

Requirement Analysis for SMART Supply Chain Management for SMEs

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Abstract

Since the published report of the Industry 4.0 in 2013 by the German National Academy of Science and Engineering, comprehensive researches and developments were provoked in both academia and industry professionals. Researchers tried to conduct exploratory studies of its unforeseen phenomena and practitioners tried to optimize its applications to gain competitive advantages. Along with buzzword terminologies such as, cloud manufacturing, Internet of Things, cyber-physical systems, augmented reality and artificial intelligence, along with highly anticipated concepts such as SMART factory, SMART manufacturing, SMART warehousing and SMART production, the SMART supply chain was introduced. However, for Small and Medium Enterprises (SMEs), the concept of SMART supply chain is often abstract and disruptive in nature. Therefore, in this paper, a SSCM implementation model as a conceptual framework in identifying the transitional phases and requirements of SSCM for SMEs was presented. Three transitional phases have been introduced to clarify the adaptation stages for SMEs and its practical implications. Finally, several key benefits of SSCM have been highlighted in this paper, which offers new opportunities for SMEs to compete in the global market and for future research directions.

Keywords

SMART supply chain management, SMEs, Industry 4.0 and implementation model

1. Introduction

In the current era of digitalization, companies are forced to revamp ways to design their supply chain practices. Along with the ever-growing customer expectations, customers are providing higher order details of product and service to meet with customer demand. Since the introduction of emerging technologies to manufacturing environments, a strategic initiative called “Industry 4.0” (I4.0) was proposed to portrair the fourth industrial revolution (Wang et al. 2015). The main idea of I4.0 was originally introduced in 2013 by the German National Academy of Science and Engineering (Stock and Seliger 2016). The German government initiated the computerization of manufacturing industries in their I4.0 program, while in the United States, Smart Manufacturing Leadership Coalition (SMLC) program was promoted and other major manufacturing companies such in Japan, Korea and China have also established national agenda on SMART manufacturing, warehousing and logistics programs (Wang et al. 2015; Stock and Seliger 2016; Thoben et al. 2017).

With regards to the adaptation of technologies to large companies, small and medium-sized enterprise (SMEs) are suggested to use these available information technologies to achieve higher competitive advantage. According to World Trade Organization (WTO), SMEs account for more than 49 percent of GDP in developed countries and 35 percent in developing countries (WTO 2016). With the current phenomena of technology, a number of distinctive terms were used to describe the new communicated global business systems, such as SMART supply chain (Wu et al. 2016). In this paper, we intent to bridge the literature gap in between SMART supply chain and SMEs in relation to implementation and integration.

The reminder of the paper is structured as follows. The next further introduces the nexus of SMEs and technology. This is followed by the identification of SMART supply chain, SMART supply chain management (SSCM) implementations and integration. Then a discussion of the remaining research issues of SSCM for SMEs is presented. The paper concludes by future research suggestions for practitioners and researchers.

2. The Nexus of SMEs and Technology

It is worth noting that an international standard of defining SMEs does not exist. This is due to the differences in the legislation and size of the domestic economy that lead to various definitions of SMEs across countries. Furthermore, various types of indicators are used to breakdown the size of a firm. For example, in OECD countries, most of them use the number of employees. However, in some South East Asian countries, mechanical horse powers and capital investments are commonly used to draw the line in between small, medium and large sized companies (OECD 2017). Furthermore, SMEs account for approximately 99 percent of all firms which create 70 percent of jobs by on average generating 50 percent to 60 percent value added. In emerging countries, SMEs contribute to approximately 45 percent of employment rate with 33 percent of GDP (OECD 2017).

