Aligning the Supply Chain Operations Reference (SCOR) Model with Enterprise Applications: Real-time Value Chain Intelligence

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ABSTRACT
In recent years, significant attention has been given to understanding and implementing extended enterprise management solutions – efforts that integrate product, process, and information flows within and across organizational boundaries. The global competitive business environment, complex and rapidly changing customer demands, and advances in information technology forced enterprises to look for efficiencies in their internal operations as well as in coordinated operations with their suppliers, partners and customers. The challenge has been, and still is, how to effectively use information technologies to identify, communicate and continuously improve internal and extended enterprise processes. This paper introduces the Supply Chain Operations Reference (SCOR) model as the vertical- and technology-neutral enabler for process management. In order to achieve the full benefits from SCOR as a catalyst for Supply Chain Management (SCM) initiatives, effective business process management and agile enterprise software applications must be implemented. The paper describes iSCOR as a methodology with an associated implementation toolset for achieving and sustaining world-class SCM practice. The paper describes how the SCOR model can be aligned with enterprise applications as well as generic business processes to generate real-time supply chain intelligence. The goal is to enable Strategic Enterprise Management (SEM) that measures and improves internal and extended enterprise business processes and the enabling technology.

1. INTRODUCTION

The last decade of the 20th century witnessed a dramatic transformation in the way we think about and manage product, process, and information flows within and across organizational boundaries. We were introduced to concepts such as Business Process Reengineering (BPR), Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Collaborative Planning, Forecasting and Replenishment (CPFR). In most cases these concepts were grounded in the systems engineering, operations research and management principles of the post World War II industrial expansion and were enabled by dazzling computing power and applications. These concepts, however, all focused on one fundamental goal: improved efficiencies that result in increased customer satisfaction and stakeholder value. The path to achieving that goal has been a rocky one. Cultural, structural and technological challenges kept managers and academia busy in search of the holy grail of strategic management success.

Managing an organization has been likened to many different disciplines- engineering, biogenetics, etc. In all cases the underpinning idea is that the manager needs measurement data, similar to a pilot in an airplane cockpit (command, control and communication center for that unit.) That pilot also needs buttons and switches to navigate the complex machine safely and efficiently. Although the airplane is a collection of a number of also complex subsystems, they are all integrated to perform the process of transportation from one point to another safely and efficiently. Sometimes the pilot or the owner of the plane needs to obtain wrench, hammer and a variety of more sophisticated tools, the engineering blueprints and qualified personnel to perform routine or major maintenance. Continuous improvement is necessary to get to and remain in front of the competition. So how do today's managers measure the operational performance of their value chains and create the efficiencies that ensure competitive advantage?

To answer that question, this paper focuses on SCM and related concepts, which will be defined in the next section under the conceptual framework. In that section we highlight varying definitions and semantic distinctions of SCM. Section three draws on the dilemma faced in the practice of operations management today. The SCOR model is then presented as a high-level business process reference model that can be used in designing the supply chain manager's command center. The next section integrates Business Process Management and Enterprise Integration concepts to lay the foundation for technology-enabled value chain management. We then introduce the iSCOR methodology that combines all the concepts discussed so far, placing the power of real-time supply chain analytics and intelligence in the hands of operations managers. How can such a methodology be implemented in real operational environments? We introduce our implementation work at Ingram Book Company that was geared towards setting up a continuous process measurement, benchmarking and improvement system at its central Distribution Center. Ingram Book Group is an integral node in the fast-paced book distribution chain. The introduction to the implementation work at Ingram provides a valuable understanding of issues discussed thus far, from an end-to-end logistics perspective. The concluding section peers into the future research direction with the iSCOR business intelligence methodology.

2. CONCEPTUAL FRAMEWORK DEFINED

In order to define our conceptual framework we draw upon the definitions of APICS, The Educational Society of Resource Management and the Supply Chain Council (SCC). APICS defines SCM as the "planning, organizing, and controlling of supply chain activities" (APICS 1998). The SCC defines the supply chain activities as "all customer interactions, from order entry through paid invoice; all product (physical material or service) transactions, from supplier's supplier to customer's customer; and all market interactions, from the understanding of aggregate demand to fullfilment of each order."(SCC 2000) When combined, the two definitions highlight the transformation in professional practice from an inward-looking materials, production and logistics management, to product and information flow management across multiple enterprises of suppliers, customers and partners.

In academic research the broad definition of supply chain activities and the related management discipline is reiterated and further examined to identify the underlying principles. SCM is the integration of activities related to the transformation and flow of goods and services, including their attendant information flows, from the sources of raw materials to end users. (Ballou, Gilbert and Mukherjee 2000) In this conceptual framework, SCM consists of three integration dimensions: Intra-Functional, Inter-Functional or Cross-Functional integration, and Inter-Organizational or integrated extended enterprise. Each link or node within the paths of a supply chain network should implement all the three dimensions of integration.

