Chapter 4

Modeling the Supply Chain Management Creation of Value — A Literature Review of Relevant Concepts

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http://dx.doi.org/10.5772/59656

1. Introduction

The increased competition in the global market has obliged firms to maintain high customer service levels while at the same time, to reduce cost and maintain profit margins [1]. The paradigm shift in business practices-going from the “product-driven orientation” of the past to today’s “customer-driven orientation” – is characterized by increased demand variability, product variety, amounts of customer-specific products, and shortening product life cycles [2]. In this context, firms need to be able to produce and deliver a variety of customized products at low cost, high quality and short lead time [3], while possessing high reliability and flexibility to ever-changing requirements [4]. On the other hand, the competitiveness of a company is continuously tested and determined by its participation in networks of customers, distributors, partners and suppliers [5]. This trend of globalization has forced individual firms to compete as part of supply chain (SC) links, that is, the SC of the enterprise versus the SC of its competitors [6], [7]. Therefore, the ultimate success of a company depends on its managerial capability to make strategic alliances with other reliable partners, to efficiently handle the flow of products up to the end consumers [8]. From here the idea that that the ultimate success of any enterprise is coupled with the destiny of its SC [9], [10], [11]. This changes the focus of competitiveness from the local manufacturing company to the international SC [12], [13]. Improving the overall performance of this scenario requires taking a holistic perspective [14], because at the end, the SC performance improvement depends on the individual SC partners performance, and their willingness and ability to inter-coordinate their activities [15]: by proceeding in this way, sub-optimal SC decisions-i.e. the cost saving of an individual firm could mean increased costs to the supply chain as a whole-can be avoided [16]. This degree of SC integration can be achieved through SC management [1], [17].

1.1. A supply chain management formulation

In his published work of 1999, [18] stated that the competitiveness level of the current industrial scenarios (at that time) made of SC management (SCM) a topic of interest. Since that day, several books and articles have been written about it and even today there is a diversity of interpretations and understandings of SCM, as there is a lack of agreement on the precise definition of it [7]. However, a random sample of the work of various authors in the SC arena – i.e. [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30], and [31]-allows the identification of a set of basic SCM concepts:

- Achievement of overall value-adding performance.
- Coordination of geographically-distributed independent companies.
- Operation as a whole unit.
- Synchronization of interrelated business processes.
- Suppliers' supplier to customers' customer scope.
- Strategic, tactical, and operational scale.
- Materials, information, and cash flows context.
- Set of objectives and constraints.

In this paper we summarize these concepts in the following SCM formulation:

$$\text{SC value creation} = f\{\text{BP synchronization, S\&D elements realignment, C\&O fulfillment}\}$$

where :

1. SC value creation; the primary goal of SCM is the creation of value…
2. BP synchronization; result of synchronizing the geographically-distributed Ss-Cc interrelated business processes of the independent companies (so they work as a whole unit) …
3. S&D elements realignment; based on the realignment of the SC partners' static and dynamic elements (i.e. network structure and decision-making processes) affecting the material, information, and cash flows…
4. C&O fulfilment; in the face of internal/external constraints and local/global objectives.

1.2. SC design & modeling

In general terms, a SC can be considered as 1) composed by inbound logistics, component suppliers, final assembly plants, and outbound logistics echelons [32], [33], [34], [35], where the relevance of the physical functions (i.e. transportation and storage) to the efficient supply, are prior to the market mediation functions, i.e. supply and demand matching [36]; and 2) these echelons can have convergent and divergent interactions [37], and are characterized by a value-adding process, information inputs, disturbances, and a decision-making process [27]. As SCs are multi-layer dynamic systems, where linear flows are uncommon [38], each SC member has its own information sources [5], and decisions are made to optimize their own interest [39], SC management (SCM) becomes highly complex. A discipline that can aid in the overcoming of these issues is SC design: according to [1], the optimal platform provided by a proper SC design can improve the efficiency and effectiveness of the SCM practice. Within this context, the SC design problem consist of making the strategic (i.e. plants/warehouses location), tactical (i.e. supplier/distribution channel/transportation mode selection), and operational (raw material/semi-finished/finished product flows) decisions to satisfy customer demands while minimizing the total costs [40], taking into account that some of the critical design parameters-such as customer demands, prices and resource capacities-are generally uncertain [41]. Moreover: SC design has a strong impact on overall profitability and success [40], therefore, there is a need of SC models that provide a better understanding of the SC complexity [42], and insight of the consequences of managerial decision making rather than to predict future quantitative behavior [43]. SC modeling involves identifying the SC elements-i.e. the structure of the network, the hierarchy of decisions, the randomness of the various inputs and operations, and the dynamic nature of interactions among SC elements [44]-and translate them into the elements of the model, i.e. goals, constraints, and decision variables [6]. For this reason it has been suggested that in order to be efficient, SCM requires the modeling of the SC [45]: if the effect of operational decisions taken at each echelon need to be checked against their consequences on the SC as a whole [46], then a SC model can be built and used for this purpose [47].

1.3. Current challenges

1.3.1. The SCM formulation challenge

The implementation of the previous SCM formulation proves to be a challenge: authors like [1], [13], [15], [17], [38], [39], [48], [49], [50], [51], and [52] recognize the fact that SC partners operate independently, with their own objectives which are often conflicting. [22], and [39] go further and states that the promises of mutual benefits are rarely realized as SC members tend to seek their own profit, by working on an opportunistic local perspective. [39], [53], and [54] attribute this to the fact each SC member seeks to maximize their own objective (i.e. to maximize throughput and lower costs) rather than that of the entire system. Overcoming these problems require the entire SC to have a level of information sharing and collaboration that is uncommon to most businesses [55], mostly because each SC member operates as an independent, decentralized decision-maker that may not be willing to share necessary sensitive information (for fear of information leak or fear of a weak negotiation position) to plan and control the supply chain in a proper way [52], [56], [57]. In this context, making consumer demand data available to every echelon of the SC is often naïve: if the retailer informs that he is facing an inventory shortage, the supplier gains a strong negotiation position; if the supplier declares that he is overstocked, then it is the retailer who has an advantage. Now, even if a dominant SC member controls segments of the SC, in general, no SC member can control the entire SC [39], [58]. Moreover, trying to find the best set of trade-offs for any one entity often leads to sub optimize the SC performance, and independently managing entities in SC can result in very poor overall behavior [7]. In fact, in a dominance relationship, one SC partner is satisfied while the rest are not, where in an interdependent relationship, all SC partners are satisfied [5]. Also, within each partners' site, the story is repeated as the marketing, distribution, planning, manufacturing, and purchasing functions are still operated independently [1], [50], i.e. purchasing and selling contracts are often negotiated with very little information regarding capability and/or inventory levels.

1.3.2. The SC design & modeling challenge

Even though the discipline of SC design has been gaining importance due to the increasing competitiveness introduced by the market globalization [59], it presents a big challenge. With an increasing SC complexity due to the need of a quick response to market opportunity windows [60], and the fact that the structure and operation of the SC is influenced by market and product characteristics [58], it becomes essential for the businesses-in order to retain its competitive edge (and deliver products to customers in an efficient and effective way)-the dynamic reconfiguration of the SC from time-to-time [61]. This dynamic SC reconfiguration calls for serious research attention [15], as it presents several challenges:

- In the ideal world, SCs are designed focused upon customer efficiency [16], with an integration of the decisions and operational activities of the business partners [39]; in real life, SC are designed focused upon factory effectiveness [16], as traditionally, managers focus on the management of their internal operations to improve profitability [39].
- It involves the re-establishment of the sophisticated real-time cooperation in operation and decision-making (across different tasks, functional areas, and organizational boundaries), in order to deal with the uncertainties proper of a mass customization, quick response, and high-quality service environment [15].
- Most of the published research (in the area of SC design), focus on high level strategic issues (i.e. generic guidelines for business executives) rather than specific tools for plant managers [62].

