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Computer-assisted supply chain configuration based on supply chain operations reference (SCOR) model

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Abstract

A supply chain is a network of facilities that procure raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system. To achieve integrated supply chain management, a number of researchers and practitioners have devoted their efforts in developing models to describe the elements and activities of a supply chain. The supply chain council, supported by over 650 member organizations (both academia and industry) worldwide, has developed the supply chain operations reference (SCOR) model. The SCOR model is a process reference model, which is intended to be an industrial standard that enables next-generation supply chain management. It contains a standard description of management processes, a framework of relationships among the standard processes, standard metrics to measure process performance, management practices that produce best-in-class performance, and a standard alignment to software features and functionality. This paper summarizes the SCOR model, its benefits along with illustrative case stories and describes a computer-assisted tool to configure supply chain threaded diagram per SCOR specification.

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1. Introduction

In today's rapidly changing global economy, some companies are able to change with the times to adapt and thrive in the increasing uncertain world of the early 21st century. They can be recognized by their ability to anticipate and understand changes in the market, to recognize new opportunities, to deliver new customer services, and to adapt their businesses rapidly to meet and exceed their customers'

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requirements. All these companies have recognized the importance of one key element, agility (or flexibility) to change fast. Agile businesses view themselves as the center, or hub of networks of material and information flows. These flows extend from the customer interface at marketing and sales through production and procurement to the building of relationship with suppliers. These businesses achieve agility through a constant review and realignment of these closely linked networks. Over the past decade, a new term, supply chain management (SCM), has been coined to a management approach to deliver this required agility to change while maintaining cost efficiency.

SCM is having profound impact on business results. It ‘encompasses all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end user, as well as the associated information flow’ (Handfield & Nichols, 1999). Clearly, the idea of SCM is to view the chain as a total system and to fine-tune the decisions about how to operate the various components (companies, functions, and activities) in ways, which will produce the most desirable overall system performance in the long run. Doing so is extremely difficult due to the number and complexity of the decisions to be made, as well as the inter- and intra-organization issues that must be addressed. Never has so much technology and brainpower been applied to improving supply chain performance. Examples include point-of-sale scanners that allow companies to capture the customer’s voice. Electronic data interchange lets all stages of the supply chain hear that voice and react to it by using flexible manufacturing, automated warehousing, and rapid logistics. Concepts such as quick and accurate response, efficient consumer response, mass customization, lean manufacturing, and agile manufacturing offer models for applying new technologies to improve performance.

One can argue that a proliferation of interpretations of what SCM means has led to some confusion among researchers and practitioners. There should be some characteristics unique to supply chain management that differentiates it from past research that fell under the aegis of integrated logistics. Houlihan (1985) made it clear that the differentiating factor is the strategic decision making aspect in managing the supply chain. SCM reaches out beyond the boundaries of cost containment and links operating decisions to strategic considerations within and beyond the company. To assist organizations in achieving better strategic decision making, a number of researchers and practitioners have devoted their efforts to developing models to describe the elements and activities of a supply chain. Beamon (1998) provided a literature review on multi stage-supply chain modeling, which consists of four categories, namely, deterministic model (Voudouris, 1996), stochastic model (Tzafestas & Kapsiotis, 1994), economic model (Christy & Grout, 1994), and simulation model (Towill, 1991). The author proposed a research agenda for supply chain design and analysis: (1) the evaluation and development of supply chain performance measures, (2) the development of models and procedures to relate decision variables to the performance measures, (3) consideration of issues affecting supply chain modeling, and (4) the classification of supply chain systems to allow for the development of rules-of-thumb or general techniques to aid in the design and analysis of manufacturing supply chains.

Although various supply chain models have been proposed, most of them emphasize on inventory management and distribution logistic. As previously mentioned, strategic decision making is critical in supply chain management, which requires a framework model that can serve as an industry standard. The supply chain council (SCC), a not-for-profit organization established in 1996 that now has over 650 organization members worldwide, has taken the initiative in developing such a model—the supply chain operations reference (SCOR) model. The SCOR model is intended to be an industrial standard that enables next-generation supply chain management. It contains a standard description of management processes, a framework of relationships among the standard processes, standard metrics to measure

process performance, management practices that produce best-in-class performance, and a standard alignment to software features and functionality. This paper summarizes the SCOR model (Section 2), presents a computer-assisted tool to configure supply chain threaded diagram per SCOR specification (Section 3), demonstrates SCOR benefits with case history and illustrations (Section 4), discusses areas where the SCOR model can be improved (Section 5), and points out future research issues (Section 6).

2. The supply chain operations reference model

2.1. Background

The SCOR model is a process reference model. Specifically, it is a model that links process elements, metrics, best practice and the features associated with the execution of a supply chain in a unique format. It provides a balanced horizontal (cross-process) and vertical (hierarchical) view as compared to the classical process decomposition models, which are developed to address one specific configuration of process elements. It is designed to be (re)/configurable and aggregates a series of hierarchical process models. The use of a process reference model allows companies to communicate using common terminology and standard descriptions of the process elements that help understand the overall supply chain management process and the best practices that yield the optimal overall performance.

The SCOR model is the first model that can be used to configure the supply chain based on business strategy. It provides unambiguous, standard descriptions for the thousands of activities within the supply chain. It also identifies the performance measurements and supporting tools suitable for each activity. This process reference model enables all departments and businesses involved in developing and managing the integrated supply chain to collaborate effectively.

The SCOR model integrates the well-known concepts of business process reengineering, benchmarking, and process measurement into a cross-functional framework. It captures the ‘as-is’ state of a process and then derives the desired ‘to-be’ future state. It quantifies the operational performance of similar companies and establishes internal targets based on ‘best-in-class’ results. It also characterizes the management practices and software solutions that result in ‘best-in-class’ performance. The structural framework of the SCOR model is composed of the following elements:

- Standard descriptions of the individual elements that make up the supply chain processes.
- Standard definitions of key performance measures.
- Descriptions of best practices associated with each of the process elements.
- Identification of software functionality that enables best practices.