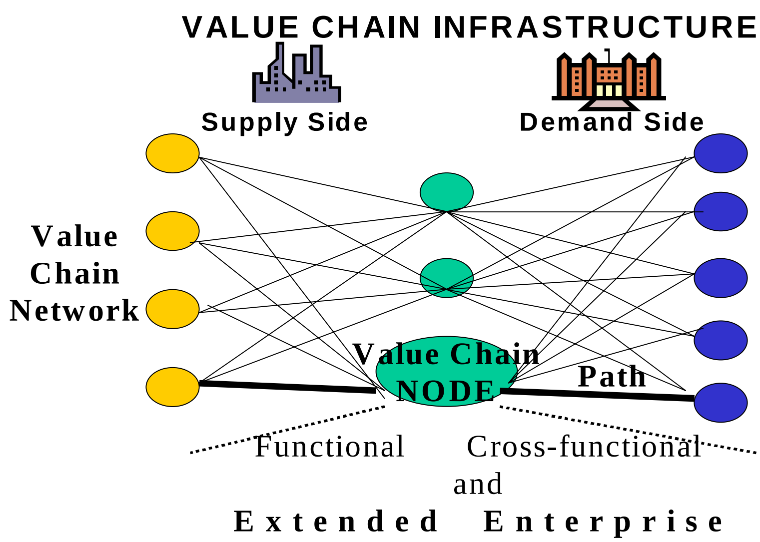

Figure 1. Value Chain Layers and Node Dimensions

With the availability of powerful computing technology and a shift to horizontal process-oriented thinking, early implementations focused on cross-functional and extended enterprise integration. Efforts were made to identify issues in managing supply chain networks and the benefits of integration (Womack et al. 1990, Lee and Billington 1992 and 1993, Davis 1993, Billington 1994). More recent research endeavored to improve supply chain design (Fine 1998, Strader, Lin and Shaw 1999, Ballou et al. 2000). This paper builds on the earlier research as well as on an understanding of the practitioner's needs.

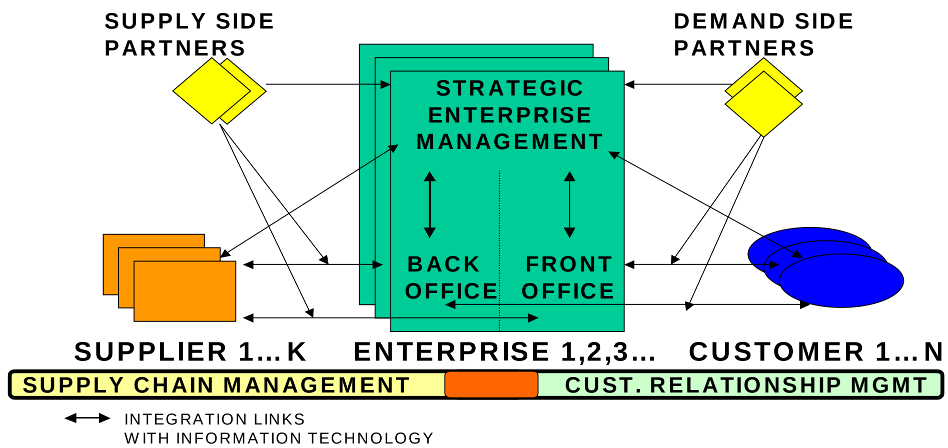

Figure 2. Value Chain Management in Perspective

As highlighted in Figure 2 the whole system can be described as the value chain or network. Activities within this framework are geared towards generating value for all parties involved. It is helpful to study the intersection between front- and back-office activities. From a process flow perspective there are activities (e.g., order entry) that can be implemented as both SCM and CRM processes. In addition, information flow from the demand-side becomes critical for supply-side effectiveness and vice versa. Although "chain" is the widely accepted semantic, suppliers and customers positioning themselves in other, possibly competing, "chains" result in more of a web- or network-like dynamics. It is possible to speak of a chain when only one product line is considered, and there are different supply paths making up threads of that chain.

This research sheds light on three components of state-of-the-art supply chain architectural design: product, process, and organization. We review the management challenges that fall into each area, and examine how our proposed methodology can contribute to addressing these challenges. Information technology is viewed as an enabler within the process infrastructure and for given organizational resources.

3. THE STRATEGIC ENTERPRISE MANAGEMENT DILEMMA

Strategic Enterprise Management refers to decision support concepts designed to enable measurement of financial and non-financial performance of key business segments. These measures allow managers, if they so choose, to focus on deriving increased shareholder value. Without integrated enterprise systems, collecting and analyzing enterprise-wide data was cumbersome, costly and time consuming. The second half of the 1990s witnessed an explosion of Enterprise Resource Planning (ERP) software implementations. Other enterprise technology initiatives such as SCM, CRM and e-Commerce systems followed. After this period, however, the need for strategic management approaches became more urgent than before for two reasons:

1. Few companies met their objectives for technology initiatives and satisfactory results in the minority (BCG 2000). In order to leverage the full value of their investments, performance measurement and application tuning methods, based on reliable data became necessary.

