of SCM was proposed by Xu et al. (2014). More relevant to this study, a model related to the management of a product–service supply chain (PSSC) was developed. This concept can be found in several academic studies and is identified as the servitization of manufacturing. The aim of this model is to extend the value chain from a product manufacturer by

delivering additional value to customers through the integration and provision of services with the manufactured product (Baines, Lightfoot, Benedettini, & Kay, 2009; Lightfoot, Baines, & Smart, 2013; Weeks & Benade, 2015).

The Problem

In general, the research studies on supply chain management in maintenance and repair service operations are limited (Sakhuja & Jain, 2012; Xinping, 2013). Thus, there is a need to conduct research studies within this area to strengthen the existent literature and knowledge about the SCM practices applied within the maintenance and repair service sector. This will enable interested practitioners and academics to gain a better understanding of how current operations are structured within service providers, to understand the integration of the principal business processes, and to recognize the gaps between the existing practices and structures of SCM and the theoretical models of management for PSSCs proposed in the literature. These were the motives behind the conducting of this research, and the study attempted to answer the following three questions:

- Which types of SCM structures and models are deployed within the selected maintenance and repair service supply chain and what are the main contributors to building these structures and models?
- What are the key differences between the identified SCM structure and model from maintenance and repair service operations and the proposed conceptual models in the literature?
- What are the key factors that influence business success and customer satisfaction levels in the maintenance and repair service sector that are linked to SCM?

In this paper Section 2 will include a brief review of the literature to enable knowledge construction through a theoretical frame of concepts, practices, and reference models. Section 3 will provide information about the research methodology used. Section 4 will include analyses and discussions of the research outcomes based on the empirical data gathered through the research instrument. Finally, in Section 5 the conclusions, recommendations, theoretical and practical contributions, and implications will be presented.

LITERATURE REVIEW

Management of Service Supply Chains

The service sector is growing rapidly, contributing to the development of economies, and employs a major portion of the workforce in some countries. The operational models from manufacturers and service providers have similar principles of transforming the available resources into valuable outputs; therefore, comprehending how the techniques and methods of operation management from the manufacturing industry could be used successfully within the service industry has become important (Prajogo, 2006). A service is identified as a crucial operational activity within an organization that exerts a positive

impact on customer retention rates; however, SCM research studies still remain focused on manufacturing operations (Giannakis, 2011). Service operation is characterized by intensive interactions with customers and direct links with service levels. The integration and management of services within product supply chains, which are achieved through the effective integration of business processes beyond the organizational operational boundaries, generate important values that can be added to a product in the continual provision of services to the customer throughout the entire life cycle of the product (Baines et al., 2009; Lockett et al., 2009) , that is, transforming a chain of supply into a chain of values (Baltacioglu et al., 2007). This subject has become a relevant area of interest for academics and practitioners nowadays due to the value that can be co-produced and delivered by an SC through collaborative relationships with suppliers, service providers, and customers. Due to the importance of customer perceptions regarding the level of performance of the services provided, which have a direct impact on the success of the business, it has become crucial to develop management models and frameworks for PSSCs' operations that can deliver efficient management of service-level agreements (SLAs), the development of service quality, the reduction of costs, and improvements in the revenues throughout the collaborative partnerships within the supply network.

Supply Chain Management Models for Service Operations

Several theoretical models of SCM originating from the manufacturing industry have been analyzed and discussed in several studies, including their weaknesses, focuses, and applicability to fulfill the needs of the service sector in properly managing its supply chain operations. In 2004 a generic model of SCM focusing on the management of service purchasing within an SSC was presented. The concept of service supply chain management (SSCM) was defined as the "management of information, processes, capacity, service performance and funds from the earliest supplier to the ultimate customer" (Ellram et al., 2004, p. 25). As result, the term service performance was identified and defined as the level of effectiveness of the SSC. This can be measured according to the quality of the service provided based on the contract terms. Considering the structural differences between an SSC and a product SC due to the unique characteristics of services, such as intangibility, heterogeneity, and perishability, Baltacioglu et al. (2007, p. 112) expanded the definitions of an SSC to a "network of suppliers, service providers, consumers and other supporting units that perform the functions of the transaction of resources required to produce services, transformation of these resources into supporting and core services, and the delivery of these services to customers" and SSCM to the "management of information, processes, resources and service performance from the earliest supplier to the ultimate customer." On the journey towards expanding the chain of values by transforming themselves into distinct firms with a business oriented towards the provision of products and services, and no longer as product-oriented organizations focused on producing and delivering physical products only, manufacturers started to demand a new operational model to develop the effective management of product and service supply chains (Maull, Smart, & Liang, 2014). The defended model of business that prescribes this trend of adding services to the offer of a product is identified as a product–service system (PSS), which is aimed at the provision of products and services in an integrated fashion that fulfills the market needs and adds values to the business by developing a competitive advantage at the same time as minimizing the operational costs along PSSCs. The strategic approach of SCM for the support of a PSS

must be centralized on the recognition of the customer values and no longer on the product only, which can be seen as the service and product that the client is willing to pay for considering the existing market alternatives (Magretta, 2012, p. 40), but it is also influenced by the service level that is provided during the entire life cycle of the customer experience (Lee, Geum, Lee, & Park, 2015). Therefore, the perception of value in PSSCs is influenced by the availability, degree of responsiveness, and operational efficiency of a maintenance service provider, and variations along these three dimensions generate a direct impact on the level of satisfaction and retention of the customer.

