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A Framework for Knowledge Based Software Service Supply Chain (SSSC): A Comparative Analysis with Existing Frameworks

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Abstract

Knowledge management adoption in the supply chain (SC) is at its infancy and related scholarly research is relatively scarce. The main difficulties are in figuring out how to combine knowledge management concepts with the SC development process, to improve the overall steps, performance and productivity of the SC. The purpose of this paper is to test and analyse the existing knowledge based SCs frameworks in the literature (including manufacturing, service and software SCs), and verify how they integrate with the knowledge management concepts, taking into consideration some parameters including lessons learned, etc. which we believe, hinder such knowledge process in the existing frameworks. To come up with the proposed framework, we conducted an extensive research on the existing frameworks to identify how they handle and transfer knowledge during the development process of the SC and how they integrate the knowledge management concepts with their frameworks. Few SC frameworks were tested to figure out their efficiency and effectiveness. Finally, after detailed comparative analysis and testing, the research suggests that the proposed framework adds value to existing research and could be adopted by SC participants as a useful knowledge based framework which could increase the SC overall speed, performance and productivity. The proposed framework consists of parameters which should be introduced for more effective SSSC operations, while the absence of major parameters (identified in this paper) makes a framework less efficient.

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Keywords: Software Service Supply Chain (SSSC); Knowledge Management (KM); Service Supply Chain (SSC)

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1. Introduction

Recent information technology (IT) initiatives have had a deep effect on businesses' daily operations, productivities and performance structure. It is obvious that the 21st century is the century of knowledge and learning [1] [2]. Currently, businesses are operating within a new competitive environment as a result of the fast adaptation and utilization of IT in their supply chains. Collaboration and the utilization of knowledge management practices have become the main factors for surviving and succeeding within this new environment [3]. The new competitive environment is driven by the technological and globalization revolution. Advances in technical innovation, the worldwide increase in income and accordingly customer needs, institutional development and structural changes in the division of labor have let to the rapid development of the service sector in recent decades [4]. 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 productivities [2].

A knowledge based supply chain (SC) is integral for increase in productivity, competition, better quality and innovation services. Thus, the implementation of knowledge management concept in the organizational supply chain allows the organization to be more adaptive, responsive and eventually achieve an advanced strategic competitive position in the market place [3]. Therefore, it is integral to incorporate within the processes of the SSSC a KM mechanism to enhance knowledge sharing. It is essential for the software companies to adopt KM practices to facilitate knowledge sharing with the companies [5]. In addition, King [6] posits that with KM in place, organizations can provide an environment where knowledge can be shared among employees. In addition, [7] described that the KM systems are the life-blood of supply chains, all elements of supply chain must be connected to enable the flow of knowledge, organization must learn about the existing knowledge flow within their organization.

The literature identifies two types of the SC: Manufacturing SC and Service Supply Chain (SSC). La Londe [8] 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 a supply chain. Raw materials and component producers, product assemblers, wholesalers, retailers and transportation companies are all members of the supply chain". The SSC includes businesses specializing in different kind of services including software development, finance and accounting, insurance, retail, medical and government services. Baltacioglu [4] Defined the Service Supply Chain 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". However, Software Service Supply Chain (SSSC) is a relatively new research area with its roots in the traditional manufacturing supply chain. We define the SSSC as a set of clients' requirements fulfilments activities required for the development of the clients' software needs from client's demands to the software deployment.

2. Overview of different knowledge based frameworks

The implementation of knowledge management initiatives in the SC frameworks is at its infancy. Consequently, few researches clearly define a specific way of capturing and retaining knowledge during the SC development process. In the following research, we will introduce the most widely knowledge based frameworks for the different supply chain types including manufacturing SC, service SC and SSSC. The following research discusses the different existing knowledge based SC frameworks:

2.1. Done's framework for the service supply chain

Done [9] formulated a unifying framework for knowledge management in the service supply chain. As shown in Fig. 1, the author defined three types of learning in his framework including: Vicarious learning, experiential learning and the combination of vicarious and experiential learning (Table 1). In addition, he introduced three phases of the SC development composing of SC Knowledge transfer, SC Competence and SC Maturity.

2.1.1. SC knowledge transfer

This phase augments from three different resources: congenital learning, adsorptive capacity and vicarious learning. Congenital learning results in the creation of an initial knowledge base composed of both explicit and tacit knowledge; this knowledge will extend and grow via further vicarious learning [9]. Absorptive capacity is the absorptive capacity for the SC members as a result of participating in internal and external SC activities [9]. Vicarious learning results in knowledge transfer from the supply chain partners [9]. The levels of previous congenital knowledge and absorptive capacity determine the level of adoption of external knowledge transfers [9].

