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IBM SmartSCOR - A SCOR Based Supply Chain Transformation Platform through Simulation and Optimization Techniques

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IBM SMARTSCOR - A SCOR BASED SUPPLY CHAIN TRANSFORMATION PLATFORM THROUGH SIMULATION AND OPTIMIZATION TECHNIQUES

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ABSTRACT

Identified as a strategic area, supply chain transformation plays a critical role in today's IBM business. In this paper, we introduce an effort in IBM Research Division named SmartSCOR, which provides a comprehensive framework and methodology for On-Demand SCM problem-solving based on the cross-industry process standard Supply Chain Operations Reference (SCOR) model and a variety of simulation/optimization techniques. SmartSCOR sees transformation in two different levels, from supply chain strategy design/redesign to supply chain process improvement. Supply chain strategy design/redesign transforms a supply chain in a fundamental manner by means of manufacturing and distribution network reconfiguration, value chain integration, etc. Supply chain process improvement helps align the underlying business processes to strategy setting and get them streamlined. The two levels interact with each other and result in a profound while smooth transformation. SmartSCOR has been successfully applied in two supply chain transformation projects for validation and hardening.

1 INTRODUCTION

Supply chain transformation is an emerging service area in the market which is offered to help companies in maximizing the performance of their supply chain operations while reducing costs. A supply chain transformation initiative consists in changing the ways how an enterprise form and operate its supply chain, concerning the decisions from supply chain network rationalization to business process re-engineering. It is a very complex initiative which may involve various departments and has major impact on a supply chain's performance.

How to transform a supply chain? From industrial point of view, we see transformation initiatives in two categories. One is to improve a supply chain from managerial point of view, which may involve a lots of consulting activities related to, e.g. supply chain strategy review, maturity assessment, network optimization and process re-engineering. This type of transformation consists in helping clients better design and plan their supply chain strategy and operations, by aligning to best-practice and operation excellence. The other is more IT (Information Technology) oriented, which focuses on either the implementation of new IT systems or upgrading existing IT systems, e.g. ERP (Enterprise Resource Planning) system, CRM (Customer Relationship Management) system, etc. IT-oriented transformation intends to add more supply chain visibility and improve operation efficiency via advanced IT systems. The two types of transformation are interrelated with each other and require a comprehensive platform to support the decision-making.

Identified as a strategic area, supply chain transformation plays a critical role in today's IBM business. In addition to the IT related solutions, IBM is continuously enhancing its SCM offering to provide more integrated supply chain transformation service ranging from consulting service to supply chain system implementation. To fulfill clients' demanding requests as well as respond to the fierce competition, SCM related staff are all looking for methodologies and supporting tools which enable efficient and effective supply chain transformations.

In this paper, we introduce an effort in IBM Research Division named SmartSCOR, which provides a comprehensive framework and methodology for On-Demand SCM problem-solving based on the cross-industry processes standard SCOR model and a variety of simulation/optimization techniques embedded. SmartSCOR sees transformation in two different levels, from supply chain strategy design/redesign to supply chain process improvement. Supply chain strategy design/redesign transforms a supply chain in a fundamental manner by means of manufacturing and distribution network reconfiguration, value chain integration, etc. Supply chain process improvement helps align the underlying business processes to strategy setting and get them streamlined. The two levels interact with each other and result in a profound while smooth SCM transformation through the simulation/optimization toolkit embedded.

Supply chain transformation is a relatively new area in the market, while relevant research topics have been studied for years in academia. The challenge consists in how to integrate different models, methods and technologies in a single transformation service delivery platform. SmartSCOR represents a way how IBM Research addresses this problem.

The remainder part of the paper is organized as follows. Section 2 presents i) a brief review of the SCOR model, ii) models and methods for supply chain design and planning, and iii) business process management. Section 3 first describes the whole picture of SmartSCOR, then presents the major modules for network optimization, simulation and process analysis. Section 4 presents two case studies where SmartSCOR has been used as the major consulting tool for supply chain transformation. Conclusions and perspectives are given in Section 5.

2 REVIEW OF TECHNIQUES AND TOOLS FOR SUPPLY CHAIN TRANSFORMATION

Since a variety of models and techniques are employed in SmartSCOR, we organize the review part as follows. First we introduce the SCOR model, which serves as the foundation of SmartSCOR and provides the end-to-end guideline for supply chain transformation. Then different models and techniques developed in the past, respectively for supply chain design/planning and business process management, are reviewed and compared.

