A Knowledge Capture and Sharing Approach to Effective Software Service Supply Chain Management

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Abstract

In recent years, with the increase of demand in the service industry, we have witnessed the emergence of a new kind of supply chain (SC) (the service SC [SSC]) which is characteristically different from the traditional manufacturing/production SC. The research addresses the software service supply chain (SSSC), research on SSSC is scarce, and there is a need for a proper definition as well as identification and setting up of the phases of such SC. The service enterprise continues to apply and adapt practically the same phases of the manufacturing SC management. The lack of understanding and definition of the SSC negatively impacts the service sector productivity and performance, in particular, the software service sector. The research will introduce an SSSC definition as well as a knowledge-based framework which introduces the phases of the SSSC. Prior research on SSC fell short in defining, addressing, and introducing the basic steps for the SSSC. In addition, no prior research introduced a framework which combines knowledge management (KM) concepts to improve the overall steps and productivity of the SSSC. The research will provide answers on how the service supplies chain in general and the SSSC in particular could be improved based on the benefits of its employees’ accumulated knowledge as a result of their involvement in the activities and processes in both the service company and the clients’ companies while developing the clients’ software development demands. In addition, the research will argue against the perishable nature of services in the software service industry and will posit and justify the reusable nature of the “software” in the SSSC by arguing that if a service (software) is not consumed when available; it should be retained for future use. A framework for knowledge-based SSSC will be also suggested to reflect all phases of the SC in the software service industry. These phases are closely integrated and implemented with concepts from KM to improve the current and future needs of a company’s processes and competitive advantages in the marketplace. Furthermore, a software service company will be chosen from the software industry as an example case study to verify the research outcome. This experimental case study will highlight and analyze a real-life scenario of the software production SC of the chosen company and identify all aspects of lessons learned during the software development.

Keywords: Software Service Supply Chain; Knowledge; Knowledge Management; Supply Chain; Service Supply Chain

1. Introduction

The recent information and technology evolution has significantly influenced the customers’ attitudes when selecting new products and services. Thus, the market is moving toward hyper-competition (rapidly escalating competition), extreme emphases on price, quality, and satisfaction of customer needs, and an increasing focus on innovation and continuous learning (Hitt et al., 1998). Recently, the success of any organization becomes considerably depended on the continual investment in learning and acquiring new knowledge. This continual investment in knowledge learning creates more business opportunities and improves the existing supply chain (SC) productivities (Jelenic, 2011). In addition, the service industry becomes prominent as a new way of doing business. As a consequence, the software service industry gained momentum as more organizations needed more software to run their
operations and to effectively fulfill customers’ increasing demands. Research on the software service supply chain (SSSC) is scarce, and there is a need for a proper definition as well as identification and setting up of the phases of such SC. The management of knowledge created and exchanged among employees during the phases of the SSSC is an integral part of its success because of obvious reasons. Accordingly, a knowledge-based SC is required to ensure increase productivity, competition, and quality and innovation services. Thus, the implementation of knowledge management (KM) concept in the organizational SC allows the organization to be more adaptive, responsive, and eventually achieve an advanced strategic competitive position in the marketplace (van Zyl, 2003). It is also considered that the main important strategic resource for any functional business is the individual and the organizational learned knowledge and experience (Jelenic, 2011).

1.1. Services characteristics and reusable nature in the service in the SSSC

Baltacioglu et al. (2007) stated that the structural difference of a service SC (SSC) from that of the traditional SC arises from the unique characteristics of services, which distinguish them from goods. Lovelock (1981) summarized the characteristics of the services in the following four steps:

1. Intangibility: Service can neither be seen, smelled, heard, touched, nor be tasted before being delivered.
2. Simultaneity: Service is created and consumed at the same moment. Thus, customers must be present for the service to be provided and delivered.
3. Heterogeneity: Service cannot be easily standardized and measured.
4. Perishable: If a service is not consumed when available, there is no chance to stock it for future use. Because a service is a deed or performance, rather than a tangible item that the customer keeps, it is “perishable” and cannot be stocked for sale or future use.