2. For the first time managers were able to gather cross-functional data for their internal operations, as well as for the extended enterprise operations across the value chain. This held the promise of alleviating competitive pressures in the presence of rapidly fluctuating (fast-clockspeed) customer preferences.

Academic research underlines the value of SEM as well. For example Ballou et al. mention three managerial requirements in the supply chain:

1. A new set of **metrics** (beyond normal accounting measures) for capturing inter-organizational data,
2. An **information sharing mechanism** for transferring information about cooperative benefits among channel members, and
3. An **allocation method** for redistributing the rewards of cooperation in a way that all parties benefit fairly (Ballou et al. 2000).

In his “clockspeed” methodology, Fine emphasizes benchmarking; understanding, mapping and assessing and analyzing your supply chain; and implementing three-dimensional concurrent engineering and competency development for successful SCM. His last point exploits ideas from the “lean production” paradigm (Womack et al. 1990) and the Theory of Constraints (TOC). The TOC is a widely accepted approach that focuses on product bottleneck and buffer management (Goldratt 1997). Will the SCM discipline provide its practitioners with tools and methodologies that can enable them to be more proactive using reliable integrated performance measurement in the extended enterprise?

Another SCM challenge is the bullwhip effect (Lee and Padmanabhan, 1997). Fine defines it as the volatility amplification, “a phenomenon whereby the volatility of demand and inventories in the supply chain tend to be amplified as one looks farther ‘upstream’- that is away from the end-user.” (Fine, 1998) Can the supply chain managers measure and counteract the bullwhip effect given the right tools and visibility into their supply chains?

Supply chain design and management can be a source of competitive advantage. Fine supports that by focusing on Dell Computer. In the PC industry, inventory doesn’t age gracefully. While other PC manufacturers have to fill their distribution pipeline with inventory and have to carry obsolescence costs, Dell, with its lean chain, is winning market share and profits. The other OEMs are not able to move to the Dell model swiftly, but only gradually because of years of dependency on their channels/resellers. Dell Computer Corporation illustrates a richer way of thinking about supply chain design – not as a static collection of contractors, but as a company’s most important competency.

Competitive interdependence demands understanding the needs of the whole supply chain and working towards a common goal. How are common goals defined and communicated in a consistent language? How are the strands of the interdependencies identified? And can the performance of the internal and external supply chain operations monitored and improved?

Our research hypothesis is the following: ***An integrated and real-time enterprise SCOR view enables managers to better align supply chain applications with their business processes and strategic objectives, and supports a more effective implementation of SCM process improvement initiatives.*** This hypothesis is tested with our iSCOR methodology as implemented in the iSCOR Toolset. A successful test of the above hypothesis should demonstrate efficiencies in SCM processes, effective technology deployment and management, and a financial impact on corporate balance sheets. This paper will address the above hypothesis in a limited way because the implementation project, highlighted in the last section, is in its initial phase. The impact on technology deployment, revenue growth, asset utilization and cost reduction will be tested as more data becomes available in the course of the project. At this stage of the research, however, we will discuss the methodology and toolset, therefore framing the test of the above hypothesis.

4. THE SCOR MODEL FOR EFFECTIVE SUPPLY CHAIN MANAGEMENT

The Supply Chain Operations Reference (SCOR) model was a grassroots initiative in SCM. Around 69 industry visionaries founded the Supply-Chain Council (SCC) in 1996 as a professional forum on the emerging integrated management concepts in the extended enterprise. The SCOR model became SCC's key knowledge contribution to the field at a time when functional barriers still challenged the practice. Since then the model has been revised a number of times, and the latest release (SCOR version 4.0) continues to shape how many in the field approach SCM improvement projects (SCC 2000). The membership of the Council has reached 700, mainly consisting of practitioners, along with technology and consulting services providers, government and academic organizations.

Rather than a vertical- or technology-specific approach, the aim is to produce a high-level process model. The model can be applied to any and all product and information flow in the supply chain at high-levels of modeling abstraction. The company specific processes are then linked to the lowest layer of the SCOR model (Level 3) at the implementation phase. We discuss the model's approach to supply chain design and management in the section below.

Industry's response to the SCOR initiative is one of its most important features. As the SCOR model is more widely accepted and implemented, it gains critical mass. This means that the benefits derived from a de facto industry standard are realized. The process management and performance measurement related benefits that are derived from such wide usage are discussed below. The SCC has been proactive in disseminating the model and integrated SCM thinking through professional conferences, seminars and workshops. The Council also works closely with the academic community to foster research using the model.

4.1. The Business Process Reference Model

The SCOR model describes high-level business processes associated with all phases of satisfying customer demand (SCC 2000). At the highest level the SCOR model is organized around four business process types: Plan, Source, Make, Deliver. One additional process, Return, is scheduled to be added in the soon to be released version 5.0. These processes represent the vertical-neutral abstractions from all demand/supply planning, purchasing/procurement, manufacturing, order entry and outbound logistics, and returns processing activities.

