

AN EMPIRICAL REVIEW ON SUPPLY CHAIN INTEGRATION

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ABSTRACT

The purpose of this research is to review a sample of literature in the area of supply chain integration. Considering the extensive amount of literature on supply chain integration, it appears that it is still in its infancy. This study reviews a sample of 152 articles and in doing so throw light on different aspects of supply chain integration namely: vertical integration, functional integration, integration models. 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.

KEYWORDS

supply chain integration, vertical integration, functional integration, integration model.

Introduction

There have been significant attempts in the extant literature to understand developments in supply chain management (SCM). The concept of SCM was first introduced by [1], who suggested that success of industrial business is dependent on the “interactions between flows of information, materials, manpower and capital equipment”. But the term “supply chain” did not become popular until early 1980s [2]. Only handful of articles mentioned the phrase “supply chain” in the period 1985-1997. The acceleration in development of SCM paradigm took place only in late 1990s, with majority of theoretical and empirical investigation starting in 1997 [3, 4].

The Council of Supply Chain Management Professionals (CSCMP) defines SCM as it “encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, in-

termediaries, third party service providers, and customers. In essence, SCM integrates supply and demand management within and across companies” [5]. This paper deals with presenting an overview of integration and its various elements in 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). Integration is the quality of collaboration that exists among clusters to achieve an effective, efficient and united system. [6] define SCI as the degree to which a manufacturer strategically collaborates with its supply chain (SC) 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.

The objective of the paper is to provide a comprehensive assessment of studies in SCI. The paper

starts with the methodology used to assemble the sample of articles to be reviewed in Sec. 2. Literature review in Sec. 3 provide introduction to the research topics. Section 4 is devoted to discussion on findings, identification of gaps and future directions for empirical research in SCI. Finally, the paper is concluded in Sec. 6.

Methodology

This section gives the sample of articles used in the literature review in terms of journal names, year, and classification scheme. Authors chose to limit the review period between 2000 and 2012, a 12 year time horizon.

Journal selection

The collected articles were taken from four major management science publishers' namely Emerald, Science Direct, Springer and Wiley. The idea of pa-

per is to represent the average population of articles and majority of journals publishing SCI studies. From all the four publications a total of 152 articles were found out that published articles in the SCI area (Appendix A).

Article classification scheme

Selected literature is classified into three main perspectives: vertical integration, functional integration, and integration models. The number of articles in each class is presented in Fig. 1. The literature review section put forwards a short review over each class.

Literature review

This section goes through 57 selected articles which are related one or more SCI classes presented in Fig. 1. It makes the base for the discussion which comes on the next section (Table 1).

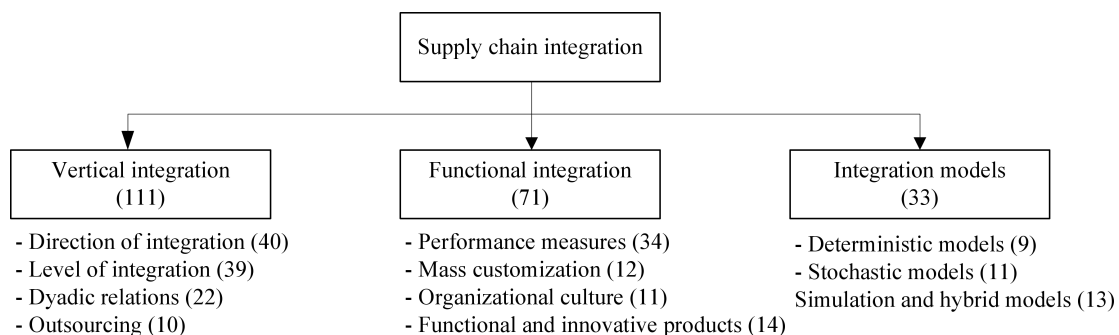


Fig. 1. Classification of articles by topics. Number in parenthesis represents the number of articles studied in each class.