In the recent decade, the changing technologies have allowed SMEs to grow in niche market segments and to gain competitive advantages. Through exploitation of information technologies, commercial opportunities were able to be captured and responded to the growing diversification of customer needs. For larger firms, this was considered as difficult due to lack of economy of scale. Nevertheless, SMEs are more dependent than large firms on their business eco-system and due to their constraints, they are vulnerable to market failure, economic crisis and policy inefficiencies (OECD 2017). In terms of supply chain management (SCM), SMEs drive competitiveness of the supply chain by offering products and assemble goods at lower price within the quality standards aligned by larger firms (Thakkar et al. 2009). In comparisons with larger firms, SMEs are sensitive to economic, social and political environment, thus, they would focus on their core competence and develop a network of outsourcing partners to ensure business viability in their competitive environment. With the current amount of data and information, a growing amount of innovative supply chain applications are being introduced to make ‘smarter’ decisions and to yield higher business process efficiencies and effectiveness. Therefore, in order to facilitate these new supply chain applications to SMEs business eco-system, an understanding of SMART supply chain is examined hereunder.

3. What is SMART Supply Chain?

Supply chains can be defined differently ranging from industries to industries. According to Wu et al. (2016) the goal of a supply chain is to have the right item in the right quantity at the right time at the right place for the right price in the right condition to the right customer. Whereas others define it as the management of upstream and downstream

relationship with suppliers and customers in order to create enhanced value in the final market place at less cost to the supply chain as a whole (Christopher 1992). However, due to the complexity and uncertainty of involved factors, the increasing challenges has propelled the supply chain to become more smarter (Butner 2010). The key success driver lies in the adaptation of intelligent and efficient movement in many intermediary steps and components in a holistic way.

The growing attention of technological integration in the supply chain has led to innovative systems such as, SMART containers, SMART warehousing, SMART ports, SMART shelves and SMART manufacturing (Tu 2018). Along with the movement of I4.0, management of these integral systems and understanding the insights of actionable intelligence has drawn attention to the need of SSCM. SSCM is only useful if it adds benefit to strategic management and responds to the value of customer demand. Unlike ordinary SCM, the use of digitalization in logistics and supply chains with the IoT (Internet of Things) systems, such as autonomous decisions (self-driving vehicle), has forced human to sharpen their skills such as strategic management and cooperate decisions which is still yet fully replaceable by technologies. Examples of human decision-making tasks are presented hereunder.

- Adding the right level of autonomy and intelligence to logistics,
- Finding the right balance between self-organizing and semi-autonomous system and human planning, and
- Transforming the ways of working and managing

According to Ivanov et al. (2016), the concept of I4.0 is a network of machines and products interacting with each other without the control of people. Such structure evolves over time based on the complexity of the network. Based on the literature conducted by Wu et al. (2016), the field of SSCM has been quite fragmented and divergent in many relevant disciplines. For example, in the field of engineering, isolated smart hardware applications are often studied in the field of data analysis and information system research, advanced analytics are often investigated to resolve newly evolved supply chain related issues. According to Wu et al. (2016), SSCM possess six distinctive characteristics presented hereunder:

- *Instrumented*: utilization of sensors or tags on machines to allow collection of information.
- *Interconnected*: network of business entities and products being connected in a SMART supply chain.
- *Intelligent*: performances are optimized through large-scale optimal decisions made via SMART supply chains.
- *Automated*: automated process flows via machines to replace low-efficiency resources such as labor.
- *Integrated*: real-time collaboration across stages in a supply chain to make joint decisions and information sharing.
- *Innovative*: development of new values to meet new needs and requirements.

One of the main catalysts to make SSCM possible is through advancement of information system and technology. In retrospective, SSCM will allow business entities to capture new value through new business models and improvement of business processes through reduction of cost and risk. As most supply chains are demand-driven, detailed information of customer demand is the essential piece of information to be shared among the supply chain system. This is important because it will lead to other important information such as inventory, cost, pricing, location, capacity, quality and technological information (Pedroso and Nakano 2009).