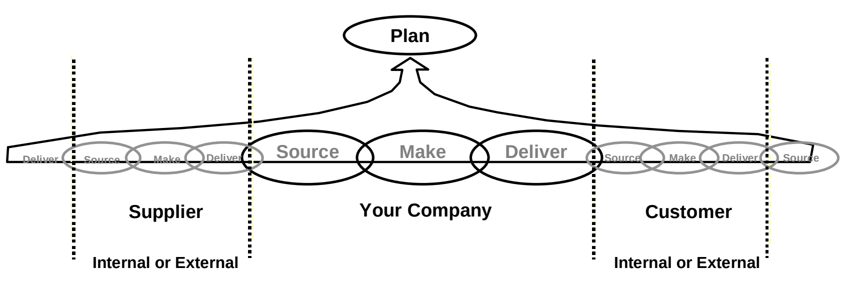

Figure 3 – Single Supply Chain Path or "Thread" in SCOR Terminology (SCC 2000)

The model, therefore, provides a business process framework with standard descriptions and interdependencies among processes. The aim is to meaningfully map supply chains and supply chain activities with varying complexities across multiple industry-verticals.

The hierarchical process framework decomposes to the third level. At Level 3, the Process Element Level, activity definitions are still generalized, so they still apply to a variety of product and information flows (including services). The model, for the top three levels, provides the framework for analyzing, designing, and implementing actual operational supply chain execution or planning processes. Best-practices and enabling technology indexing/cataloging are also linked to the Process Elements, and they can be used to guide implementation. The model's business process framework provides a common language to facilitate horizontal process integration across different business units and players in the value chain. This framework is a strategic tool for describing, communicating, measuring, implementing and controlling, and fine-tuning complex SCM processes. Given that the Council membership has increased to 700 companies across five continents, the model offers the benefits of standardization if all value chain participants implementing the SCOR model adhere to the framework.

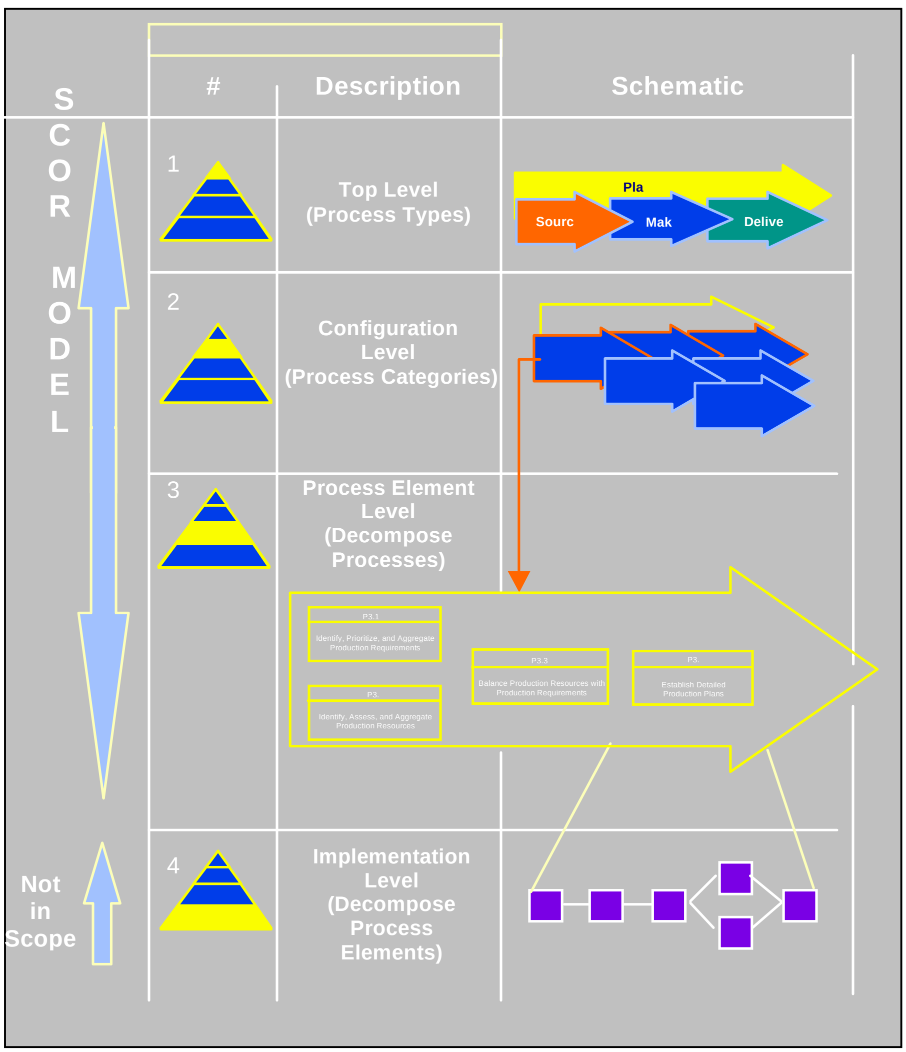

Figure 4 – SCOR's Hierarchical Structure (SCC 2000)