2.1 SCOR Model

The supply chain operations reference (SCOR) model, developed by the Supply-Chain Council (SCC), is widely accepted as the cross-industry standard for supply chain management. Designed to facilitate the blending of business objectives, strategy, process, and technology, the SCOR model not only provides the structured vocabulary of definitions of supply chain processes, but also defines a set of measures that can be used to evaluate processes at each level of the process hierarchy.

The SCOR model provides a common supply chain framework and standard terminology for evaluating, positioning and implementing supply chain improvements. SCOR integrates the well-known concepts of business process reengineering, benchmarking, and process measurement into a cross-functional framework. More concretely, the structural framework of the SCOR model is composed of the following elements (Huang et al. 2005):

- 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.

The SCOR model consists of five basic processes: plan, source, make, deliver and return (see Figure 1), and the SCOR modeling approach starts with the assumption that any supply chain process can be represented as a combination of the five basic processes.

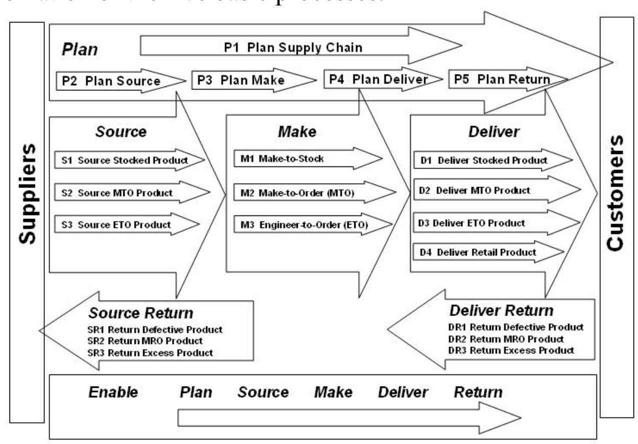


Figure 1: The SCOR Infrastructure

Since the model's first introduction in 1996, SCOR has been continually evolving based on practical needs by SCC, and the latest version is 7.0. SCOR has been successfully adopted worldwide by SCC members across various industry sectors, such as consumer foods, electronics, software and planning, aerospace and defense, etc.

2.2 Supply Chain Design and Planning

Supply chain decisions are usually classified into three levels, respectively strategic, tactical, operational level, according to the planning horizon (Ballou 1992). Supply chain transformation requires decision-making related to supply chain design and planning, which are mostly at strategic and tactical level. Supply chain design concerns how to build up the supply chain infrastructure, e.g., select suppliers for raw materials and components, locate the plants and warehouses, etc. Supply chain planning consists in determining the policies or rules under which a supply chain is operated, e.g. how to control inventory, how to manage transportation, etc.

Simulation and optimization are two popular techniques which play an important role in supply chain design and planning. As a generic technique, simulation is very suitable for the analysis of complex and dynamic systems (Towill 1991). A number of simulation frameworks and tools have been developed in the past, among which IBM Supply Chain Analyzer (SCA) is one of the most popular tool (Bagachi et al. 1998). IBM SCA is a software tool that can help the decision-making about both the design and planning of supply chains. The tool has been used in a number of IBM internal and external supply chain projects and results in multi-million cost saving for those firms.

Some of the simulation tools are developed as a decision support system for supply chain network design. A simulation model, proposed by (Belhau et al. 1999), is developed to deal with the supply chain facility location problem. The simulation model is used for the selection of the right geographical disposition for distribution centers, aiming to minimize the total transportation cost. A supply chain simulation tool, named LOCOMOTIVE is presented in (Hirsh et al. 1998). The tool is adopted to evaluate a logistics network for packing eco-reusing and recovery. In (Botter et al. 1998), the authors present a case study where simulation is applied on a beer distribution network design problem. The decision concerns whether or not to entirely outsource the logistics process to a third party logistics provider (3PL).

In the area of supply chain planning, lots of models and tools have been developed in both academia and industry. IBM SCA is actually a very powerful tool for inventory analysis, which deploys a mix of simulation and optimization functions to model and analyze the inventory allocation problem (Ettl et al. 2000). A simulation tool, named Supply Solver, is presented in (Schunk and Plott 2000). The tool is connected with external modules and provides optimal solution on the production and distribution allocation problem. Supply Chain Guru, developed by Promodel Corporation, is a commercial simulation tool for supply chain design and planning, with a specific module for inventory planning (Supply Chain Guru 2006).