4. SSCM Implementations

The evolution of supply chains has undergone a massive change (Cerchione and Esposito 2016). With the current status of advancement in technologies, SMEs are seizing new opportunities through identification of new resources and data patterns in making strategic decisions. The benefits of data integration flows have allowed companies to make “smarter” decisions with lower-risk through data analytics. Integrating the digital and physical worlds lead to new investment decisions for SMEs, which has generally shifted from hardware-related application to more of a software-related application. According to Wu et al. (2016), there are three stages in the implementation of SSCM, namely: Local Application Model (LAM), Isolated-system Application Model (LAM) and SMART Supply-chain Application Model (SSAM).

4.1 Local Application Model

Cost reduction is an unending cycle for manufacturers, retailers and distributor while trying to stay viable in the business. LAM is the stage where information technologies are used at a functional level of the firm with an intension to save cost. For example, due to the increasing affordability of the identification tags, several firms are using it to

record and share real-time data with other functions within the organization. Other data such as customer demand or feedback can be collected via internet platforms (e-survey) which assist in production planning or product design. Furthermore, radio frequency identification (RFID) is one of the most discussed retail technologies which allow users to follow the product down the supply chain all the way to a retail setting (Attaran 2018). With these technologies, various functions in the firm are being restructured to increase efficiency and effectiveness. The key enablers in the LAM is through the process of data sourcing and collection, then transmitting them in real-time through an Internet of Thing (IoT) structure and finally redesigning and replacing the existing platform with the new one in order to optimize the use of the newly collected data (Wu et al. 2016).

4.1.1 Data Sourcing and Collection

Given the current implementation pace, the objective of this stage is to explore the use of tags (Barcode, RFID) to transmit signals to a reader which allow the device to be able to communicate with each other. The data is then transmitted to a host (Computer) which interprets and stores the information. Finally, the information will undergo a form of formulated heuristics that generate actions or decisions (Attaran 2018). This is an example of technology adaptation which has proven to save supply chain cost. According to Krivda (2004), using tag technologies, retailers are able to reduce the cost of receiving, inventory and shrinkage by 11-18 percent, they can decrease the occurrence of stock out by 9-14 percent and cut logistics delays by up to 5 percent.

4.1.2 IoT Structure

Since the introduction of IoT, several innovative applications of logistics and supply chain has created to make promising influences on the future of supply chain practices. The main goal of IoT is to create a platform to facilitate exchange of commodities, services and information (Tu 2016). In 1999, Massachusetts Institute of Technology has established the Auto-ID center to propose the structure of electronic product code (EPC) to ensure the connectivity of supply chains through RFID (Thiesse et al. 2009). Through the structuring of these new applications, a new structure has been applied in the field of logistics, manufacturing and supply chains through a Closed Loop Supply Chain (CLSC) to improve automation and efficiency (Tu 2016).

The benefits of IoT has been proven in several literature but at the same time it is also disruptive (Wu et al. 2006; Wamba and Boeck 2008; Tu 2016). Several factors need to be considered in the phase of adaptation, such as compatibility and technology transfer in the supply chain. These are critical decisions of IoT structuring in synchronizing supply chain members through existing information and product in order to provide a complete and transparent supply chain flow. One of most commonly used IoT structure that is currently available for supply chain application is the EPCglobal Network (Liu and Sun 2011). The EPCglobal Network is created to allow interoperability of RFID data in real-time throughout the supply chain network. This technology has played a key role in the IoT logistics application of agricultural supply chain (Tu et al. 2018a).

4.1.3 Information (IoT) Redesign and Replacement

The adaptation of IoT technology in the supply chain is often a complicated process. Even though IoT has led to an evolution in manufacturing and supply chain operation in numerous industries at a global scale, reluctance to accepting changes are often the main obstacle for SMEs due to different attitude and expectations (Tu 2018 and Tu et al. 2018a). Another challenge that may occur when adopting the IoT technology are the nature of data sources and control logics which may be disseminated to different companies at different locations. This may lead to poor business decisions due to incomplete data structure (Tu et al. 2018a). To remedy this problem, a common software architecture to account for different IoT environment and diverse software modules is needed (Bandyopadhyay and Sen 2011).