Table 1
Selected research works.

| Reference | Related areas | Scope and findings |
|-----------|---------------|--|
| 1 | 2 | 3 |
| [7] | VD, VL, VY | They empirically investigate the problems encountered in trying to integrate supply chains in the UK construction industry. The findings reveal that the large number of supply chain partners and the significant level of fragmentation limit the levels of integration that are achievable. The interplay of environmental and procurement related factors renders the realization of truly integrated supply chains very problematic and difficult to achieve. |
| [8] | VD, FF | They look at the issue of what managerial practices affect new product development team effectiveness when suppliers are to be involved. They also consider whether these factors differ depending on when the supplier is to be involved and what level of responsibility is to be given to the supplier. Finally, they examine whether supplier involvement in new product development can produce significant improvements in financial returns and/or product design performance. They used survey in data collection. |
| [9] | VD, VL, FP | He reviews a sample of the literature relating to the integration and implementation of SCM practices from a strategic viewpoint. He serves to highlight the inter-dependence between integration (technologies, logistics, and partnerships), a strategic view of supply chain systems, and implementation approach. |

| 1 | 2 | 3 |
|------|----------------|--|
| [10] | VD, VL, FP | They point out the need to react to market changes and the critical role of the SC in meeting this need, and the potential benefits of integrating the SC, can no longer be ignored. This potential, however, will be realized only if the interrelationships among different parts of the SC are recognized, and proper alignment is ensured between the design and execution of the company's competitive strategy. |
| [11] | FP, MS, MH | It presents a framework which encapsulates the market sensitiveness, process integration, information driver and flexibility measures of SC performance. The paper also explores the relationship among lead-time, cost, quality, and service level and the leanness and agility of a case supply chain in fast moving consumer goods business. It employed analytic network process to do quantitative analysis of decisions. |
| [12] | VL, FP, FF, MD | They study the links between SCI and manufacturing improvement programs. Results of this research show that the adoption of the lean production model has a strong influence on the integration of both information and physical flows, while no significant influence emerged from the adoption of ERP. |
| [13] | VL, FP, MS, MH | The introduced SISCO, an object-oriented simulation tool for the simulator for SCI operations. The user specifies the structure and policies of a supply chain with a GUI-based application and then saves the supply chain description in the open, XML-based SC modeling language format. SISCO generates the simulation model to a library of supply-chain-oriented simulation classes. |
| [14] | VD, VL, VY | They operationalize supplier integration as a bundle of practices that include a set of internal and external practices. They find that practices in specific configurations can be as important a source of performance differentials as the adoption of individual practices themselves. They show that deviations from the optimal profile are associated with performance deterioration, and that indiscriminate and continued investments in integration may not yield commensurate improvements in performance. |
| [15] | VL, FP, FM, MD | He finds that in small firms, efficient SC integration may play a more critical role for sustainable performance improvement, while, in large firms, the close interrelationship between the level of SCM practices and competition capability may have more significant effect on performance improvement. It is concluded that, in early stage, the emphasis on systemic SCI may be more crucial. Once SCI has been implemented, it may be advisable to focus on SCM practice and competition capability. |
| [16] | VD, VL, FP, FO | Breaking the traditional decentralized system and introducing the concept of a single, integrated plan, which a company could work together with their suppliers has led to cost reduction, lead-time reduction, improved visibility, reduced time to market, and increased efficiency in the company. This research is based on a single case study in manufacturing industry in china. |
| [17] | VL, FO | This study argues that the stage of life cycle variables is associated with the various dimensions of SCI, and that environmental complexity and munificence have significant moderating effects on the relationships. This research posits that, for efficiency and success, a strategic fit must exist between environmental, strategic and operations variables, and that specific dimensions of integrative effort are appropriate for given situations. That fit would attenuate bullwhip inefficiencies, either of inventories and other mechanical decisions, or of the less tangible human and structural interaction. |
| [18] | VD, VY | They develop a conceptual framework to explore dyadic relationships across a range of industries, involving firms of different size. Their findings suggests: significant perceptual differences are more apparent in shorter term relationships; suppliers have stronger views of the relationship; relationships may not necessarily follow a linear development path over time. |
| [19] | VD, VL, FP, FO | The paper's departure point is a controversial hypothesis: the contribution of SCI is not as obvious as logistics and supply chain researchers usually think. Through a review on literature they realized that empirical evidence cannot permit to clearly conclude and that integration as well as performance is defined, operationalised and measured in different and often limited ways. |
| [20] | VY, FP | This research focuses on describing and comparing the activities of the performance management process. Most activities show low levels of integration in the dyads studied. Defining metrics and target setting are considered most important to integrate. Lack of common metrics definitions and ERP deficiencies were important obstacles for integration. Research issues related to four areas of supply chain PM are discussed. |
| [21] | VD, VL, FF | This research tries to solve the trade-offs between marketing and R&D domains and to minimize information loss in new product development. The integrated design process determines a point of compromise between the optimums of conjoint analysis and Taguchi method. Sequential application of two methods ensures full utilization of both methods and no loss of information. |