Since the model’s introduction in 1996, SCOR has undergone several major revisions based on practical needs. The following paragraphs summarize the SCOR model based on materials presented in Stephens (2001) and SCC (2001).

2.2. SCOR processes and levels

The SCOR model is originally founded on five distinct management processes, namely, *Plan*, *Source*, *Make*, *Deliver* and *Return* which are called Level 1 processes. The processes are further

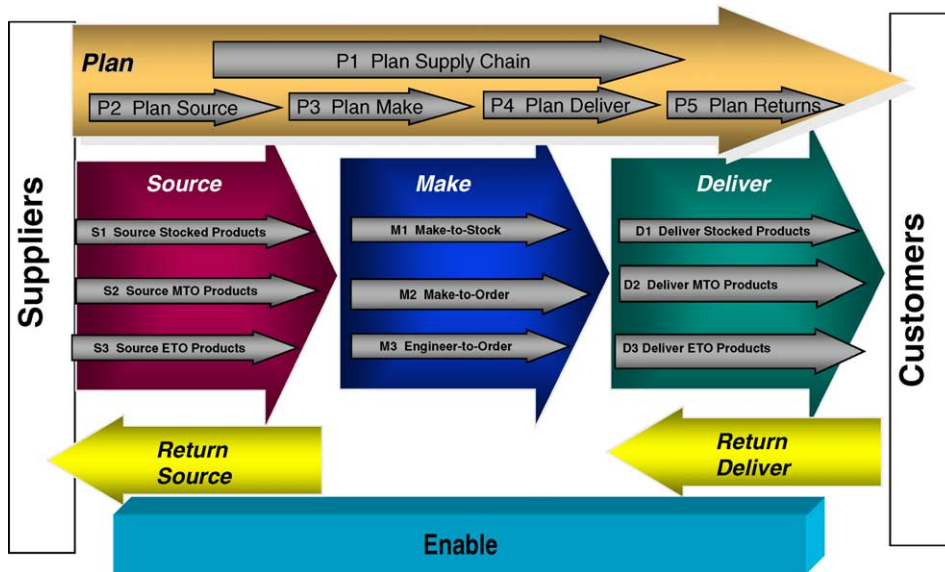


Fig. 1. The SCOR infrastructure (Stephens, 1999).

decomposed into process categories (Level 2) depending on the type of environment in which the SCOR model is applied. The process categories further contain process elements, which is the third and the last Level in the SCOR model. At Level 3, the elements model contains performance attributes, metrics, best practices and software features required for that element. Fig. 1 shows the infrastructure of the SCOR model, while Fig. 2 shows the process levels (Stephens, 2001).

The five management processes—Plan, Source, Make, Deliver and Return—are discussed first. The Plan process consists of processes that balance aggregated demand and supply to develop a course of action which best meets the business goals. Plan processes deal with demand/supply planning, which include the activities to assess supply resources, aggregate and prioritize demand requirements, plan inventory, distribution requirements, production, material, and rough-cut capacity for all products and all channels. The Source process contains processes that procure goods and services to meet planned or actual demand. Sourcing/material acquisition includes the jobs of obtaining, receiving, inspecting, holding, and issuing material. Management of sourcing infrastructure includes vendor certification and feedback, sourcing quality, in-bound freight, component engineering, vendor contracts, and vendor payments. The Make process includes functions that transform goods to a finished state to meet planned or actual demand. Make is the core process of the system in which actual production execution takes place. It includes the jobs of requesting and receiving material, manufacturing and testing product, packaging, holding and/or releasing the product eventually. The Deliver process consists of processes that provide finished goods and services to meet planned or actual demand. This typically includes the functions of order management, transportation management, and distribution management. Managing the deliver

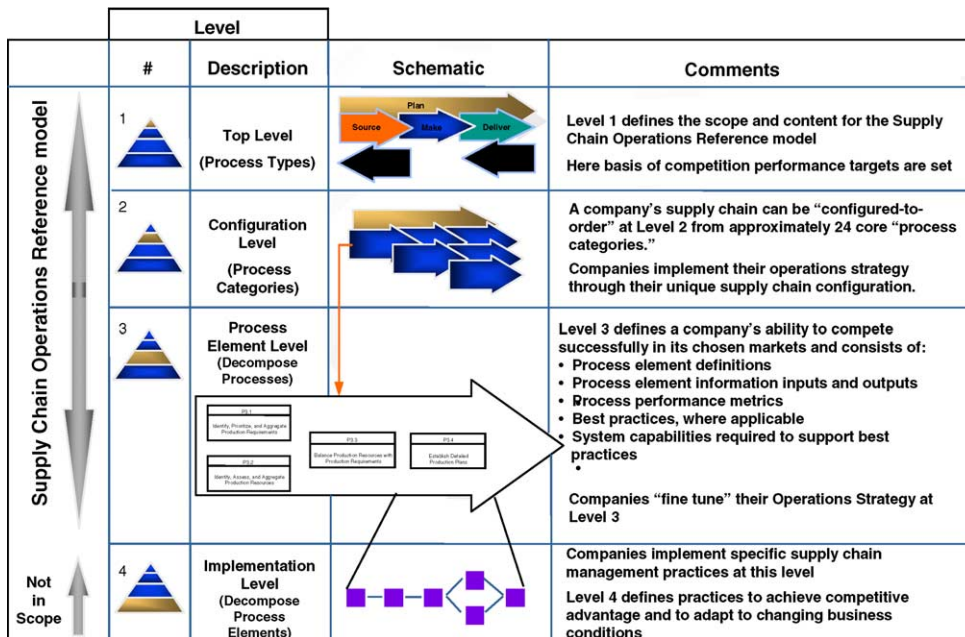


Fig. 2. The SCOR process levels (Stephens, 1999).

process includes managing channel business rules, ordering rules, managing deliver inventories, and managing deliver quality. Return is the latest addition to SCOR model. It deals with managing reverse flow of material and information related to defective, surplus and MRO products. This includes authorizing, scheduling, receiving, verifying, disposing and replacement or credit for the above types of materials. Each basic supply chain is a 'chain' of Source, Make, Deliver and Return execution process. Each interaction of two execution processes is a 'link' in the supply chain. Planning sits on top of these links and manages them.