The architecture of an IoT system is divided into four layers namely; perception, transmission network, communication and application (Farooq et al. 2015). Perception is the application of technologies in logistical functions such as, 2D-barcode, sensors, actuators, controllers, RFID tags, mobile communications and EDI. Transmission network are device modelling, secured wireless networks, ethernet, gateway control, Bluetooth and cloud database. Finally, communication and application are results offered by the IoT system such as, track and trace, diagnosis, navigation, retail logistics, supply chain, manufacturing and transportation. However, it is worth noting that IoT does not solely focus on the replacement of existing assets and manufacturing technologies but to create a network connecting these assets and technologies through available information and communication technology (ICT) platform (Trappay et al. 2017).

4.2 Isolated-system Application Model

IAM is the stage where companies construct a general architecture of the SMART factory and explore the operational mechanisms that organizes technological and system components (Wang et al. 2016). Under the SMART factory production system, transitional phases can be identified when compared with traditional production lines. For example, in a traditional production line, resources are limited due to careful calculation of production requirements to avoid redundancy cost, however, under SMART factory production system, resources are diversified through production of multiple types of small-lot products. This is achieved through dynamic routing of products which are able to reconfigure automatically through a self-organized artificial intelligence (AI) functions (Wang et al. 2016). In a traditional production line, the routing of products is often fixed would require high setup cost if reconfigured. Finally, under a SMART factory production system, advance analytics of big data are performed through the IoT structure to allow the system to generate multi-staged scenarios to counter-measure unforeseen risks, whereas, in traditional production lines, the machine may record its own process information but seldom used by others (Wang et al. 2016; Tu et al. 2018a; Tu et al. 2018b).

4.2.1 Advance Analytics

Advance analytics is the advent of cloud computing and CPS framework, which allows firms to build a self-aware system to prevent potential operational issues through collection of big data. The self-aware system will be able to assess the machine outputs with a data-driven algorithm to learn from its mistakes and to create a form of adaptive control to avoid error (Lee et al. 2014). Multi-dimensions of data ranging from machine data, marketing data, consumer data and financial data are collected and processed through advance analytics to provide 'informed' and 'smarter' decisions (Lee et al. 2014; Witkowski 2017). According to Forrester (Russom 2011), big data consists of three dimensions (3Vs) namely, volume (amount of data), variety (variety of the data) and velocity (the speed of generation of new data and analysis). According to Zhang et al. (2017), manufacturing enterprises has begun to widely use advance information technology to carry out their general management. Furthermore, Wamba et al. (2017) also pointed out that with big data analysis, a sustained competitive advantage can be reached through improvement of customer service experience. For example, 35 percent of purchase made on Amaon.com are generated from personalized purchase recommendations to customers based on big data analysis.

With the exponential increase in volume of these real-time data (i.e. design information, material list, assemble instruction, production history data, production plan, inventory status, quality information of each component, operational condition, operating time, failure causes, maintenance history, customer purchases, sales volume, market analysis, etc), advance analytics and management of these data is needed for firms to feed into their decision-making process, otherwise, it will be considered as digital waste (Romero 2018).

4.2.2 Business Process Redesign and Streamlining

In response to new business process design, adopting new information systems will allow dynamic manufacturing activities to make immediate actions to resolve disruptive production or causes to customer dissatisfaction (Tu et al. 2018b). With embedded devices through IoT platforms, industrial machines are empowered with internet technologies which allow them to be able to communicate and collaborate with each other as machine to machine (M2M) services (Tu et al. 2018b). In order to integrate IoT with enterprise IT infrastructure and business processes, IoT applications must be integrated with intra and inter-organizational business processes and information systems to allow efficient supply chain integration (Tu et al. 2018a).