| 1 | 2 | 3 |
|------|----------------|--|
| [22] | FP, MH | They show that effective utilization of information technology and the role of business process modeling and simulation are all vital in supply chain integration projects. The presented combination of business process and demand/supply simulation in this research enables an estimation of changes in lead-times, process execution costs, quality of the process and inventory costs. |
| [23] | VD, VL, VO, FP | Outsourcing of non-core activities and the subsequent vertical disintegration within manufacturing organizations is necessary for process integration in SC. The findings show that the “soft” collaboration rather than the “hard” technical issues are the main improvement drivers. It also developed a maturity scale for SCI. |
| [24] | MS, MH | This paper examines an agent-mediated approach to on-demand e-business supply chain integration. Each agent works as a service broker, exploring individual service decisions as well as interacting with each other for achieving compatibility and coherence among the decisions of all services. |
| [25] | FP, FF, MS | This research develops a multi-period SC model for new product launches under uncertainty. The model allows simultaneous determination of optimum procurement quantity, production quantity across the different plants, transportation routes and the outsourcing cost in case of shortages. |
| [26] | VL, VO, FP, FM | This study investigates the relative effects of SCI, SC information sharing and SC design on SC performance. The only significant effects on resource and output performances belong to SC design. Integration and information sharing are correlated with performance measures, but their relative effect sizes are lower than SC design. |
| [27] | VD, VL, VO, FP | This paper analyses relationship between SCI and performance through a survey-based research approach. Findings show that three categories can be distinguished: attitudes, practices and patterns. This research argues on further research direction based on the aforementioned categories. |
| [28] | VD, MS, MH | It proposes a two-stage mathematical model to evaluate the suppliers and to determine their periodic shipment allocations given a number of tangible and intangible criteria. It employed analytic network process and Archimedean goal programming modeling approaches. |
| [29] | VD, VL, FP | It discusses the ambiguity associated with SCI. To clarify it addresses internal and external process integration. The research emphasized the importance of taking a process approach to gain efficiencies rather than viewing functional areas and departments in isolation. |
| [30] | VD, VY, FP | The empirical results of this study suggest strategic skills and perceived status are essential antecedents to SCI and subsequent performance. Further, the relationship between strategic skills and performance is mediated by SCI. |
| [31] | VD, FO, FP | Through an empirical approach it identifies SC relationship and operational obstacles as main hinders of SCI. Studies relationship obstacles are: lack of trust, different goals and priorities and lack of parallel communication structure. Operational obstacles: manual performance data management and non-standardized performance metrics |
| [32] | VY, FP | The study finds that firms with a desire to improve, operating in a challenging competitive environment typically experience high levels of performance. Further, barriers to SCI can actually increase the firm’s ability to achieve firm performance as the firm is required to make greater efforts to overcome those barriers and develop effective SC linkages. |
| [33] | VL, VY, FP | It looks into linkages among SCM practice, competition capability, the level of SCI, and firm performance. Through a case study approach it shows that efficient SCI may play more critical role for sustainable SCM competitiveness, while, in Japanese firms, the close interrelationship between the level of SCM practices and competition capability may have more significant effect on SCM competitiveness. |
| [34] | FP, MD | It proposes a mixed integer linear programming model and solution algorithm for solving SC design problems in deterministic, multi-commodity, single-period contexts. The model integrates location and capacity choices for suppliers, plants and warehouses selection, product range assignment and production flows. |
| [35] | VD, VL, FO | This research argues and empirically confirms the notion that an employment and compensation system that increases SC executives risk bearing reduces willingness to make risky decisions and thus discourages supply SCI. |
| [36] | FM, MH | This research focuses on the contradictions between scale production, customized demand, and mass customization. A dynamic and multi-objective optimization mathematical model and the appropriate solving algorithm are set up by introducing these relieving methods into the operating process. |
| [37] | VL, FP | This paper focuses on how the integration process unfolds in practice to give rise to a number of socio-technical changes essential to the integration of management systems. It reveals that integration streamlines operational processes through a number of structural, functional, and operational changes. Integration reforms bureaucratic structures, further giving rise to operational excellence and strategic flexibility. |