1.4. Research objective and structure of the paper

In view of the previous sections, the main objective of this paper is to present a literature review of the concepts relevant to the modeling of value creation in a SCM context: Section 2 reviews the concept of SCM value and its governance mechanisms; Section 3 reviews the current SC modeling practices and their shortcomings; Section 4 establishes the conditions and abilities necessary for a successful SCM value creation, the modeling requirements of a SC model to be used for SCM purposes, and futures research venues; Section 5 presents the concluding remarks.

http://dx.doi.org/10.5772/59656

2. SCM value creation

As the focus of SCM has shifted from production efficiency to customer-driven and partnership synchronization approaches [15], its objective is to optimize the order fulfillment process [63], which is basically driven by customer issues [64], and influenced by the profitability of all the SC members [65]. [31] states that the objective of SCM is to synchronize supply with demand in order to drive down costs whilst increasing customer satisfaction. [1], and [4] claim that the ultimate goal of a SC is to meet the specified high customers' service levels while at the same time maintaining overall profit margins, while [36] points out that it is important that the SC maximizes the overall value generated, because sticking to a portion of the chain not only makes no commitment to maximizing overall chain profit but also reduces the whole supply chain profitability. In other words, creating and delivering value to the customer and in turn creating sustainable value for all its stakeholders. For these reasons, the demand for achievement of 'overall value-adding performance' requires putting special attention to the concept of 'value' within the SC: as the SC is formed around a value stream or set of linked activities directly contributing to the customer-perceived value of the product or service [58], authors like [6], [13], [66], and [67] agree that the main goal of a SC is the creation of internal and external value.

2.1. Internal and external value

The objective of a business is to make a profit by delivering more value to a customer at a similar cost to the competition, or the same value as the competition at a lower cost [68]. As organizations form part of supply chains, value becomes a more complex and multidimensional characteristic [69]. In this context, two perspectives of value are [70]:

- Internal value (or shareholder perspective, i.e. wealth) refers to the increase of profits that supports the business financial objectives and continuous grow of the SC partners. According to [71], when the strategic priorities of each SC partner are translated into SC objectives, they can be implemented as SC operations. When this translation-implementation process is successful, then a proper alignment between each SC partner strategy and the SC strategy is achieved. [72] highlights the importance of this translation-implementation process, when he states that the SC strategy must allow the rapid alignment of the SC operations in response to the business environment dynamics. [73] suggests that, in order to smooth these SC operations (and act according to the chosen SC strategy), it must be decided where the right capacities and inventories should be positioned. [74] claims that these capacities and inventories (in the form of facilities and stocking locations, production policies, distribution resources, etc.) form the supply chain structure, which needs to be optimized in order to achieve a high level of supply chain performance. [72] relates the creation of internal value to the SC design, which focuses on the design of the supply chain's strategy, structure, processes, operations, and management elements to achieve the market objectives. Finally, in order to remain competitive and profitable, each SC partner needs to realign properly their structural elements [75].

- External value (or customer perspective, i.e. satisfaction) refers to providing high quality products that meet the customer needs of price, service, and image. Both [9], and [76] claim that the success or failure of the SC is ultimately determined in the marketplace by the end consumer. [77] points out that the service provided to the end customer is determined by the effectiveness and efficiency of the cooperation of all the companies in the supply chain-or in the words of [78]-supply chain competitiveness is something holistic. Therefore, in this customer/market-oriented context [79], the SC as a whole must focus on providing end users (the right customer) with what they want (the right product), how (the right amount/price), where (the right place), and when (the right time) they want it [62], [80]. In this context, [72] relates the creation of external value to the design for SC, which focuses on the design of the product that fits the designed supply chain to fulfill the market requirements. Within this design for SC context, in order to be effective and efficient at the SC level, it is required to simultaneously take into account the SC, product, process, and resource domains [81].

2.2. Governance mechanisms: The SC C^4 concept

According to [82] there are some governance mechanisms that are necessary precursors to SC value creation: structural mechanisms, i.e. SC partners selection; and behavioral mechanisms, i.e. the sharing of key information, the match of SC partners capabilities, the establishment of mutual trust, and the support of strategic commitments. These behavioral mechanisms resemble the set of "social abilities" exhibited by intelligent software agents [83]: communication (to allow information integration), coordination (to allow the integration of all the involved partners), collaboration (to allow the over-ruling of the involved partners' usual behavior), and cooperation (to allow the detection of feasible common goals). As we are interested in identifying the abilities the SC partners need to exhibit (in order to support the creation of value), the rest of this section analyzes more into detail the SC C^4 concept (communication, coordination, collaboration, and cooperation). Table 1 shows the similarities between concepts coming from different research disciplines.

2.2.1. SC integration

According to [6], and [7], the success of each SC partner depends on the managerial ability to integrate themselves with the rest of the SC. This integration can be achieved through the implementation SCM practices [1], [17]. SC integration can be defined as the process by which the SC partners collaboratively plan, implement, and manage the raw material/information/cash flows along the SC, so all the players think and act as one-the ideal seamless supply chain [84]-in order to improve individual and collective business operations in terms of speed, agility, real time control, and/or customer response [85]. This requires many decisions relating to the flow of information, product, and funds [40], an inter-organizational, and cross-functional synergy [8]. In the case of this last, [3] mentions shared goals, communication, a reward system, and conflict resolution as elements that impact its effectiveness. According to [86], a number of studies have found that supply chain integration does not necessarily result in benefits for both suppliers and buyers. [39] attributes this last to the fact that a completely integrated solution – that may result in optimal system performance-is not always in the best

<table>
<tr><th colspan="3">C^4 literature</th><th colspan="2">Software agents social abilities [83]</th><th colspan="2">Behavioral mechanisms [82]</th></tr>
<tr><td rowspan="4">SC integration</td><td colspan="2">SC infrastructure: convergent/divergent interactions of inbound/outbound logistics, and manufacturing/assembly echelons</td><td colspan="2">NA</td><td colspan="2">NA</td></tr>
<tr><td colspan="2">SC communication/information sharing: provide correct/easy to use & understand/timely/accurate/ complete information via a free flow, free access environment</td><td colspan="2">Communication; allows information integration</td><td colspan="2">Share key information</td></tr>
<tr><td rowspan="2">SC coordination: harmonization of actions/decisions via the establishment of a sole mission/objective/ goal</td><td>SC collaboration; working together via jointed decision making and benefits/risks sharing</td><td>Collaboration; allows the over-ruling of the involved partners' usual behavior</td><td rowspan="2">Coordination; allows the integration of all the involved partners</td><td rowspan="2">Match the SC partners capabilities</td><td>Establish mutual trust</td></tr>
<tr><td>SC cooperation; achieving common benefit via alignment of objectives/ goals/policies with strategic/tactical/operational decisions</td><td>Cooperation; allows the detection of feasible common goals</td><td>Support strategic commitments</td></tr>
</table>

Table 1. Relationship between the SC C^4 concept and different disciplines

interest of every individual member in the system, as they are more interested in optimizing their individual objectives rather than that of the entire system. In any case, essential elements of SC integration are:

- The SC infrastructure [87].
- The level of SC communication/information sharing [88].
- The degree of SC coordination [89], [90].