Xu et al. (2014) developed a new model of management for PSSCs that considers suppliers, the leading service provider, other providers, and the customer as the principal participants in a system in which the value is co-created among their interactions and defends the idea that the value recognized by the customer is obtained through integrated and active work between all the participants during the production and delivery of services. As cited by the authors, the creation of value in PSSCs can be achieved through the existence and efficient management of two types of processes, the functional and enabling processes. The group of functional processes is crucial for the customer recognition of values and consists of the management of the demand, capacity, resource allocation, and service delivery. The execution of daily activities is effectively supported, from the technological and managerial perspectives, by the existence of the following enabling processes of management: performance, customer relationships, service provider and supplier relationships, information technology, and network service management. The functional process of service delivery management must converge in fulfilling the established commitments to the customers whereby customer perception and satisfaction are directly affected in terms of how the service is performed and delivered; therefore, a high level of customer satisfaction requires efficient planning of the tasks to be performed and active management of their execution during service production (Xiao & Yang, 2008).

The design, implementation, and control of a reverse logistics function to cover the repair services of damaged parts with the original manufacturer has become an essential element to the effective management of PSSC operations nowadays (Amini, Retzlaff-Roberts, & Bienstock, 2005). Information technology management is recognized as the process that facilitates the sharing of accurate and reliable information among all the participants in the SC through the use of innovative technologies and computer systems, such as EDI, RFID, and ERPs (Brookman, Smit, & Silvius, 2012; Haddud, 2011; Laosirihongthong, Punnakitikashem, & Adebanjo, 2011; Li, 2011) and generates significant results in terms of the integration of business processes, collaborative control over the demand forecasting and planning, and level of responsiveness through the reduction of lead times (Auramo et al., 2008; Kumar, 2001).

RESEARCH METHODOLOGY

Research Method and Participants' Profile

A quantitative research approach was adopted for this study. This research is exploratory in nature, and an online survey was chosen as a tool to collect the primary data. Easterby-Smith, Thorpe, and Jackson (2012) stated that exploratory surveys can be used to establish the understanding of the existence of organizational and group behavior patterns from numerical data by collecting and analyzing the opinions, experiences, and values of

the research participants. The survey was developed online on the QuestionPro online platform (QuestionPro, 2016). The data were collected from participants working in the service sector of in the selected Middle East country. The selected participants shared the same common characteristic of working in an organization that actively operates in PSSCs and had the necessary knowledge and expertise to complete the survey. The participants were middle- and senior-level SCM professionals, for example logistics, purchasing, planning, and operations managers, working in the selected service sector within both private and public organizations. Data were collected about the structures, functions, and processes of SCM currently deployed within their operations. The data collection process began on May 29, 2016 and concluded on June 11, 2016. A total of 342 potential participants were selected and contacted through an invitation email to participate in the research by filling in the questionnaire survey. A total of 131 surveys were completed, 42 of which were incomplete and therefore unusable. The 87 fully completed surveys resulted in a response rate of approximately 25%.

Survey Design

The survey assumed a structured model with closed-ended questions, expressed as multiple choices with single and multiple answers, and multi-point Likert scale questions, wherein the primary variables were presented to gather specific and defined responses that facilitated their frequency analysis. The main variables under assessment were presented along with the questions to ensure that the answers provided the expected contribution to the context of the research.

The identification of the current structures and models of SCM deployed among service providers was initially performed by capturing the perceptions from the survey participants regarding several key areas and the importance of customer services was ascertained through the application of multiple choices with a single answer question (Appendix A), followed by four questions on a five-point Likert scale to collect the respondents' opinions regarding the entities that should participate in PSSCs' structures, the business functions from SCM that positively influence the level of business success through the efficient management of PSSCs, and the factors that improve the levels of business success and customer satisfaction.

The empirical evidence that supported the construction of the answer to the main research question, regarding the current structures and models of SCM management implemented by maintenance service providers along PSSCs, was obtained by analyzing the results of the major frequency of occurrences identified among the answers provided by the survey participants to three multiple-choice questions with multiple answers (Appendix B). Based on a presented list of pre-selected variables, the answers from these three questions revealed the group of functional areas and business processes currently deployed within the participants' operations and among the supply chain participants.

Profile of the Participants

Demographic information was collected about the participants, and this included age, gender, level of education, job role, organization operational sector, organization core activity, customers' operational sectors, and business size. The results are shown in Table 1. All the participants worked in the same selected Middle Eastern country.