Optimization is another important means for supply chain design and planning. The classical work by Geoffrion and Graves (1974) laid the foundation of distribution network optimization. This model does not explicitly address several important issues, but as the authors pointed out, the proposed model has enough flexibility to accommodate a variety of additional constraints. A review on global supply chain design problem is presented by (Verter and Dincer 1992), in which half of the reviewed models are dedicated to the design of production-distribution networks. The authors emphasized on the absence of consideration of uncertainties in most existing models. Geoffrion and Powers (1995) analyzed the evolution of distribution system design in the twenty years before 1995. They identified a number of elements which had significantly contributed to the evolution of distribution systems, including the logistics functionalities, optimization algorithms, information systems, etc.

2.3 Business Process Management

Today, business process gained much attention from both academia and industry. Business processes play an important role in supply chain transformation. The realization of all strategic changes has to rely on the operational business processes.

A variety of definitions of business process are available in the literature (Hammer and Champy 1993) (Davenport and Short 1990). The authors (Hammer and Champy 1993) defined a business process as "a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer." There are usually four steps in business process management lifecycle, respectively process design, system configuration, process enactment, and process diagnosis.

A complete business process model with a necessary level of granularity does give a clear landscape of a supply chain. What's more than that? Given the process model, simulation is a very useful means for its analysis. Process simulation is usually based on token flow semantics, which is described in UML2 superstructure specification with details (OMG 2005). In this paradigm, the simulation model is a sequence of processes, which fall into two categories: control process and executable process. During the simulation, tokens are generated from some beginning processes, and then pass through the succeeding processes. When a token reaches a control process, the token is modified, copied, or directed to some selected processes. When a token reaches an executable process, the process is activated, and an instance of the process is created and executed. Tokens are disposed at the end of flow.

Some commercial-off-the-shell (COTS) tools are available for business process modeling and analysis (Miers and Harmon 2005). Business process modeling is the mostly supported functionality. However, rare of the tools provide functions beyond that, except some form of simulation capabilities at business process level. Hardly the end user can use these tools directly to analyze supply chain problems such as inventory control. IBM WebSphere Business Modeler (WBM) is a business process modeling tool that enables supply chain analyst to model, simulate and analyze business processes, integrate the new and revised process, and define the organization, resources and business items (Wahli et al. 2006). IBM WBM has been used as the foundation for process modeling and analysis in SmartSCOR. For more details about the evaluation of different COTS tools, readers are directed to (Miers and Harmon 2005) (Hall and Harmon 2005).

3 THE TRANSFORMATION PLATFORM

3.1 Platform Architecture

SmartSCOR is an integrated platform to support an end-to-end supply chain transformation, which deploys a variety of models and techniques including SCOR, simulation and optimization. To support an end-to-end transformation, SmartSCOR comprises a number of modules for the analysis. These modules could be used separately as specific function unit or used as a comprehensive package. Figure 2 depicts the architecture of SmartSCOR.

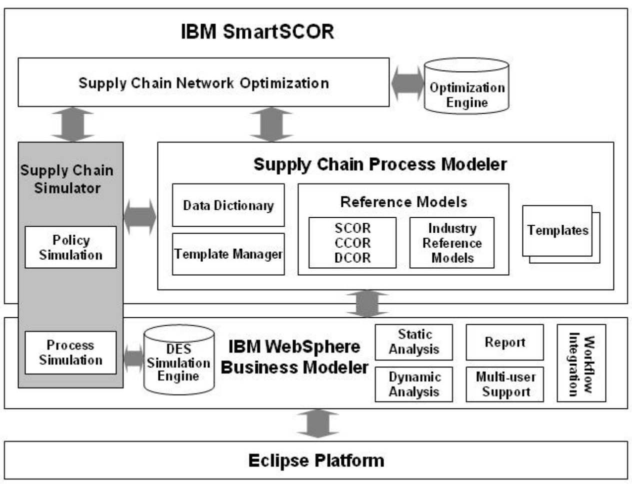


Figure 2: SmartSCOR Architecture

More specifically, a supply chain network optimization module is developed to address supply chain design issues, such as where to locate new plants and distribution centers, how to define the distribution strategy, etc. Once the network structure is determined, major supply chain processes could be modeled according to SCOR model using the process modeling module. Execution level processes could be further modeled in WBM. These three modules address decisions at different levels and interact with each other. Supply chain simulation module is a key component in SmartSCOR. It supports the analysis of supply chain from strategic level to operational level. Accordingly the simulator has connections with all other three modules.