4.2. Performance Measurement and Benchmarking Using the SCOR Model

In addition to the management process template and a best practices index, the reference model includes standard performance metrics for measuring process performance. The metrics are defined in their specific layered structure. Twelve Level 1 metrics are used to measure five areas of strategic enterprise supply chain performance: reliability, responsiveness, flexibility, cost, and asset management. These metrics decompose into lower level metrics that are linked to one or more process elements in the model (SCC 2000b). The concept is to use widely accepted and meaningful measures at appropriate levels of the organization to support strategic decision-making. The developers of the model used an approach similar to a variety of researchers including Kaplan and Norton's Balanced Scorecard (Kaplan and Norton 1992) that emphasize an horizontal end-to-end view of the enterprise.

Industry-wide acceptance and the cross-functional nature of the SCOR performance view make it an ideal candidate for supply chain focused work in Strategic Enterprise Management. There are many cases that illustrate the value of consistent internal and channel-spanning performance measurement. For instance a manufacturer of scientific products continuously received low marks from a customer on delivery (Anderson, Britt, Favre 1997). The company's internal measures indicated that performance was superior. The problem was that the customer and the company were not measuring the same thing. The customer accepted only full truckloads; i.e., anything brought the following week because it would not fit onto the truck was deemed backordered. From the manufacturer's perspective, however, "full truckload orders" were being shipped as promised.

Academic work focusing on SCOR model implementations is currently limited. As presented at various SCC events, industry applications are mainly comprised of ad-hoc performance measurement at Level 1. This, we believe, is a direct result of a lack of SCOR-enabled analytical and monitoring software tools. It becomes too costly to collect both high-level and detailed metrics on a periodic basis, let alone real-time, especially when functional or organizational boundaries are crossed. Automated measurement also requires that as-is enterprise process logic is well documented and data can be rolled up from these processes into the SCOR view. Our research aims to respond to this challenge with the right tools and methodologies.

In review, the SCOR model approach is aligned with the academic and professional work that promotes supply chain architectural design, performance measurement using reliable and consistent data models, and communication of process blueprints. However, the scope of SCOR model implementations remains limited to internal operations or to a few nodes up and down the chain. There is a clear need for enterprise knowledge-enabled tools and methodologies that roll-up reliable data periodically or even real-time into the model and communicate supply chain performance across the value chain. More research and analysis is needed to understand the financial impact of the non-financial metrics of the model. The SCOR model does however hold out the promise of a consistent framework that enables effective and collaborative supply chain management.

5. ENTERPRISE APPLICATIONS AND PROCESS MANAGEMENT

In the days when computing power was scarce and costly, enterprise automation was limited to specialized manufacturing, logistics and accounting systems. Interfaces among these systems consisted mainly of manual data entry and re-entry. In the 1990s the development of client-server architectures for computer systems, along with the doubling processing power every 18 months, paved the way for a new breed of enterprise IT-enabled solutions. Enterprise Resource Planning (ERP) systems integrated fragmented operational data around business processes. It became possible to track a customer's order from order entry to manufacturing to delivery to accounts receivable using one integrated packaged software solution. Although intuitively straightforward, such tasks required robust, complex and expensive software systems. In addition how these systems are configured and implemented determined whether returns on these investments are actually realized (Davenport 1998).

Much has been written and is still being written on the issues and challenges related to ERP-enabled intra-enterprise integration. Extended enterprise integration, which includes business-to-business e-commerce, is even more challenging. In the next section, we highlight the current literature in enterprise applications and focus on one specific solution package to show the concepts behind the alignment of the SCOR model.

5.1. Packaged Software Solutions

An overview of the enterprise applications landscape is presented in the figure below. The software solutions can be grouped into four areas based on general functions they perform: Transactional/Back Office, Execution, Planning and Strategic Decision-Making. After reviewing these concepts, we focus in the next section on how SEM tools can be effectively aligned with planning, execution and transactional systems, therefore providing valuable support to strategic decision-making.