| 1 | 2 | 3 |
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| [6] | VD, FP, MD | They study the relationship between dimensions of SCI, operational and business performance, from both a contingency and a configuration perspective. They use a hierarchical regression to determine the impact of individual SCI dimensions (customer, supplier and internal integration) and their interactions on performance. Results indicated that internal and customer integration are more strongly related to improving performance than supplier integration. |
| [38] | VL, FM | It explores SCI e-technologies (e.g. e-commerce and e-procurement) to achieve mass customization. Their findings suggest that lean practices can reasonably predict mass customization performance whereas ERP doesn't. |
| [39] | VD, VY, FP | This research identifies four SCM constructs as being important factors in predicting firm performance: information integration, 3PL selection criteria, performance evaluation, and relationship building. |
| [40] | VL, FP, FM, FF | It examines the relationship between SCI and modular product design, as well as their impact on product performance. The results confirm that information sharing, product co-development and organizational coordination are crucial organizational processes within SCI. |
| [41] | VY, FF | This research explores the relationship between product modularity and SCI. Findings of this paper increase the understanding of the dynamics of modular product design and supply chain management. The paper also explores four contingency factors affecting the relationship. |
| [42] | VD, VY, FO | This research identifies factors that facilitate and inhibit upstream aspects of SCI. The results indicate that buyer-side leadership is an important antecedent for building motivation, trust, and commitment among suppliers and for shaping their mindsets. This, in turn, facilitates strategic alignment and enables suppliers to build collaborative capabilities, which are finally shown to be a key enabler for successful supplier integration. |
| [43] | VD, VL | It studies the role of integration mechanisms to enhance interaction and collaboration in the firm SC, especially in the buyer-supplier interface. Findings suggest internal integration between purchasing and manufacturing groups plays a significant role in supplier collaboration. Customer integration is more important to address supply problems for contract manufacturers than for original equipment manufacturing firms |
| [44] | VD, FP | This study presents two cases in the textile industry to exemplify how the focal firms make use of virtual organization approach to integrate their activities in order to balance the demand from market side and supply from the manufacturing side. After the integration, the responsiveness of the supply chains has improved, and flexibility in response to the market demand is satisfactory. |
| [45] | VD | This research reveals that Supplier integration positively moderates the relationship between customer integration and efficiency, whereas its analyses do not support the hypothesis that in general customer integration positively impacts on efficiency. It also shows that when supplier integration is at a low level, customer integration can even make efficiency worse. |
| [46] | VD, MS, MH | This study proposes a customer satisfaction inventory model that incorporates customer relationship management into an inventory model, where the probabilistic concepts of Markov chains of uncertainties in customer relationships of retention or migration are adopted. |
| [47] | VD, VL | It expands models of integration by developing and testing a multi-dimensional theory of SC value integration that explains the relationships between resource dependency theory, resource-based view of the firm, and relational exchange theory. |
| [48] | FP | This paper identifies the level of existing integration between parties, as this has been associated with SC performance. It proposes a set of measures for auditing purposes to provide an overall picture of the performance of a closed-loop SC by revealing high levels of stock for the products analyzed, consequence of the difficulty to generate accurate forecasts and the accumulation of high quantities of product prior to launch. |
| [49] | VD, VL, | They develop a conceptualization of inter-organizational systems characteristics. They also empirically examine their proposed configuration choices made by firms with different SCI profiles. Their results support the notion that successful firms sequence the configuration of inter-organizational systems characteristics toward effectively developing and supporting their supply chain process capabilities. |
| [50] | VD, VY | This paper explores the interplay of the supplier-supplier and network of analysis by focusing on the inherent tension between cooperation and competition, using a multiple case study design in the Japanese and German automobile industries. It argues that the buyer is able to exert influence not only on the cooperation level but also in the cooperative tension in the overall network. |
| [51] | VD, VL, FP | They build and empirically test a theoretical model of the contingency effects of environmental uncertainty on the relationships between three dimensions of SCI four dimensions of operational performance. They argue that under high uncertainty, the associations between supplier/customer integration, and delivery and flexibility performance, and those between internal integration, and product quality and production cost, will be strengthened. |