Table 1: Profile of the Participants

Classification		Frequency	Percentage
Participant Age	26–40 Years	53	59.6
	41–55 Years	32	36.0
	56 Years or Older	4	4.5
Participant Gender	Female	8	10.1
	Male	80	89.9
Level of Education	High School	2	2.2
	College	4	4.5
	Bachelor's Degree	36	40.4
	Master's Degree	43	48.3
	Doctoral Degree	3	3.4
	Professional Degree	1	1.1
Role in the Company	Upper Management	29	32.6
	Middle Management	43	48.3
	Junior Management	8	9.0
	Supervisor	2	2.2
	Coordinator	4	4.5
	Adm. Staff	1	1.1
	Consultant	2	2.2
Organization Operational	Public Sector	6	6.7
	Private Sector	82	92.1
	Not for Profit	1	1.1
Organization Core Activity	Service-Only Provider	32	36.0
	Product–Service	57	64.0
Customers' Operational	Agriculture	5	2.5
	Mining Including Oil and Gas	21	10.6
	Manufacturing	24	12.1
	Construction	22	11.1
	Maintenance	9	4.5
	Banking	8	4.0
	Telecommunications	13	6.6
	Retailing	30	15.2
	Professional Services	10	5.1
	Non-profit Activity	5	2.5
	Education	5	2.5
	Government Services	27	13.6
	Private Consumers	19	9.6
Business Size	Micro (1–9 Employees)	1	1.1
	Small (10–49	10	11.2
	Middle (50–249	23	25.8

Classification		Frequency	Percentage
	Large (More than 250 Employees)	55	61.8

Reliability of the Survey Instrument Used

A construct containing 19 items was used to collect participants' perceptions about the SCM models used, PSSCs' structures, and their impact on business development through the deployment of theoretical models of SCM. Each of the 19 items used a 5-point Likert agreement scale: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree. This allowed the final score for each item to range from 19 to 95. The Cronbach's alpha coefficient for this construct was 0.947, reflecting a good level of internal consistency reliability and homogeneity among the items. The scale mean was 79.13, the variance was 202.68, and the standard deviation was 14.237. Table 2 shows the detailed item analysis output obtained from SPSS for this 19-item scale.

Validity of the Survey Instrument Used (Factor Analysis)

Factor analysis began to be used a century ago, and it is still one of the most utilized multivariate statistics procedures for projects of applied research within the domain of management (Brown, 2006). Factor analysis is commonly used for the validation of constructs and in psychometric evaluations of a test instrument with multiple items, confirming the capacity of a single factor to explain the inter-correlations between several items and supporting the determination of whether all the elements are logical indicators of the fundamental construct under analysis; that is, what is the level of the relation between each item and the factor (Chong, Ooi, Lin, & Tang, 2009). The extraction method of principal factor analysis, a technique that is frequently used for dimension reduction from exploratory factor analysis with continuous indicators, was adopted to confirm the construct validity, identify the number of factors from each research instrument, and capture the variance in the observed measures.

Knowing that the current survey questionnaire instrument was still not applied in local service organizations, an exploratory factor analysis was conducted on the scale questions to assess and validate the instrument's validity. This section shows the results of the exploratory factor analysis (EFA) applied to the primary four-scale constructs of this research to identify and extract the number of factors that contributed to the major variations along the collected measures, to measure how the items under each construct are linked with each other, and to estimate the loading factors from each element onto the extracted factors (IDRE, 2016). The relationship pattern between the items and the common factors of a construct, that is, the factor loading, with a value superior to 0.30 was considered to be significant, a factor loading superior to 0.40 was assumed to be important, and values above 0.50 were considered to be very important (Hair, Black, Babin, & Anderson, 2014, p. 115).

Table 2: SPSS Output for Structures and Functions from SCM for Business Success

Statistics for Scale	**No. of Items**	**Mean**	**Variance**	**SD**
	19	79.13	202.686	14.237

	Mean	**Minimum**	**Maximum**	**Range**	**Max./ Min.**	**Variance**
Item Means	4.165	3.944	4.629	0.685	1.174	0.042
Item Variances	1.095	0.645	1.450	0.805	2.249	0.065
Inter-Item Correlations	0.492	0.163	0.929	0.766	5.708	0.021

Item–Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item–Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Business Process Integration with SC Participants	75.15	181.65	0.634	0.820	0.945
Logistics System Coordination within SC	75.01	177.83	0.729	0.923	0.944
Coordination of Spare Part Systems within SC	75.19	181.66	0.697	0.805	0.944
Maintenance System Coordination within SC	75.18	181.10	0.730	0.782	0.944
Manufacturing System Coordination within SC	75.18	181.47	0.664	0.810	0.945
Use of Information and Communication Systems	74.97	179.17	0.701	0.916	0.944
OEM	74.96	178.00	0.731	0.727	0.944
Other Service Providers	75.18	181.58	0.696	0.663	0.944
Suppliers of Parts and Components	74.87	185.78	0.636	0.643	0.945
Repair Service Providers	75.10	183.30	0.644	0.663	0.945
End Customer	74.85	182.42	0.599	0.579	0.946
Design of Services and Innovation	75.13	185.66	0.657	0.725	0.945
Planning of Demand and Service Capacity	75.01	183.13	0.671	0.678	0.945
Efficient Production of Services	75.01	180.83	0.687	0.686	0.944
Collection of Customer Feedback	74.94	180.08	0.752	0.828	0.943
Application of Customer Feedback	74.96	181.73	0.735	0.843	0.944
Availability	74.61	186.38	0.705	0.784	0.944
Responsiveness	74.51	187.64	0.655	0.831	0.945
Efficiency	74.63	187.08	0.637	0.784	0.945
Reliability Cronbach's Coefficient for the 19 Items		**0.947**			

