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Commonalities and differences between service and manufacturing supply chains: Combining operations management studies with supply chain management

Ming Zhou
San Jose State University, ming.zhou@sjsu.edu

Taeho Park
San Jose State University, taeho.park@sjsu.edu

John Yi
Saint Joseph's University

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Ming Zhou • Taeho Park
San Jose State University, San Jose, CA

John Yi
Saint Joseph's University, Philadelphia, PA

The service sector of the US economy has been gaining importance. As the service sector evolves, the study of service supply chain starts to gain attention. In this study, we conduct an exploratory review on the studies of manufacturing and service supply chains. We focus on the studies that explore the differences and commonalities between manufacturing and service supply chains. We combine operations management literature with supply chain studies in order to provide an inter-disciplinary framework that brings up both the operational and strategic views on the management commonalities and differences between the two types of supply chains.

I. INTRODUCTION

The study of services has lagged the study of manufacturing. When Fred Harvey proposed that services can be standardized and managed systematically, standardization and systematic management had been applied in the manufacturing sector by pioneers such as Eli Whitney and Frederick Taylor. The first business school course that focused on service management was not introduced until 1973 (Heineke and Davis, 2006). Despite the lag of academic attention, the service sector has been gaining importance as the US economy becomes more and more service-centric. According to the US Census Bureau, the service sector accounts for fifty five percent of the US economic activities in 2007 (Services Annual Survey, 2007). Along with the evolvement of service industries, service research starts to catch up and a variety of aspects of service management are identified and explored. In recent years, one aspect of service management, the service supply chain, has attracted research attention (Sampson, 2000; Frohlich and Westbrook, 2002; Ellram et al., 2004). Service firms also transact with their suppliers and serve their downstream customers. This very much resembles the classic manufacturing supply chain structure. In addition, service outsourcing becomes increasingly common a practice (Allen and Chandrashekar, 2000; Adler, 2003; Crockett and Ante, 2004). Hence, service supply chain is of great strategic importance in today's business.

Despite the large amount of research on service supply chains, studies that comprehensively elaborate the commonalities and differences between manufacturing supply chains and service supply chains are still scant. Furthermore, the success of any supply chain management tightly hinges on the operational efficiency of supply chain partners. Although a couple of extant studies already attempted to identify the commonalities or differences from conventional supply chain management perspective, insights from operations management are yet to be integrated. In another words, an inter-disciplinary perspective is not

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witnessed in existing literature. In this study, an exploratory review is conducted in order to bridge the above gaps and provide a preliminary framework that better enhances our understanding of the service supply chain. Please note that we are making no attempt to exhaust the existing literature relevant to service supply chains. Instead, the purpose of this paper is to identify and discuss major findings that contrast service and manufacturing supply chains as well as adding an operations management perspective to existing understandings.

Before we can proceed to compare service supply chains with manufacturing supply chains, a definition of services should be provided. Frohlich and Westbrook (2002) used the standard industry classification (SIC) system to define service industries. As defined by the US Census Bureau, the US economy can be segmented into good-producing industries and non-good producing industries, where retail trade, wholesale trade and service industries all fall under the non-good producing sector. Such a classification is constructive in understanding the structure of the US economy and where the service industry is positioned. Unfortunately, it does not provide much meaningful information as to what service is. Sampson (2000) specifically discussed what service is. One set of definitions focuses on the intangibility of services. However, intangibility is only an important characteristic of services. Sampson (2000) argues that services have tangible part as well. A second definition describes services as a solitary unit that fails to reveal the dynamic aspect of services. For instance, Levitt (1972) defines services as a personal performance. These definitions over-amplify one or more elements of the whole service supply chain. The definition that Sampson (2000) supported took the process view and included the whole process, which certainly better fits the study of service supply chains. Hence, we use Sampson's definition of services where services act on people's mind, on people's bodies, and on people's belongings, act on people's information etc.

In the next section, the commonalities of manufacturing and service supply chains are summarized and discussed. In section three, the particularities of service supply chains are identified and analyzed. In the last section, we conclude the article and discuss future research.

II. SERVICING AND MANUFACTURING COMMONALITIES

The commonalities between manufacturing supply chain and service supply chain have not been discussed much in extant literature. This is natural given that servicing and manufacturing share so much similar processes and the ultimate goals are both operational and/or financial success. A survey by Nie and Kellogg (1999) shows that many operations management educators who are manufacturing operations researchers are unwilling to accept the idea that service should be studied "in different ways, using different theories, skills, competencies, and language…" One reason for the denial to have service studies as a new field is that manufacturing and servicing businesses really have a lot in common. The set of commonalities are very likely much larger than the set of differences. Hence, we will not and can not exhaust the commonalities in this section. We highlight some of the studies that identified commonalities between manufacturing and service settings. Since commonalities often suggest transferability of techniques and managerial insights developed under manufacturing, we believe the commonalities are worth discussing.