As previously mentioned, the SCOR model contains three Levels of process detail. Level 1 is the top level that deals with process types. Level 2 is the configuration level and deals with process categories. Level 3 is the process element level and is the lowest level in the scope of the SCOR model. Implementation levels that are below Level 3, in which we decompose process elements into tasks and further activities in classical hierarchical manner, are not in scope of the SCOR model, but will be briefly mentioned here.

Level 1 defines the supply chain using five key processes: Plan, Source, Make, Deliver and Return. The SCOR model Level 1 metrics characterize performance from customer-facing and internal-facing perspectives. Therefore, at Level 1, basis of competition is defined and broad guidelines are provided to meet the competition. Specific tasks to be completed at Level 1 are: set business requirements and define basis of competition, evaluate the performance of current operation vis-à-vis required performance, set the SCOR model metrics and targets, and define the gap, set business priorities and state what needs to change. Also at Level 1, current supply chain is modeled considering asset, product volume and mix, and technology requirements and constraints.

Level 2 defines different categories within the Level 1 processes. At this level, processes are configured in line with supply chain strategy. At Level 2, internal redundancies can be identified and eliminated:

- A business that has grown through acquisition typically finds multiple redundancies at this level, such as overlapping planning processes, duplicated purchasing, or excessive intra-manufacturing transfers.
- Some businesses discover that customer orders are delayed at many points in the supply chain, indicating a need for customer and supplier integration.
- Others may find that the same planning process is carried out both internally and by the customer. One of them should be eliminated.

The goal at Level 2 is to simplify the supply chain and enhance its overall flexibility. At Level 2, the SCOR model provides a tool kit of 22 process categories (version 5.0), as shown in [Table 1](#). Any supply chain configuration can be represented with this tool kit. Here the company should reconfigure the supply chain configured in Level 1 to determine the expected performance. At Level 2, market constraints, product constraints and company constraints are considered to configure the inter- and intra-company process categories.

Level 3 allows businesses to define in detail the processes identified, as well as performance metrics and best practices for each activity. The software functionality required to support best practices is also identified, as well as the commercial software and tools currently providing required functionality.

Table 1
SCOR Level 2 process categories

Notation	Process category
P1	Plan supply chain
P2	Plan source
P3	Plan make
P4	Plan deliver
P5	Plan return
EP	Enable plan
S1	Source stocked products
S2	Source make-to-order products
S3	Source engineer-to-order products
ES	Enable source
M1	Make-to-stock
M2	Make-to-order
M3	Engineer-to-order
M0	Make infrastructure
ED	Enable deliver
D1	Deliver stocked products
D2	Deliver made-to-order products
D3	Deliver engineered-to-order products
R1	Return defective product
R2	Return MRO product
R3	Return excess product
ER	Enable return

Inter- and intra-company process elements are also defined. Performance levels and practices are defined for these process elements. Benchmarks and the required attributes for the enabling software are also noted at this level. Specific tasks to be performed at this level include: develop process models that support strategic objectives and work within the new supply chain configuration developed at Level 2, set process metrics and performance targets, establish business practices at operating level, build system requirements that support the supply chain configuration, processes and practices, and finally select appropriate systems. At Level 3, inputs, outputs, and basic logic flow of process elements are captured.

Level 4 describes the detailed tasks within each of the Level 3 activities. These tasks, and their interactions, are unique to each business. This level of detail is needed to implement and manage the supply chain on a day to day basis. Level 4 process definition equates to quality process definition (e.g. ISO 9000) in most companies. At Level 4, implementation of supply chain processes takes place. At this level, immediate goals are set, intra- and inter-company supply chain improvements take place, priorities are set and rapid results are expected and studied.

There are three types of processes in the SCOR model: planning, execution and enable. Planning processes plan the whole chain along with planning specific type of execution process. Execution processes cover all process categories of Source, Make, Deliver and Return except the enable process categories. Enable process of a particular process type defines the constitution of that particular process element. Using the four levels of the SCOR model, a business can quickly and unambiguously describe its supply chain. A supply chain that is defined using this approach can also be modified and re-configured rapidly as business and market requirements change. The SCOR model has a powerful role in implementing supply chains. The SCOR model Levels 1 and 2 metrics keep management focused, while Level 3 metrics support on-going diagnosis.

2.3. Metrics

Operating a supply chain is far different from running a stand-alone company, and so are the metrics. The supply chain can be looked at as an externalization of business processes toward greater profitability. Trading partners, to a greater or lesser degree of formality, are linking their productive assets to gain efficiencies in cycle times, procurement, inventory, logistics, and cash flow. Given these relationships, how the partners measure effectiveness of their intertwined processes becomes quite different than assessing internal operations. Their shared metrics needed to achieve this balance call for accepted common standards in the field, as well as issues of change management and company culture for all partners.

The SCOR model endorses 13 performance metrics. A company cannot be best in all 13 of the Level 1 metrics, so it should wisely target its strength in several, those by which it differentiates itself in the market, while ensuring that it stays competitive in the others. In practice most companies typically choose among four to six of the 13 performance metrics to focus on. Those chosen tend to fall into five defining categories: supply chain reliability, supply chain responsiveness, supply chain flexibility, supply chain costs, and efficiency in managing assets (working and fixed capital) in the supply chain, as shown in Table 2. A brief description of these metrics is given as follows:

- *Delivery performance.* Percentage of orders delivered on time with respect to the total number of orders delivered. The components of delivery performance include total number of orders received, number of orders scheduled to customer's request date, total number of orders delivered, percentage

Table 2
SCOR model level I performance metrics

<i>Delivery reliability</i>
Delivery performance
Fill rates
Perfect order fulfillment
<i>Responsiveness</i>
Order fulfillment lead times
<i>Flexibility</i>
Supply chain response time
Production flexibility
<i>Cost</i>
Cost of goods sold
Total supply chain management cost
Value-added employee productivity
Warranty/return processing costs
<i>Assets</i>
Cash-to-cash cycle time
Inventory days of supply
Asset turns

of orders delivered on time (to request date), number of orders delivered on-time to commit date, and percentage of orders delivered on-time to customer commit date. It affects the balance sheet on accounts receivable.

