# A REVIEW ON SUPPLY CHAIN INTEGRATION: VERTICAL AND FUNCTIONAL PERSPECTIVE AND INTEGRATION MODELS

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## Abstract

*This paper reviews a sample of the literature relating to vertical and functional perspectives toward supply chain integration as well as integration models. Considering the extensive amount of literature on supply chain integration, it appears that it is still in its infancy. Although the need for integration is pointed out by both academic and industrial experts, little works has been carried out in terms of developing a comprehensive integration system. This study reviews a sample of recent and classic literature, and in doing so throw light on different aspects of supply chain integration. It discusses and criticizes the current state of literature on this context so that future researches find directions to contribute to missing points and remove obstacles. The scope of this review is limited to a cross-section of the literature in this area. As such, it cannot, and does not, attempt to be an examination of the full range of the literature, but a sampling of important and influential works.*

***Type of the article:*** *Theoretical paper.*

***Keywords:*** *Supply chain integration; vertical integration; functional integration; integration models.*

***JEL Classification:*** *L1, M11.*

## 1. Introduction

This paper deals with integration and its various elements in supply chain (SC). The terms like coordination (joint operation), collaboration (working jointly), cooperation and coordination are complementary to each other and when used in the context of SC can easily be considered as a part of supply chain integration (SCI) (Kanda and Deshmukh, 2008). Integration is the quality of collaboration that exists among clusters to achieve an effective, efficient and united system. Flynn et al. (2010) Define SCI as the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organization processes. The eventual goal of SCI is to achieve effective and efficient flows of products and services, information, money and decisions, to provide maximum value to the end customer (Rosenzweig, *et al.,* 2003).

Importance of supply chain management (SCM) was stressed on early 80's by Oliver and Webber (1982) and in the same decade integration was pointed out as a strategic winning factor by Stevens (1989). SC's are generally complex and are characterized by numerous activities spread over multiple functions and organizations, which pose challenges to reach effective SCI. SCM is an interdisciplinary topic that addresses diverse fields: materials management, quality, industrial market, purchasing, logistics, inventory, procurement, production planning, intra- and inter-organizational relationships, policy making, etc. Collaboration between buyer and supplier or building of a relationship lies at the core of SC. In the literature, integration is also discussed as removing barriers (or boundaries) between organizations. Integration as a key factor in achieving improvements has been one of the main themes in the SC literature, therefore it is frequently examined by researchers and they have shed light of its different aspects (Childerhouse *et al.,* 2011; Danese & Romano, 2011; Fisher, 1997). A great deal of research has been done on the importance

of integrating suppliers, manufacturers, distributors, and customers (e.g. Lam and Ip, 2011; Lockstrom *et al.*, 2011; Spralls *et al.,* 2011) that in other words covers integration of SC members from technical and strategic aspects. Researchers have employed different approaches to examine these issues. There seems to be no consensus on definition of SCI, although different authors have presented numerous definitions depending on their research concern.

Objectives of this paper are to: report and review various perspectives on vertical and performance integration; report and review integration models; identify the gaps and obstacles existing in the literature. The papers related to SCI are searched using library databases covering a broad range of journals. In paper selection procedure the focus has been on recent works however a few of old references are also considered due to their influence on literature.

The current research contributes to both theory and practice through identification of gaps discussed in the discussion section. Researchers may get direction to address theoretical gaps and find novelty in their research works. In addition to theoretical gaps in the literature, it lacks record of empirical works in this context which may be addressed by practitioners. Structured case studies and documenting failure and success stories are among beneficial works which may be done by practitioners.

## 2. Vertical integration

Vertical integration takes place at different levels of the SC. The integration between producer and the distributor enables better physical and information flows, improvements in the trade-off between level of service and average stock, more economical inventory management control and better transportation systems (Soosay *et al.,* 2008). Most referred driving forces of vertical integration are: demand fluctuations, environmental uncertainty, customer focus, advanced technology, information technology, and intensified competition are among most referred driving forces of vertical integration (Guan & Rehme, 2012; Olausson *et al.*, 2009). Diverse amount of issues are involved in vertical integration such as direction and level of integration, outsourcing, and vulnerability to disturbances. A review on literature about these issues is presented in this section.