2.2.2. SC communication (information sharing)

As the level of SC integration needed depends largely on the amount of uncertainty within the SC [91]-an issue that has to be properly dealt with in order to define an effective supply chain policy [8]-the development of an integrated SC requires the management and coordination at different levels of abstraction, i.e. operational and tactical, of material flow [92] and information flow [54], [93]. This in turn depend on the interoperability between business processes, via their standardization, mutual adjustment of practices, or synchronization of the decision centers [94]. As the majority of business processes deal primarily with information-based inputs and outputs, the key to business process integration is improving the accessibility, accuracy, availability, granularity, timeliness, and transparency of information flows between activities in a process, [95]. SC information sharing is a key ingredient for SC coordination [63], SC collaboration [56], and SC cooperation [96]. This SC information sharing can be upstream or downstream, partial or complete [96], and must contribute to flexibility rather than add complexity [89]. Therefore, different types of SC may require different SC information sharing strategies [63]. In any case, the deeper the SC information sharing level is, the more benefit and risk is associated [96], as information becomes more uncertain due to transformations, delays and losses throughout the SC [89]. Also, this information sharing needs to be preceded by the necessary incentives for collaboration, mutual trust, and openness [31], as the better-informed party will have no incentive to share the information with the uninformed party if there is no benefit for them in doing so [97]. At the end, the idea behind information sharing is to minimize the coordination efforts between activities of a process [95]: the fewer steps and handoffs of information in a process, and the less effort is involved with each handoff, the greater the integration of the process.

2.2.3. SC coordination

Distributed work requires coordination to manage the interdependencies of the process activities, even though it has no direct impact on the process output [95]. As the SC partners become closer, the more important the coordination of the entire SC becomes [98]. For [18], the coordination is about solving conflicts (among members) via clarification of viewpoints (and their grouping in accordance with different inclinations) in a way that everyone can get to know what other members are thinking. On the other hand, [99] understands SC coordination as the distribution of the right raw materials, production of goods, and services on the right time to the right customers. SC coordination-also called interface management [27]-refers to the act of harmonizing actions, decisions, and objectives among the SC partners for the achievement of the SC goal [22], i.e. the objective of SC operations planning is to coordinate order release decisions (release of materials and resources) in an optimal way (customer service constraints are met at minimal costs) when more than one company (decision authorities) are involved [52]. Therefore, SC members should develop a common mission, goals, and objectives for the group as a whole, while pursuing independent policies at individual members' level [7]. Only if the SC operates in a coordinated manner-from the customer order through the delivery [17] – the SC performance can be optimized [19]. This requires the development of mechanisms that can align the objectives of independent supply chain members and coordinate their decisions and activities so as to optimize system performance [39]. The objective of these mechanisms, called 'coordination mechanisms', is to align the objectives of individual supply chain members, in order to allocate the benefits from coordination among the individual supply chain members [38]: at the core of a coordination mechanism there is an incentive scheme based on the supply chain decision structure and nature of demand, which highlights the behavioral aspects and information need in the coordination of a supply chain. This can be accomplished in two ways [11]: by having less need for information processing or by having more capacity for information processing. However, the dynamics of each SC partner and the market makes SC coordination difficult [17]. For this reason, it is needed that SC collaboration and SC cooperation are in place [28].

http://dx.doi.org/10.5772/59656

2.2.4. SC collaboration and cooperation

SCs are one of many different forms of inter-enterprise practices [25]. The ideal business model for achieving inter-organization integration is "collaboration", as limited visibility into supplier contracts and performance exposes enterprises to inflated costs, diminished negotiation leverage, missed rebates and saving opportunities, overcharging by suppliers, low-compliance rates, greater risk of supply, policy and regulatory violations [93]. In the case of SC collaboration, it is often defined as two or more chain members working together to establish a functioning alliance [100] that creates a competitive advantage through a unified approach to value creation [70], which in turn requires considering several points of view [14]. It is achieved by jointed decision making and benefits/risks sharing [22]. Effective collaboration within each SC partner (cross-functional) and between SC partners (cross-enterprise) is essential to achieve supply chain goals, individually and collectively [73]. To implement the strategic SCM shift, from production efficiency to customer-driven, requires high-level collaboration between supply chain partners [15]. However, when getting into a collaborative practice, the closer the relationship, the higher the possibility that the transaction comes true, but also, the higher the uncertainty and risk of being stuck-in and being caught with a single partner [101]. On the other hand, cooperation is necessary for achieving common benefit or win-win situations [30], and maximize profits [15]. A cooperative SC is only possible when goals, policies, and objectives are aligned with the strategic, tactical, and operational decisions of each SC partner [56]: using effective incentive systems such as accounting methods, transfer pricing schemes, quantity discounts, etc., the objective of each partner can be aligned to that of the supply chain as a whole [8]. Cooperation, therefore, is achieved through negotiation rather than central management and control [5].

3. SC modeling: Current work

3.1. Approaches, elements, perspectives, and purposes

Even though the discipline of SC design has been gaining importance due to the increasing competitiveness introduced by the market globalization [59], it presents a big challenge. With an increasing SC complexity due to the need of a quick response to market opportunity windows [60], and the fact that the structure and operation of the SC is influenced by market and product characteristics [58], it becomes essential for the businesses-in order to retain its competitive edge (and deliver products to customers in an efficient and effective way)-the dynamic reconfiguration of the SC from time-to-time [61]. This dynamic SC reconfiguration calls for serious research attention [15], as it presents several challenges:

- In the ideal world, SCs are designed focused upon customer efficiency [16], with an integration of the decisions and operational activities of the business partners [39]; in real life, SC are designed focused upon factory effectiveness [16], as traditionally, managers focus on the management of their internal operations to improve profitability [39].

- It involves the re-establishment of the sophisticated real-time cooperation in operation and decision-making (across different tasks, functional areas, and organizational boundaries), in order to deal with the uncertainties proper of a mass customization, quick response, and high-quality service environment [15].
- Most of the published research (in the area of SC design), focus on high level strategic issues (i.e. generic guidelines for business executives) rather than specific tools for plant managers [62].

In response to the challenges presented in section 1.3.2., a great deal of work has been done in the area SC design & modeling-i.e. [59] presents an extensive literature review with examples – so is not the intention of this paper to go through it again, but to present the topic divided into four aspects: approaches, elements, perspectives, and purposes.

Regarding the SC modeling approaches; [44], [77], [102], and [103] classify the different approaches for SC modeling, as analytical or simulation models. [42] offers a similar classification: deterministic, stochastic, or hybrid models. [104] divides the approaches in deterministic (where all the parameters are known), stochastic (at least one parameter is unknown but follows a probabilistic distribution), economic game-theoretic, and simulation-based (to evaluate the performance of various supply chain strategies). [105] Zhang suggests combining simulation models with Artificial Intelligence (AI) approaches-i.e. case-based reasoning (CBR), multi-agent systems, and neural networks – to evaluate not only the traditional cost and lead-time decision variables but other qualitative attributes (via interaction and logical protocols). According to [10], traditional supply chain modeling approaches involve the application of optimization, mathematical, simulation, and system dynamics models. Within the analytical (or mathematical) approach, [104] mentions the use of continuous-time differential equation models, discrete-time difference models, discrete event models and classical operational research methods. While these models allow the maximization of certain aspects, simulation models allow a more realistic capture of the SC characteristics and provide a means to evaluate the impact of policy changes [106]. More recently, [107] states that deterministic mathematical models are widely employed and are useful to evaluate the impact of various types of uncertainty on operational performance, while simulation models are employed to incorporate uncertainty in various system parameters, and are useful for evaluating the operational performance of only a particular scenario. Because of this last, simulation models have gained importance in the area of supply chain decision making [42] as powerful tools for analyzing/designing the whole supply chain in the view of managing its stochastic behavior [108].