- *Fill rate*. Fill rate is percentage of ship-from-stock orders shipped within 24 h of order receipt. The fill rate affects the balance on accounts receivable and is calculated as: [number of orders filled from stock shipped within 24 h of order receipt]/[total number of stock orders].
- *Order fulfillment lead time*. The average actual lead time consistently achieved from customer authorization of purchase order to final installation/order completion at customer end. It affects the inventory on balance sheet. It is calculated as: [sum of lead time required for each order fulfillment from purchase order authorization to final installation]/[total number of orders].
- *Perfect order fulfillment*. The percentage of orders meeting deliver performance and with complete and accurate documentation with no shipping damage. Components of perfect order fulfillment include all items and quantities delivered on-time (using customer's definition) and documentation for packing slips, bills of lading, and invoices. It is calculated as: [total orders shipped on time and in full-orders without faulty documentation—orders with shipping damage]/[total orders].
- *Supply chain response time*. The time it takes the integrated supply chain to respond to abnormal (significant) change in demand. It is calculated as [order fulfillment lead time + source cycle time] and it affects the inventory on the balance sheet.
- *Production flexibility*. Production flexibility can be seen in two parts, upside flexibility and downside flexibility. Upside flexibility is number of days required to achieve an unplanned sustainable 20% increase in production. Downside flexibility is percentage order reduction sustainable at 30 days prior

to delivery with no inventory or cost penalties. The production flexibility is dependent upon internal manufacturing capacity, direct labor and material availability and affects inventory on balance sheet.

- *Total logistics management cost.* The sum of supply chain related costs for order management, material acquisition, inventory carrying, finance and planning, and MIS costs. It is calculated as sum of the costs. To see the cost elements in detail of categories mentioned here please consult official documentation of the SCOR model (SCC, 2001).
- *Cost of goods sold.* The cost associated with buying raw materials and producing finished goods. This cost includes direct cost (labor, material) and indirect cost (overhead)
- *Value added productivity.* It is calculated as: $[\text{Total Product Revenue} - \text{Total Material Purchases}] / \text{Total Employment (in full time equivalents)}$.
- *Warranty cost or returns processing cost.* It includes materials, labor, and problem diagnosis for product defects. A warranty cost has impact on inventory on balance sheet.
- *Cash-to-Cash cycle time.* Cash-to-Cash cycle time is a measure of the time required in days to convert cash paid to suppliers into cash received from customers, including the inventory required. It is calculated as $[\text{Inventory days of supply} + \text{days sales outstanding} - \text{days of payables}]$. It impacts inventory, accounts payable, accounts receivable, and total assets on the balance sheet.
- *Inventory days of supply.* Total gross value of inventory at standard cost before reserves for excess and obsolescence.
- *Asset turns.* Total turns of capital employed. It impacts inventory, accounts payable, accounts receivable, and fixed assets on the balance sheet. It is calculated as total gross product revenue divided by total net assets.

3. A computer-assisted configuration tool

The SCOR model can help upper management of an organization in designing and reconfiguring its supply chain to achieve desired performance. The implementation consists of four steps as guided by the roadmap shown in Fig. 3 (Stephens, 2001). The four steps are:

1. Analyze basis of competition.
2. Configure supply chain.
3. Align performance Levels, practices, and systems.
4. Implement supply chain processes and systems.

Supply chain configuration (Step 2) is one of the core concepts in supply chain management philosophy. The configuration defines the structure of supply chain, which is one of the key success factors in achieving desired supply chain performance. A computer-assisted tool has been developed to configure ‘as is’ thread-diagram or ‘to be’ thread-diagram (per SCOR specification) of a particular supply chain based on the user’s input. In the hands of supply chain professionals, this computer-assisted tool can play an important role in making decisions regarding dynamics and structure of the chain. The customized supply chain configuration diagram generated from the tool will help upper management understand the interaction of the particular company with its alliances and partners.

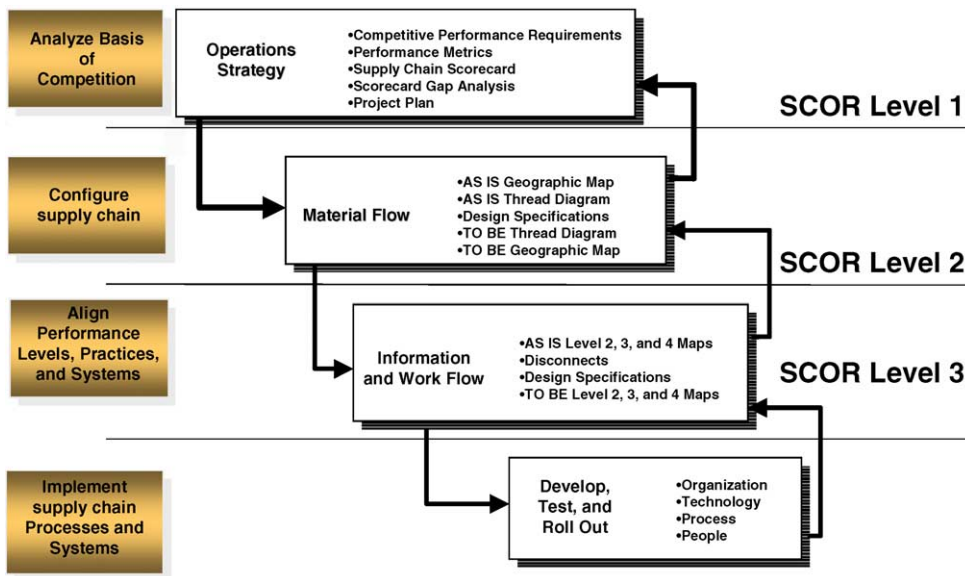


Fig. 3. The SCOR project roadmap (Stephens, 2001).