Operational activities are to be interconnected in between machines and information systems which can intelligently collaborate toward a common goal set by the user. For example, using machine-learning approach to model complex relationships on data such as, information of weather conditions, production capability and transportation planning, forecasting and delivery performance are expected to increase by 30 to 50 percent (Alicke et al. 2016). Firms must re-engineer their current business practice to eliminate business process delays (Kopitsch 2005). Evaluation of an IoT based SMART factory or service is undoubtedly out perform traditional way in terms of cost and time. However, the cost concern of investing a cyber-physical system (CPS) based system though IoT technology might be one of the main barriers to many manufacturers, especially for SMEs, with tight profit margins (Wang et al. 2015).

4.2.3 Process Automation and Improvement

With implementation of IoT and CPS, a SMART factory is capable of managing complex and flexible manufacturing system which corresponds to the rapidly changes of customer demand, inventory and production volume (Trappy et

al. 2017). To cope with these changes, a more efficient and precise supply chain is needed. Through adaptation of new business process design, active operational controls can be controlled and improved through AI and automated systems at human competence levels (Klumpp 2018). For example, automated vehicles will be able to re-route based on real-time traffic conditions of an oncoming street which is not visible to human driver, production sequence can be re-scheduled instantly when delay of inbound supplies is detected at the production site, automated warehouse systems are able to release stock information from distant locations based on real-time information of end-customer sales or production demand. According to Klumpp (2018), there are three levels of human-artificial collaborations described hereunder.

- *AI competences*, are applications of AI in specific fields such as forecasting demand or automated navigation systems. These functions solely rely on human supervisions and controls.
- *AI decisions*, are applications of AI in providing suggested decisions on a limited area of actions. For example, guided cruise control for vehicles or route suggestions on navigation system. These functions will provide suggestions based on human supervisions of scope and information, and
- *AI autonomy*, are applications of AI in performing autonomous behaviors with human interactions. For example, driverless vehicles or factory bots. In these cases, humans take over a passive supervising.

The collaboration based on AI in business processes allows firms to make “better” decisions in avoiding waste and lowering supply chain risks.

4.3 SMART Supply-Chain Application Model

SSAM is the stage where firms collaborate with other firms which shares similar visions in SSCM. With SMART networking, members in the SSCM are able to incorporate information and materials through collaborative CPS and make cohesive decisions (Ivanov et al. 2016). Such system requires adaptation and reconfiguration of SMART factory or manufacturing to allow machines and products to interact with each other without human control. According to surveys conducted by PWC, 50 percent of German companies are gearing towards SMART networking and 20 percent of them are already involved with SMART factory or manufacturing (Ivanov et al. 2016). In addition, SSAM can be seen as an interaction in between supply chain collaboration, data sharing, integration and partnerships which ultimately leads to a possibility of process and product innovation.

4.3.1 Supply Chain Collaboration and Data Sharing

One of the key benefits of adopting technology and sharing data in the collaboration of supply chains is to eliminate waste while increasing agility of the supply chain. An end-to-end connectivity allow supply chain members to have a quicker response to market changes through configurable supply chain cloud network. According to Brettel et al. (2014), collaborative development and manufacturing environment is critical for SMEs with limited resources. Under a collaborative environment, data transparency would allow firms to gain access to an expended perceivable market opportunity with diversified risk. The importance and value of information for an effect SCM has been extensively highlighted in the literature and most notably in the area of data sharing (Wamba et al. 2015). According to Alicke et al. (2016), the impact of SSAM is expected to lower 30 percent of operational cost, 75 percent of lost sales and 75 percent of decrease in inventories. However, to allow such system to work efficiently, adaptation and reconfiguration of the existing structure are needed.