This paper conforms to the first three characteristics listed above and argues against the “perishable” nature of services in the SSSC. It is believed that services in an IT service company are application software and would not necessarily perish as it is the case in other service industries such as airline, hotel, insurance, and health industries. In such industries, services have no value if not used. Thus, we argue that the software service company’ services are generally reusable rather than perishable. It is anticipated that not all software would be reusable, but those that the organization decides on their possible future “re-use” would be captured and retained in the organizational knowledge base. Hence, the literature characteristics listed above would be amended to reflect the possible non-perishable nature of the services in the software industry:

- Intangibility: Services cannot be seen, touched, smelt, or tasted.
- Simultaneity: Reflects the fact that customers must be present for the service to be provided.
- Heterogeneity: The fact that services cannot be easily standardized.
- Reusable: If a service is not utilized/adopted when available, it is retained for future use. In other words, in the software industry, the unused software must be documented and stored in the company’s knowledge base for future utilization and adaptation. Thus, a new client may require similar or almost similar software; therefore, to facilitate the production process, the retained software can be retrieved from the company’s knowledge base and slightly amended to meet the new client’s requirements with very limited time and cost.

2. Organizational Knowledge

2.1. Defining organizational knowledge

Organizations are becoming more and more dependent on their employees’ know-how and expertise for competitive advantage. Nonaka (1994) stated that knowledge has been recognized as a strategic resource for any successful organizational performance. Organizations will continuously need to obtain and retain knowledge that enables them enhancing their performance. Managers and decision-makers must learn how to acquire manage and utilize these intangible assets that have a direct
influence on decision results, which in terms influence organizational and SC performance. Therefore, the participants of the organization SC must coordinate and share their knowledge to respond to new economic, social, and environmental requirements and challenges (Elaine et al., 2011). Knowledge is usually held by teams and individuals who have been assigned jobs and participating in different activities and working on focused problems. This knowledge is usually embedded in the organization’s products, processes, and external relationships (King, 2009). Therefore, the management must openly accept and encourage employees to gather, sort, transform, record, and share knowledge. Otherwise, this important asset will be wasted and lost over the period. Tacit knowledge, in particular, is lost through outsourcing, downsizing, and terminations of employment. Therefore, employees who leave the organization will definitely take their valuable knowledge resources, skills, and experience with them (Smith, 2001).

2.1.1. KM

KM is the process of identifying and locating knowledge and knowledge sources within the organization and then transfer this knowledge into explicit form that can be shared, utilized, and retained in the organization’s knowledge base for the future use and effective decision-making (Dalkir, 2005). In addition, according to El-Den, 2004a; 2004b, “the management of knowledge has become of paramount importance, particularly tacit knowledge, as organizations are becoming more aware of the importance of the knowledge ‘imbedded in the heads’ of their employees, as well as the organization’s explicit knowledge. They are also realizing that the success of their businesses depends on the proper management of both of these issues.” Wiig (1994) stated that the main aim of the KM is to facilitate an organization in acting intelligently to secure its success and to make an organization to realize the best value of its knowledge assets. Kristin (2012) defined that the purpose of KM is to share perspectives, ideas, experience, and information: To ensure that these are available in the right place at the right time to enable informed decisions and to improve efficiency by reducing the need to rediscover knowledge. For the purpose of this paper, KM is a process of identifying the knowledge sources in the SC and then transfers this knowledge from tacit knowledge into explicit knowledge to be retained in the SC knowledge base and then retrieve it by the SC participants and share it across the SC when needed.

2.1.2. KM processes in literature

To develop and suggest an effective KM process for our paper, we revise and analyze the following KM processes by some recognized academic authors (Table 1).