Regarding the SC modeling elements; [109] classifies the SC modeling elements into structural (production, transportation) and control (flow, inventory, demand, supply, information) elements. [6] establishes three structures that need to be taken into account before any SC modeling effort: type of SC partnership, structural dimensions of the SC, and process links among the SC partners. [110] states that some requirements of the modeling phase are the modeling of interdependencies, the various levels of abstraction, the modeling of splits and joins, and the modeling of simple and conditional transitions. Regarding the level of abstraction issue, [10] points out that if the focus of the SC model is more on planning and studying behavior at an aggregated level, then a certain level of aggregation must be resorted, as too many organizations in the model might lead to such a complex network that making sense of its collective behavior could become virtually impossible.

Regarding the SC modeling perspectives; [32] proposes the SCOPE paradigm, a three dimensional model that includes a discrete breadth perspective (work, business process, SC, and holistic networks elements), the interlinked width perspective (material, information, cash, and capacity elements), and the integrated depth perspective (organization, people, technology, and controls elements). [111] proposes a causal model which contains stakeholders, business, strategy, processes and enabling technology perspectives. [45] proposes the network structure, coordination relationships, coordination mechanisms, and process requirements perspectives. [14] presents a model which contains stakeholders, topology, enabling technology, levels of collaboration, business strategy, and processes perspectives. [105] talks about process, system, and enterprise perspectives. [72] suggests the physical alignment (of the SC with the market requirements), the reconfiguration of production processes (within the SC), and the behavioral and relationship (between the SC members) perspectives.

Regarding the SC modeling purposes; [112] suggests that there is a relationship between the type of model and the use of the model, i.e. optimization models fit the needs of continuous improvement and re-engineering projects while simulation models fit the needs of design for logistics and breakthrough projects. On the other hand, [26] suggests that SC models are either coordination-oriented (de-centralized decision making) or logistics-oriented (centralized decision making).

3.2. Shortcomings

Last section can be summarized as follows: traditional SC modeling is quite suitable for modeling SC decisions within a single enterprise, as it employs a centralized decision-making treatment, typically involves a single comprehensive model, and is based on the assumption of information symmetry, that is, every bit of information is known to everyone else or at least available to the model builder/decision maker [10]. In this section we review the issues related to the modeling approaches, analytical models derived, and the use of simulation models.

Regarding the approaches; [43] states that most approaches to SC modeling pay little attention to 1) multiple relationships, and focus on single supply chain; 2) the effects of competition and strategy, do not incorporate price competition and/or changing order allocation; and 3) exchanges other than inventory and orders. According to [113], even though in the real world most SC consist of firms that manage both backlogs and inventories simultaneously, most of the recent work considers only pure inventory SC. [65] states that traditional SC models focus solely on determining the profit or revenue-maximizing, or cost-minimizing production schedule. [4] mentions that most of the SC modeling studies deal with the production, distribution and logistics exclusively and ignore the benefits of the integrated approach when in fact, one of the most important issues in multi-plant SC modeling is the integrated process planning and scheduling [8]. Finally, it is the opinion of [15] that due to the highly complex nature of large SCs, the use of formal and quantitative approaches are very difficult.

Regarding the use of analytical models; are fairly complex and time-consuming to solve [17]; are too simplistic to be of practical use for complex SCs [7], [105], [106], [114]; are limited to address two or three factors at a time that rarely answers both 'what if?' and 'what's best?' questions [53]; the obtained near-optimal models are easily compromised due to unstable market environments [115]; do not capture the truly dynamic behavior of most real-world SC [61]; are high abstraction models for business processes under simplifying assumptions [42], [114]; are not able to handle all the dynamically changing supply chain variables [108]; are either oversimplified, or just qualitatively described, and difficult to be applied for evaluating real SC with quantitative analysis and decisions [15]; ignore the impact of uncertainty on the chain performance, the environment and SC members dynamics, and the complex material relationships that occur if upstream installations fail to serve downstream installations [7], [114]. In the case of uncertainty, in real life, SCs operate within an uncertain demand–supply environment-uncertainty in customer demand/quantity in supply/lead time [36], and uncertainties associated with the estimates of various operating costs and product prices [8]-which have negative effects on operational performance (i.e. cost, profitability, quality, and customer service), so the inclusion of them makes pure mathematical modeling intractable [107].

Regarding the use of simulation models; they strongly focus on the representation of physical interactions between SC partners, and entities related to SC coordination are often implicitly modeled [116]. The majority of these models are steady-state models based on average performance or steady-state conditions, static models which are insufficient when dealing with the dynamic characteristics of the supply chain system, i.e. demand fluctuations, lead-time delays, sales forecasting [104].

4. Conditions and abilities for SCM value creation: Modeling requirements

4.1. Conditions

The SCM formulation introduced in section 1.1 synthesizes the recurrent basic SCM concepts, present in the work of several different authors through the years. As this formulation considers the goal of SCM to be a function of three elements, in this paper we propose to consider them as the necessary conditions to achieve a SCM value creation. An example of some of the work already validated and reported in the literature, is the following:

- *BP synchronization*; [117], [44] states that business-process (BP) synchronization is achieved when a properly timing is achieved via a lead time variability reduction. For [94], on the other hand, BP synchronization takes place at the decision level, when two (or more) BPs have a common decision center. [118] mentions that within the workflow management field, an activity can be understood as a sequence of states, and two activities (or BPs, for that matter) can be synchronized through synchronization constraints dependent of their activity states. Finally, the GRAI modeling formalism [119], [120] seems to summarize the last positions, as it considers a decision center (located at the GRAI grids) as the cross between a function and a decision, where there is a time-driven part and an event-driven part: the time-driven part synchronizes the different functions based on the intervals of time

http://dx.doi.org/10.5772/59656

over which a decision extends and after which a decision needs to be reconsidered; the event-driven part represents the change of states that triggers a new function-decision interaction (represented by GRAI nets).

- *S&D elements realignment*; [121] states that alignment can be defined as the extent to which the two related variables (independent of any performance anchor) meet the theoretical norms of mutual coherence (match/fit): if a SC partner lacks the capabilities required to meet the needs of the SC, there is an inherent inefficiency in the system. He proposes a matrix that provides the means to align the individual capabilities with the overall SC strategy and practices, in order to achieve the efficient SCM: the closer a firm is to the matrix's diagonal, the more aligned. [122] extends further the concept: SC alignment means making/taking the appropriate SC decisions to match SC objectives with the competitive objectives, making an emphasis on a holistic value creation maximization, so operating policies can be implemented through OW/OQ capabilities (i.e. volume & mix flexibility, service, dependability & speed delivery, cost, quality, innovativeness, etc.). With this idea on mind, he develops a five classification criteria to find the SC that best fits the marketplace demand and/or customer needs: forecast uncertainty, demand variability, demand volume, product variety, and delivery time window.

- *C&O fulfillment*; [41] mentions that the multi-site, geographically dispersed nature of the SC entails the coordination of SC, product, and process decisions, which in turn presents diverse constraints that need to be satisfied. For this purposes, he proposes to formulate a constraint satisfaction problem by 1) incorporating the interdependencies among markets, products' characteristics, production capacities, and multi-site structure; and 2) representing them it as a triple <V, D, C >, where V is a set of variables, D contains all the possible values that can be assumed by V, and C is a set of constraints on variables in V. The solution space that is free of constraints is expressed as a constraint graph and the solution is found beginning from the root to the leaves.

4.2. Abilities

The review of the SC C^4 concept (made in Section 2.2.) shows how the behavioral mechanisms for SC value creation can be directly related to the elements composing an integrated SC, and for this reason, in this paper we propose to consider them as the necessary abilities to achieve a SCM value creation. Within this context, we identify four abilities necessary for SCM value creation:

- Communication; ability to share key information by providing an environment of free flow & access to correct, easy to use & understand, timely, accurate, and complete information. In this way, communication is possible when the means are in place and the shared information is relevant to each SC partner.