From implementation point of view, all SmartSCOR modules are developed on the Eclipse platform which enables a seamless integration with other applications. Eclipse is an open source platform to build Integrated Development Environment (IDE) and applications. The easy extensibility of SmartSCOR is ensured based on such an universal development framework.

In the following subsections, we first present a brief overview of the network optimization module. Then we focus on the introduction of the two modules for simulation and process analysis.

3.2 Supply Chain Network Optimization

The supply chain network optimization module is developed to facilitate decision-making at strategic level, concerning facility location, production and distribution strategy design, transportation volume allocation and service territory assignment. Figure 3 illustrates a simplified scenario of supply chain design, where two manufacturers M1 and M2 assemble products to fulfill demands from two customers, using the components procured from three suppliers.

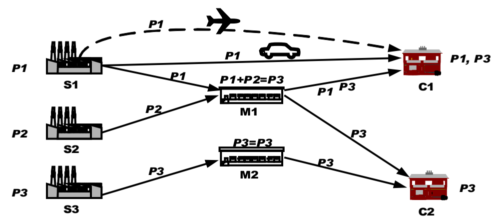


Figure 3: An Illustrative Supply Chain

A variety of methods are employed to enable the optimization, including mixed integer programming, linear programming, heuristics and meta-heuristics. The key enabling component is a mixed integer programming model addressing multi-commodity facility location and network flow optimization problem. The objective is to minimize the total supply chain cost, with respect to all necessary constraints. More specifically, the total cost function is composed of procurement cost, transportation cost, assembly cost, operation cost, facility fixed cost, facility investment cost, inventory carrying cost and tax. A large number of constraints have been taken into account in the model, including supply capacity, assembly capacity, transportation capacity, single sourcing rule, etc. The programming model could be solved using heuristics, open source solver and commercial optimization solver. Two solvers, lp_solve and Cplex, are integrated in the module.

To facilitate an efficient network modeling, an intuitive and easy-to-use graphical user interface (GUI) is provided. Supply chain data could be entered manually using the tool interface, or automatically imported from Excel files or Access database. Moreover, a Geographic Information System (GIS) is integrated for graphical representation, which enables a flexible and precise representation of the actual supply chain networks. Figure 4 shows two screenshots of the module.

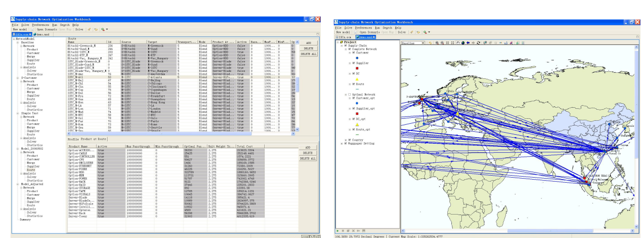


Figure 4: Supply Chain Network Optimization Module

3.3 Supply Chain Simulation

3.3.1 Simulation Framework

To support an end-to-end transformation, supply chain decisions may cross levels from strategic, tactical to operational level. It requires the modeling with various level of details. Simulation has its unique advantages in handling the modeling of different level of details. Considering that, we position simulation as the pivot analytical means in SmartSCOR, which sticks different modules together. More specifically, this module consists of four main parts:

- Supply chain domain model
- Geographical model editor
- Business process model editor
- Business process simulator

Supply chain domain model describes the static structure and dynamic activities of a supply chain. For the sake of extensibility, the supply chain domain model is built as an independent library based on the Eclipse Modeling Framework (EMF). Geographical model editor and business process model editor are two graphical modeling environments for creating and editing supply chain domain model and business process model respectively. Business process simulator implements the token-flow semantics based on business process models. It creates task instances and run them in time sequences. In SmartSCOR, we use IBM WBM as the business process modeling tool. The WBM simulation engine is used as the business process simulator. It's important to note that, as a reusable and extensible programming library, the domain model could be connected with different simulation engines besides the WBM simulation engine. Figure 5 shows the system architecture of simulation module.