Table 1. Done's framework summary [4]

Types of knowledge (learning)	SC stages
Vicarious learning (congenital leaning and absorptive capacity	SC knowledge transfer
Experiential knowledge	SC competence
Vicarious and experiential knowledge	SC maturity

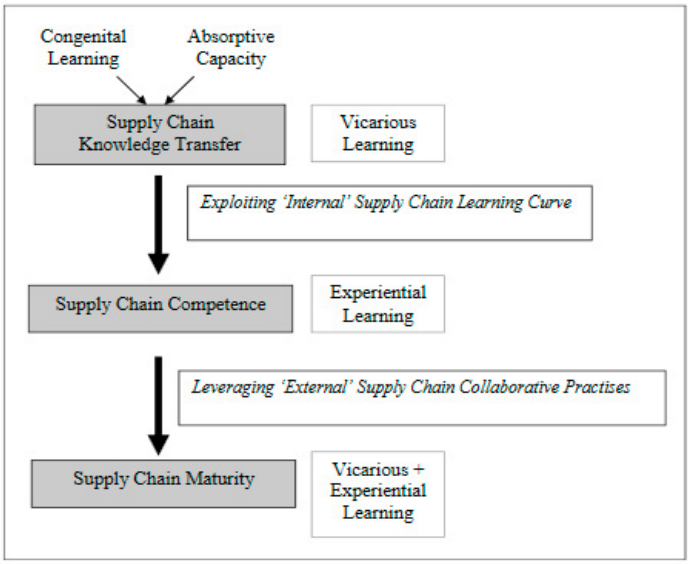

Fig. 1. Done's framework [9]

2.1.2. Supply chain competence

Experiential learning leads to the improvement of the knowledge as well as the development of supply chain competence [10]. This knowledge evolution and experience based supply chain competence leads to a learning curve operating performance improvement. The collaborative transfer and implementation of appropriate supply chain practices is likely to facilitate such continuous knowledge development and learning mechanisms [9]. The "supply chain competence" considers the acquisition and improvement of created/ transferred knowledge within specific individual and organizational experience based context specific competences [9].

2.1.3. Supply chain maturity

In this phase, the vicarious and experiential learning are imbedded in the SC operation to stimulate and enhance the overall SC performance and production process. This phase will also enlarge and lead to a continuous vicarious and experiential learning knowledge [9].

2.2. Yi Jiabin's framework for the manufacturing supply chain

Jiabin [11] stated that a successful knowledge transfer includes two basic processes: the transmission of knowledge and the receiving of knowledge which results in two different participants – a knowledge sender and a knowledge recipient. A model of knowledge transfer process among supply chain members is developed (Fig. 2), where the supply chain members were divided into three layers, namely, the knowledge transfer layer between supply chain and external environment, the knowledge transfer layer between members of supply chain, and organizations internal Knowledge transfer layer as in Table 2.

Table 2. Jiabin's framework summary [11]

Levels	Knowledge areas of the supply chain
1st level	K. Transfer between SC and external departments
2nd level	K. Transfer between the members of the SC
3rd level	K. Transfer between the organization interior suppliers, manufacturers and distributors

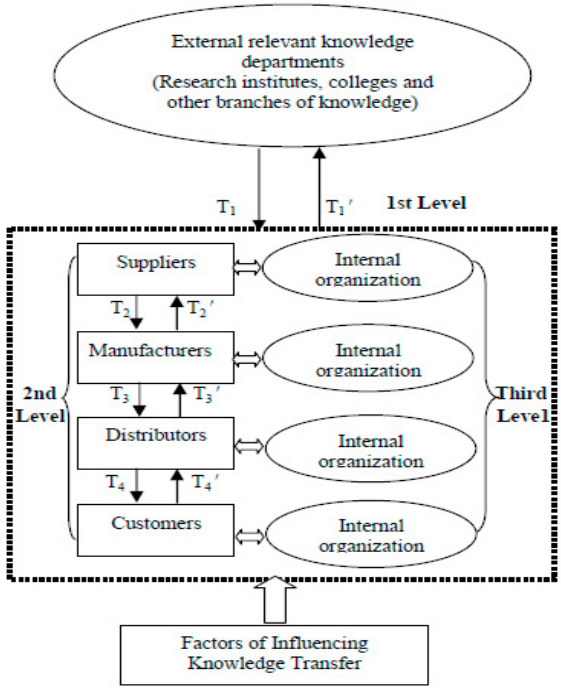

Fig. 2. Yi Jiabin's framework [11]

2.2.1. The knowledge transfer layer between internal and external environment

The knowledge transfer from the external departments for instance research institutes, colleges and other branches create value across the SC and enhance its production process. Therefore, the behavior of absorb knowledge from external relevant knowledge departments in environment, including research institutes, colleges and other branches of knowledge, become the starting point for knowledge transfer and the source of knowledge innovation and value creation [11].