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<td>Individual</td>
<td>Get</td>
<td>Acquisition</td>
<td>Knowledge</td>
<td>Knowledge</td>
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<td>Identify</td>
<td>Sourcing</td>
<td>and group</td>
<td>Use</td>
<td>Refinement</td>
<td>capture and/or</td>
<td>initiation/release</td>
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<td>Create</td>
<td>Compilation</td>
<td>learning</td>
<td>Lean</td>
<td>Store/retrieve</td>
<td>creation</td>
<td>Knowledge</td>
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<td>Acquire</td>
<td>Transformation</td>
<td>Knowledge</td>
<td>Contribute</td>
<td>Distribution</td>
<td>sharing and</td>
<td>nurturing</td>
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<td>Share</td>
<td>Dissemination</td>
<td>claim</td>
<td>Assess</td>
<td>Presentation</td>
<td>dissemination</td>
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<td>Store</td>
<td>Application</td>
<td>validation</td>
<td>Build/sustain</td>
<td>Divest</td>
<td>acquisition</td>
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<td>Value</td>
<td>Information</td>
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<td>and application</td>
<td>Knowledge</td>
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<td>realization</td>
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KM: Knowledge management
2.1.3. The research proposed KM process

Figure 1 shows the KM process in this paper:

Knowledge creation: This phase consists of the following three phases:
• Knowledge initiation: In this phase, the initial discussion of the expected outcome from the development process is initiated among the SSSC experts. This will result in a deep understanding and observation of the knowledge content.
• Capture knowledge: As a result of the discussion, the individual captures, amplifies, and enlarges that knowledge by his/her reflection and perception on previously accumulated knowledge by the group. Furthermore, the captured knowledge is a result of the members’ interaction with other members.
• Knowledge nurture: As a result of “capture knowledge phase,” the knowledge content is nurtured because it is understood and new opinions and ideas may be formed based on it.

Knowledge refinement: In this phase, the knowledge content from the previous phase has to be filtered against the organization objectives and goals; if the content meets the company’s objectives, then it is contextualized with some indexing, explanation, and user-friendly description that will simplify the retention and retrieval process. This phase consists of the following two phases:
• Knowledge filtration: After the creation of the new knowledge content, the knowledge passes by the knowledge filtration phase. In this phase, the knowledge is verified and assessed against the company’s goals and objectives. If knowledge does not meet the organization goals, then it is disposed or outsourced.
• Knowledge contextualizing: In this phase, the filtered knowledge is contextualized with some explanation or metadata form to simplify its future use.

Knowledge retention: After filtering and nurturing the initiated knowledge, knowledge has to be retained and employed back in the company SC to facilitate and improve its process. This phase requires continuous maintenance to insure its accessibility and functionality.

3. SC

3.1. Types and definition of SC

There are two types of SC in the literature: Manufacturing SC and SSCs. La Londe and Masters (1994) proposed that “manufacturing SC is a set of firms which pass the materials among each other during the production process. Normally, several independent firms are involved in manufacturing a product and placing it in the hands of the end user in an SC. Raw materials and component producers, product assemblers, wholesalers, retailers, and transportation companies are all members of the SC.” Baltaciglu et al. (2007) defined SSC as “a network of suppliers, service providers, consumers, and other supporting units that performs the functions of transaction of resources required to produce
services; transformation of these resources into supporting and core services; and the delivery of these services to customers.” SSC is a wide area that includes businesses specializing in different kinds of services including software development, finance and accounting, insurance, retail, and medical and government services. Despite the growing importance of the service sector, there is still limited academic literature which focuses on the SSC definition and framework; unfortunately, the service sector remains short of a common definition, framework, and proper process to accomplish the steps of the SSC. Service enterprises continue to apply and adapt the SC management concept of the manufacturing industry. Both practitioners and academics need to better understand the SSC to gain and sustain competitive advantages in the marketplace (Zhou and Park, 2009). The combination between the manufacturing SC and services SC and the lack of understanding and definition of the SSC negatively impacts the service sector productivity and performance, in particularly, the SSSC where the software experts and their prior knowledge and expertise are the vital part of the SC productivity and performance. For the purpose of this paper, we will propose that SSC is initialized from: (1) “know-how” skills and knowledge of the employees; (2) create and develop the service (including outsourcing and suppliers’ involvement); (3) testing the functionality of the service; (4) deliver, distribute, and implement the service at the customer level; (5) utilize the service by the end-customer; (6) finally, collect customers experiences and implementation knowledge.