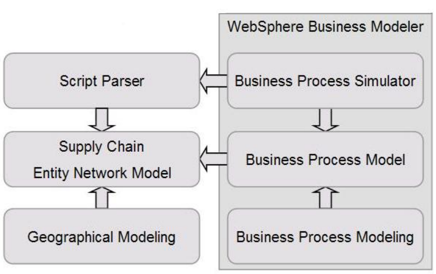


Figure 5: Simulation Architecture

WBM provides a powerful and industry-neutral business process simulation engine. However, since it is for general purpose, it is not easy to be used in supply chain context. Accordingly we develop the supply chain domain model to support supply chain simulation. As the bridge between WBM simulation engine and supply chain domain model, a script language parser is developed in the system which enables users to write scripts for process elements. When instances of process elements are created and executed, the scripts attached are evaluated accordingly. Scripts here could be used to initialize a simulation run, to set supply chain policies and conditions, to calculate delay, cost and revenue. The scripts can also be used to access details of the business process simulation engine and token-flow.

3.3.2 Process-oriented Simulation Model

The supply chain domain model contains two sub-models, respectively supply chain structure model and behavior model. The structure model is developed to represent a static supply chain. The dynamics of a supply chain are taken into account in the behavior model.

3.3.2.1 Supply Chain Structure Model

The supply chain structure model consists of different entities in a supply chain. More specifically, four types of basic entities are defined and developed in the library, including Customer, Distribution Center (DC), Plant, and Supplier. A Customer is the source of demand, which places customer orders periodically. A DC receives customer orders, and fulfill the orders by inventory. A Plant assembles raw materials into finished goods. A Supplier provides raw materials or components for assembly, or even final products to fulfill customer demands. These entities are interconnected with each other via order flows, product flows and financial flows. These entities have some common features and processes, which are identified and extracted as components. Typical components are Order Processor, Inventory, Sourcing, Delivery, and Assembler. Each supply chain entity consists of several components, which are employed to perform various activities, such as order processing, inventory replenishment, etc. Some components have embedded queues for tasks. For example, orders can be put in Order Queue, sourcing requests can be put in Sourcing Queue. The whole model is thus viewed as a queuing network. Figure 6 shows the supply chain structure model.

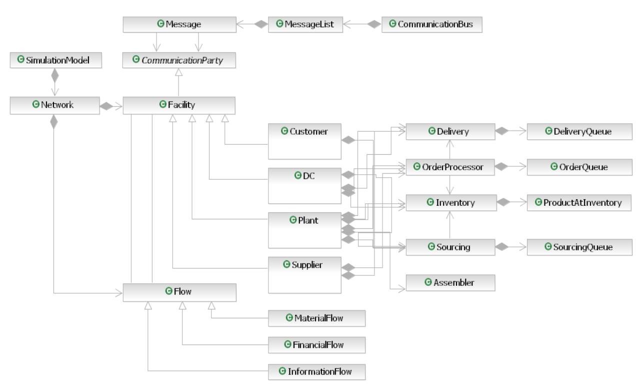


Figure 6: Supply Chain Structure Model

Besides the four basic supply chain entities, product and resource are also important building blocks to represent a static supply chain. Each product maintains its bill of material (BOM) necessary for the simulation of assembly process. Resource utilization and relevant constraints are also considered in the model.

3.3.2.2 Supply Chain Behavior Model

The behavior model is developed to enable a reliable and flexible study of supply chain dynamics. It describes the relationship and interactions between different supply chain entities. Considering that we have adopted a process-oriented simulation framework, it is necessary to decompose a supply chain process into segments. Thus the segments could be assigned to tasks, which are the building blocks of a business process model.

In order to decompose the simulation process, we design a communication bus for information sharing and exchange. All supply chain entities are connected to the communication bus. The entities could contact with others via the bus. Material flow, information flow, and financial flow all pass through the communication bus. Thus different supply chain processes, such as customer order processing, inventory replenishment, procurement and delivery, can be decomposed into segments. Each segment could be assigned to different tasks in business process models. Figure 7 illustrates how the process for customer order processing is decomposed.

