



DIGITAL SUPPLY CHAIN MANAGEMENT

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ABSTRACT

The purpose of this paper is to present a conceptual model that defines the essential components shaping the new Digital Supply Chains (DSCs) through the implementation and acceleration of Industry 4.0. The scope of the present work exposes a conceptual approach and review of the key literature from 1989 to 2019, concerning the evolution and transformation of the actors and constructs in logistics and Supply Chain Management (SCM) by means of examining different conceptual models and a state-of-the-art review of Industry 4.0's concepts and elements, with a focus on digitization in supply chain (SC) processes. A detailed study of the constructs and components of SCM, as defined by their authors, resulted in the development of a referential and systematic model that fuses the inherent concepts and roles of SCM, with the new technological trends directed toward digitization, automation, and the increasing use of information and communication technologies across logistics global value chains.

Having achieved an exploration of the different conceptual frameworks, there is no compelling evidence of the existence of a conceptual SCM that incorporates the basic theoretical constructs and the new roles and elements of Industry 4.0. Therefore, the main components of Industry 4.0 and their impact on DSC Management are described, driving the proposal for a new conceptual model which addresses and accelerates a vision of the future of the interconnectivity between different DSCs, grouped in clusters in order to add value, through new forms of cooperation and digital integration. This conceptual framework will further aid researchers in the exploration of knowledge regarding the variables and components presented, as well as the verification of the newly revealed roles and constructs to understand the new forms of cooperation and implementation of Industry 4.0 in digitalized SCs.

Key Words – Industry 4.0 - Digitalisation – supply chain.

INTRODUCTION:

Supply chains (SCs) and production logistics processes are an important part of the daily enterprises of many professional and personal activities in modern life, and they are highly significant for global development. The great speed of the changes in the different markets and in the economic, financial, social and technological aspects results in SCs being in a state of constant movement and evolution. SCs do not remain static, but evolve and change in their size, shape, configuration and the manner in which they are coordinated, controlled and managed. The impact of the new digital era on the fourth industrial revolution, the Information and Communication Technologies and the Internet of Things (IoT)-based cyber-physical system (CPS) architecture for production logistics and SC applications have led to the implementation and acceleration of innovations that are required for the digitization of the industry. The objective of this research is to contribute to the understanding and evolution of SC models, both conceptual and structural, by means of a literature review; and subsequently, to present a detailed analysis of the principal models, in order to create a well-founded proposal for the evolution for these conceptions, through a new Digital Supply Chain (DSC) model which considers new actors and roles together with the principal constructs and elements of Industry 4.0. Therefore, the purpose of this prospective model could be a starting point in order to continue explaining and observing the best way to accelerate and implement Industry 4.0 practices for digitalized SCs.

DIGITAL SUPPLY CHAIN MODEL IN INDUSTRY 4.0:

The proposal DSC model in Industry 4.0 consists of six continuously interconnected dimensions of the SCMPs and SCMCs; the SCNS; the Industry 4.0 technology enablers and features; the flows; the virtual value creation (which generates the virtual value chain); and the digital and physical world. These dimensions interact constantly within the physical SC and a virtual SC, or as a physical SC scope and a digital data value chain scope. The main intention of the DSC model is to present a framework with possible interconnections and configurations to the new digitalized SCs in Industry 4.0 and which are spreading out as part of the evolution of its daily activities. According to Graham and Hardaker (2000), the virtual value chain identifies the changing nature of value creation, but, just as importantly, indicates how new products and services are emerging through the information-driven economy. Taking as a starting point this proposal, the most important output in any DSC is to achieve virtual value creation through the new construct, now embodied in this proposed model, called CC and Cloud Robotics (CR). Only with this powerful intelligence, is it possible to reach the value of availability (making products and services available to the customer via autonomous delivering), plus the value of digital servitization (several IT-based service options going beyond the simple distribution of products or physical services), and the value of digital integration (that arises through a permeable transparency and traceability along the DSC)

Further more, it is worth taking into account how global connectivity and performing different types of flows are transforming the value chain in the digital era, toward the construction of a virtual value chain; the conceptualization described previously can be observed.

BENEFITS OF SUPPLY CHAIN MANAGEMENT (SCM) :

Effective Supply Chain Management (SCM) systems provide the following benefits to optimize the organization's performance.

Improve the customer service by delivering them the right product at the right time and at the right location, which in turn increases the organization's sales.

Enable the companies to bring the products to the market at a quicker rate. Thus, the companies get their payment sooner than those who lack an efficient supply chain.