3.2. SSSC

SSSC is a relatively new research area with its roots in the traditional manufacturing SC. Generally, traditional SCs in one way or another rely on the software use to facilitate organizational processes and operations. For example, a government SSC heavily relies on developing application software to process, store, and retain data/information on clients, and a manufacturing SC builds software to monitor and control the production process for products and services. It is apparent from the literature that there is a lack of academic literature that discusses and suggests a framework for the SSSC. Therefore, in this paper, SSSC will be discussed and the development of a proper framework will be introduced to highlight the phases of an SSSC with emphasis on managing the know-how, expertise, and experience of the “people” involved in the software development process. For convenience of the research, we will assume and refer to the software service company as a source company. Simply stated, the source company develops and sells application software to clients’ in different industries.

3.2.1. SSSC definition

Du et al. (2013) stated that “software service supply chain (SSSC) is the whole development, release, deployment, and maintenance processes of software from source code to the final software delivering to users.” They added that software SC is a complete process starting from customer demand to providing the customer’s required products and services. For the purpose of this paper, we propose that the SSSC encompasses the following steps:

1. Administration arrangement, legal and contract agreement between the customer and the source company
2. Analysis of customer’s requirements
3. Roles, expertise, and resources assignment for the project
4. Software design, development, and test
5. Capture and retention of employees’ know-how during the “internal” software development process
6. Software delivery and implementation at the customer end
7. Providing ongoing support and maintenance of the software
8. Capture and retention of employees’ know-how during “external” information gathering and software deployment.

3.2.2. Differences between SSSC and traditional SCs

According to Sampson, 2000, the participant in the SC receives inputs from suppliers and then processes these inputs and delivers them to the customers, whereas in the services organizations, the customers
are the primary suppliers who provide their bodies, minds, belongings, or information as inputs to the service processes. Table 2 draws comparisons between the manufacturing SC, the SCC, and the SSSC:

### 3.2.3. SSSC process

Figure 2 shows a high-level description of the proposed source company’s SC. It is based on the literature’s main description of an SSC. The four main activities shown in Figure 2 are to be extended later in the research.

- **a. Demand/project management phase** includes the analysis of customer’s requirements, management of customers’ demand, management of suppliers/outsourcing, and legal agreement. It is triggered by a demand of service by a client. The output from this phase is a legal binding agreement between the two parties.

- **b. Supply/org knowledge phase** is a phase where the source company is developing the client’s software. Knowledge and expertise which will be used later are identified, captured, and retained in the organization’s knowledge base. This knowledge base is integral to the software development process and the delivery of effective services for the “client” organizations’ projects.

- **c. Design/production phase** is what the source company produces. Based on the components in the “supply/org knowledge phase,” the source company’s employees design and develop software solutions to the clients’ SC as well as engage in developing the source company’s innovations in software applications and services. Thus, this phase is a source of internal organizational learning and knowledge acquisition process.

<table>
<thead>
<tr>
<th>Area</th>
<th>Manufacturing systems supply chain</th>
<th>Service industry SC</th>
<th>SSSC</th>
</tr>
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<tbody>
<tr>
<td>Development duration</td>
<td>Standard development duration for all the goods</td>
<td>Short process – on spot service while the client present</td>
<td>Long process, depends on the software complexity – it involves testing, re-developing, updating, and integrating between many skills and expertise</td>
</tr>
<tr>
<td>Delivery/and ongoing support and maintenance</td>
<td>Goods sold to the client – no visit or ongoing support needed</td>
<td>Service delivered in the present of the client- for example opening a bank account – no site visit required – but however, the ongoing support are required</td>
<td>The software has to be delivered, installed, tested and implemented at the client site by the source company’s developers – this process requires direct interaction between the source company developers and the client IT system and environment – ongoing support and maintenance are essential in this SC</td>
</tr>
<tr>
<td>Error prone/obstructions</td>
<td>Products are verified and tested on delivery – very little chance for error and faults in goods</td>
<td>Less error prone because it is a standard services that has been already provided to the many clients</td>
<td>It may show undesired behavior when faced with unexpected emergent situations – it is highly an error prone process</td>
</tr>
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</table>