2.2.2. The knowledge transfer layer between members of the supply chain

This layer refers to the knowledge transfer between members of the supply chain, mainly, between suppliers and manufacturers, manufacturers and distributors and distributors and customers [11].

2.2.3. Organization's internal knowledge transfer layer

The organization's internal knowledge transfer layer refers to the knowledge transfer within the organization's interior, including suppliers, manufacturers, distributors and other members of the supply chain nodes and consumer groups [11].

2.3. Mehta's framework for the global software supply chain

Mehta [12] introduced a KM framework, as in Fig. 3, for the global software supply chain were three capabilities of the KM process are identified including articulating the KM strategic intend, facilitating knowledge flows to enable innovation and assessing KM value, as shown in Table 3.

Table 3. Mehta's framework summary [12]

Stages	KM stages in the software supply chain
Stage 1	Articulating the KM strategic intent
Stage 2	Facilitating knowledge flows to enable innovation
Stage 3	Assessing KM value
Stage 4	Giving feedback to stage 1 and stage 2

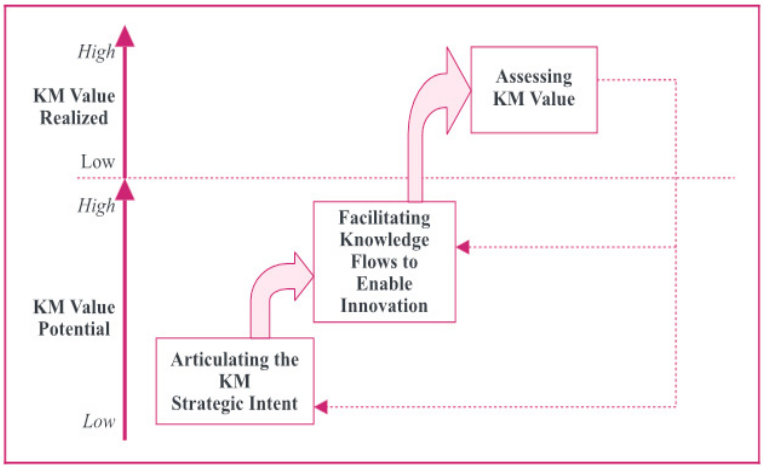

Fig. 3. Mehta's framework [12]

2.3.1. Articulating the KM strategic intend

It helps the software companies identify their strategic knowledge gaps, which reflect the divide between companies' existing knowledge resources and their future knowledge requirements. Therefore, the objective of KM programs is to fill these gaps [12].

2.3.2. Facilitating knowledge flows to enable innovation

After identification of the KM gaps in the SC, the facilitating capability improves the organizational knowledge flows by initiating KM processes supported by appropriate organizational and individual facilitators. Improves

knowledge flows lead to better utilization of existing knowledge resources and creation of new ones. Thus, filling the strategic knowledge gaps and helping firms innovate. Incorporating internal innovations creates internal value, while external innovations are delivered to market for external value [12].

2.3.3. Assessing KM value

The assessing capability helps evaluate both internal and external values. The light dotted arrows in the framework represent the feedback communication processes that carry insights gathered via the Assessing capability. These processes play a critical role in the future modification of the framework's capabilities [12].

2.4. Research proposed framework

As shown in Fig. 4, our previous research [13] proposed a knowledge-based framework for the SSSC where the SSSC is divided into three processes: The project administration process, the internal software developing process and the external implementation of the software at the client's site process. Accordingly, three types of knowledge were also identified: The project administration knowledge, the internal knowledge and the external 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 form the installation and implementation of the software at the client supply chain level. Most of this knowledge is in tacit knowledge forms which it is imbedded in the heads of the source company's employees [13].