| 1 | 2 | 3 |
|------|------------------------|--|
| [52] | VL | This paper presents a Knowledge-based Customization System for SCI which is developed based on three core technologies: visualization of topologies, network analysis, and knowledge-based system so as to obtain quantified actionable information and formulate configuration strategies for long term success. |
| [53] | VD, VL, VY, FP, FM, FF | This study investigates the role of SCI in mediating the effects of product and process modularity strategies on service performance. The results demonstrate that customer integration mediates the linkages from product modularity and process modularity to delivery performance, as well as mediating the relationship between process modularity and support performance. In contrast, supplier integration mediates the relationship between process modularity and delivery performance only. |
| [54] | VD, VY, MH | This paper proposes a methodology for SCI from customers to suppliers through warehouses, retailers, and plants via both adaptive network based fuzzy inference system and artificial neural networks approaches. |
| [55] | VD, VL, FP | This research investigates the effectiveness of SCI in different contexts. It shows that SCI increases performance if supply complexity is high, while a very limited or no influence can be detected in case of low supply complexity. |
| [56] | VD, VL, VY, VO | This study finds that the most important driving factors of manufacturer's to vertical integration are the demands of large retail chains and the manufacturer's decisions to focus on developing its positioning strategy in the chain. Vertical integration has transformed the manufacturer 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. |
| [57] | VL, FF | This study builds a conceptual model to describe the relationships among operational integration and strategic integration of SC, product-based and customer action-based service provided by industrial manufacturers, and firm performance. It shows that operational perspective on SCI has positive direct effect on product-based service, while strategic perspective has positive direct effect on customer action-based service. |
| [58] | VD, VL, FP | Results of this study show that internal integration improves external integration and that internal and external integration directly and indirectly enhance company performance. |
| [59] | VL, FF, FP | This paper proposes a hub-and-spoke model to integrate green marketing and sustainable SCM from six dimensions: product, promotion, planning, process, people and project. Empirical results of this research show that multi-dimensional integration has been in practice in industries, this is particularly true in large companies. It also put forwards various corresponding strategies for the product-, promotion-, planning-, process-, people- and project-based integration. |
| [60] | VL, VD, VY, FP | This paper studies various aspects of integration in order to structure and define the concept of SCI. They realized that there is limited empirical research discussing SCI and there is a lack of empirical evidence supporting the claimed benefits, especially beyond the relationship level. There is also a lack of detailed frameworks and concrete recommendations for how SC's can become more integrated. It points out there is significant confusion regarding the term SCI and thus the paper proposes a definition of SCI. |
| [61] | V, FP, FM | This research investigates the integrations of both information and material flows between SC partners and their effect on operational performance. It concludes that logistics integration has a significant effect on operations performance. Information technology capabilities and information sharing both have significant effects on logistics integration |
| [62] | VD, VL, VY, FP | This study proposes a differentiation-integration duality and contingency theory to suggest that manufacturing firms should seek to achieve both integration through supply chain co-ordination activities and differentiation through modularity-based manufacturing practices. |

| | | |
|------------------------------|--|-----------------------------------|
| Direction of integration: VD | Performance measures: FP | Deterministic models: MD |
| Level of integration: VL | Mass customization: FM | Stochastic models: MS |
| Dyadic relations: VY | Organizational culture: FO | Simulations and hybrid models: MH |
| Outsourcing: VO | Functional and innovative products: FF | |

Discussion and remarks

In the previous sections a literature review was presented 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.