- Coordination; ability to match the SC partners capabilities by harmonizing the individual actions/decisions with the common mission, objectives, and goals. In this way, coordination is possible when each SC partner's actions and decisions are driven by a common goal.

- Collaboration; ability to establish mutual trust by adjusting the individual behavior in accordance to a jointed decision-making and benefits & risks sharing. In this way, collaboration is possible when each SC partner's behavior is ruled by decisions taken in agreement and because each SC partner accepts the consequences of those jointed decisions.
- Cooperation; ability to support strategic commitments by aligning the individual strategic, tactical, and operational decisions with the common objectives, goals, and policies. In this way, cooperation is possible when each SC partner's decisions are driven by a common benefit.

It must be noted that the definitions offered differ from the traditional concepts present in the SCM literature, as we consider them to be part of a continuum-in the sense of the types of SC configurations presented by [123], Table 2-of enablers to advance through the stages of the SC management maturity model proposed by [124], as shown in Figure 1.

SC configurations [123]				
Type	Goal congruence	Trust level	Information sharing	Decision making
communicative	absence	reliability	nearest-neighbor basis	Myopic (parity-based)
coordinated	weak to moderate	reliability (deterrence-based)	supply chain-wide	Myopic (asymmetric)
collaborative	moderate	reliability, competency, goodwill (openness)	supply chain-wide for focal function	Dyadic (centralized)
cooperative	true	reliability, competency, goodwill	web of relationships	Dyadic (parity-based)

Table 2. Types of SC configurations, adapted from [123]

4.3. Modeling requirements

Traditional SC modeling approaches are quite limited and indeed unrealistic, considering the fact that most of the SCs involve enterprises with independent ownerships, and that the ability to model information asymmetry and distributed/decentralized mode of controls is required [10]. From this last, we identify three SC modeling needs: 1) to represent many realistic features, i.e. different supply chain structures/configurations and production/inventory parameters, in order to validate the concepts of cooperation and collaboration (imbedded in SCM), and to optimize the existing business processes [42]; 2) to represent the dynamic system nature of the SC by using concepts of state variables, flows, and feedback processes [7]; and 3) to be flexible and parametric for evaluating different scenarios [108]. From here our proposal: SC modeling faces issues dealing with the number and nature of the variables used (scale-related issues), and with the assumptions and extension of the analysis (scope-related issues). The scale-related issues refer to the characteristics of real-life SCs-i.e. multiple end products, facilities,

http://dx.doi.org/10.5772/59656

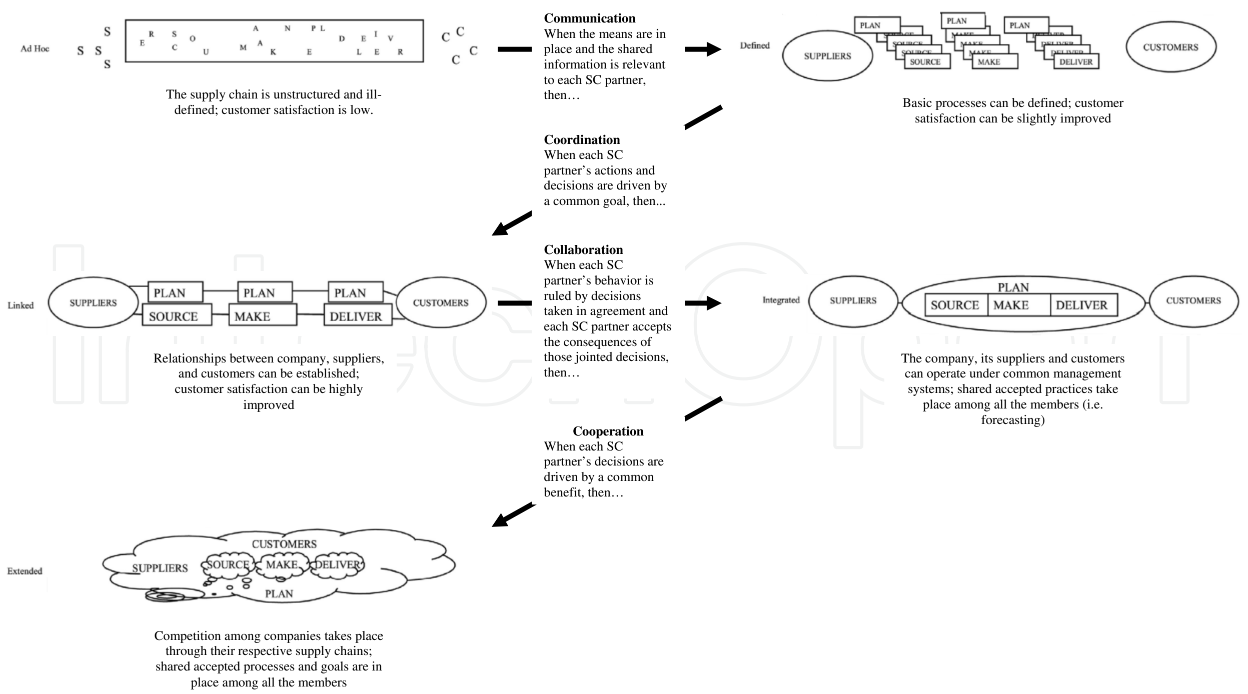

Figure 1. SCM value creation abilities, in the context of [124] SC maturity model

and capacities [49] – that make difficult the modeling effort, as there are a large number of tangible/intangible, dynamically changing variables [103], [125]. The scope-related issues refer to the existing SC models, that are limited by a number of assumptions, focus only on one certain part of the SC, or are not flexible enough to allow easy exploration of innovative policies [106], [126]. We claim that these scale and scope related issues will be overcome when SC modeling becomes comprehensive, dynamic, detailed, and realistic:

- Comprehensive, including all the members of the SC [17]; and dynamic, accommodating the upstream and downstream flows [127]. This calls for a multi-view model, as it is impossible to describe the SC from a single standpoint [45], [115], [126], [128].
- Detailed, including all the strategic, tactical, and operational levels [106]. This calls for a multi-level model, as in practice a SC face more problems concerned with quantitative issues at the operational level than with qualitative issues at the strategic level [48], [129].
- Realistic, based on real-life assumptions [126]. This calls for a multi-stage model, as the goal of SCM is the creation of value, and there is a set of conditions and abilities necessary for this creation to take place.

4.4. Directions for future research

As the focus of SCM has shifted from production efficiency to customer-driven and partnership synchronization approaches, its objective is to optimize the order fulfillment process, which is basically driven by customer issues, and influenced by the profitability of all the SC members. For these reasons, the demand for achievement of 'overall value-adding performance' requires putting special attention to the concept of 'value' within the SC: as the SC is formed around a value stream or set of linked activities directly contributing to the customer-perceived value of the product or service, it is agreed that the main goal of a SC is the creation of internal and external value. If we take into account that:

1. The main goal of a SC is the creation of internal and external value, and that there are some governance mechanisms necessary precursors to SC value creation, i.e. communication, coordination, collaboration, and cooperation (SC C^4).

2. An efficient SCM requires the modeling of the SC, and in order for these models to be useful and realistic, these models need to follow a multi-view, multi-level, multi-stage approach,

then the research challenge becomes then how to represent – for modeling purposes – the set of actions, decisions, goals, objectives, benefits, risks, etc. (discrete value creation conditions), within the SC C^4 (continuum value creation abilities) context, and from a multi-view, multi-level, multi-stage perspective. Future research will address this issue.