4.3.2 Supply Chain Integration and Partnership

The challenges for supply chain experts today are to determine how to integrate technology with the existing supply chain management and customer relationship management applications with the entire system. Digitally integrated supply chain functions such as predictive analytics in demand planning, closed-loop planning, automation of knowledge work, advance profit optimization a scenario planning would allow supply chain members to gain competitive edge through the process of planning. Other digitally integrated functions such as automation of warehousing, autonomous smart vehicles, human-machine interfaces, SMART logistics planning algorithms, reliable online order monitoring, real-time re-planning, real-time vender inventory monitoring and no-touch processing would also provide advantages through the process of physical flow and order management (Brettel et al. 2014; Alicke et al. 2016). To ensure the exchange of information, a uniformed standard for information transfer is to be applied throughout the supply chain.

According to Wang et al. (2016), three key features of integrations should be addressed in order to understand the relationships in between each supply chain members: horizontal integration through value networks, vertical integration and networked manufacturing systems, and end-to-end digital integration of engineering across the entire value chain.

- *Horizontal Integration.* Cooperation in between related-firms that stimulates value through inter-corporation horizontal integration. This would allow firms to form efficient eco-systems through information, finance and material flow.
- *Vertical Integration.* This is a self-organized system (SMART production, SMART manufacturing and SMART logistics) that allow reconfiguration through a firm's own physical and informational subsystems.
- *End-to-End Engineering Integration.* This is a continuous and consistent model which involves through a chain of activities such as customer requirement expression, product design and development, production planning, production engineering, production, service, maintenance, and recycling to create a product-centric value creation process.

To maintain a global competitive advantage, companies will have to focus on their core competencies while outsourcing other activities to collaborators in the network. According to Christopher (2000), the ability to leverage competencies of partnerships in order to respond to market need can lead to sustainable advantages. Therefore, the effort of integration and partnership along the supply chain eco-system may foster a trustful relationship which may lead to higher level of information-sharing across parties (Kache and Seuring 2017).

4.3.3 Process and Product Innovation

Through supply chain collaboration and integration under the platform of SSCM, higher utilization of information and communication technology allow products and production to be engineered digitally. Modular simulations and techniques allow firms to decentralize and alter production processes and thereby stimulate faster innovation of process and product (Brettel et al. 2014). According to Kache and Seuring (2017), the reduction of lead time in product design and prototyping through improved supply chain visibility, provides time benefit of increased data availability on the supply chain level, especially in regard in time compression of innovation cycles. Other than the benefit of time, the use of collaborative prototyping also allows supply chain members to save cost in research and development process and to accurately response to customers' specific demands (Tan et al. 2015). A schematic flow of SSAM is illustrated hereunder (Figure 4.1).