**Direction of integration:** Direction of integration addresses downstream integration with suppliers and upstream integration with customers. Downstream integration is a key managerial area to improve performance in supply networks. Though most studies agree that downstream integration positively influences performances, the literature also reports cases of failures in achieving significant improvements (e.g. Dabhilkar, 2011; Danese and Romano, 2012; Lintukangas *et al.,* 2009). Company position determines whether downstream or upstream integration has more effectiveness. Downstream integration helps firms to secure the distribution channels of their products, especially in markets with increased uncertainties. Second, it can offer a way to control efficiency gains and cost reductions in the SC (Frohlich and Westbrook, 2001). Third, downstream markets can offer important benefits in addition to large new sources of revenue (Guan and Rehme, 2012). Supplier integration refers to the degree to which a firm can partner with its key suppliers to structure their inter- organizational strategies, practices, procedures and behaviours into collaborative, synchronized and manageable processes in order to fulfil customer requirements (Yeung *et al.,* 2009). Supplier or upstream integration increases the productivity of the SC and leads to reduction of wastes.

Inditex owns nearly the entire SC. It is a good example of upstream and downstream integration which eight different brands (Zara, Pull and Bear, Massimo Dutti, Bershka, Stradivarius, Oysho, Zara Home, and Kiddy's Class) and 3,914 stores in 70 countries (Guan and Rehme, 2012). High vertical integration has provided Inditex competitive advantages of planning flexibility, short lead time, frequent replenishment of stores, and differentiated products.

**Level of integration:** Level of integration refers to the extent integrative activities within one dimension are developed. SCM literature agrees that the position of company in SC strategically influence its level of integration with other members (e.g. Cook *et al.,* 2011; Olhager, 2003). Most of SCI studies hold the same view that level of SCI has a positive influence on performance

outcomes. Kim (2009) argues that there exists a significant interrelationship between SCI practice level and competition capability. However, when it comes to decision making, strategic concentration is a key issue for manufacturing companies when designing a SC. As a corporate strategy and a SC governance strategy, high integration level efficiency relates to organizational economics and strategic SCM (Guan & Rehme, 2012). Results of the research by (Olausson, Magnusson & Lakemond 2009) indicates that the level of vertical integration affects how and to what extent a new product development projects can access and take advantage of manufacturing competence (internal or external).

**Outsourcing:** Outsourcing refers to allocation of business activities from a source internal to an organization to a source outside of the organization (Kroes & Ghosh, 2010). Some theorists argue that outsourcing increases the efficiency of SC (e.g. Lutz & Ritter, 2009; Tsay, 2010; Williamson, 2008). There are success stories of outsourcing SC activities. For instance companies such as The Gap (U.S.), Hennes & Mauritz (Sweden), and Benetton (Italy) tend to outsource activities to outside partners to be able to keep strong vertical integration along their chain. Although outsourcing is prevalent in certain industries and segments, it has been argued that different economic and technological circumstances require distinct SC governance strategies. The selection of outsourcing service providers should be more emphasis on its core competence and the integration degree of SC, so that outsourcing service providers can better enhance the SC's competitive advantages (Cao and Zhu, 2011).

**Lack of vertical Integration:** The lack of integration may result in poor performance of SC (Kanda and Deshmukh, 2008). Ramdas and Spekman (2000) report consequences of lack of integration as: inaccurate forecasts, low capacity utilization, excessive inventory, inadequate customer service, inventory turns, inventory costs, time to market, order fulfillment response, quality, customer focus and customer satisfaction. Fisher *et al.* (1994) has cited a study of the US food industry, which estimated that poor integration among SC partners was wasting $30 billion annually. The mismatch between supply and demand results in rise of the costs of stock out, markdown , expediting, shipment, advertising, and sale preparation, excess inventory, obsolescence, and disposal . Wolf (2011) believes that the lack of SCI is partly due to a lack of knowledge and structural framework as to how internal and external integrations can be achieved. A consequence of lack of integration is reduction of control. For instance, an enterprise has a contract with a supplier for buying a maximum amount of a product, but the context changes and that organization needs more than the fixed amount for a certain period of time. It has to renegotiate with the supplier to buy a higher amount, but it is really up to the supplier to deliver more than agreed previously, and it is possible that he won´t do it. Now, if the organization is handling that product by itself, it just has to increase production - it has the control to increase or reduce production, at will, so there is more supply chain coordination.