5. Concluding remarks

In order to remain competitive within a global economy context, companies need to compete through their SCs. This demands that companies focus in create value for their customers and shareholders, act in a synchronized way when conducting their business practices, think in terms of strategic and operational impacts, and fulfill constraints and objectives in the process. A way to address this challenge is through the use of SCM practices. There are several issues related to the implementation of a successful SCM practice, which-it has been suggested – can be overcome with the help of SC design. In this paper we reviewed the issues related to the creation of value in a SCM context, as well as the approaches, elements, perspectives, and purposes of SC modeling. The contribution of this paper to the SCM literature is a set of SCM value creation conditions and abilities that need to be taken into account in a multi-view, multi-level, multi-stage context, in order to develop a real-life useful SCM model. It must be noticed the exploratory nature of this research, which does not pretend to be neither comprehensive nor final but instead, the starting point for establishing the basis of the novel discipline of SCM modeling.

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http://dx.doi.org/10.5772/59656

References

[1] Altiparmak F., Gen M., Lin L., Karaoglan I. A steady-state genetic algorithm for multi-product supply chain network design. Computers & Industrial Engineering 2009; 56 521–537.

[2] Hilletofth P. How to develop a differentiated supply chain strategy. Industrial Management & Data Systems 2009; 109 (1) 16-33.

[3] Emery CR. A cause-effect-cause model for sustaining cross-functional integration. Business Process Management Journal 2009; 15 (1) 93-108.

[4] Tiwari MK, Bachlaus M, Pandey MK, Mahajan C, Shankar R. Designing an integrated multi-echelon agile supply chain network: a hybrid taguchi-particle swarm optimization approach. Journal of Intelligent Manufacturing 2008; 19 747–761.

[5] Harding JA, Lin HK. A manufacturing system engineering ontology model on the semantic web for inter-enterprise collaboration. Computers in Industry 2007; 58 428–437.

[6] Min H, Zhou G. Supply chain modeling: past, present, and future. Computers and industrial engineering 2002; 43 231-249.

[7] Pawlak M, Małyszek E. A local collaboration as the most successful co-ordination scenario in the supply chain. Industrial Management & Data Systems 2008; 108 (1) 22-42.

[8] Demirli K, Yimer AD. Fuzzy scheduling of a build-to-order supply chain. International Journal of Production Research 2008; 46 (14) 3931–3958.

[9] Agarwal A, Shankar R, Tiwari MK. Modeling the metrics of lean, agile and leagile supply chain: An ANP-based approach. European Journal of Operational Research 2006; 173 211–225.

[10] Govindu R, Chinnam RB. MASCF: A generic process-centered methodological framework for analysis and design of multi-agent supply chain systems. Computers & Industrial Engineering 2007; 53 584–609.

[11] Meijboom B, Voordijk H, Akkermans H. The effect of industry clockspeed on supply chain co-ordination: Classical theory to sharpen an emerging concept. Business Process Management Journal 2007; 13 (4) 553-571.

[12] Olhager J, Rudberg M. Manufacturing networks and supply chains: an operations Strategy perspective. Omega 2003; 31 29 – 39.

[13] Ismail HS, Sharifi H. A balanced approach to building agile supply chains. International Journal of Physical Distribution & Logistics Management 2006a; 36 (6) 431-444.

[14] Angelides MC, Angerhofer BJ. A model and a performance measurement system for collaborative supply chains. Decision Support Systems 2006; 42 283– 301.

[15] Deshmukh SG, Jain V, Wadhwa S. Select supplier-related issues in modeling a dynamic supply chain: potential, challenges and direction for future research. International Journal of Production Research 2009; 47 (11) 3013–3039.

[16] Christopher M, Peck H, Towill D. A taxonomy for selecting global supply chain strategies. The International Journal of Logistics Management 2006; 17 (2) 277-287.

[17] Khoo LP, Yin XF. An extended graph-based virtual clustering-enhanced approach to supply chain optimization. International Journal of Advanced Manufacturing Technology 2003; 22 836–847.

[18] Li D, O'Brien C. Integrated decision modeling of supply chain efficiency. International Journal of Production Economics 1999; 59 147-157.

[19] Fox MS, Barbuceanu M, Teigen R. Agent-Oriented Supply-Chain Management. The International Journal of Flexible Manufacturing Systems 2000; 12 165–188.

[20] Barut M, Faisst W, Kanet JJ. Measuring supply chain coupling: an information system perspective. European Journal of Purchasing & Supply Management 2002; 8 61–171.

[21] Robertson PW, Gibson PR, Flanagan JT. Strategic supply chain development by integration of key global logistical process linkages. International Journal of Production Research 2002; 40 (16) 4021-4040.

[22] Simatupang TM, Wright AC, Sridharan R. The knowledge of coordination for supply chain integration. Business Process Management Journal 2002; 8 (3) 289-308.

[23] Chibba A, Horte SA. Supply chain performance – A Meta Analysis. European operations management association & Production and operations management society Joint conference, Como Lake, June, 16-18; 2003.

[24] Lambert DM, García-Dastugue SJ. Internet-enabled coordination in the supply chain. Industrial Marketing Management 2003; 32 251– 263.

[25] Truong TH, Azadivar F. Simulation based optimization for supply chain configuration design. Proceedings of the 2003 Winter Simulation Conference, 1268-1275; 2003.

[26] Schneeweiss C, Zimmer K. Hierarchical coordination mechanisms within the supply chain. European Journal of Operational Research 2004; 153 687–703.

[27] Lewis I, Talalayevsky A. Improving the interorganizational supply chain through optimization of information flows. The Journal of Enterprise Information Management 2004; 17(3) 229-237.

[28] Mansouri SA. Coordination of set-ups between two stages of a supply chain using multi-objective genetic algorithms. International Journal of Production Research 2005; 43(15) 3163–3180.

[29] Samaranayake P. A conceptual framework for supply chain management: a structural integration. Supply Chain Management 2005; 10(1) 47–59.

[30] Udin ZK, Khan MK, Zairi M. A collaborative supply chain management framework: Part 1 – planning stage. Business Process Management Journal 2006; 12(3) 361-376.

[31] Bailey K, Francis M. Managing information flows for improved value chain performance. International Journal of Production Economics 2007; 111 (1) 2-12.

[32] Berry D, Evans GN, Mason-Jones R, Towill DR. The BPR SCOPE concept in leveraging improved supply chain performance. Business Process Management Journal 1999; 5(3) 254-275.

[33] Kehoe DF, Boughton N. Internet based supply chain management: A classification of approaches to manufacturing planning and control. International Journal of Operations & Production Management 2001; 21(4) 516-524.

[34] Van der Vorst JGAJ, Beulens AJM. Identifying sources of uncertainty to generate supply chain redesign strategies. International Journal of Physical Distribution & Logistics Management 2002; 32(6) 409-430.

[35] Ydstie BE, Grossmann IE, Perea-Lopez E. A model predictive control strategy for supply chain optimization. Computers and Chemical Engineering 2003; 27 1201-1218.

[36] Heydari J, Kazemzadeh RB, Chaharsooghi SK. A study of lead time variation impact on supply chain performance. International Journal of Advanced Manufacturing Technology 2008; 40(11-12) 1206-1215.

[37] Mills J, Schmitz J, Frizelle G. A strategic review of "supply networks". International Journal of Operations & Production Management 2004; 24(10) 1012-1036.

[38] Wu C, Xu K, Liu L. A three-layered method for business processes discovery and its application in manufacturing industry. Computers in Industry 2007; 58 265–278.

[39] Wang A, Li X. Coordination mechanisms of supply chain systems. European Journal of Operational Research 2007; 179, 1–16.

[40] Bidhandi HM, Yusuff RM, Ahmad MMHM, Bakar MRA. Development of a new approach for deterministic supply chain network design. European Journal of Operational Research 2009; 198 121–128.