A general yet important issue is that many of the studied articles have hardly built on previous works. Most authors seem to open a new window and develop their argument, models, factors, parameters, etc

without considering other related works. As a result it is complicated to put them into groups and clearly recognize one group from another.

The initial challenge in reaching a comprehensive SCI is lack of clear definition for it. This challenge is pointed out in the literature but not an appropriate action has been taken. SCI definition depends on the way SCM is defined. Available SCM definitions (dominant definitions are presented in Table 1) 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. [63] 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 fulfillment response, quality, customer focus and customer satisfaction. Here we should emphasize that as [64] 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. 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 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 fulfillment, 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). 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 [65] 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 [32] 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. 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 ob-

serving 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 [48], 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 [66] 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 [67] and [68] 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 SC's, which involve few decision variables and restrictive assumptions. However modeling complex environments such as SCM requires involving uncertain-

ty and benefiting from implicit experts knowledge. Therefore, stochastic approaches suit more for this context. Another modeling approach is agent-based modeling in which interacting players can be modeled 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 modeling 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.

Conclusion

The current paper reviews a set of 152 research articles in SCI and classifies them into three main perspectives: vertical integration, functional integration, integration models. About 40% of reviewed articles are from 2010 onward which indicates the increase of research works in SCI during this time frame. The current research discusses about: lack of consensus on SCI definition; the effect of industry sectors; SCI driving forces; positioning in the chain; lack of reports in fail stories; focuses of SCI literature on vertical integration and performance measures and missing other aspects; modeling approaches; limitation of SCI empirical literature to single case and survey-based researches.

The limitation of the current study is that only four publishing houses are considered for article selection. Second, there is subjectivity involved in classification of articles as it depends on the authors and their understanding.

Appendix A: Classification of articles by year and by journals

| Journal name | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | Total |
|---|----------|----------|-----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|
| Benchmarking: An International Journal | | | | | 1 | | 1 | | | | 1 | | 1 | 4 |
| Computers & Industrial Engineering | | | 3 | 1 | 1 | | | | | 3 | | | 2 | 10 |
| Decision Sciences | | | 1 | | | | | | | 1 | 1 | 1 | 1 | 5 |
| Decision Support Systems | | | | | | | 1 | 2 | | | 2 | | | 5 |
| European journal of operational research | 1 | | | | 2 | | 1 | | | 1 | 1 | | | 6 |
| Expert Systems with Applications | | | | | | | | | 1 | | 1 | 1 | 1 | 4 |
| Industrial Management & Data Systems | | 1 | | | | | | 2 | | | | | | 3 |
| Industrial Marketing Management | | | | | | | | 1 | | 1 | | | 1 | 3 |
| Information Technology and Management | | 1 | | | | | | | | | 1 | 1 | 1 | 4 |
| Integrated Manufacturing Systems | | | 2 | 1 | | | | | | | | | | 3 |
| International Journal of Operations & Production Management | | | | | | | 2 | | | 1 | 4 | | 1 | 8 |
| International Journal of Physical Distribution & Logistics Management | 1 | | 2 | 1 | | | 1 | 2 | 1 | 1 | 1 | 2 | | 12 |
| International Journal of Production Economics | | | | | 2 | 1 | | 1 | 1 | 5 | 5 | | 4 | 19 |
| Journal of Business Logistics | | | | | | | | | | 1 | 1 | | | 2 |
| Journal of Manufacturing Technology Management | | | | | | | | | 3 | | | | | 3 |
| Journal of Modelling in Management | | | | | | | | 1 | 1 | 1 | | | 1 | 4 |
| Journal of Operations Management | 1 | 1 | | 1 | | 1 | 1 | 1 | 2 | | 4 | 2 | 1 | 15 |
| Journal of Supply Chain Management | 1 | | 2 | 1 | 1 | | 1 | | 2 | | 1 | 1 | 2 | 12 |
| Operations Management Research | | | | | | | | | 1 | 1 | 4 | 2 | 2 | 10 |
| Supply Chain Management: An International Journal | | | 1 | | | 5 | 2 | 3 | 2 | 1 | 1 | 3 | 2 | 20 |
| Total | 4 | 3 | 11 | 5 | 7 | 7 | 10 | 13 | 14 | 17 | 28 | 13 | 20 | 152 |

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