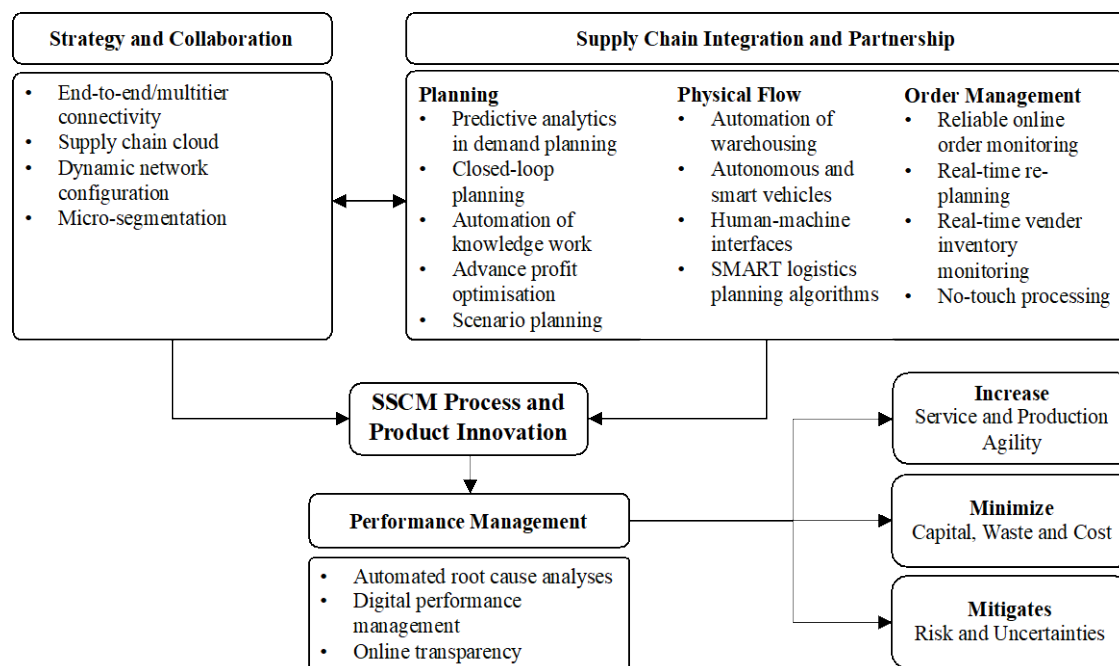


Figure 4.1: Schematic flow of SSAM

5. Integration of SSCM for SMEs

According to the proposed SSCM implementation model, three transitional phases are presented as LAM, IAM and SSAM. Each individual phase represents the level of information and technology integration in the firm and the performance benefits that are expected. With the IAM phase, SMEs would apply information technologies to support functional activities such as inventory management, order management and production management but under a CLSC environment. Some of the main reasons why SMEs would adopt technologies in their management practices would be cost, time, human error and competition (Wu et al. 2016). With the introduction of SMART factory and services, a high level of trust and acceptance in technology are to be built in order to elevate an overall supply chain performance. SMEs would need to empower their system to allow them to make operational decisions based on a self-aware AI system. This is often a very difficult task to comply due to lack of confidence and other disruptive factors such as dynamic business conditions, contestability of local market and rapid obsolescence of knowledge and skills (OECD 2017). Furthermore, the requirement of sharing information through the supply chain is often considered as a very sensitive due to the risk of information leakage (Kembro et al. 2017). Therefore, a certain period of adaptation is needed to resolve these barriers. Finally, through a period of adaptation and usage, SMEs can advance itself to SSAM phase where activities such as integrate sourcing, product and retailing process would further increase an overall supply chain performance. In this phase of SSCM implementation, SMEs would empower information technologies to make operational decisions. Instead of using human-to-machines interfaces, machine-to-machine (M2M) are relied on. This gives SMEs the ability access strategic resources which are critical for their competitiveness and allow rapid process and product innovations. The SSCM implementation model is presented hereunder (Figure 5.1).