Table 3 displays the results of the factor analysis of the construct of structures and functions from SCM and their relation to the success of the business. Although two

components, or factors, were initially identified by the factor analysis test, a single factor was considered and extracted due to the significant degree of factor loading from the items under the identified single component. The calculated values of the loading factor from each item under the selected factor ranged from 0.649 to 0.793. The outcomes confirmed the contribution from each item instrument construct to measuring the participant's comprehension regarding the relation of the deployment of appropriate structures and functions of SCM and the development of business success.

Table 3: Factor Analysis of the Structures and Functions of SCM and Business Success

Construct	Scale Item	Component or Factor (Factor Loading)	Percentage of Variance
Structures and Functions of SCM for Business Success	Business Process Integration with SC Participants	0.661	202.686
	Logistics System Coordination within SC	0.746	
	Coordination of Spare Part Systems within SC	0.719	
	Maintenance System Coordination within SC	0.751	
	Manufacturing System Coordination within SC	0.684	
	Use of Information and Communication Systems	0.721	
	OEM	0.764	
	Other Service Providers	0.735	
	Suppliers of Parts and Components	0.684	
	Repair Service Providers	0.686	
	End Customers	0.649	
	Design of Services and Innovation	0.706	
	Planning of Demand and Service Capacity	0.715	
	Efficient Production of Services	0.737	
	Collection of Customer Feedback	0.793	
	Application of Customer Feedback	0.775	
	Availability	0.755	
	Responsiveness	0.710	
	Efficiency	0.696	

RESULTS AND DISCUSSION

Item Statistics for Structures and Models of SCM and Business Success

Table 4 provides the statistical details from the scale, which had a mean of 79.13, a standard deviation of 14.28, and significant variance of 202.686. The mean average from the items was 4.17, with values ranging from 3.94 to 4.63. Items 1, 2, 3, 4, 5, 8, 10, 12, 13,

and 14 had a mean below the average, which indicates that most of the correspondents tended to answer from the center to the right of the Likert scale. The analysis of the item-to-total correlation criteria showed that all the items had values higher than 0.5, that is, values above the minimum acceptable value of 0.40. All the items had negative item skewness values below - 0.5, indicating asymmetrical distribution that was highly skewed to the left.

Table 4: Item Statistics for the Structures and Models of SCM and Business Success

Item	Description	Mean	Standard Deviation (SD)	Item Skewness	Item-to-Total Correlation	Mode
1	Business Process Integration with SC Participants	3.99	1.153	-1.343	0.634	4
2	Logistics Systems Coordination within SC	4.12	1.204	-1.600	0.729	5
3	Coordination of Spare Part Systems within SC	3.94	1.059	-1.060	0.697	5
4	Maintenance System Coordination within SC	3.96	1.043	-1.014	0.730	5
5	Manufacturing System Coordination within SC	3.96	1.117	-1.311	0.664	4
6	Use of Information and Communication Systems	4.17	1.180	-1.610	0.701	4
7	OEM	4.18	1.192	-1.344	0.731	5
8	Other Service Providers	3.96	1.065	-0.775	0.696	5
9	Suppliers of Parts and Components	4.27	0.926	-1.182	0.636	5
10	Repair Service Providers	4.03	1.049	-0.974	0.644	5
11	End Customers	4.28	1.168	-1.534	0.599	5
12	Design of Services and Innovation	4.00	0.905	-0.848	0.657	5
13	Planning of Demand and Service Capacity	4.12	1.020	-1.500	0.671	5
14	Efficient Production of Services	4.12	1.116	-1.503	0.687	5
15	Collection of Customer Feedback	4.19	1.065	-1.606	0.752	4
16	Application of Customer Feedback	4.18	1.006	-1.398	0.735	5
17	Availability	4.53	0.813	-2.428	0.705	5
18	Responsiveness	4.63	0.803	-2.857	0.655	5
19	Efficiency	4.51	0.854	-2.198	0.637	4

Item Statistics for Questions with Multiple Choices

The importance of customer services

The frequency analysis performed on this question identified the extent to which the survey participants recognize the importance of customer services throughout the business operations of product service organizations. The results identified a mean of 4.51 with a standard deviation of 0.725, as shown in Table 5.