An example, the ALPHA Company taken from SCC's SCOR workshop material, is used to illustrate the computer-assisted configuration tool. When running the configuration tool, a welcome screen appears first. The welcome screen contains general instructions along with the welcome message. It also contains a button that, when clicked, leads to another screen where the user can develop a customized SCOR Level 2 supply chain configuration. The user is prompted to enter the name of the company for which the supply chain is to be designed. Once the user enters the company name, ALPHA, and clicks the continue button, the screen shown in Fig. 4 appears. The screen is divided into three zones and marked with name messages displayed in each zone, one each for the company, its suppliers, and for its customers or warehouses, respectively. In this particular example, the warehouse is the downstream node and is considered as the customer of the manufacturing facility. Here, the user gets to select the type of manufacturing facility from three types, Make-to-Stock, Make-to-Order, and Engineer-to-Order, as classified by the SCOR model.

In this example, the manufacturing facility type is Make-to-Stock (M1). It is placed on screen and the information about the sourcing activity of the facility is requested. A particular type of manufacturing may require any of the three types of sourcing activities classified by the SCOR model, i.e. source stocked materials, source make-to-order materials, and source engineer-to-order products. The user has the choice of selecting one or more of the options available depending on requirements of the particular manufacturing facility.

In this example, two types of material are sourced for the make to stock manufacturing facility, namely, source stocked materials (S1) and source make-to-order materials (S2). As the user inputs the number of suppliers and clicks the continue button, the sources are generated based on the user input (Fig. 5). The user is prompted with the question if he has information about the supplier's manufacturing facility. If the answer is no then the next part is skipped. In our example, the information about supplier is available. The user is then prompted to input the number of sources for ALPHA'S suppliers.

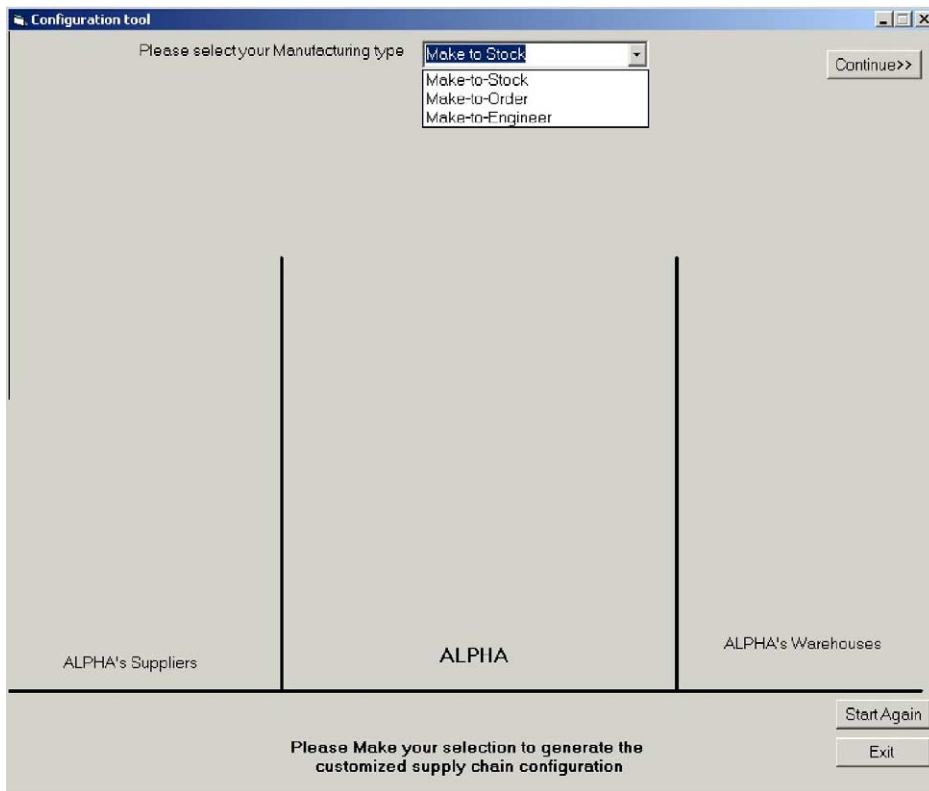


Fig. 4. Snapshot of manufacturing type selection screen.

After the sources are generated, the user is prompted to enter the information about the warehouses (Fig. 6). If the manufacturing facility supplies to multiple warehouses, the number of warehouses is shown by the multiple arrows for the sourcing activity of warehouse and delivery activity of the company. In addition to that, the number that is shown in the label (enclosed in the parenthesis) indicates the number of warehouses.

As the user enters the warehouse information, in this particular example which is one, and clicks the continue button, the customized supply chain configuration is generated without placement of the planning activities. Fig. 7 is the screen capture of the supply chain configuration of ALPHA. Now the user is prompted to place the Level 2 planning activities. P2 is placed on the sourcing activities, P3 on make and P4 is placed on the delivery activities of ALPHA. The user is now prompted for the final step, the placement of Level 1 planning activities. Fig. 8 shows the final screen capture which contains the supply chain configuration for ALPHA along with Level 2 planning activities. The final step of placing plan supply chain (P1) activity is completed here. P1 is placed in two zones—inter- and intra-company. Intra-company P1 activity gets input from other Level 2 planning activities from the facility, whereas inter-company P1 activity crosses the boundary of enterprise and reaches the alliances and partnerships, which is the heart of supply chain management philosophy.