[41] Xu Q, Jiao RJ, Ng NK, Wu Z. Coordinating product, process, and supply chain decisions: a constraint satisfaction approach. Engineering Applications of Artificial Intelligence 2009; 22(7) 992-1004.

[42] Roder A, Tibken B. A methodology for modeling inter-company supply chains and for evaluating a method of integrated product and process documentation. European Journal of Operational Research 2006; 169 1010–1029.

[43] Allwood JM, Lee JH. The design of an agent for modelling supply chain network dynamics. International Journal of Production Research 2005; 43(22) 4875–4898.

[44] Narahari Y, Garg D, Viswanadham N. Design of Six Sigma Supply Chains. IEEE Transaction on automation science and engineering 2004; 1(1) 38-57.

[45] Li Z, Kumar A, Lim YG. Supply-chain modeling – a coordination approach. Integrated Manufacturing Systems 2002; 13(8) 551-561.

[46] Leach NP, Makatsoris H, Richards HD. Supply chain control: Trade-offs and system requirements. Human Systems Management 1997; 16(3) 159-169.

[47] Gunasekaran A, Patelb C, McGaughey RE. A framework for supply chain performance measurement. International Journal of Production Economics 2004; 87 333–347.

[48] Li D, O'Brien C. A quantitative analysis of relationships between product types and supply chain strategies, International Journal of Production Economics 2001; 73 29-39.

[49] Kaihara T. Multi-agent based supply chain modelling with dynamic environment. International Journal of Production Economics 2003; 85 263–269.

[50] Altiparmak F, Gen M, Lin L, Paksoy T. A genetic algorithm approach for multi-objective optimization of supply chain networks. Computers & Industrial Engineering 2006; 51 197–216.

[51] Chiadamrong N, Prasertwattana K. A comparative study of supply chain models under the traditional centralized and coordinating policies with incentive schemes. Computers & Industrial Engineering 2006; 50 367–384.

[52] Boulaksil Y, Fransoo JC. Order release strategies to control outsourced operations in a supply chain. International Journal of Production Economics 2009; 119 149–160.

[53] Shang JS, Li S, Tadikamalla P. Operational design of a supply chain system using the Taguchi method, response surface methodology, simulation, and optimization. International Journal of Production Research 2004; 42(18) 3823–3849.

[54] Robinson EP, Sahin F, Gao LL. Master production schedule time interval strategies in make-to-order supply chains. International Journal of Production Research 2008; 46(7) 1933–1954.

[55] Sahay BS. Supply chain collaboration: the key to value creation. Work Study 2003; 52(2) 76-83.

[56] Chandra C, Kumar, S. Enterprise architectural framework for supply-chain integration. Industrial Management & Data Systems2001; 101(6) 290-303.

[57] Kaipia R, Hartiala H. Information-sharing in supply chains: five proposals on how to proceed. The International Journal of Logistics Management 2006; 17(3) 377-393.

[58] Kehoe DF, Dani S, Sharifi H, Burns ND, Backhouse CJ. Demand network alignment: aligning the physical, informational and relationship issues in supply chains. International Journal of Production Research 2007; 45(5) 1141–1160.

[59] ELMaraghy HA, Majety R. Integrated supply chain design using multi-criteria Optimization. International Journal of Advanced Manufacturing Technology 2008; 37 371–399.

[60] Romano P. How can fluid dynamics help supply chain management?. International Journal of Production Economics 2009; 118 463–472.

[61] Dong M, Chen FF. Process modeling and analysis of manufacturing supply chain networks using object-oriented Petri nets. Robotics and Computer Integrated Manufacturing 17, 121-129; 2001.

[62] Huang GQ, Zhang XY, Liang L. Towards integrated optimal configuration of platform products, manufacturing processes, and supply chains. Journal of Operations Management 2005; 23 267–290.

[63] Tan GW, Shaw MJ, Fulkerson B. Web-based Supply Chain Management. Information Systems Frontiers 2000; 2(1) 41-55.

[64] Muckstadt JA, Murray DH, Rappold JA, Collins DE. Guidelines for Collaborative Supply Chain System Design and Operation. Information Systems Frontiers 2001; 3(4) 427–453.

[65] Puigjaner L, Guillen G, Badel, M. A holistic framework for short-term supply chain management integrating production and corporate financial planning. International Journal of Production Economics 2007; 106 288–306.

[66] Dror S, Barad M. House of Strategy (HOS): from strategic objectives to competitive priorities. International Journal of Production Research 2006; 44(18–19) 3879–3895.

[67] Eskandari H, Rabelo L, Shaalan T, Helal M. Value chain analysis using hybrid simulation and AHP. International Journal of Production Economics 2007; 105 536–547.

[68] Wilding R. The supply chain complexity triangle. International Journal of Physical Distribution & Logistics 1998; 21 599-616.

[69] Ashkenas R, Ulrich D, Jick T, Kerr S. The Boundaryless Organization. San Francisco: Jossey-Bass; 1995.

[70] Bititci US, Martinez V, Albores P, Parung J. Creating and managing value in collaborative networks. International Journal of Physical Distribution & Logistics Management 2004; 34(3/4) 251-268.

[71] Schnetzler MJ, Sennheiser A, Schonsleben P. A decomposition-based approach for the development of a supply chain strategy. International Journal of Production Economics 2007; 105 21–42.

[72] Ismail HS, Sharifi H. Achieving agility in supply chain through simultaneous "design of" and "design for" supply Chain. Journal of Manufacturing Technology Management 2006b; 17(8) 1078-1098.

[73] Kampstra RP, Ashayeri J, Gattorna JL. Realities of supply chain Collaboration. The International Journal of Logistics Management 2006; 17(3) 312-330.

[74] Azadivar F, Truong TH. Optimal design methodologies for configuration of supply chains. International Journal of Production Research 2005; 43(11) 2217–2236.

[75] Vernadat F. UEML: towards a unified enterprise modeling language. International Journal of Production Research 2002; 40(17) 4309 – 4321.

[76] Christopher M, Towill D. Supply chain migration from lean and functional to agile and customized. Supply Chain Management 2000; 5(4) 206-213.

[77] Terzi S, Cavalieri S. Simulation in the supply chain context: a survey. Computers in Industry 2004; 53 3–16.

[78] Duclos L, Vokurka R, Lummus R. A conceptual model of supply chain flexibility. Industrial Management & Data Systems 2003; 103(6) 446-456.

[79] Vonderembse MA, Uppal M, Huang SH, Dismukes JP. Designing supply chains: Towards theory development. International Journal of Production Economics 2006; 100 223–238.

[80] Griffiths J, James R, Kempson J. Focusing customer demand through manufacturing supply chains by the use of customer focused cells: an appraisal. International Journal of Production Economics 2000; 65(1) 111-120.

[81] Martinez-Olvera C, Shunk D. A comprehensive framework for the development of a supply chain strategy. International Journal of Production Research 2006; 44(21) 4511–4528.

[82] Jayaramy J, Kannanz VR, Tan KC. Influence of initiators on supply chain value creation. International Journal of Production Research 2004; 42(20) 4377–4399.

[83] Caridi M, Cigolini R, De Marco D. Improving supply-chain collaboration by linking intelligent agents to CPFR. International Journal of Production Research 2005; 43(20) 4191–4218.

[84] Towill DR, Childerhouse P, Aitken J. Analysis and design of focused demand chains. Journal of Operations Management 2002; 20 675–689.

[85] Manthou V, Vlachopoulou M, Folinas D. Virtual e-Chain (VeC) model for supply chain collaboration. International Journal of Production Economics 2004; 87 241–250.

[86] Yao Y, Evers PT, Dresner ME. Supply chain integration in vendor-managed inventory. Decision Support Systems 2007; 43 663– 674.