SSSC: Software service supply chain, SC: Supply chain
d. Delivery/services phase identifies the different assignments and activities employees from the source company undertake in the client’s company starting from information gathering until the software implementation and subsequent maintenance. This phase is also a source of knowledge and expertise capture by employees during its fulfillment. The feedback from this phase to the previous phases represents the lessons learned, expertise gained, and knowledge acquired by the SSSC’s individuals and groups during or at the end of the fulfillment of the project.

### 3.2.4. SSSC framework

Figure 3 is the proposed framework for the SSSC, the framework focus on the project administration process, internal software developing process, and it also focuses on the external implementation of the software at the client’s site. The framework highlights three types of knowledge: Project administration knowledge, internal knowledge, and external knowledge.

#### 3.2.4.1. Administration knowledge

It represents the knowledge which is generated as a result of project administration and management. This knowledge is vital for the organization because it sets up the direction for the whole project including timing and general requirements.

#### 3.2.4.2. Internal knowledge

Once the legal agreement signed and a project manager assigned, then the software internal development process is initiated. In this process, the project manager appoints a specialized experts group to accomplish the project. Moreover, the project analysis report is completed which involves

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**Figure 3:** Software service supply chain framework

Source: Baydoun and El-Den, 2016
visiting the client’s premises, meeting with the key person/team and determining client system requirements by conducting interviews, system investigation and observation, planning, and document gathering. And then, sequentially, the assigned experts initiate and complete the processes of software designing, developing, and testing. And then the project manager organizes the services and project delivery process. Therefore, the experts who accomplished the whole internal developing process of the software are a vital source of new knowledge. This knowledge represents the knowledge that is gained from the internal developing process of the software; thus, the staff who participates in the developing process will be an important source of knowledge. This knowledge consists of “know-how,” lessons learned, experiences, “know-why,” decision made, new way of doing things, skills, expertise, prior experience, etc.

3.2.4.3. External knowledge
Once the software tested and completed, then the source company delivers the software to the client’s site and then its employees implement and install the software in the client’s computer system, aiming to complete the demand and satisfying the client’s needs. As a result, the employees who participate in this external installation process are a crucial source of external knowledge, lessons learned, and “know-how” skills. In this turn, the external knowledge is very essential for the source company’s benefit and competitive advantages because it represents the practical experience which is accumulated from the real-world experiences and challenges. Besides, the source company’s employees will also be a rich source of external contacts and connection as a result of interacting directly with the client SC.

3.2.5. Integration between SSSC framework and KM process
After identifying the source of knowledge in the SSSC, the source company has to filter this knowledge against the source company’s objectives and then retain this important asset to gain competitive advantages and profit. Nonaka and Takeuchi (1995) state that “knowledge is the only resource that provides sustainable competitive advantage, and therefore, the firm’s attention and decision-making should focus primarily on knowledge and the competitive capabilities derived from it.” In addition, according to Liao, 2003, “knowledge is a very important resource for preserving valuable heritage, learning new things, solving problems, creating core competencies, and initiating new situations for both individual and organizations now and in the future.”

As shown in Figure 4, the source company’s employees accumulate and gain three types of knowledge: Project administration knowledge, internal knowledge, and external knowledge. Project administration knowledge is gained from administrating and managing the projects; this knowledge involves outsourcing contacts and notes, contracts, planning templates, and projects management description and templates. Internal knowledge is gained from the individual’s involvement in developing process of the client software, and external knowledge is gained from the installation and implementation of the software at the client SC level. Most of this knowledge is in tacit knowledge forms which it is imbedded in the heads of the source company’s employees. Omotayo, 2015 points out that “the crucial point in KM is to capture the information and knowledge that is in people’s heads as it was and that has never been explicitly set down and make this available so that it can be used by others in the organization.” As highlighted in the above SSSC framework, project administration, internal, and external knowledge are the main sources of knowledge assets in the SSSC process.