## 3. Functional perspective

Functional perspective towards SCI emphasis stems from the fact that SCM is supposed to be a boundary-spanning activity. It is critical antecedent to effective SCI (Fawcett & Magnan, 2002). Functional integration enables information transfer among different manufacturing/ logistics/ business functions more accurate, fast, and cost effective, which enhances the information processing capabilities. From historical point of view, SCI literature is mostly concentrated on vertical aspects (Fisher 1997; Rothaermel *et al.,* 2006; Schoenherr & Swink, 2012) however in the new century functional aspects are also discussed in the literature. This section reviews literature about functional perspective of integration in terms of performance measures, mass customization, organizational culture, and functional and innovative products.

***Performance measures:*** Without output measures no assessment of the operational performance of a collaborative SC is possible (Angerhofer & Angelides, 2006). SC performance measurement and auditing are of particular relevance at a time when SC networks have become

more complex due to conditions affecting markets such as globalization, innovations in information and communication technology, advances in manufacturing processes, shortened product lifecycles and discerning customers demanding high quality products at low prices (Kostina *et al.,* 2012; Mondragon *et al.,* 2011). With respect to SC performance, a large number of measures have been used in the literature, stressing that performance is a multi-dimensional concept itself (Van Donk & Van Der Vaart, 2005; Hartmann *et al.*, 2012). A performance measurement program for a SC should be complete—important aspects of performance in any link are not ignored—and they must be tailored to varying needs of participants. This requires collaboration of industry consortiums, consultants, and researchers.

***Mass Customization:*** The notion of mass customization emerged in the late 1980s to emphasize on the need to provide outstanding service to customers by providing products that meet customers' individual needs through unique combinations of modular components (Hsuan Mikkola & Skjott-Larsen, 2004). In other words, mass customization is the ability to offer a relatively high volume of product options for a relatively large market that demands customization, without substantial tradeoffs in cost, delivery, or quality (Liu *et al.,* 2006). The study by Lai *et al.* (2012) suggest that the development of mass customization could be initiated from the internal core competences and then leveraging external correlations. Pursuing mass customization, however, increases uncertainty in demand, supply and the production process of the firm. Performance integration among SC members is suggested as an effective approach to reduce the negative impact of uncertainty on mass customization and firm performance (Liu *et al.,* 2012). Studies have shown that companies with both highly differentiated and highly integrated business functions tend to outperform other companies. It is due to the fact that achieving mass customization is a multi-disciplinary effort where functional areas must be aligned in their goals, have access to appropriate information, and perform in a systematic manner to design, produce, and deliver customized products to customers quickly and cost effectively (Svensson & Barfod, 2002). Therefore, mass customization facilitates achieving performance integration in SC members.

**Organizational culture:** Organizational culture is the pattern of beliefs, values and learned ways of coping with experience that have developed during the course of an organization's history, and which tend to be manifested in its material arrangements and in the behaviour of its members (Sun, 2008). Therefore, firms may react differently to the same levels of perceived institutional pressures to adopt SCI due to the differences in their organizational cultures. Organizational culture is identified to be a key factor influencing SCI. According to a survey by Sambasivan and Yen (2010) there is a relationship between the culture type of SC members and the degree of integration (trust, communication, and commitment). However, there is little empirical research that studies the relationship between human resource and SC success in detail. Shub and Stonebraker (2009) believe this omission may be due to the notable lack of studies that evaluate the soft variables and their alignment with SC, using high confidence methods.

**Functional and innovative products:** Fisher (1997) and then Ramdas and Spekman (2000) believe that if one classifies products on the basis of their demand patterns, they fall into one of two categories: they are either functional or innovative. And each category requires a distinctly different kind of SC practices. According to Fisher (1997) functional and innovative products differ in terms of: product life cycle, product variety, average stock rate, average margin of error in the forecast at the time production is committed, average forced end-of-season markdown as percentage of full price, and lead time required for made-to-order products. High performers among innovative-product SC's use practices that enhance revenues more than high performers among functional product SC's. They are more likely to engage in SC to enhance revenues (Ramdas & Spekman 2000; Shevtshenko *et al.* 2012). Lo and Power (2010) investigate the relationship between product nature and SC strategy by using Fisher's model as the framework. In contrast, their results indicate that the association between product nature and SC strategy as articulated in Fisher's model is not significant. Furthermore, as a result of their survey, they found that more than two-thirds of surveyed organizations pursue efficiency and responsiveness strategies simultaneously. Therefore, a

hybrid strategy (pursuing efficiency and responsiveness) is recommended which can be employed by most organizations irrespective of the nature of the primary product they supply.