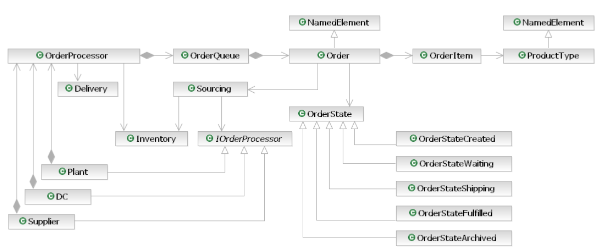


Figure 7: Customer Order Processing

Resource management is critical for supply chain simulation. The resource management mechanism, provided by WBM, is employed in SmartSCOR. Relevant interfaces are developed to enable the connection between WBM and supply chain behavior model.

3.3.3 Business Process Simulation

Supply chain simulation at the business process level is another function area addressed by SmartSCOR. Based on the SmartSCOR methodology, when the supply chain configuration and operational policies are determined, it is time to design/re-engineer the underlying business processes. The simulation analysis at the business process level is partially supported by WBM.

Based on the simulation functionality provided by WBM, analysts are able to estimate resource allocation, total processing time, cost/revenue caused by tasks, etc. These are standard features of WBM.

However, WBM was designed to support generic business process modeling and analysis. Moreover, much attention has been paid to enable mapping of business process to IT workflow. Consequently, limited support is provided for supply chain analysis directly. Thus, we extend the WBM simulation module to support the analysis in a supply chain scenario. End users can model supply chain details in a programming way using script language. Scripts can be used to set task attributes, such as processing time, cost, revenue, resource allocation, etc. Boolean expressions are used to control output branch of decision nodes. Although basic programming skills are needed here, it provides great flexibility to business analysts. They can define business items and execution flow for special purpose. In addition, they can create text or graphical outputs on monitor panels in SmartSCOR.

3.3.4 Implementation

SmartSCOR supports simulation modeling with a geographical model editor in a drag-and-drop manner. The application of GIS is optional, which provides precise location and route info for the real supply chain. Parameters for each entity could be specified in the graphic interface, including basic properties, decision policies and other settings. When a simulation model is defined in the geographical model editor, the model is then mapped to business process model according to the given parameters and behaviors. Each supply chain entity is driven by a group of tasks and control nodes.

An integrated graphic panel is provided in SmartSCOR to monitor simulation process and results. Both text mode and chart mode are supported. Business analysts can view running status and final outputs of the model, so as to validate the model and make decisions according to the results. Figure 8 shows a simulation process for a supply chain with multiple raw material suppliers. The two panels on upside are geographical model and corresponding business process model. The two panels on bottom are for simulation script and monitoring chart.

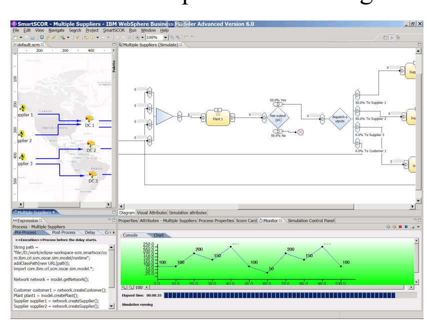


Figure 8: Supply Chain Simulation in SmartSCOR

3.4 Supply Chain Process Analysis

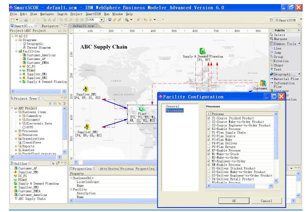
Despite the widespread recognition of the importance of business processes in supply chain transformation, there are still many issues which require further studies. Firstly, the principal gap in the current business process modeling is not the modeling tool itself, but how to abstract business processes from real world supply chain, i.e., the difficulty mainly lies in the process of understanding specific processes and expressing them in a logical way, while not the concrete expression modes. Domain knowledge is crucial to an effective business process modeling, so it is important to utilize industry best practices and accumulate knowledge in the modeling process. Secondly, in order to find the gaps existing in the as-is business processes, more effective analysis methods are required for the diagnosis, especially those quantitative methods. Moreover, most of the COTS tools are modeling-oriented, while lacking a global view of the whole transformation process.

In order to overcome the above issues, SmartSCOR provides an end-to-end support for business process transformation in supply chain by leveraging the advantage of SCOR model and WBM. Two important steps of this transformation process, i.e., business process modeling and business process diagnosis, will be introduced in detail in the following subsections.