[87] Goutsos S, Karacapilidis N. Enhanced supply chain management for e-business transactions. International Journal of Production Economics 2004; 89 141–152.

[88] Kumara S, Surana A, Greaves M, Raghavan UM. Supply-chain networks: a complex adaptive systems perspective. International Journal of Production Research 2005; 43(20) 4235–4265.

[89] Sivadasan S, Efstathiou J, Shirazi R, Alves J, Frizelle G, Calinescu A. Information complexity as a determining factor in the evolution of supply chains. Proceedings of International Workshop on Emergent Synthesis, 237-42; 1999.

[90] Mertins K, Jochem R. Architectures, methods and tools for enterprise engineering. International Journal of Production Economics 2005; 98(2) 179–188.

[91] Van Donk DP, Van der Vaart T. A case of shared resources, uncertainty and supply chain integration in the process industry. International Journal of Production Economics 2005; 96 97–108.

[92] Mason-Jones R, Towill DR. Using the Information Decoupling Point to Improve Supply Chain Performance. International Journal of Logistics Management 1999; 10(2) 13-26.

[93] Mohammed IR, Shankar R, Banwet DK. Creating flex-lean-agile value chain by outsourcing: An ISM-based interventional roadmap. Business Process Management Journal 2008; 14(3) 338-389.

[94] Blanc S, Ducq Y, Vallespir B. Evolution management towards interoperable supply chains using performance measurement. Computers in Industry 2007; 58 720–732.

[95] Berente N, Vandenbosch B, Aubert B. Information flows and business process integration. Business Process Management Journal 2009; 15(1) 119-141.

[96] Li G, Yan H, Wang S, Xia Y. Comparative analysis on value of information sharing in supply chains. Supply Chain Management 2005; 10(1) 34–46.

[97] Hung W, Chu J, Lee CC. Strategic information sharing in a supply chain. European Journal of Operational Research 2006; 174 1567–1579.

[98] Zimmer K. Supply chain coordination with uncertain just-in-time delivery. International Journal of Production Economics 2002; 77 1–15.

[99] Ardalan A, Ardalan R. A data structure for supply chain management systems. Industrial Management & Data Systems 2009; 109(1) 138-150.

[100] Chiu M, Lin G. Collaborative supply chain planning using the artificial neural network approach. Journal of Manufacturing Technology Management 2004; 15(8) 787–796.

[101] Hallikas J, Virolainen VM, Tuominen M. Understanding risk and uncertainty in supplier networks-a transaction cost approach. International Journal of Production Research 2002; 40(15) 3519-3531.

[102] Raghavan NRS, Viswanadham N. Performance analysis and design of supply chains: a Petri net approach. Journal of the Operational Research Society 2000; 51 1158-1169.

[103] Son YJ, Venkateswaran J. Impact of modelling approximations in supply chain analysis – an experimental study. International Journal of Production Research 2004; 42(15) 2971–2992.

[104] Sarimveis H, Patrinosa P, Tarantilisb CD, Kiranoudis CT. Dynamic modeling and control of supply chain systems: A review. Computers & Operations Research 2008; 3530 – 3561.

[105] Zhang DZ, Akanle OM. Agent-based model for optimizing supply-chain configurations. International Journal of Production Economics 2008; 115 444– 460.

[106] Shah N, Hung WY, Kucherenko S, Samsatli NJ. A flexible and generic approach to dynamic modelling of supply chains. Journal of the Operational Research Society 2004; 55 801–813.

[107] Kadipasaoglu SN, Acar Y, Day JM. Incorporating uncertainty in optimal decision making: Integrating mixed integer programming and simulation to solve combinatorial problems. Computers & Industrial Engineering 2009; 56 106–112.

[108] Longo F, Mirabelli G. An advanced supply chain management tool based on modeling and simulation. Computers & Industrial Engineering 2008; 54 570–588.

[109] Swaminathan JM, Smith SF, Sadeh NM. Modeling supply chain dynamics: a multiagent approach. Decision Sciences 1998; 29(3) 607-632.

[110] Huang S, Hu Y, Li C. A TCPN based approach to model the coordination in virtual manufacturing organizations. Computers & Industrial Engineering 2004; 47 61–76.

[111] Akkermans HA. Renga: a systems approach to facilitating inter-organizational network development. System Dynamics Review 2001; 17(3) 179-193

[112] Appelqvist P, Lehtonen JM, Kokkonen J. Modelling in product and supply chain design: literature survey and case study. Journal of Manufacturing Technology Management 2004; 15(7) 675–686.

[113] Anderson EG, Morrice DJ, Lundeen G. The "physics" of capacity and backlog management in service and custom manufacturing supply chains. System Dynamics Review 2005; 21(3) 217–247.

[114] Chan FTS, Chan HK. The future trend on system-wide modeling in supply chain studies. International Journal of Advanced Manufacturing Technology 2005; 25 820–832.

[115] Kim J, Rogers KJ. An object-oriented approach for building a flexible supply chain model. International Journal of Physical Distribution & Logistics Management 2005; 35(7) 481-502.

[116] Van der Zee DJ. A Modeling Framework for Supply Chain Simulation: Opportunities for Improved Decision Making. Decision Sciences 2005; 36(1) 65-95.

[117] Narahari, Y., Garg, D., Viswanadham, N. Design of Six Sigma Supply Chains. Proceedings of the 2003 IEEE International Conference on Robotics & Automation, Tsipei, Taiwan, September 2003, 1737-1742; 2003.

[118] Wu, Q., Pu, C., Sahai, A. DAG Synchronization Constraint Language for Business Processes. Proceedings of the 8th IEEE International Conference on E-Commerce Technology and the 3rd IEEE International Conference on Enterprise Computing, E-Commerce, and E-Services, CEC/EEE'06, 10; 2006.

[119] Ducq Y, Vallespir B, Doumeingts G. Coherence analysis methods for production systems by performance aggregation. International Journal of Production Economics 2001; 69 23-37.

[120] Poler R, Lario FC, Doumeingts G. Dynamic modeling of decision systems. Computers in Industry 2002; 49 175-193.

[121] Shah R, Goldstein SM, Ward PT. Aligning Supply Chain Management Characteristics and Interorganizational Information System Types: An Exploratory Study. IEEE transactions on engineering management 2002; 49(3) 282-292.

[122] Bolat B, Ellialtioglu B. A proposed conceptual framework for building supply chain strategies to meet marketplace requirements International Conference on Computers & Industrial Engineering CIE 2009, 6-9 July 2009, 886 – 891; 2009.

[123] Lejeune MA, Yakova N. On characterizing the 4 C's in supply chain management. Journal of Operations Management 2005; 23 81–100.

[124] Lockamy A, Smith WI. A strategic alignment approach for effective business process reengineering: linking strategy, processes, and customers for competitive advantage. International Journal of Production Economics 1997; 50(2) 141-153.

[125] Lee YH, Cho MK, Kim YB. A Discrete-Continuous Combined Modeling Approach for Supply Chain Simulation. Simulation 2002; 78(5) 321-329.

[126] Hwarng HB, Chong CSP, Xie N, Burguess TF. Modelling a complex supply chain: understanding the effect of simplified assumptions. International Journal of Production Research 2005; 43(13) 2829–2872.

[127] Narasimhan R, Mahapatra S. Decision models in global supply chain management. Industrial Marketing Management 2004; 33 21– 27.

[128] Fayez M, Rabelo L, Mollaghasemi M. Ontologies for supply chain simulation modeling. Proceedings of the 37th conference on Winter Simulation Conference, 2364-2370; 2005.

[129] Huang SH, Uppal M, Shi J. A product driven approach to manufacturing supply chain selection. Supply chain management 2002; 7(4) 189-199.