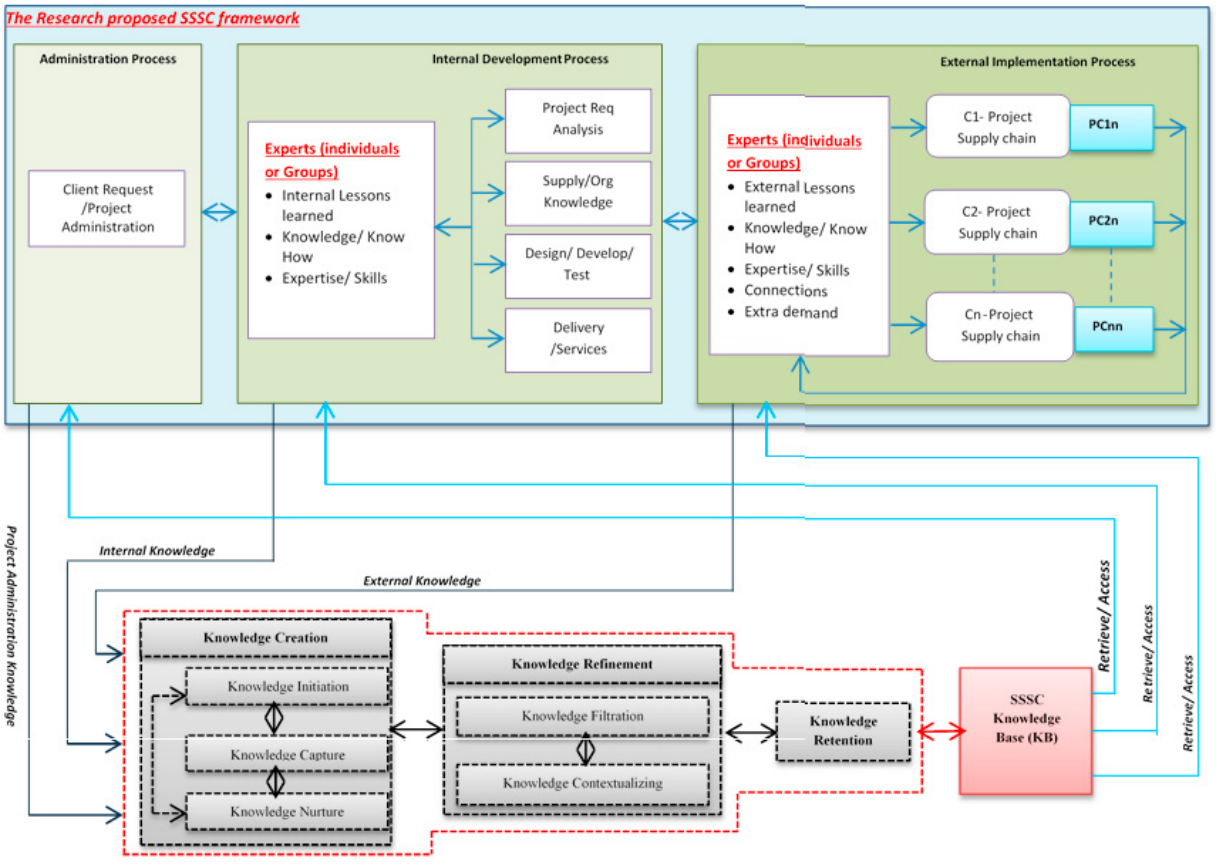

Fig 4. Integration between SSSC and KM cycle [13]

2.4.1. Administration knowledge

It represents the knowledge which is generated as a result of the project's 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 [2].

2.4.2. Internal 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 this knowledge. This knowledge consists of the "know how", lessons learned, experiences, "know why", decision made, new way of doing things, skills, expertise, prior experience, etc. [13].

2.4.3. External knowledge

This knowledge is very essential for the software 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 be also a rich source of external contacts and connection as a result of interacting directly with the client SC [13]. After identifying the source of knowledge in the SSSC, Baydoun et. al. [13] proposed that the software company has to filter this knowledge against the company's objectives and then retain (in a knowledge base) this important asset in order to gain competitive advantages and profit. Nonaka et. al. [14] stated 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.

Liao [15] stated that "knowledge is a very important resource for preserving valuable heritage, learning new things, solving problems, creating core competences, and initiating new situations for both individual and organizations now and in the future." Moreover, Omotayo [16] pointed 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 it can be used by others in the organization." As highlighted in the Fig. 4 SSSC framework, project administration, internal and external knowledge are the main sources of knowledge assets in the SSSC proposed framework.

The source of a project' administration knowledge is the project's administration staff including the project manager who manages and administers 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 are 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 boarders.