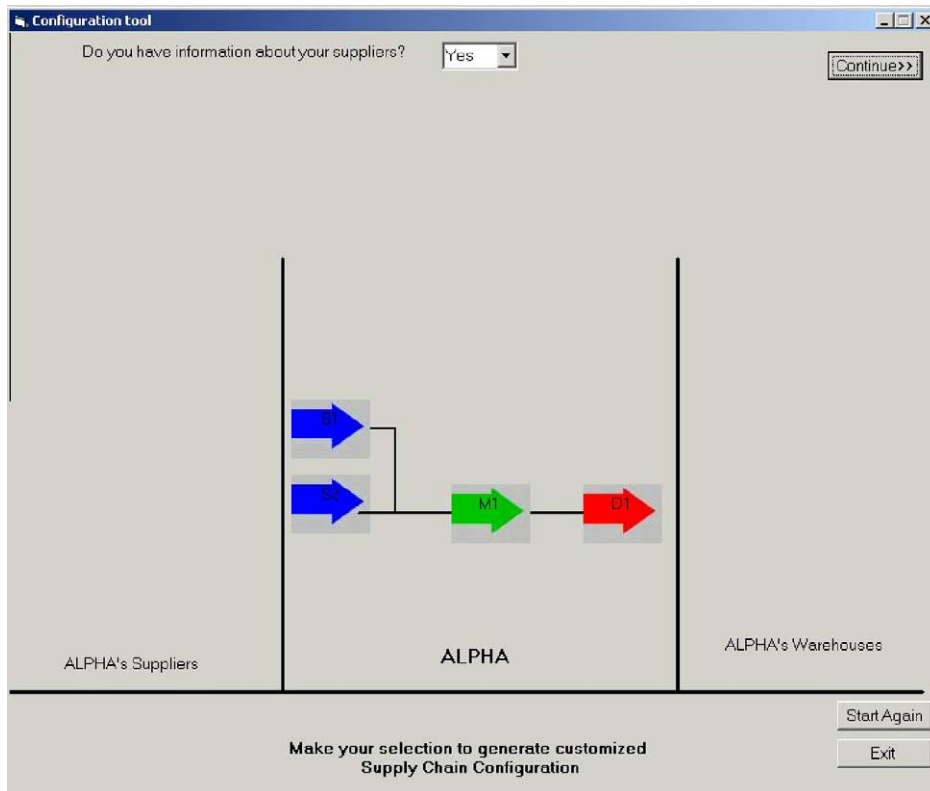


Fig. 5. Snapshot of supply chain configuration—make.

4. SCOR benefits

The advantages of SCOR model has been widely publicized by Supply Chain Council with illustrative case histories. The condensed generalized achievements of SCOR implementation in wide range of industries worldwide can be cited as follows (Bolstorff & Rosenbaum, 2003):

- Cost reduction and customer service improvement, offering on average 3% rise in total operating income.
- Within 12 months of project implementation, almost 2–6% improvement in return on investment (ROI).
- Noticeable improvement in return on assets (ROA) because of cognizant decisions in capital investment.
- Standard supply chain definitions and interpretations facilitating use of standard features of IT systems, reducing the operating costs drastically.
- 1–3% profit step up through continuous improvements in supply chain management.

More specifically, Intel is one of the SCOR beneficiaries worldwide that were forced to improve their complex and dynamic virtual supply chain networks, because of emergence of Business to Business

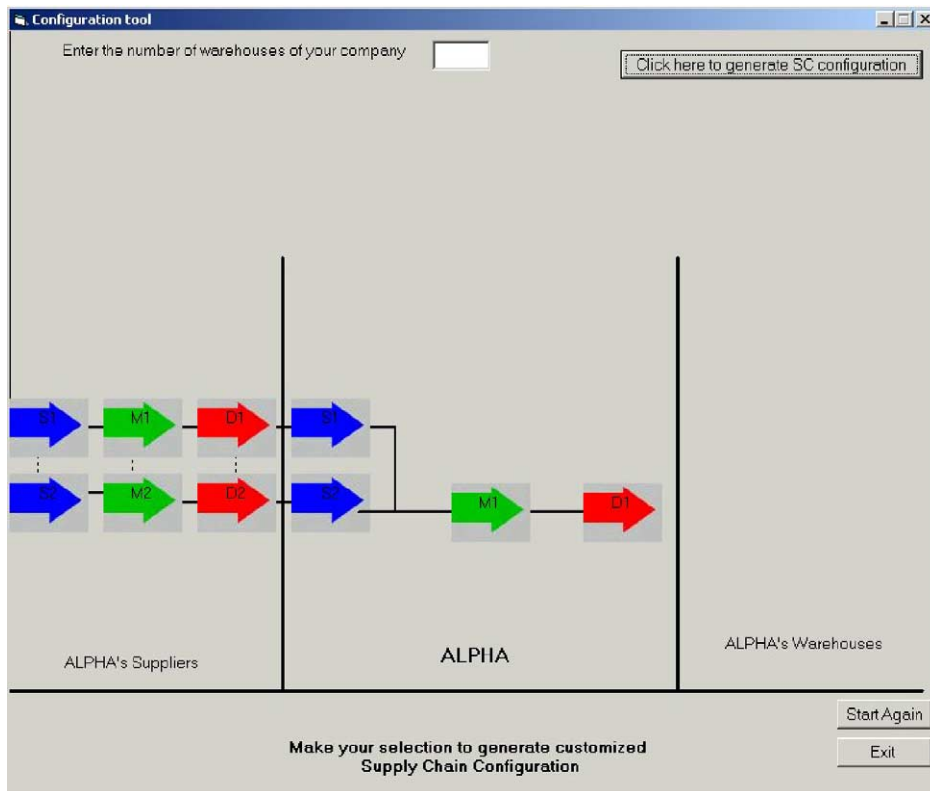


Fig. 6. Snapshot of supply chain configuration—make and source.

Integration (B2Bi). Intel Corporation suitably adapted and seamlessly integrated SCOR methodology in their supply chain improvement efforts (Intel 2002). SCOR initiatives at Intel were intended to achieve following objectives:

- Documentation of the supply chain and process improvement efforts currently in place.
- Identification of short term improvements.
- Identification of owners for long term improvements.
- Most importantly, learning and incorporating the SCOR methodology in the improvement efforts.

Intel developed SCOR BKM ('Best Known Method'), their own methodology to implement SCOR project road map. It consists of four face to face (FTF) meetings of cross-functional team members. The members have to finish assigned tasks offline in between two meetings. SCOR based simulation studies are introduced at early stage of projects to explore alternate configurations and improvements.

The methodology facilitates mechanism for Intel to set benchmarks using best in class industry performers. Performance indicators are aligned and customized at various operational and strategic levels. Scorecard is used as standard mean for identifying performance improvement opportunities.