Some manufacturing supply chain insights have been documented to fit the service supply chains. For instance, Hurkens et al. (2006) documented a case where a service firm, Carglass, needed to procure physical goods. The authors showed that many aspects and evaluation processes are very similar to the procurement decisions under manufacturing

settings. As a result, the idea of total cost of ownership (TCO) that is traditionally used in manufacturing settings (Degraeve and Roodhooft, 1999) can be applied here as well. The case served as documented evidence to show there are many decisions that exist both in service industries and manufacturing industries. Such commonalities imply that manufacturing techniques can be easily transferred to service settings, such as TCO. Another research that can attest to this point is the study by Stewart and Chase (1999). They applied the Generic Error Modeling System (GEMS) that has been used in manufacturing settings (MacCarthy and Wilson, 2001) to study service failures. They showed that GEMS can be applied to identifying failures in the service delivery process, where the steps of the delivery process are tangible.

On strategic and operational level, management commonalities still exist between manufacturing and service supply chains. Demirkan and Cheng (2006) showed that the idea of letting the entity that is the closest to the demand coordinate the supply chain also generates more profits for all partners in a service supply chain. Anderson and Morrice (2000) revised the classic beer game in manufacturing supply chain and fitted the game into a service supply chain. More specifically, a mortgage supply chain was simulated where the whole mortgage generation process was coordinated by four steps, initialing, credit checking, surveying and titling. A class of MBA students played the game and the authors concluded that sharing of end-user demand information throughout the supply chain contributed to the reduction of bullwhip effect. Information sharing here is a classic countermeasure developed in the manufacturing supply chain. Sengupta et al. (2006) compared effects of strategic practices on the performance of supply chains. Their correlation analysis suggested that information sharing positively correlates with the financial performance in both service and manufacturing supply chain. Akkermans and Vos (2003) specifically studied the bullwhip effect in a service supply chain. Using case study method, they identified the root causes and countermeasures of bullwhip effect along a service supply chain. They found that demand signaling due to the distance between upstream players and end consumers also plays an important role in service supply chains. Price variation due to promotion and marketing campaign is another cause of bullwhip effect that applies to the service supply chain. Table one summarizes this section.

Overall, the management of manufacturing supply chain and service supply chain shares commonalities at various levels. Tactically, the existence of physical aspects along a service supply chain certainly justifies the commonalities. Strategic-wise, coordination along service supply chain is also needed. Many issues bothering manufacturing supply chains surely are applicable to service supply chains.

III. SERVICING AND MANUFACTURING DIFFERENCES

Although we believe that the manufacturing and service supply chains share a lot more in common than how much they differ, it is the smaller set, the differences, that ultimately

TABLE 1: SUMMARY OF COMMONALITIES

Article	Commonality
Hurkens et al. (2006)	Procurement decision
Stewart and Chase (1999)	Causes of errors in delivery process
Demirkan and Cheng (2006)	SCM coordination - information
Anderson and Morrice (2000)	Existence of Bullwhip effect
Akkerman and Vos (2003)	Causes of bullwhip effect - demand signaling

determines how a service supply chain can be effectively and efficiently managed. Some of the For instance, a regression analysis rejected the hypothesis that information sharing may have a causal effect on performance for both manufacturing and service supply chains (Sengupta, Heiser, and Cook, 2006). The result is worthy of further exploration since the data set is not longitudinal and the size of their data is fairly small. However, this serves as a good example where a commonality fails to hold after further inspection. In this section, we start with presenting the major particularities of service industries. Then, we discuss the strategic and operational differences identified by extant studies and how the differences can be related to the service industry particularities. The differences can be summarized in Table 2.

The inherent particularities of service industries can be generally summarized as follows: labor intensive, customer involvement and service heterogeneity, intangibility, simultaneity of production and consumption, and customer-supplier duality:

- Labor intensive: delivery of service products often involves many manual processes that require the interaction of human beings. Hence, solutions that use standardization and automation to improve operational efficiency are less applicable in the service industry (Sengupta, Heiser, and Cook, 2006). Furthermore, labor intensive industries often require a more advanced scheduling system in order to better coordinate the preferences of commonalities, as the service supply chain progresses, may be only temporary in nature. their employees. This imposes another level of difficulties.
- Customer involvement and service heterogeneity: customer often plays a critical role in service delivery process or sometimes even the service initiation process itself, for example, electronics repair service. The impact of customer involvement easily leads to service heterogeneity and impacts service quality (Ellram et al., 2004). The distinctive needs by customers essentially change the content of each service product offered, which makes service quality hard to measure and monitor (Zeithaml et al., 1996).
- Intangibility: service provided is often intangible, such as education. Sampson (2000) believes that intangibility leads to three issues, namely, difficulty to store, difficulty to account for, and difficulty to identify suppliers. An intangible good can be stored probably only in scientific novels. This characteristic significantly shifts the focus of management from buffering by inventory to managing capacity and ensuring capacity flexibility (Sengupta, Heiser, and Cook, 2006; Akkermans and Vos, 2003). Ellram et al. (2004) found that one of the ways that service procurement can be better controlled is to implement two way match of service receiving process. The invoices and a purchase document are matched upon receiving, where such process includes the matching of an