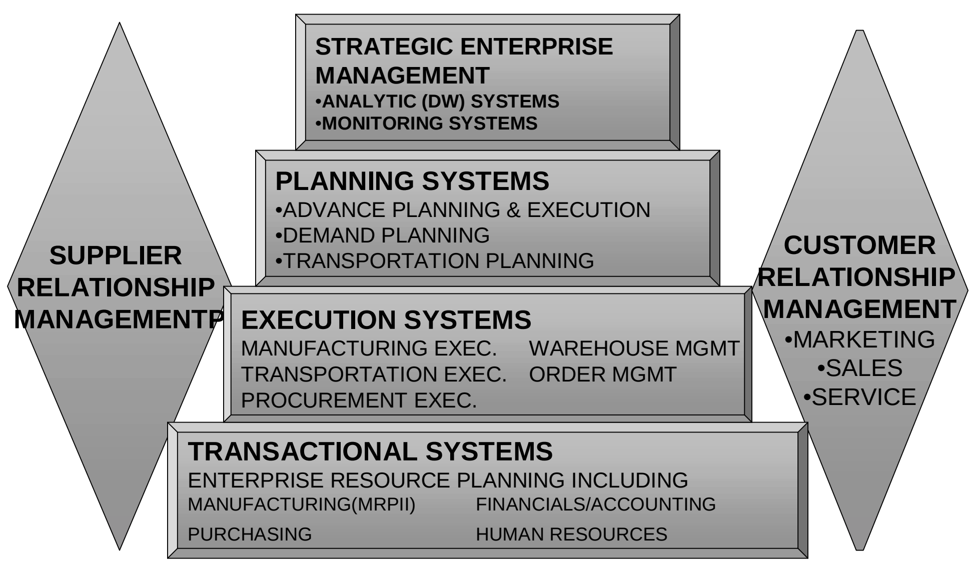

Figure 5. Enterprise Applications Domain

Modern transactional/back-office applications are implemented as standard software solutions. Leading such software providers are SAP, Oracle, BAAN, JDEdwards and PeopleSoft. There are approximately 50 additional vendors offering varied functionality for varying levels of scalability. As the functionality and the modules suggest, these applications form the backbone of enterprise software. By efficiently tracking all resources across end-to-end business processes, reliable data can be provided to execution, planning and strategic decision-making applications. In the early years of ERP, execution and planning systems were mostly “bolt-ons,” not fully integrated into the software offerings. Through the years, the leading application vendors have increasingly included execution and planning functionality within their systems.

The successful deployment of enterprise applications has created value by reducing cycle times, raising customer responsiveness, and improving asset management. In addition, legacy IT support and interoperability costs were reduced. Organizations also benefited when they redesigned their business processes to align with best-practice configurations of the software. On the one hand, by providing universal, real-time access to operating and financial data, the systems allowed companies to streamline their management structures, creating flatter, flexible, and more responsive organizations. On the other hand, information became more centralized, and business processes became increasingly standardized. Enterprise applications imposed their business process logic on companies' strategies, cultures and organizational structures (Davenport 1998). This new paradigm required a solid strategic vision and commitment to change management. Failure to invest in up-front strategic analysis, an inability to understand business capabilities and requirements, and an inability to monitor and reevaluate progress were some of the reasons for unsatisfactory results. (BCG 2000) Along the same lines, the attention given to SEM tools was limited to analytical approaches through Data Marts or Data Warehousing using traditional cost and organizational stovepipes-focused metrics (Smith 2000). This narrow focus denied decision-makers of end-to-end process-oriented near real-time or real-time performance measurement. We now examine business process management and knowledge-based applications implementation methodologies and how they relate to SEM.

5.1.1. ORACLE eBusiness Suite

The Oracle Corporation is best known for its robust, scalable, widely-used database management system. It became a major player in the enterprise applications market in the second half of the 1990s. Oracle was able to develop or acquire and then integrate end-to-end functionality from front-office to back-office modules running on a central database repository. In order to use the power of the Internet, Oracle also added browser-based self-service applications to its offerings. At a time when seamless Enterprise Application Integration (EAI) is still a technically elusive and costly goal, browser-enabled supply chain integration, as implemented through Oracle eBusiness Components provides improved efficiency and visibility along the supply networks.

Oracle eBusiness Components are built on a function-oriented architecture vis-à-vis the more structured business process-oriented approach of SAP. Although affording implementation flexibility, the complexity increases when translating business requirements to software functionality. Therefore understanding, implementating, and user training for the Oracle eBusiness Suite require expertise and intimate knowledge of the system interdependencies. Oracle and third-party implementation consultants have released methodologies that speed up the undertaking and improve its success probability. As the only end-to-end fully integrated solution in the Applications marketplace, the Oracle e-Business Suite is the enterprise solution that is most important for this research. However, the methodology developed here applies to other enterprise applications as well.

5.2. Process Knowledge Management

Business Process Management became the focus of academic and professional attention in the early 90s (Davenport and Short 1990). The constant quest for competitive advantage, supported by integrated applications, unleashed the private sector management transformation that is still underway today. Davenport and Short state that "thinking about information technology should be in terms of how it supports new or redesigned business processes, and business processes and process improvements should be considered in terms of the capabilities that information technology can provide." Davenport and Short go so far as to call this new approach to process management *The New Industrial Engineering*.

Business Process Management, as considered in this research, includes:

- Documenting processes to obtain how work flows within the enterprise to generate value,
- Assigning process ownership in order to establish managerial accountability,
- Managing the process to improve or optimize measures of process performance, and
- Improving the processes to enhance product quality and stakeholder value.