Table 5: Frequency Analysis of the Importance of Customer Services in PSSCs

Mean	Variance	Std. Deviation
4.51	0.526	0.725

	Frequency	Percentage
Not Important	1	1.10%
Slightly Important	1	1.10%
Somewhat Important	3	3.40%
Very Important	31	34.80%
Extremely Important	53	59.60%

Item statistics for the main participants in supply chains

The frequency analysis from the construct items is detailed in Table 6. All the items had a frequency above 50 percent. Item 1 (OEM) had the dominant frequency of 76.40 percent among the total of answers received from the participants and a low standard deviation of 0.182. The lowest frequency of 50.60 percent was observed for item 4 (repair service providers), with a standard deviation of 0.253. Items 2, 3, and 5 had a frequency of 64, 68.5, and 65.2 percent of the total, respectively.

Table 6: Frequency Analysis of the Main Participants from PSSCs

Item	Description	N	Percentage	% of Total	Mean	SD	Variance
1	OEM	68	23.50%	76.40%	0.760	0.42	0.182
2	Other Service	57	19.70%	64.00%	0.640	0.48	0.233
3	Suppliers of Parts	61	21.10%	68.50%	0.690	0.46	0.218
4	Repair Service	45	15.60%	50.60%	0.510	0.50	0.253
5	End Customers	58	20.10%	65.20%	0.650	0.25	0.230
	Total	28	100.00%				

Item statistics for business processes implemented during operations

The frequency analysis from the construct items is shown in Table 7. The dominant frequency was obtained from item 1 (CRM) with 67 percent and a variation of 0.226. The lowest frequency of 23.90 percent was found for item 14 (service network management), with the lowest variance of 0.182. Items 2, 3, 4, and 9 had variances near 0.25 and frequencies above 50 percent. The remaining items had a frequency below 50 percent.

Table 7: Frequency Analysis of Business Processes Implemented within Operations

Item	Description	N	Percentage	% of Total	Mean	SD	Variance
1	CRM	5	10.40%	67.00%	0.66	0.47	0.226
2	SRM	5	9.10%	59.10%	0.58	0.49	0.246
3	Customer Services Mgmt.	4	8.20%	53.40%	0.53	0.50	0.252
4	Service Demand Mgmt.	3	5.30%	34.10%	0.34	0.47	0.226
5	Service Delivery Mgmt.	4	7.50%	48.90%	0.48	0.50	0.253
6	Service Performance Mgmt.	4	7.40%	47.70%	0.47	0.50	0.252
7	Capacity Mgmt.	3	6.10%	39.80%	0.39	0.49	0.241
8	Resource Mgmt.	3	6.50%	42.00%	0.42	0.49	0.246
9	Order Process Mgmt.	5	9.80%	63.60%	0.63	0.48	0.236
10	Product Flow Mgmt.	4	7.20%	46.60%	0.46	0.50	0.251
11	Information Flow Mgmt.	4	7.40%	47.70%	0.47	0.50	0.252
12	Product/Solution Dev.	2	4.40%	28.40%	0.28	0.45	0.204
13	Reverse Logistics Mgmt.	4	7.00%	45.50%	0.45	0.50	0.250
14	Service Network Mgmt.	2	3.70%	23.90%	0.24	0.42	0.182
	Total	5	100.00%				

Item statistics for existing functional areas within operations

The frequency analysis from the construct items is detailed in Table 8 below. The highest frequencies were obtained from item 4 (logistics, warehousing, and transportation) and 2 (sourcing, purchasing, and procurement), with 94.4 and 89.9 percent and the lowest variances of 0.054 and 0.092, respectively. The lowest frequency of 37.10 percent was obtained from item 8 (research and development), with a variance of 0.236. Items 1, 3, 6, and 7 had frequencies above 50 percent. Items 5, 9, and 10 had the same frequencies of 44.9 percent, which is below 50 percent.

Table 8: Frequency Analysis of Functional Areas Implemented within Operations

Ite	Description	N	Percenta	% of	Mea	SD	Varian
1	Material Planning	68	12.20%	76.40%	0.76	0.42	0.182
2	Sourcing/Purchasing/Procurem	80	14.40%	89.90%	0.90	0.30	0.092
3	Contracts/Legal	57	10.30%	64.00%	0.64	0.48	0.233
4	Logistics/Warehousing/Transp	84	15.10%	94.40%	0.94	0.23	0.054
5	Production of Goods or	40	7.20%	44.90%	0.45	0.50	0.250
6	Finance	61	11.00%	68.50%	0.69	0.46	0.218
7	Marketing and Sales	53	9.50%	59.60%	0.60	0.49	0.244
8	R&D	33	5.90%	37.10%	0.37	0.48	0.236
9	Engineering	40	7.20%	44.90%	0.45	0.50	0.250
10	Reverse Logistics	40	7.20%	44.90%	0.45	0.50	0.250
	Total	55	100.00%				

Discussion of the Analyzed Data

The main construct with four multi-point Likert scales, with the means and modes of each item illustrated in Table 4, was applied to support the comprehension of how the theoretical models of SCM are understood by the area practitioners.