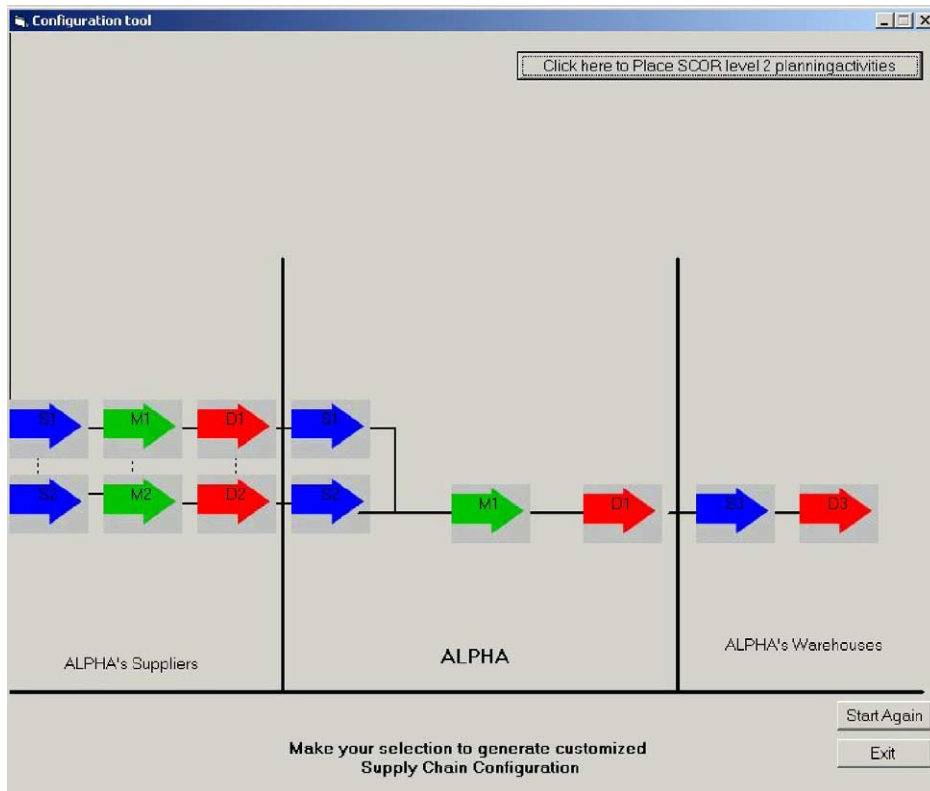


Fig. 7. Snapshot of supply chain configuration—make, source, and deliver.

SCOR BKM created a structured way to identify and prioritize supply chain improvements. It gave the management clear visibility across the supply chain which helped them prioritizing and expediting the improvements projects currently in place. One of such projects, which dealt with restructuring geographic inventory management and improving delivery performance, achieved great results. SCOR facilitated managing geographic inventory levels through min–max control limits, daily review, scheduling replenishment shipments, and assigning customer orders to the best point of supply based on lead time and availability. It also provided the required delivery capability and reliability in meeting customer commitments by improving planning of throughput time and operating calendars, and by changing carrier contracts and execution to delivery date requested by the customer.

In short, SCOR implementation improved Intel's customer responsiveness and reliability, delivery performance, and factory agility focused on building the right product, reducing the inventory carrying and obsolescence costs and resource/space fluctuations.

Similarly, many other organizations like Avon, LEGO, Siemens Medicals to name a few, pursued SCOR methodology and road map to achieve significant improvements in their supply chains. Table 3 summarizes their achievements along with the best practices utilized by these three organizations.

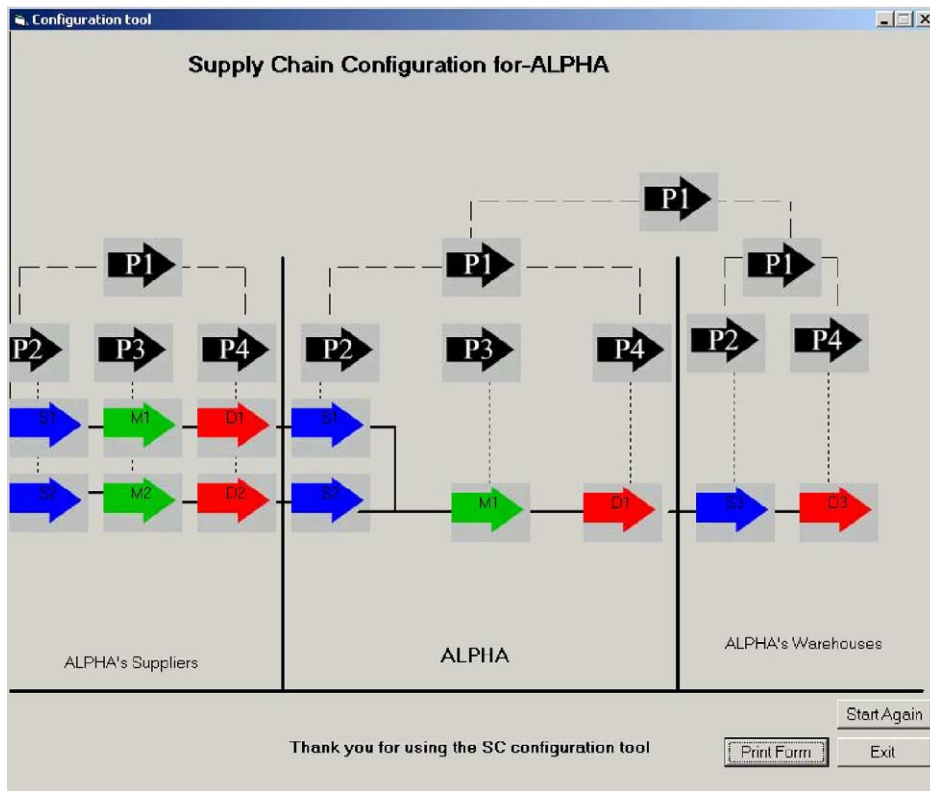


Fig. 8. Snapshot of final supply chain configuration.