The achievement of competitive advantage through effective process management has been well documented in variety of organizations. Compaq (Davenport 1998), IBM, Texas Instruments, Owens Corning and Duke Power (Hammer and Stanton 1999) are some examples of corporations that strategically analyzed and redesigned their business processes to respond to changing market conditions, to facilitate the implementation of enterprise applications, and to create responsive management structures. For example, the Hewlett Packard case illustrates a successful process management approach that also integrates with business and IT strategy (Feurer, Chaharbaghi, Weber and Wargin 2000). Not only was the strategic impact of specific business process elements analyzed, but an understanding of how the business processes aligned with software functionality also helped in the selection of better fitting software modules.

There have been a number of methodologies developed to represent business processes, such as Petri nets (e.g., Peterson 1981 and van der Aalst, Desel and Oberweis 2000), event-driven process diagrams (Scheer 1994), and specializations and coordination theory representations (Malone et al. 1999). Studies have documented that the use of software tools improves effectiveness of business process redesign and improvement projects (e.g. Im, Sawy and Hars 1999). These tools vary greatly from basic flow chart modeling functionality to integrated formally defined modeling of business processes, organizational models, and object (information) models that can generate function and data models used in CASE tools. In addition, while most of these tools have static analysis capabilities, a few use simulation techniques for dynamic evaluation and improvement. "Process Compass," developed at Massachusetts Institute of Technology (MIT), and later commercialized as Phios is an example of using web-enabled authoring over a model repository database (Malone et al. 1999). This research and development project at MIT also produced a "Process Handbook" of generic and specialized business processes. The aim was to make a variety of process designs available, to help managers redesign existing business processes and invent new processes by sharing a knowledge base. Although this approach provides insight as an extensive "Handbook", it lacks the functionality to facilitate IT alignment. The ARIS methodology by (based on Scheer's implementation of event-driven process chains) is a good example of an integrated process management methodology (Scheer 1994 and Kirchmer 1996). Organization, function, and data models that are integrated around business processes provide comprehensive modeling and analysis capabilities, including simulation. ARIS concepts were the core process management methods used to design and develop the SAP R/3 reference model. Therefore ARIS provides beneficial support in SAP-related enterprise initiatives for process-oriented analysis, design and implementation.

The Petri nets modeling language combines the advantages of graphical representation with a formal definition. Beyond simple visualization, Petri nets provide for analysis and validation of business processes (Desel and Erwin 2000). INCOME Process Designer by PROMATIS implements Petri nets as behavior models that describe business processes (PROMATIS 2000). The process models are hierarchical, in other words they represent high-level activities (process elements), which are decomposable down to specialized tasks. The objects are inputs and outputs to the business processes. The information objects that are linked to the processes (e.g., invoices or purchase orders) are described in the object models. The resources required by these activities are defined in the organization model, with additional information such as availability or cost. All model elements are stored in a model repository. The models are used for analysis (static and dynamic), process monitoring, evaluation, and continuous improvement. The INCOME toolset also includes functionality that integrates the models developed in the Process Designer to all phases of enterprise applications implementations, beginning with feasibility studies and ending with CASE development and user training.

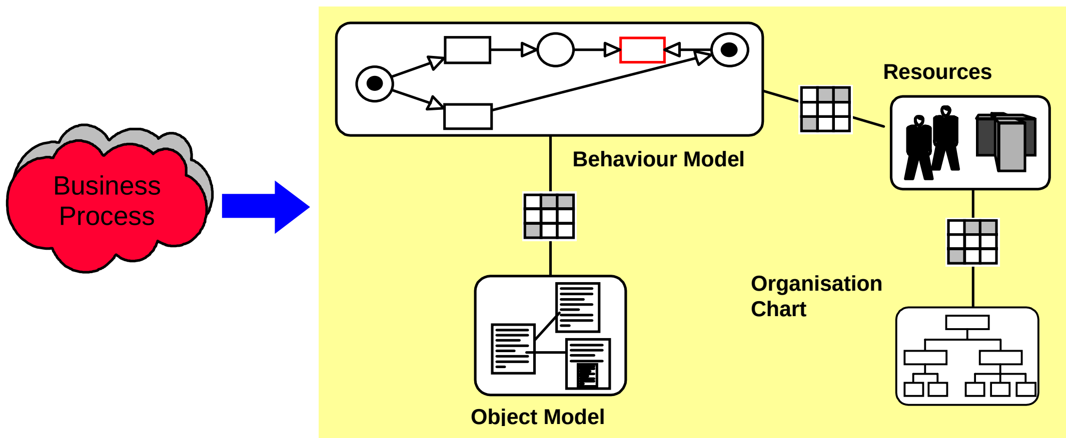

Figure 6. Petri-net Modeling using INCOME Process Designer (PROMATIS)

As in the MIT research effort, PROMATIS consultants have also developed generic business process reference models, called "knowledge bases." These models represent end-to-end processes for specific software modules, e.g., purchasing, financials, manufacturing, etc. The goal is to accelerate all implementation stages, thereby reducing implementation cycle-times. Using integration cartridges, the Oracle e-Business Suite can be configured to align with business process requirements. The next section refers to this functionality in more detail, while explaining how this methodology may be aligned with the SCOR model for supply chain implementations.