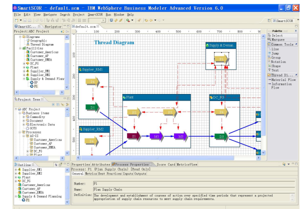
3.4.1 Business Process Modeling

Besides the powerful functions on business process mapping, WBM can also model detailed organization, resource, and data information. It also provides some advanced features such as multi-user support, detailed reporting, and workflow integration. In order to enhance WBM's modeling ability in supply chain management, we introduce SCOR model and seamlessly integrate it with WBM.

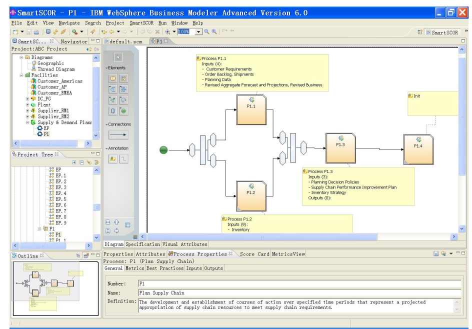
As a process reference model, SCOR provides a hierarchical framework for supply chain process expression. Level 1 is the top level and deals with process types. It defines the scope and content for SCOR, i.e., the five basic processes. Level 2 is the configuration level and deals with process categories, and it defines 26 categories within the Level 1 processes. Level 3 allows businesses to define in detail the processes identified, as well as performance metrics and best practices for each activity. Level 4 describes the detailed tasks within each of Level 3 activities. These tasks and their interactions are unique to each business, so implementation of supply chain processes takes place at this level. SCOR provides the framework for supply chain process modeling and defines some general aspects of supply chain processes in high level (Level 1-3), while leaving the concrete features of processes (Level 4 and below) and workflows to WBM. With this hierarchical framework, a business can quickly and unambiguously describe its supply chain. Figure 9 gives some interfaces of process modeling at different levels in SmartSCOR.



(a) Geographic Diagram



(b) SCOR Level 2



(c) SCOR Level 3 and Below

Figure 9: Hierarchical Process Modeling in SmartSCOR

More important, SmartSCOR provides various industry best practices, including typical business processes, input and output logics, organizations, roles, resource and data definition, reference cases, performance measures, and benchmarks. It also provides a mechanism for knowledge accumulation, so that enable a continuous self-improvement. These industry best practices enable a fast modeling from scratch.

3.4.2 Business Process Diagnosis

WBM provides a variety of analysis functions that allow users to diagnose or validate processes. Besides process simulation, there are two types of analysis one can perform:

- Static analysis: analysis of the models in their static form.
- Dynamic analysis: analysis of the data generated by a simulation of a modeled process.

Static analysis is comprised of three subsets of analyses: resource analysis, organization analysis, and general analysis, while dynamic analysis has four categories: aggregated analysis, process instance analysis, weighted average case analysis, and comparison analysis.

Besides the above analysis methods provided by WBM, we introduce a performance driven change mechanism for business process transformation. SCOR defines a set of measures that one can use to evaluate processes at each level of the process hierarchy, and WBM also provides the performance measures modeling function, so it will be much easier to build up the performance model while mapping the processes. Based on the performance model and the measurement results, the following analyses can be conducted to aid decision making and find appropriate direction to improve.

(1) Gap analysis

Gap analysis is an easy and effective method for diagnosis. By comparing the actual value of performance measures with benchmarks, the gaps against industry best practices will be obvious. SCORCard and the spider chart are good tools for comprehensible expression.

(2) Causal analysis

Based on the performance model with quantitative and qualitative relationships between performance measures, three kinds of analyses are provided (see Figure 10):

- What-if analysis

Given the changes of one or more performance measures, what is the impact to other related measures?

- Root cause analysis

This analysis is to find the reasons that cause the existing phenomena.

- Policy design

Given an objective (usually a function of one or several measures), to find an optimal policy (the measures that can be changed as decision variables) to achieve it. This is usually an optimization problem.