Lower the total supply chain cost, including procuring materials cost, transportation cost, inventory, carrying cost, etc. The reduction in supply chain cost helps to increase the firm's profitability.

DISCUSSION AND PRACTICAL IMPLICATIONS FOR THE DIGITAL SUPPLY CHAIN MODEL:

It will be important to recognize that the evolution of the SCs is not only due to the implementation of physical and virtual digitalization in network structures or in the information and communication technology systems of traditional SCs (e.g. having invested and installed a brand-new 3D printer, or implemented IoT in work area); instead, the transformation requires special attention in the embodiment of new forms of administration to generate a culture of change with a focus on digitalization, creating a proper environment for the evolution of each one of the components already studied in traditional SCs. The DSC model proposal provides a framework for the adoption and incorporation of the current and nascent Industry 4.0 technology enablers and features within the current SCM in order to evolve in a digitalized SCM. This approach is shown within a multi-dimensional and interconnected framework with the following technological and managerial implications. Historical SCM studies have defined the base line of the main elements and constructs to operate the entire chain structure and activities. However, problems have been observed in the literature regarding SC integration, flexibility, communication and customer satisfaction. Therefore, it is significant to recognize that ancient studies and SCM models laid the foundations for those SCs that lived and operated in a different world, and to realize how innovation research, inventive transformation and the rapidity of the emerging Industry 4.0 technologies will lead to an imminent revolution and evolution toward the digitalization of SCMs. Failure to accept this change could put business models at risk, and they could become stuck in the adoption and implementation of technology enablers, thus leading to their decline.

To achieve a superior SC performance (cost, quality, flexibility and time performance) requires multi-lateral integration: internal/external integration; functional integration; geographical integration; integration in chains and networks; and integration through IT. This integration goes even further to include the supplier's supplier and the customer's customer to leverage the power of the "network" beyond their own part.

Five essential elements are crucial for successful Industry 4.0 technology implementation into DSCs, which are: project management to digitalize and manage the culture's organizational behavior in the SCMCs; human and technology relationships in digital SCMPs; the formation of a technology infrastructure or a digital and physical SCNS; Industry 4.0 technology enablers and features deployment, all without losing sight of the ever wider-ranging digital and physical SCFs in order to provide the right digitalization. On the other hand, interconnectivity and mass customization efforts improve the customer experience. When drawing up a near-term strategical objective for digital improvements, clients' preferences should never be far from the leaders' minds. Consumers want "convenience, choice and control," and when SCs become more digital and data-driven, they can create services that provide these benefits. Each player involved into the value chain delivery are ready to stop thinking about the connectivity between each actor and the structure of the SC in a linear way, and start betting on development as a multi-dimensional organizational strategy for the following characteristics of the DSC: transparency, communication, collaboration, real-time responsiveness, accuracy and flexibility.

To create a real organizational vision, the digital strategic enterprise needs to recognize and bear in mind the main characteristics of the global world, from which arise changes in customer behavior and a shift in the market's overall demands, challenges and risks. A reasonable number of processes will have to take on new virtual and intelligent-automated characteristics to give companies the full DSC experience. As more businesses take the plunge into this new style of operations, companies that retain too many outdated manual processes may fall behind.

Triggered by the proposal framework, it is possible to arrive at a formulation of a new visual manifestation of the current functioning of directed networked SCs in globally integrated clusters. DSCs, enabled by the CC, have clear challenges which together drive unprecedented visibility, insights, and flexibility while operating rapidly and on a large scale. Due to losing control over data that were previously housed on internal servers and/or computer hard drives, the safety of these data on the web and service outage situations also present some challenges. Technology development systems processed within multiple DSCs and their clusters will be the developers of the actual integration of diverse smart factories and even more of the global integration, knowledge and information in real time. The virtual world will emerge from the physical one, but beyond that will have the capacity for prediction, multiple intelligences and inter connectedness directed toward a digital world.

Each of the components of the DSC model, both in Industry 4.0 and in a digital and smart world, is already boosting a revolution of integration, interconnectivity and great added value for final consumers, as well as internal customers and suppliers. Consequently, a pertinent stage of this historical visualization and of the present status of the state-of-the-art DSCs is realizing the developmental stages which are moving from internal integration and growth in the direction of external integration—headed toward a goal-directed network SC and DSC management to achieve evolution for collaborative DSC clusters.