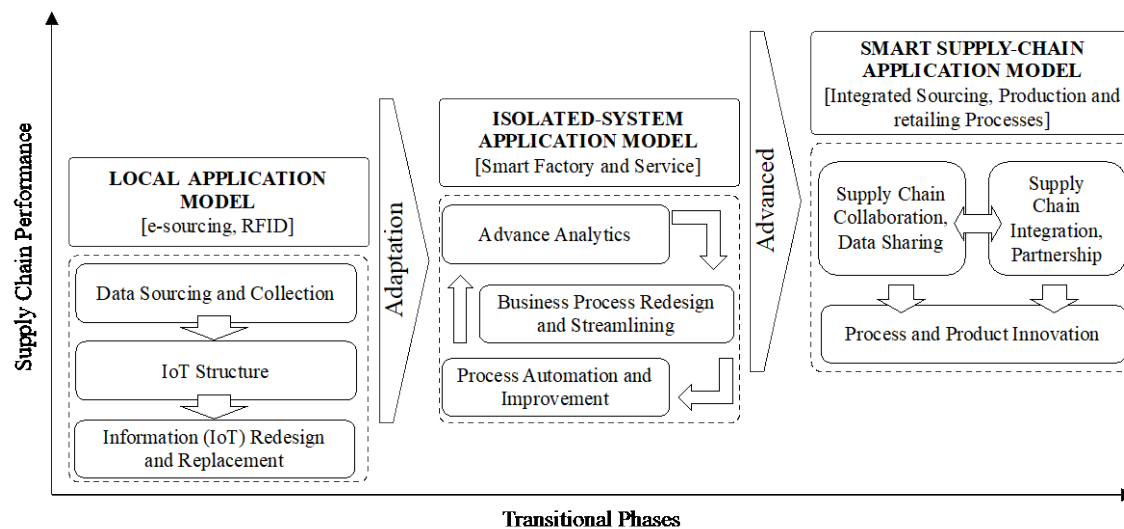


Figure 5.1: SSCM Implementation Model

6. Discussion

In this paper, we have presented the SSCM implementation model as a conceptual framework in identifying the transitional phases and requirements of SSCM for SMEs. Several key benefits of SSCM has been highlighted in this paper, which offers new opportunities allowing for SMEs to compete in the global market. However, according to OECD (2017), majority of SMEs have not been able to acquire the benefits of the technological transitions and are lagging behind in adopting these available technologies to their management practices. For example, in most developed countries over 75 percent of firms adopt enterprise resource planning (ERP) application to manage business information flow, while only 20 percent or less are used by SMEs. The transformation process of the SSCM for SMEs requires three key managerial enablers, namely: a clear definition, new capabilities and a supportive environment. The key technological enablers are integration of cloud manufacturing and IoT information infrastructure capabilities which supports real-time planning and execution of supply chain synchronization system (Qu et al. 2016). The lag of adaptation of SMEs is mainly due to lack of investment and knowledge assets, such as research and development, human resources, organization changes and process innovation (Wang et al. 2015; OECD 2017).

In light of this research, the contribution of this study is geared towards firms in realizing the benefits of adaptations to gain competitive edges. Due to the nature of SMEs, especially family enterprises, lack of appropriate corporate governance structure, inconsistency of decisions and business transfers may result in poor management practices. However, it has been proven that the recognition of IoT and CPS technologies allow firms to offer customers products with superior quality and competitive in price (Brettel et al. 2014). Therefore, realization of SSCM practices would enable SMEs to gain a better understanding of processes within the firm, the need of their customers and the overall business environment (Ivanov 2016; Wang et al. 2016; OECD 2017). Under the context of academic research, we have contributed to the emerging field of I4.0, supply chain management and SMEs and its supply chain relationships. Along with the highlighted phases of implementation, deliberation of new supply chain models is possible along with new introduction to digital value-chain. We have also conceptualized three distinct transitional phases of SSCM along with the relationship of their individual enablers. While there is voluminous research literature available on SCM, only a hand full of research indicates the applications of SSCM to SMEs. To consolidate the discussion threads, new possible research directions such as; IoT data analytics for SMEs, development of SSCM for SMEs, economic value of SSCM applications for SMEs and SSCM practices for SMEs is worth future investigations.

7. Future Research Suggestions

This paper is informative in nature. It is worth noting that only a handful of literature, mostly conference articles, are published over the past 5 years since the introduction of I4.0. However, the very prediction of I4.0 has created unique opportunities for researchers to investigate the endless possibilities of supply chain practices and its impact on the business environment. The SSCM implementation model offers a stringent perspective on the adopting of new information technologies, which could be recognized in a portion of the analyzed literature. Newly articulated dimensions of supply chain management would require innovative integration of different expertise and new business development strategies. The main implications for future research include a need for more work in theoretical issues of SSCM for SMEs and empirical research, such as case studies, to provide practical insights. Furthermore, it will be interesting to systematically compare the transitional phases and the situational enablers of SMEs in different industries or countries. Nevertheless, there is still a strong demand for future SSCM research activities in the context of SMEs.

Acknowledgements



The project “SME 4.0 – Industry 4.0 for SMEs” has received funding from the European Union’s Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No. 734713.

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