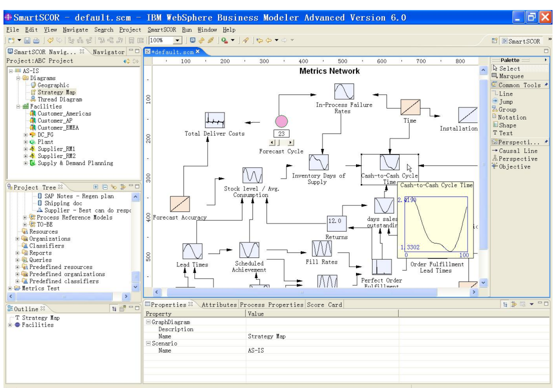


Figure 10: Causal Analysis for Performance Diagnosis

Through above analyses, we can know the gaps and which measures should be improved, and the objectives as well. SmartSCOR provides best practices for each Level 2 and Level 3 processes, which aim to identify management practices and software solutions used successfully by similar companies that are considered top performers. The identification of the best business practices needed to support the “to-be” state of the processes becomes the roadmap for implementation.

4 CASE STUDIES

As an integrated workbench for supply chain analysts, SmartSCOR has been used in a number of supply chain consulting projects for validation and hardening. Due to the space limitation, we briefly introduce two case studies in this paper, where SmartSCOR has been used as the major support tool for supply chain transformation.

4.1 Practice in Manufacturing

One supply chain transformation project has been done with a home improvement tool manufacturer. The client is a global leader in the design, manufacturing and sales of home improvement products. As one of the leading manufacturers, it maintains an expanding stable of well-established and fast growing brands. According to the product features and demand patterns, the client works on a mixed basis with both original equipment manufacturing and original design manufacturing. In addition to original equipment manufacturers (OEM), original design manufacturers (ODM) further provide our client the flexibility in managing product portfolio and help react responsively to varying customer demands. While how to control inventories along the supply chain and manage the raw material procurement processes at ODMs is still a quite challenging issue. In such an ODM scenario, the client would like to take a supply chain transformation initiative and escalate its supply chain to a more cost-effective, responsive, and resilient one. The objective of the project was to i) identify the best inventory holding position plus the optimal control policies, and ii) evaluate the impact of central raw material procurement on its supply chain performance.

SmartSCOR addresses this transformation problem in two ways. The inventory control problem is studied using simulation, which provides the customer an insightful view about their supply chain when setting up buffer stocks for raw materials. The appropriate position for inventory holding and corresponding control parameters are determined by SmartSCOR.

The transition from distributed raw material procurement management to central procurement management needs a considerable effort in business process re-engineering. SmartSCOR was used firstly for the As-Is process modeling. Some analysis were conducted to identify the bottlenecks of the current process model. With respect to the cross-industry process standard SCOR model, a To-Be process model is proposed to our client.

After the transformation project, the client has adopted the solution and applied it in a few sites for pilot run. The pilot run is successful and it is expected to generate a cost saving of half million US dollars during the first year. Based on the successful pilot run, the client is planning to roll out the solution to other sites.

4.2 IBM Internal Case

As one of the largest manufacturer of computer servers, IBM owns a large-scale supply chain covering a wide area including procurement, manufacturing and distribution. To improve its supply chain efficiency and reduce costs, IBM initiated a number of supply chain transformation projects. SmartSCOR has been used in the project related to supply chain network rationalization.

The objective is to rationalize the supply chain network of one type of IBM servers by refining the supplier portfolio, setting up new and cost-effective transportation links and consolidating distribution channels. The network optimization module of SmartSCOR has been employed in this study. Following the SmartSCOR methodology, firstly we focus on modeling the As-Is supply chain network. Much efforts have been made for data collection and cleaning. The numerical results provided by SmartSCOR is then compared with the financial data for As-Is model validation. Confirmed with the financial data, we moved to the optimization modeling phase, which consists in building a more complete supply chain network with potential new sites (suppliers, plants and distribution centers), new transportation lanes, and new products. A mixed integer programming model is built using SmartSCOR for the optimization. The project is under going currently.

5 CONCLUSIONS

This paper gives an overview of SmartSCOR, an integrated supply chain transformation workbench developed by IBM Research. SmartSCOR addresses supply chain decisions from strategic level, tactical level to operational level. A variety of optimization and simulation techniques are employed in the tool.

As a comprehensive tool for supply chain analysis, SmartSCOR has been applied in a number of consulting projects. The models and methods developed by researchers are then tested and verified in practice. The industry insights and experiences, gained from real supply chain consulting practice, are then fed back to researchers. Such a close loop of research and practice would help further enhance SmartSCOR.

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