## 4. Integration models

Existing multi-view enterprise-modelling methodologies have been utilized for the modelling and integration of a single company or within an enterprise, but they do not specifically address the techniques for inter-enterprise modelling and integration. In the literature different terms are used to address integration such as: enterprise modelling, business process engineering, enterprise engineering, enterprise integration modelling, supply chain integration model, enterprise collaboration model, etc. Although there is slight difference in the wordings of these terms but the ultimate objective is to integrate inter-enterprise relations. Integration of processes provides the adequate information, in the right place, at the right time for each role. Considering a broad spectrum of the SC concept, various classification schemes are available to categorize SC models.

***Types of models:*** SCI models must be able to represent prime-sub relationships, capable of demonstrating how the functions and information, and it must show metrics, etc. Closer relationships between SC members need models that support processes which communicate across organizational boundaries. These must complement traditional support for internal business processes. SCI models can be classified based on their problem scope or application areas. SC is cross-functionally organized in order to optimize both data sharing and business processes (Angeles, 2009). Therefore, SC models involve tradeoffs between more than one business process (function) within the SC. SCI models deal with both vertical and fictional aspects of integration. However, Recent studies have shown vertical integration may result in improvements in functional performances as well (Olhager & Prajogo, 2012). Depending on the direction (see section 2 paragraph 2) and level (see section 2 paragraph 3) of integration, it may have different types.

***Modelling approaches:*** Supply chain modelling approaches can be classified into three main types namely deterministic (all variables are known), stochastic (at least one of the variables is unknown and is assumed to follow a known probability distribution), and hybrid (e.g. simulation models that are capable of handling both deterministic and stochastic variables) (Figure 1).

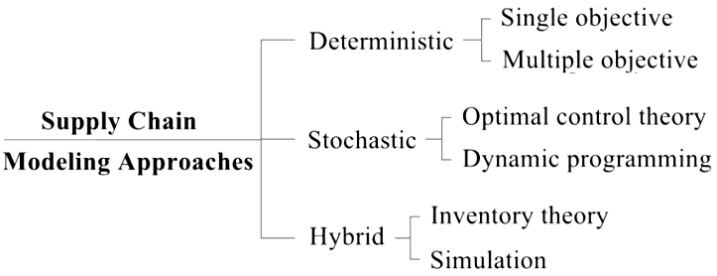


**Figure 1.** Supply chain modelling approaches

In a deterministic model no randomness is involved in the development of future states of the system. Thus, such model will produce the same output from a given starting condition or initial state. Deterministic models include single objective and multiple objective models which were dominantly used in the previous century. However, it is still used in sub optimizations. This approach models quantitative variable with deterministic values. For instance, Mohammadi Bidhandi *et al.* (2009) use deterministic supply chain network to determine facilities location and allocation. Another application of deterministic model is the paper by Dumrongsiri *et al.* (2008) that studies a dual channel supply chain in which a manufacturer sells to a retailer as well as to consumers directly. Deterministic models pick specific variables and analyze them in order to get optimum outputs.

In contrast with deterministic way of modelling, the stochastic approach uses range of values for variables in the form of probability distributions. The use of uncertainty models in SCM

problems is a natural extension of the traditional deterministic approach. This happens due to the fact that most problems faced by companies have as a characteristic some degree of uncertainty. Thus, the assumptions that all the parameters used in modelling are deterministic is not realistic, especially when considering elements that are in most cases beyond the scope of the company, such as demand, prices, and efficiency rates. Fuzzy logic and Bayesian network are two examples of stochastic approaches which are widely used in SCM context. In addition, stochastic versions of deterministic approaches are available which cover randomness and uncertainty (Maleki & Cruz-Machado, 2013). For instance, a stochastic Petri net, is stochastic version of a deterministic approach that adds nondeterministic time through adjustable randomness of the transitions.

Due to the significant influence of inventory of the SC cost, the literature dealing with inventory theoretic model is relatively rich. For instance, Sodhi and Tang (2009) extend deterministic linear programming model for SC planning using stochastic programming by incorporating demand uncertainty to consider unmet demand and excess inventory and by incorporating cash flows to consider liquidity risk. And (Esmaeili, Aryanezhad & Zeephongsekul, 2009) modelled the relationships between seller and buyer by non-cooperative and cooperative games, respectively.