TABLE 2: SUMMARY OF DIFFERENCES

Article	Differences
Sengupta, Heiser, and Cook (2006)	Labor Intensive
Ellram, Tate, and Billington (2004)	Customer involvment and Service Heterogeneity
Zeithaml et al. (1996)	Service quality is hard to measure and monitor
Sampson (2000)	Intangibility
Akkerman and Vos (2003)	Capacity versus Inventory
Sampson (2000)	Simultaneity of Production and Consumption
Sampson (2000)	Customer-supplier duality

invoice, purchase order, and shipping documents in manufacturing. Unfortunately, counting physical goods is missing in the service receiving process. The difficulty to identify suppliers makes the start of the procurement process extremely cumbersome. Ellram et al. (2004) documented that a service buyer is often not sure of the specification of the service being procured. Furthermore, due to the intangibility of service, the service quality is hard to measure. Unfortunately, both aspects play critical roles in evaluating potential suppliers.

- Simultaneity of production and consumption: unlike manufactured goods, services are created and consumed at the same moment. There is not a lead time in the middle to buffer against uncertainties. Sampson (2000) even called this essentially a JIT system. Combined with difficulty to store, it is then not surprising to see that a flexible capacity is critical to the success of a service supply chain.
- Customer-supplier duality: The best example for the duality is the electronics repair service. In that case, a customer supplies the malfunctioning electronics and receives the service to fix it. Sampson (2000) summarized four implications of the duality:
  - Service can not start until the supply of inputs from customers.
  - Service tends to be heterogeneous.
  - Service has to be labor intensive.
  - Service location is closer to customers.

Hence, there does not exist the time of distribution and warehousing as in manufacturing to prepare for the final consumption. Instead, once the customer-supplier provides the input, the service starts. This certainly challenges a manager's ability of scheduling and capacity management.

These structural characteristics certainly influence the strategies to manage a service supply chain. Frohlich and Westbrook (2002) classified web-based integration model into four categories, an integration on both supply and demand sides, integration on either demand or supply side, and a low level of integration. In their attempt to link the models with firm performance, only the hypothesis that low integration leads to inferior performance is supported for both the manufacturing and service supply chains. While a manufacturing firm that fully integrates on both sides of the supply chain outperforms those that integrated less, no statistical evidence was found to draw the same conclusion for a service firm. Moreover, they found that a manufacturer that integrates on only one side of the supply chain performs better than low integrators, but still worse than those that fully integrated. In the service case, only demand side integration generates a performance that fall in the middle of a full integration and a low integration.

Supply side integration, however, did not have the same positioning effect. The authors argue that the results may be due to the lagged development of service management. Similarly, Sengupta, Heiser, and Cook (2006) also studied supply chain strategies and performance. The performance metrics are classed into operational and financial performances. Their regression results suggest that manufacturing supply chain performance is impacted by strategic practices such as hedging, relationship development, and supplier network. In the service supply chain case, information sharing, distribution network, and product customization are identified as significant influencers instead. Hence, the service supply chain calls for distinctive strategic considerations. Integration along the whole supply chain seems not to benefit the service firms. Demand side integration, that more likely focus on customers, is more likely to generate positive returns for a service firm. This can be mostly attributed to the inherent characteristics of service products as we discussed above. More interestingly, both studies believe that manufacturing supply chain management is in a more advanced stage that is capable of taking advantage of new initiatives. On the other hand, service supply chains are less developed. Thus, the idea of a full integration or

hedging may have their applications for the service supply chains in the future.