The source of project administration knowledge is the project administration staff including the project manager who manages and administrates the SSSC development process. This knowledge consists of outsourcing management and contacts, project templates, and planning knowledge.

The source of internal knowledge is the experts (individuals/groups) who involved in the internal development process of the SSSC; this knowledge consists of lessons learned, “know-how” skills, prior experience, and expertise/skills; which are gained from the internal design and development of the software within the source company borders.

The source of external knowledge is the experts (individuals/groups) who involved in external installation and implementation process of the SSSC at the client SC level. This knowledge composes of external lessons learned, know-how skills, connections, extra demand, prior experience, real-world
experience, expertise, and skills; which are gained from the external installation and implementation of the software at the client site.

This knowledge (internal/external) is primarily possessed in the heads of employees (groups/individuals) as tacit knowledge. The KM process is emerged as a solution to transfer this knowledge (tacit) to some sort of knowledge (explicit) that can be codified, stored in the SSSC knowledge base, so it can later be used in similar projects. This knowledge is to be captured and follows the SSSC KM process to be initiated, captured, nurtured, filtered, contextualized, and finally retained in the SSSC knowledge base. Therefore, the SSSC knowledge base holds all the filtered and nurtured internal/external knowledge that generated from the development process of the source company SSSC.

Example:

- SSSC administration process: Initially, the source company’s business manager meets with the education department representative to discuss and identify the department’s needs and then negotiate and agree on the cost of the project. The business manager, in this turn, consults and discusses the source company’s capacity and project requirements with his/her administration team. The SSSC administration process includes signing a contract to commence the project and assigning a project manager to overseas, coordinate, and manage the whole development process of the project. Consequently, new knowledge is created; this knowledge consists of new project templates, meeting valuable notes, and contract. The participants in this phase can access and retrieve any required knowledge from the SSSC KB, to facilitate and improve their tasks.

- SSSC internal development process: The project manager, subsequently, appoints a business analysis expert who would be responsible for the requirement analysis of the client’s company. Then, based on the business analysis report, the project manager allocates resources (assigns roles, identify experts, and allocates finances) for the project.
• SSSC external development process: In this phase, the SSSC experts deliver the software to the client’s side. And then, they coordinate with the education department ICT system administrator to implement the software on the selected server. The source company’ experts implement and install the software and provide supporting manuals and training for the department’s staff. Thus, the experts, who participate in this phase, can refer to the SSSC KB to retrieve any knowledge that simplifies the implementation process. As a result, new knowledge might be created including external lessons, “know how and why” skills, expertise, extra demands, connections, and experiences.

The process in Figure 5 will be illustrated with a real-life example to give a perspective into the proposed framework and to point to some possible knowledge generation.

4. Conclusion

The paper provided a detailed literature about SCs in general and focused particularly on drawing comparisons between the traditional/manufacturing SC and the new emerging SSC. The paper focused on the SSSC where the main phases of such an SC were introduced. Based on these phases, the KM processes in the literature were reviewed and a KM process which facilitates and ensures the knowledge retention and sharing in the SSSC was introduced. The paper posits that the overall activities of an SSSC are conceptually different from those of a traditional particularly the non-perishable nature of its products. The paper also provided answers on how the service supplies chain in general and the SSSC in particular could be improved based on the benefits of its employees’ accumulated knowledge as a result of their involvement in the activities and processes in both the service company as well as the clients’ companies while developing the clients’ software development demands. An example was developed which demonstrated the knowledge sources during the software development process.

Figure 5: Illustration of integration between software service supply chain and knowledge management cycle

Example: Baydoun and El-Den (2016)
References