The source of external knowledge is the experts (individuals/ groups) who are involved in external installation and the systems' implementation process in the SSSC at the client supply chain level. This knowledge is lessons learned, know how skills, connections, extra demand, prior experience, real world experience, expertise and skills.

The proposed KM process (as summarizes in Table 4) introduces a solution for the transfer of the three types of knowledge (tacit) to a codified form (explicit), stored in the SSSC knowledge base so it can later be used in similar projects. This knowledge has 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 or external knowledge that generated from the development process of the software company SSSC to be used later [13].

2.4.4. SSSC KB Goals

The SSSC KB includes two main functions; to retain captured knowledge and to provide knowledge. SSSC KB is accessible by experts (individuals or groups) who participate in the SSSC. The contents of SSSC KB is accessible throughout the SC. Knowledge is accessed and used by experts (individuals/ groups) [17]. Hosseinioun et. al. [18]

stated that the main goal of the KB is to provide knowledge experts with an intelligent analysis platform which improves all the phases of the knowledge management process.

Table 4. Framework summary [13]

Stages	Knowledge activities
Stage 1	Identification of knowledge area in the SSSC (administration knowledge, internal development knowledge and external implementation knowledge)
Stage 2	Knowledge transfer - KM process (knowledge creation, knowledge refinement and knowledge retention)
Stage 3	SSSC knowledge base
Stage 4	Retrieve knowledge to facilitate the SSSC process

3. Comparative analysis between existing frameworks and the research proposed framework

This section compares the characteristics of the existing frameworks and the research proposed framework and the major differences will be highlighted. As can be seen in Table 5, Table 6, and Table 7, the proposed framework introduces additional factors to those in the literature.

Table 5. Comparison between Done's framework and the proposed research framework

Done's framework	Proposed research framework
Identification of knowledge sources (vicarious learning: congenital learning and adsorptive capacity)	Identification of knowledge area in the SSSC (administration knowledge, internal development knowledge and external implementation knowledge)
SC knowledge transfer	Knowledge transfer - through the KM process (knowledge creation, knowledge refinement and knowledge retention)
-	KM process (knowledge creation, knowledge refinement and knowledge retention)
-	SSSC knowledge base (knowledge retention)
-	Knowledge retrieval
SC maturity (combination of vicarious and experiential learning)	-

Table 6. Comparison between Yi Jiabin's framework and the research proposed framework

Yi Jiabin's framework	Proposed research framework
Articulating the KM Strategic Intent	Identification of knowledge area in the SSSC (administration knowledge, internal development knowledge and external implementation knowledge)
Knowledge transfer	Knowledge transfer - through the KM process (knowledge creation, knowledge refinement and knowledge retention)
-	KM process (knowledge creation, knowledge refinement and knowledge retention)
-	SSSC knowledge base (knowledge retention)
-	Knowledge retrieval

Table 7. Comparison between Mehta's framework and the research proposed framework

Mehta's framework	Proposed research framework
Articulating the KM strategic intent	Identification of knowledge area in the SSSC (administration knowledge, internal development knowledge and external implementation

	knowledge)
-	Knowledge transfer - through the KM process (knowledge creation, knowledge refinement and knowledge retention)
Assessing KM value	KM process (knowledge creation, knowledge refinement and knowledge retention)
-	SSSC knowledge base (knowledge retention)
Giving feedback/ facilitating knowledge flows to enable innovation	Knowledge retrieval

4. Testing the frameworks against the parameters

We have identified different parameters in our model. Then, we tested these parameters with each of the existing frameworks as well as the proposed framework. The following sections indicate the result of the testing and clarify our findings.

- Identification of knowledge source (knowledge captured/know-how skills/ lessons learned),
- KM process (knowledge transfer, knowledge creation, and knowledge refinement)
- Knowledge retention

4.1. Done's framework

Done's [9] formulated a unifying framework for the knowledge management in the service SC. This framework effectively incorporates major parameters but however, it does not incorporate any mechanism of KM process, knowledge retention, and knowledge retrieval.

4.2. Yi Jiabin's framework

The framework identifies three levels of knowledge in the SC including a knowledge transfer layer between supply chain and external environment, a knowledge transfer layer between members of supply chain, and organization's internal knowledge transfer layer. Jiabin's framework incorporates major parameters including identification of knowledge source and KM process (but it is limited to knowledge transfer). In our opinion, major concern of this framework is the absence of some KM process stages namely, knowledge creation, and knowledge refinement. In addition, the framework also falls short to include Knowledge retention and knowledge retrieval. This framework is less effective than other frameworks in describing the mechanism of KM process in the SC.