5. Discussion

The SCOR model is developed to describe the business activities associated with all phases of satisfying a customer's demand. It uses a common set of definitions to describe supply chains that are across multiple industries and are of various complexities. Therefore, it has the potential to become an industry standard that can facilitate decision making by executive managers of a company. In contrast to the mathematical models reviewed by Beamon (1998), the SCOR model is a framework model for strategic decision making. It does not prescribe how a particular company should conduct its business. We believe this is a wise decision by SCC since different companies have different supply chain strategies that dictate their operations. After discussing the advantages of the SCOR model in Section 4, now we will focus on discussing its weakness and providing insights on how SCC can enhance the SCOR model. Specifically, we will address the two issues here, namely, customization/extension and internet presence.

5.1. Customization and extension

The SCOR model needs to be provided as per the needs of a particular company. Not every company is that capable and willing to explore opportunities offered by the SCOR model. This is the reason for

Table 3
SCOR benefits illustrations

Company	Achievements	Prior	Later	Best practices
AVON	Perfect order rate	62%	90%	• Simplified processes and networks • Optimizing the manufacturing locations of different products • Centralized managed inventories • Rationalized supplier base
	Cycle time	Reduction by 50%		
LEGO	Delivery performance	70%	90–99%	• Global ATP/Product allocation • Performance measurement • Integration of IT • Vendor managed inventory • Automated order processing • More direct distribution systems • Increased percentage of made to order goods • KANBAN system
	Inventory days of supply	55 days	75 days	
	Capacity	Increase by 10%		
Siemens medicals	Delivery lead times	22 weeks	2 weeks	• More direct distribution systems • Increased percentage of made to order goods • KANBAN system
	Delivery reliability	65%	99.5%	

SCC's moderate performance and slow acceptance of the SCOR model. Therefore, SCOR model should be made easy to understand and implement. SCC website should provide a customized version of the SCOR model for a particular company along with other supply chain services. The key customized services that SCC needs to provide are:

- *Customized organization structure.* Every company has its unique organizational structure and responsibilities assigned to individuals, in spite of the requirement of performing similar industry operations. The SCOR model should be able to generate a customized organization structure for individual companies.
- *Customized task assignment.* Supply chain management requires special expertise and needs input from different departments of a company. Once the customized organizational structure is defined based on the SCOR model, the tasks of supply chain management should be assigned accordingly.
- *Customized supply chain configuration.* Supply chain configuration is one of the core concepts in the SCM philosophy. The configuration of a chain is affected by conditions in every department of a company. This is an area where the SCOR model has its strength, since standardization is desirable. The configuration might require expertise of geographical data and Internet security for data transmission, which requires outsourcing from the SCC.
- *Customized metrics.* Operating a supply chain is far different from running a standalone organization, and so are the metrics. The SCOR model defines 13 Level I metrics. In practice, most companies typically choose among four to six to focus on. The selection of level I metrics will vary from company to company and SCC needs to facilitate this customized performance measure over the Internet.

In addition to customization, the SCOR model should provide extension capability. With the rapidly growing ease of communication, the global markets cannot be ignored. Globalization is changing the fabric of business from a patchwork of discrete national and regional markets to a global market. The opportunities for growth and profit are growing exponentially; so are the potential risks. Companies wishing to compete in this environment must adopt a global supply chain management operating strategy. The principles to guide supply chain leaders in their new challenge are focusing on how to satisfy the emerging global customer through supply chain integration and responsive operations. SCC needs to pay special attention to companies doing business across the globe. Once certain models developed in different parts of the world are adopted in different countries and/or regions, the task of standardization becomes more difficult, because of varying marketing conditions and legal restrictions among others. This timeliness is of utmost importance for SCC to provide a global SCOR model.

5.2. Internet presence

The Internet has emerged as the latest technology-enabling tool. Web technologies continue to be developed which facilitate trade and simplify many business processes. Visibility between customers and suppliers has been significantly enhanced, opening up opportunities for reduced response time and significant savings for all players. The pace at which the Internet is reaching the customer base along with the factors just mentioned urges us to believe ‘e-business or out of business.’ This principle also applies to the SCOR model. The SCOR model in its current form is not easily understood and may not be customized by a company. Almost all companies need human assistance in implementing the SCOR model, which in turn put a huge burden on SCC in terms of highly skilled ‘technical managers.’ This need can be significantly reduced through the adoption of Internet technologies.

We recommend that the SCC provide all services related to the SCOR model over the Internet. Along with other factors, timeliness is extremely important. If the companies adopt their own models for different supply chain networks, the SCOR model is going to miss the first mover advantage, which is critical in Internet commerce. Standard and customized SCOR model description and supply chain configuration generation should be provided over the Internet by SCC. Also, maintenance of the SCOR model by SCC over the Internet will provide one common place to find all information about the SCOR model. Model maintenance will be much easier as SCC needs to update at one place, as compared to take care of numerous customer companies.

In addition, SCC should become a one-stop shop to help promote the SCOR model. Specifically, SCC should use its expertise in supply chain, information technology, and strategic capabilities to provide support service while endorsing the SCOR model as an industry standard. The important services that SCC can provide to its customer companies are training and secure access to customer company’s resources. Training has always been an important enabling concept in every kind of industry. It assumes more important role in the complex field of supply chain management. SCC should bear the responsibility for training its customer companies not only the SCOR model but also the related essential concepts.

6. Conclusion

The SCOR model, provided by SCC, is a useful strategic tool in the hands of upper management to tackle the complexity in supply chain management. It provides a common supply chain framework,

standard terminology, common metrics with associated benchmarks, and best practices; and can be used as a common model for evaluating, positioning, and implementing supply chain application software. It is in its growing stage of life cycle and enjoys a leverage to become a standard in supply chain management.

Supply chain configuration is an integral part in SCOR project implementation. Currently, the configuration of ‘as-is’ or ‘to-be’ threaded-diagram describing a supply chain is done manually. To automate this process, a computer-assisted configuration tool has been developed and described in this paper. The configuration tool can so far only deal with a single manufacturing facility of a company. It does not take into account the interactions among multiple manufacturing facilities. This problem will be dealt with in our future research and development effort. Furthermore, we will investigate how to optimize supply chain configuration based on certain performance measures. Specifically, based on a set of criteria, how to automatically generate ‘to-be’ threaded-diagram from ‘as-is’ threaded-diagram to optimize supply chain performance.

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