Other than strategic level differences, operational level differences are also identified. One of the best known phenomena along a supply chain is the bullwhip effect. Despite the doubt on its existence along the service supply chain (Frohlich and Westbrook, 2002), Akkermans and Vos (2003) specifically studied a service supply chain to identify the root causes of bullwhip effect and applicable countermeasures. Their results suggest that batching ordering and shortage rationing are not root causes in the service supply chain. Batching ordering refers to the practice of ordering in large quantities and shortage rationing refers to the overstating of demand by buyers in procurement of scarce supplies. Among the well-known root causes of bullwhip effect in manufacturing supply chains, only demand signaling and price variation are identified as applicable. Price variation is driven by marketing campaigns/promotions and demand signaling leads to forecasting demand based on orders received from downstream buyers, but not on the actual demand. More interestingly, their case study reports that overloaded process in a service supply chain does not prolong the lead time; instead, it deteriorates service quality. In order to reduce the amplification along the supply chain, their study finds that capacity reservation is not feasible due to the delays caused by hiring and training. Every day low price is also less likely to maintain due to the strong resistance received from marketing. Sharing information, contrary to Anderson and Morrice's simulation result (2000), only generates limited benefits since capacity can not be easily adjusted accordingly. More plausible solutions are endeavors to reduce lead time and enforce a strict quality control process. Managers in their case study reveal that upstream quality issues often cascade down to affect and very likely delay later processes. Ellram et al. (2004) focused on the service procurement process. They realize that the management of service procurement is far lagging the practices in manufacturing firms or in the case of procuring physical goods. They documented that service contracts lacks specification and the specification can be hard to develop. Unfortunately, managers usually do not recognize the existence of such problems.

Service particularities also influence how the performances of a service supply chain can be evaluated. For instance, Meters et al. (1999) studied the widely used data envelopment analysis (DEA) in service settings. Different from traditional manufacturing supply chain, service firms often have a large number of branches or local establishments. They argue that a manufacturing firm may have at the maximum hundreds of facilities, while a commercial bank can have thousands of local branches. This surely complicates the structure of service supply chains, put it another way, it is a more complicated network. Furthermore, different from the manufacturing setting where all facilities are guided under consistent strategies, each local branch can have its own strategic priorities, such as serving a certain kind of customers or providing a particular type of services. Combined with the labor intensive nature and high customer involvement in services, measuring performances of the service supply chain, such as the commercial banking in this case, can be a very challenging task. Although DEA seems to have its natural appeal in such cases, they suggest that one has to exercise caution in applying the method in evaluating service performances. For instance, it is hard to draw a mutually exclusive list of inputs for each of the outputs since a service firm often offers multi-products using generic inputs. The generic inputs can be even uncountable. Moreover, the inconsistency of strategic emphasis should be appropriately reflected in DEA weights, which can be hard to determine. As a result, there are many operational details specific to service supply chains that a manager has to be aware of before making decisions.

IV. CONCLUSION AND DISCUSSION

Given the increasing importance of the service sector in the US economy, service spending will only increase. The spending will not only include transactions within the service industry, but also the manufacturing services being traded in the market. Yougdahl and Loomba (2000) argued that even factory personnel should actively participate in design and deliver services beyond their core production to internal and external customers. Hence, more research attention will be needed in order to improve supply chain management effectiveness and operational efficiencies. Overall, the goal is always to generate more values for the ultimate customers. Thus, both the practitioners and the academics will need to better understand the service supply chain for the service sector to gain and sustain competitive advantages. By integrating operations management literature with the existing service supply chain studies, we presented and discussed both the operational level and the strategic level commonalities of service and manufacturing supply chains. Differences between manufacturing supply chains and service supply chains are also elaborated. We believe this paper expands the discussion of service supply chains and enriched our current knowledge of service supply chains.

Our review suggests that there are many commonalities of service and manufacturing supply chains. The tangible aspects of service supply chains can be considered as a service extension of the traditional manufacturing supply chain, and thus can be managed in similar manners. As long as structural or fundamental similarities exist between the two supply chains, managerial strategies and tactics should be compatible to a certain extent, if not completely. However, one can not isolate the discussion of commonalities from the existence of inherent differences. Besides the well-recognized service particularities, such as labor intensive operational and strategic differences profoundly influences how we should view and manage a service supply chain. Some strategies that are applicable and effective in manufacturing settings may not be transferable to the service supply chains.

This point is well demonstrated by the previous research that attempted to link supply chain strategies with supply chain or firm performance. We do not feel that we can draw the conclusion that those that are found to be not affecting performance by current research are surely trivial factors for the service supply chain. This is due to the lagged development of service management and the dynamic nature of our business world. Furthermore, just as many factors that are believed to be order winners reduces to order qualifiers in manufacturing supply chains, existing influencing factors may be just order qualifier for the service supply chain in the future. From an operations management point of view, many operational level practices are in urgent need to be understood, changed, and improved. As discussed by Ellram et al. (2004), the less than satisfactory state of service procurement management may simply suggest the need to establish a service appropriate procedure using the manufacturing system as a blueprint and then improve on it. The establishment process itself will require a thorough understanding of the service supply chain operations, not to mention what it takes to improve the service supply chains.

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