4.3. Mehta's framework

This framework defines three capacities of KM process in the software SC including articulating the KM strategic intend, facilitating knowledge flows to enable innovation and assessing KM value. Based on the testing parameters, Mehta's framework incorporates major parameters including identification of knowledge source, KM process (limited to knowledge assessing) but however, the major limitation of his framework is the absence of knowledge retention and knowledge retrieval mechanism.

4.4. Baydoun & El-Den's framework

The proposed framework [13] incorporates essential KM parameters such as, Identification of knowledge source (knowledge captured/Know-how skills/ lessons learned), KM process (knowledge transfer, knowledge creation, and knowledge refinement), knowledge retention, and knowledge retrieval. In addition, the proposed framework introduces KB structure to organize the knowledge retention process and to facilitate the knowledge flow and knowledge retrieval across the SC. Therefore, the proposed framework introduces the concept of a KB and defines the mechanism of retaining and retrieving knowledge in the SC. Thus, the proposed framework effectively

incorporates all the testing parameters and we strongly believe that it is an effective and efficient framework for the integration of the KM with the SSSC.

5. Findings and discussions

Table 8 summarizes the testing analysis of different existing frameworks including the proposed framework based on the identified parameters.

Table 8. testing analysis summary conducted test

Testing Summary		Parameters			
		Identification of knowledge source	KM process	Knowledge retention	Knowledge retrieval
Frameworks	Done's Framework	Y	N	N	N
	Yi Jiabin Framework	Y	N	N	N
	Mehta's Framework	Y	Y	N	N
	Research framework	Y	Y	Y	Y

Existing frameworks highlight some aspects of KM process mechanism as compared to the proposed framework which proposes a complete KM-based framework. We argued that Done's framework fails to incorporate some important parameters including a clear mechanism of KM process, knowledge retention and knowledge retrieval. However, Done's framework introduces an important service supply chain phase, namely, SC Maturity phase, which represents the result of the integration of KM and SC operations, the author posited that such integration will lead to a maturity SC, to put it simply, as a result of KM process adaptation in the SC, the SC will be more productive, effective, and in better performance and speed. We also argued that Yi Jiabin's framework is a less effective framework among the tested frameworks. It fails to incorporate most of the testing parameters including KM process (knowledge transfer, knowledge creation, and knowledge refinement), knowledge retention, and knowledge Retrieval. In addition, it does not consider as an effective framework for adaptation in the SC operations.

Finally, we argued that Mehta's framework is an effective model but also fails to incorporate important factors such as a clear KM process, knowledge retention for future use and knowledge retrieval. According to our analysis/opinion, Mehta's framework and the proposed framework are the most effective frameworks. Mehta's framework ignores knowledge retention for future use and knowledge retrieval while the proposed framework considers knowledge retention for future use and knowledge retrieval as important factors. The research proposed framework is specific to SSSC operations and incorporates most of the KM factors that need to be considered during the SSSC operations. Thus, in the context of SSSC, the proposed framework can be considered as an effective and efficient framework that which can be adopted by software companies as a useful framework in their development process. Our work and analysis reveal that all the frameworks except the proposed framework fall short to include a knowledge retention and retrieval mechanism.

6. Conclusion

The research, introduces a conceptual framework which presented the integration of KM process within the SSSC. Research on integration between KM and SSSC is still limited and almost not existed in the literature. It is obvious from the literature that the KM positively and effectively influences the SSSC productivity, performance and speed. This paper revealed the importance of KM support for the SSSC. The implementation of the KM process in the SSSC centers on KM's knowledge creation/transfer, knowledge refinement and knowledge retention and how such processes would add value to the SSSC by capturing the employees' expertise and know how during the project development process. The paper stresses that without a proper definition of introducing the KM process within the SC, SCs frameworks lack integral power to its productivity and performance. The paper's findings could be used by software companies to facilitate their SCs processes and can be also used by academics for further

research. Different parameters were derived from different KM and SC academic researches and frameworks. To test the proposed framework, we conducted a detailed analysis of existing/current literary frameworks and we highlighted their weaknesses as well as developing new parameters which we demonstrated their importance to the SSSC. The operating environment of SSSC was investigated in detail and the parameters that influence the KM adaptation were clearly identified. These factors served as the testing parameters for different frameworks against the research's framework. We posit that, a framework that consists of these parameters would be considered, effective and efficient for the SSSC operations, while the absence of major parameters is considered as an ineffective and inefficient framework.

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