1. The recognition of positive impacts from SCM factors on the success of a service provider showed that items 2, 3, and 4 had a mode of 5, which represents level 5, "strongly agree," on the Likert scale. Items 1, 5, and 6 had a mode of 4, which represents level 4, "agree," on the scale.
2. All the items related to the participation of entities within the structure of a supply chain, namely items 7, 8, 9, 10, and 11, had a mode of 5, which is level 5, "strongly agree," on the Likert scale.
3. The comprehension of critical business processes within a service provider organization was supported by items 12, 13, 14, and 16 with mode 5, which represents level 5, "strongly agree," on the Likert scale, while item 15 had a mode of 4, which represents level 4, "agree."
4. The understanding of the main factors to develop customer satisfaction and retention obtained a mode of 5 from items 17 and 18, representing level 5, "strongly agree," on the Likert scale, while item 19 had a mode of 4, representing level 4, "agree."

The research showed that the respondents have a significant level of knowledge regarding the theoretical models of SCM. The majority of the participants recognized the strategic relation between the integration of business processes, the coordination of logistics, spare parts, and maintenance and manufacturing systems, and the use of technological systems to improve the communication and information sharing among the main participants of PSSCs (Table 3) and to develop the level of business success in delivering an effective product–service solution to the market. Several functions from SCM theoretical models for the efficient management of PSSCs, such as service design and innovation, demand and capacity planning, efficiency in service production, and the application of customer feedback, were recognized by the participants as essential elements in developing business success. Availability, responsiveness, and efficiency were all factors from the service provision process that were recognized as being vital to the success of a service business. The research showed that the respondents recognized the importance of having suppliers of parts and other service providers as participants in the structures of PSSCs together with the original equipment manufacturer (OEM), service providers, and end customers.

Customer services, a critical process within service operations, was recognized by the majority of the respondents as being extremely important (Table 5) and therefore demonstrates that the business strategies from local service organizations acknowledge the crucial role of the customers in the process of service delivery.

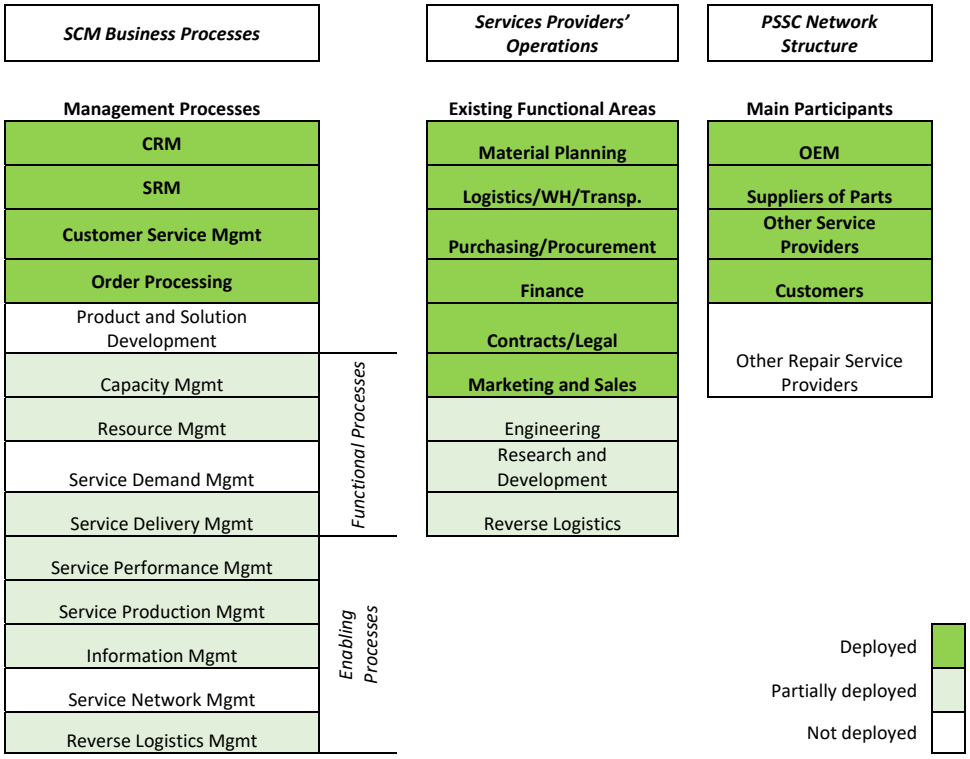
Regarding the current models of management adopted by local service organizations, the principal focus on increasing the sales by fulfilling the current market demand was evidenced through the identification of the primary business processes implemented throughout the operations of the majority of the service organizations. SRM, CRM, order processing, and customer service management are the SCM business processes most

implemented by maintenance service organizations (Table 8); other critical processes responsible for the creation of value within PSSC operations, such as the functional processes for the management of service capacity, resources, and delivery, and the enabling processes of service management performance, information flow, and product flow are still not adopted within the operations of the majority of local service providers. The management processes responsible for product or solution development, service networks, and service demand management were identified as having been implemented within only a few operations. The main functional areas identified as existing within maintenance service operations were logistics, procurement, finance, contracts, marketing and sales, and material planning (Table 8). However, the crucial business functions from SCM for PSSCs, such as reverse logistics, engineering, and research and development, are still not significantly explored by local service organizations, therefore preventing local service operations from delivering additional value to the market in terms of quality control over the services produced, efficient management of products' life cycle, and the development of innovative service solutions. Regarding the existing structures of the SC, although comprehended and recognized by the local field practitioners, the participation of business partners in the provision of repair and maintenance services along local PSSCs are still not fully explored (Table 6). The OEMs, suppliers of parts and components, other service providers, and end customers were the main participants identified in the structures of local PSSCs, which reveals a good design of the SC structures currently implemented in support of product service systems; however, there is a margin for further operational improvements through the insertion of other service and repair providers into the current PSSC structures.