However, the above concept may only be achieved by changing the construct of a single, linear SC by moving to integrated DSC networks interconnected with life cycles, constantly changing through multiple smart factories in a smart world. Therefore, three steps for the adoption of the Industry 4.0 digitalization enablers are suggested below: (1) First, perform the first digital adoption with a focus on the digital experience with the client. Offer products, services and rapid responses focused on digitalization and real time. As much as possible, be in direct contact and create virtual value. A long-term result of success in this first strategy may be the disappearance of intermediaries such as wholesalers and retailers.

Another natural result will be the evolution of digital knowledge, technologies and competitiveness, which will naturally develop 2PL, 3PL and 4PL which can be used in favor of the organization. (2) Second, make a considerable investment in the virtual value chain, particularly in the distribution channels with the support of 5th party logistics, to make the customers aware of the new delivery services. (3) Third, execute the transformation to a smart factory or, if this is the case, the development of smart services and processes. In addition, support the incorporation of this initial approach to DSC by suppliers. This can develop interesting success stories with a more effective and efficient vertical integration. Finally, a relevant implication of this study and its contribution to scholars in the field means that new SCMCs are now evolving, both in the traditional SC, as well as in the nascent and digitalized ones. It will have a great impact to be able to carry out field research on the new constructs while referring to their configuration of logistical processes and SCM, the form of administration, the flows and even new physical and digital actors who can take on relevant management roles and even implement new technological and digital structures.

CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH DIRECTIONS:

In conclusion, this paper presents a DSC Model, which includes the traditional SC actors and constructs, as well as the new and emergent elements inherent to the Industry 4.0 era.

The model is based on and supported by the results of a two-part literature review. The first part of this review identified the most significant conceptual models in the area of SCM, published from 1989 to 2019, and revealed the lack of a comprehensive DSC model. The second part of this review systematically examined the Industry 4.0 state of the art to identify a summary of the emergent elements and technology constructs used in the nascent digitalized SC. An extended formalization of the final dimension of the construct DSC model is presented, where the inter-cooperation between the components are shown, with the information and communication technology trends of Industry 4.0, as well as the digital and physical worlds, are disclosed. All this has been made possible thanks to real-time decision making, given the information gathered in the CC and CR analyzed by the monitor and drives customers' behavior (data trends) for an optimal intelligent demand assessment, as well as effective and efficient input/output processes in logistics.

The DSC model proposal provides a state of art guidance for the Industry 4.0 enablers and features to be adopted in a digital SC context and seeks to reduce some of the barriers against the implementation of all the elements surrounding this fourth transformation within the SCM, from both a technological and a managerial perspective. For example, Provide guidance with respect to pointing out the essential components of Industry 4.0 interacting in real-time with all the SCMCs, SCMPs, SCFs and structure, providing an integrated structure to facilitate the understanding in the transition for the traditional linear chains to digitalized SCs. Special considerations for some of the main barriers are the difficulty of visualizing the digital and physical flows and the determination of the appropriate level of interconnectivity between the physical and digital world. Therefore, another example of the impact of this proposed model is the reduction of gaps in the actual context-relevant situation, for how software and technology are digitalizing the service and manufacturing value chains. The DSC model in Industry 4.0 proposes as a focal point and in an innovative way, CC and CR as core elements to achieve virtual value creation, because they enable interconnection in real time with regard to the physical and the virtual: SCMCs and SCMPs along with everyone interested in the SCNS via the SCFs.

Similarly, the CPS is presented as the principal elements of the link between the physical SC (physical world/physical things) and the virtual SC (a digital data global value chain) and Industry 4.0. From this analysis, it is possible to arrive at a formulation of a new and visual manifestation of the current functioning of digital globally integrated SCs, SC clusters and goal-directed networked SCs. The integration and inter-cooperation of different DSC clusters will have to be based on strategies to help industry and governments create sustainable economic growth, thus creating a transition toward a sustainable digital world, the basis of which must be the three pillars of sustainable development: environmental, social and economic. This can only take place by working hard on the application of tactics such as green and reverse logistics, an access economy, a circular economy, a collaborative consumption/economy and a sharing economy, among others. It is expected that green behavior will become the standard for doing business and that no external pressure will be necessary to further promote this conduct.

The presented research study has taken place in the context of a literature review of existing studies and empirical evidence with regard to SCM and the elements of Industry 4.0. However, this allows for future work to be focused on the validation of the preliminary DSC model by experts and by considering real case studies from contemporary.

Manufacturers or service providers. This could provide the validation of its components and even make headway toward new and emerging constructs.

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