## 5. Discussion and remarks

Sections two, three, and four provided literature review on variety of perspectives toward vertical and performance integration as well as integration models. This section discusses aforementioned issues in order to identify obstacles and missing points regarding their current state.

The initial challenge in reaching a comprehensive SCI is lack of clear definition for it. This challenge is pointed out in the literature (e.g. Gligor & Holcomb, 2012; Yeung *et al.,* 2009) but not an appropriate action has been taken. SCI definition depends on the way SCM is defined. Available SCM definitions are inclusive but not exclusive. In other words, most definitions are broad enough to embrace SC related issues but not appropriately strict to set boundaries clarify the scope of it. Such loose definitions have resulted in confusions in SCI. Therefore, researchers frequently state that their works throw light on some aspects of SCI, yet there is no consensus on what are all aspects of SCI. The lack of integration may result in poor performance of SC. Ramdas and Spekman (2000) found consequences of lack of integration as: inaccurate forecasts, low capacity utilization, excessive inventory, inadequate customer service, inventory turns, inventory costs, time to market, order fulfilment response, quality, customer focus and customer satisfaction. Here we should emphasize that as Chiu and Okudan (2011) found truly implementation of different aspects of integration need to be initiated from the design phase of SC.

SCM and the associated idea of seamless integration is such dominantly discussed in the literature that one of the often-stated beliefs is that companies no longer compete but that SC's or supply networks do (Christopher, 2000; Mentzer *et al.*, 2001). This notion may make sense for some chains, such as the automotive industry where all different partners in a chain are attuned. It is due to the fact that in such specific context, one often encounters supplying plants that deliver all production to one final assembly automotive line. Therefore, it makes competition SC's in the automotive industry. In contrast, in some other industries, suppliers deliver to different (probably competing) companies and have to balance their capacity to be able to deliver to different customers.

Most SC's are not totally owned by the same company. In contrast, they are network of variety of companies with different core expertise which are benefiting from the product or service of one another. Therefore, it causes lack of visibility which is required in both vertical and functional integration. Some researchers such as Dawes *et al.* (2009) address this problem as lack of trust and since trust influences how culture, values, and personal and organizational relations influence the processes and outcomes of knowledge sharing. It is necessary in the face of the dynamic risks and interdependence inherent in information sharing. Although lack of trust might be a reason but we believe it is mostly rooted in lack of reliability in information security. Value

adding activities in a SC are often triggered by information flows such as demand, inventory status, order fulfilment, product and process design changes and capacity status. Even some researchers look at information flow as the bonding agent between material flow and financial flow. Therefore, issues such as information accuracy, information system security and disruption, intellectual property and information outsourcing risk are critical in establishing trust and having healthy flow of information among SC members.

Review of literature associated with vertical integration reveals that it is not limited to altering industry structure and minimizing cost which are its traditionally accepted explanation. Most important driving forces toward vertical integration are the demands of large retail chains and the manufacturer's decisions to focus on developing its positioning strategy in the SC (through preventing bullwhip effect and establishing network of suppliers and retailers) (see also Guan & Rehme, 2012). Vertical integration has transformed the manufacturing firms into a supplier to large timber products resellers, offering the firm a greater potential to provide integrated solutions and, therefore, become a strategic partner to its customers. Report of fail stories and causes of failures put forwards a realistic picture of SCI covering its contributions and pitfalls.

A misleading fact in the literature is that it commonly reports success stories while failures are rarely reflected. One of the few is Osegowitsch and Madhok (2003) which reports some cases of vertical integration and indicate that explanations such as market power, monopoly profit, and transaction cost are increasingly seen as insufficient to explain vertical integrations strategies, especially for those companies that move down to the customer interface. Another report by Jr *et al.* (2009) reflect upon both vertical and functional integration failures in terms of internal and external failures. They argue that especially internal failure is the major barrier to SCI. Internal failure refers lack of an effective planning mechanism that facilitates the synergy of business processes. Their findings show implementation of SCI requires comprehensive internal planning and external monitoring.