Although recognized by the research participants as crucial factors for value creation, the development of operational performance, and the level of competitive advantage for service operations (Table 2), which exert a direct impact on the success of the business, the existence of important components from the service operations model, such as the design of innovative services, the collection and application of service feedback, efficiency in production, and the planning of demand and service capacity, still face obstructions to their full exploration by local service providers due to the inexistence of functional processes of product, solution, and service demand management and the not-particularly-significant presence of the enabling business functions of research and development, engineering, and reverse logistics.

Figure 1 reflects the model of SCM currently deployed by local service providers regarding the management of local PSSCs attending to the market demand for services. The model was developed based on the analysis of the data collected from the research instrument and involves the main sections of the network structure and the main participants, the management processes implemented, and the existing functional areas; the color intensity identifies the level of presence of each element within each model section.

Figure 1: SCM Model for the Management of Local PSSCs



CONCLUSION

Conclusions and Recommendations

The objective of this research was to contribute to the body of knowledge in the area of operations and supply chain management regarding how the phenomenon of SCM is currently deployed in maintenance service operations for the effective management of PSSCs within the Middle Eastern market. This study was grounded on a scientific approach and conducted by applying a research methodology based on the philosophical perspective of constructivism to understand the facts and therefore the reality by gathering the perceptions and opinions of field practitioners. Through the examination of theoretical SCM models, the required evidence regarding the practices of management currently implemented among local service operations was captured and a better comprehension was developed regarding the model of SCM utilized by local repair service organizations in the management of their PSSCs.

It was revealed by this study that local professionals from the service sector have a

very good understanding regarding the operational benefits produced by the applicability of the principles from the SCM discipline for the effective management of maintenance operations. Although the benefits from SCM best practices, including SC structure participants, functions, and business processes, are recognized by the professionals, their real implementation within their PSSC operations is still in a juvenile phase when compared with the leading companies from the manufacturing industry. The inclusion of other repair service providers, as partners or collaborators within a service network, is still not being explored in the effective management of local PSSCs, therefore preventing the business from developing significant advantages in terms of capacity and resource management in the face of an unpredictable demand. The integration of key business processes from SCM among the main participants, such as service demand management and information technology, could improve the business operational performance by developing collaboration, trust, and the sharing of crucial information related to the demand, capacity, and resources along the PSSC. The implementation of critical functions from SCM within focal enterprises as service production management could generate significant positive impacts on the business performance by improving the level of competitiveness and reducing the operational costs through the development of availability, responsiveness, and efficiency. The current service levels could be improved significantly through the effective deployment of the reverse logistics function in the management of the backward flow of material and environmental sustainability issues, thereby fortifying the organization's image, improving the availability of spare parts, and reducing repair cycle times. The development of customer loyalty and satisfaction would certainly be improved by the existence of an R&D function for the creation and management of innovative solutions for the customers.

Practical and Theoretical Contributions

The practical contributions provided by this research are directly related to the findings, which can assist managers and top leaders from the service sector in better comprehending and evaluating their state of knowledge regarding the applicability of theoretical models and frameworks from SCM in the management of PSSC operations. Significant improvements in operational performance can be achieved by maintenance service providers through the use of the best models from SCM in the effective management of PSSCs, which were presented and explored within this study through the key elements of structures and participants, functions, and business processes. The development and adequacy of the existing models and structures of SCM deployed by the leading organizations should be evaluated and sought tirelessly by service providers for the achievement of an efficient and effective management of local PSSCs.

The theoretical contributions of this research involve the advancements in the comprehension of how the concept of supply chain management, including its best practices, models, and structures, are currently understood by practitioners from the discipline and effectively applied by maintenance service providers along with their operations for the management of local PSSCs. The initial model of SCM revealed by this study provided the required set of evidence to illuminate the comprehension about the maturity of the specific sector under study regarding the applicability of principles and best practices of the SCM discipline.