Mass customization as a practical approach toward SCI is advocated in the literature (see Liu *et al.*, 2006). Achieving mass customization is a multi-disciplinary effort that requires experts from different areas to act adequately and in cooperative manner to resemble a unified body. Although the positive influence of mass customization is known, however presence of practical barriers hinder firm from its benefits. Different disciplines have their specific perspective of observing procedures and they suffer from lack of common qualitative and quantitative units. For instance, monitoring units used in quality check, finance, logistics, and production planning are incompatible. Such barriers have less to do with manufacturing machinery and more to do with the planning in management level. In addition, mass customization environment increases uncertainty in terms of demand and supply uncertainties as well as scheduling and coordination complexities. Mass customization is a response to heterogeneous demand in most industries. Meanwhile it is challenging to match internal procedure with it. In addition, it requires extended network of suppliers which leads to higher uncertainty in forecasting demand of each type of component. The inevitable prerequisite of mass customization is a well defined information system which connects up stream suppliers and downstream retailers with effective information processing capabilities.

There are theoretical studies on application of electronic and virtual integration methods to approach SCI. However, majority of such methods are concentrated on performance measures and little research is conducted to move toward vertical integration. Critical issues such level and direction of integration, dyadic relations, and resilient methods to sustain against disturbances are elements of vertical integration which are missing when the scope of research is limited to performance measures. In addition, when it comes to performance measures, as it is also argued by Mondragon *et al.* (2011), SC experts face a barrier if there is shortage of relevant measures. Several researchers have come across different framework and approaches for SC performance measures. But a lot of proposed measures are too general and they lack customizable components. This fact is also pointed out by (Gunasekaran, Patel & McGauRoland, 2004) that performance measurement and metrics pertaining to SCM are generally discussed in the literature but a few practical examples are reported.

The ability to effectively and efficiently make strategic decisions in SC is critical in the development of SCI. According to Lambert and Cooper (2000) and Kanda and Deshmukh (2008) there seems to be a general lack of managerial ability to determine level of integration and consequently integrate the intricate network of business relationships among SC members. Lack of indicators for level and direction of vertical integration may lead to putting functions in competition with each other which certainly harm SCI.

Although deterministic approaches such as linear and integer programming or mixed integer programming, etc., are reliable in understanding well-defined supply chains, which involve few decision variables and restrictive assumptions. However modelling complex environments such as SCM requires involving uncertainty and benefiting from implicit experts knowledge. Therefore, stochastic approaches suit more for this context. Another modelling approach is agent-based modelling in which interacting players can be modelled as the agents who negotiate with its immediate pushing/pulling a part or product through the chain. It can effective in SCM context due to the large number of individuals interact with each other using specific internal decision structures. There is lack of strong academic work on agent-based modelling in SCM however some researchers have recommended it.

Majority of empirical SCI studies seem to be either single case or survey-based research. Therefore they are limited in terms of customization and generalization potentials so that further works can be built upon their findings. Another downside to such approaches is the open and uncontrolled environment in which they take place. This eliminates their usefulness as an indicator of cause and effect since the variables in the study are uncontrolled. This makes it too difficult or presumptuous to state that one value correlates in any way to another.

Without effective SCI, error and mistakes transform along among SC member. However, SCI mistake proofs the chain through real time sharing information. Mistake-proofing falls into the next three categories: physical, operational, and philosophical to prevent errors and deviations from the standard. Preventing human mistakes in different decision making and operational levels takes place in comprehensive SCI.

## 6. Conclusion

The current paper explored literature of supply chain integration in three main stream: vertical integration, functional integration, and integration models. It reviewed details of these main streams in order to give direction to future research in this field. The discussion section pointed out following important gaps in the SCI context:

a. There is a lack of clear definition for SCI; the definition should be inclusive to cover related fields and exclusive to set border around it.
b. There is a lack of visibility in most supply chains; it is mostly due to the fact that supply chain firms have different owners who are not willing to share information with their partners.
c. There is a paradigm shift in driving forces of integration; traditionally cost reduction was the main driving force, whereas it has shifted to developing positioning strategy.
d. Mass customization is recommended by researcher to reach SCI, although there are practical barriers in its implementation.
e. SC owners should benefit more from electronic methods.
f. There is shortage of relevant performance measures; available measures are too general and lack customizable components.
g. There is lack of empirical studies on application of stochastic and agent-based modeling approaches.
h. Current empirical studies are limited to single case and survey-based which have customization and generalization constrains.

Future research may address abovementioned gaps in the SCI context.

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