Theoretical and managerial implications

Maintenance service providers should carefully evaluate their current structures and models of management and strive to develop the level of business operational performance through the deployment of the best structures and functions within their operations, as well as in integrated key business processes along with strategic business partners, for the effective management of PSSCs. However, the major constraints that may be faced by organizations and managers during such an endeavor will be related to the main obstacles to SCM implementation (Fawcett, Magnan, & McCarter, 2008; Grimm et al., 2015; Lambert, 2014) and the redesign of the internal and external structures and business processes to support the continual improvement of operational effectiveness (Palma-Mendoza & Neailey, 2015). Therefore, the major efforts should continue towards the development and applicability of the scientific knowledge from the SCM discipline within the service sector, the execution of a top-down strategy of key stakeholder involvement, and the cross-functional integration approach to develop the business and whole SC performance and thus improve the competitive advantage (Halldorsson, Kotzab, Mikkola, & Skjott-Larsen, 2007; Oliveira, Pimenta, Hilletofth, & Eriksson, 2016; Pimenta, da Silva, & Tate, 2016).

Studies exploring the applicability of SCM principles during maintenance operations within the service sector are still scarce. Scientific studies have been produced in the main application areas of health care, tourism, logistics, and education operations (Sakhuja & Jain, 2012; Xinping, 2013); therefore, the possibility of further comparison of these study results with empirical evidence from the existing literature becomes limited. This research focused on gathering perceptions and evidence from professionals from service organizations in a country in which the economy is supported by the service sector, without a significant presence and influence from the manufacturing industry, which could explain the lack of adherence to SCM principles. This therefore hampers the identification and exploration of the external factors that could exert a direct impact on the applicability of best practices from SCM along PSSCs. Although the findings of this study improved the comprehension regarding the current model of management for PSSCs within service maintenance operations, the methods for data collection and analysis cannot reach the required range to generalize the results. Further research among service organizations from other regions, for example developed and industrialized countries, should be performed to improve the understanding of SCM models in PSSCs and thus reduce the biases of conclusions caused by the differences and limitations of operational environments.

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APPENDICES

Appendix A – Theoretical Understanding of SCM

- How much do you agree with the following factors and their impact on the success of a service provider?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Integration of business processes across the supply chain participants	❑	❑	❑	❑	❑
Coordination of logistics systems within the supply chain	❑	❑	❑	❑	❑
Coordination of spare part systems within the supply chain	❑	❑	❑	❑	❑
Coordination of maintenance systems within the supply chain	❑	❑	❑	❑	❑
Coordination of manufacturing systems within the supply chain	❑	❑	❑	❑	❑
Use of information and communication technology	❑	❑	❑	❑	❑

- How important is the participation of the entities below in the structure of a supply chain?

	Not at all important	Slightly important	Neutral	Moderately important	Very Important
Original product manufacturer (OEM)	❑	❑	❑	❑	❑
Other service providers	❑	❑	❑	❑	❑
Suppliers of parts and components	❑	❑	❑	❑	❑
Repair service providers	❑	❑	❑	❑	❑
End customers	❑	❑	❑	❑	❑

- How important is the existence of the following functions to the success of a service provider?

	Not at all important	Slightly important	Somewhat important	Very important	Extremely important
Design of services and innovation	❑	❑	❑	❑	❑
Planning of demand and service capacity	❑	❑	❑	❑	❑
Efficient production of services	❑	❑	❑	❑	❑
Collection of customer feedback	❑	❑	❑	❑	❑
Application of customer feedback	❑	❑	❑	❑	❑

- How important are the following factors for customers' satisfaction and retention?

	Not important	Slightly important	Somewhat important	Very important	Extremely important
Availability	❑	❑	❑	❑	❑
Responsiveness	❑	❑	❑	❑	❑
Efficiency	❑	❑	❑	❑	❑

Appendix B – Implemented Structures and Models of SCM

- What are the participants in your supply chain (select all that apply)?
  - [ ] Original Product Manufacturer (OEM)
  - [ ] Other Service Providers
  - [ ] Suppliers of Parts and Components
  - [ ] Repair Service Providers
  - [ ] End Customers
  - [ ] Other _____

- Knowing that a business process is a set of activities that are performed to accomplish a business objective, identify from the list of business processes below the ones that are implemented within your current operation:
  - [ ] CRM (Customer Relationship Management)
  - [ ] SRM (Supplier Relationship Management)
  - [ ] Customer Service Management
  - [ ] Service Demand Management
  - [ ] Service Delivery Management
  - [ ] Service Performance Management
  - [ ] Capacity Management
  - [ ] Resource Management
  - [ ] Order Process Management
  - [ ] Product Flow Management
  - [ ] Information Flow Management
  - [ ] Product or Solution Development Management
  - [ ] Reverse Logistics Management
  - [ ] Service Network Management
  - [ ] Other _____

- Select from the list below the business functional areas that exist within your organizational structure:
  - [ ] Planning
  - [ ] Procurement/Sourcing/Purchasing
  - [ ] Contracts/Legal
  - [ ] Logistics/Warehousing/Transportation
  - [ ] Production of Goods or Services
  - [ ] Finance
  - [ ] Marketing and Sales

[ ] Research and Development
[ ] Engineering
[ ] Reverse Logistics

- How important is the process of customer services for your business?
  [ ] Not Important
  [ ] Slightly Important
  [ ] Somewhat Important
  [ ] Very Important
  [ ] Extremely Important