Business process management requires more up-front planning and documentation; however, its advantages have been demonstrated in the professional academic literature. A consistent modeling language and usable documentation aids in the identification of bottlenecks and interdependencies by visualization and static evaluation, as well as simulation. Dynamic evaluation, and enterprise software alignment are major benefits derived from these software tools.

5.2.1. Knowledge-based Oracle Applications Implementation with INCOME Toolset

Success uncertainty in enterprise application implementations due to the managerial and technical complexity demands innovative and practical solutions. Scheer's business process-oriented ARIS approach to SAP R/3 implementation, based on the SAP reference model, is one such example (Scheer 1994 and Kirchmer 1999). INCOME Knowledge Bases that use best-practice reference models for pre-configuring Oracle e-Business Components is a similar approach. The INCOME Knowledge Base approach forms the foundation of the iSCOR methodology that is presented in the next section.

By using the INCOME methodology and Knowledge Base templates it is possible to develop clear target business process requirements, perform a gap analysis, and implement the solution (PROMATIS 2000). If add-on functionality is required, it is developed using Oracle Designer CASE tool and implemented. This implementation methodology produces a software system that aligns with the organization's strategic objectives.

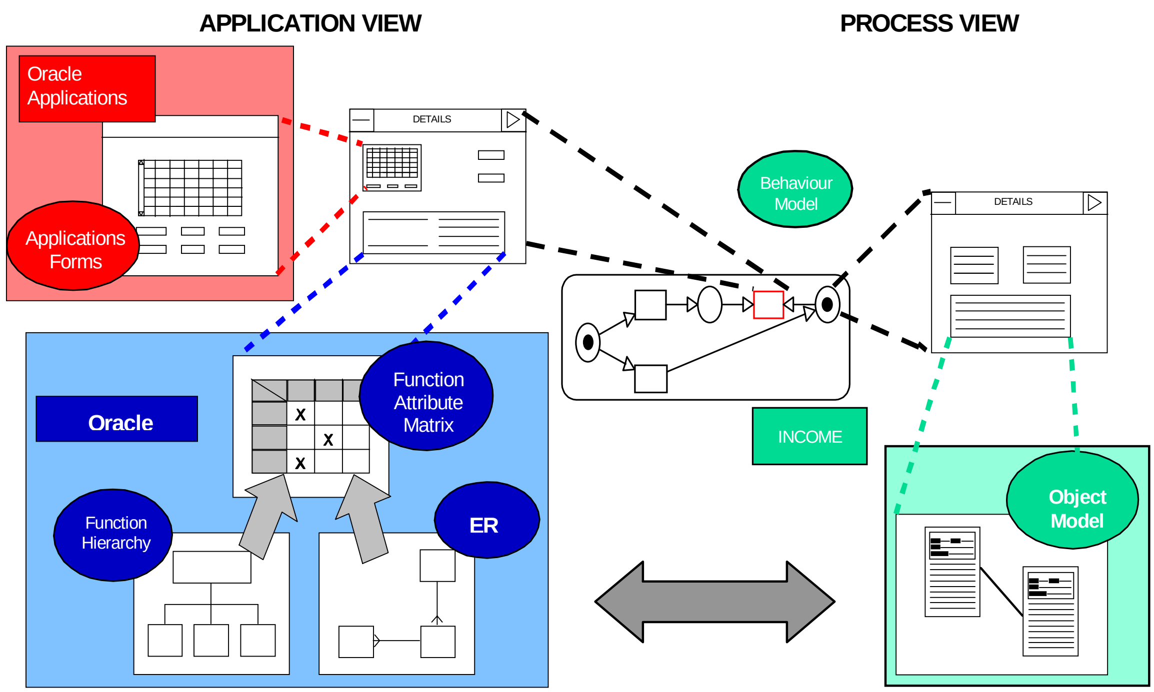

Figure 7. INCOME Process Designer for Implementing Oracle e-Business Components

The benefits of this approach extend beyond the implementation project. Proactive business process management fosters continuous improvement. Process models support integration of workflow functionality based on Oracle's workflow engine. With INCOME, the system documentation is clear, accessible, and easily maintainable. System upgrades or fine-tuning becomes less cumbersome with the aid of the Knowledge Base. Training material is part of the documentation, and graphical models provide users with a process-oriented view of Oracles function-oriented software.

In the next section we will examine how the process management approach enabled by INCOME tools supports business intelligence solutions for SCM.

6. THE *iSCOR* METHODOLOGY

This paper has identified challenges in managing business processes across multiple enterprises. Business process-oriented thinking, including the development of the SCOR model, has significantly influenced enterprise management. Enterprise applications and sophisticated process modeling and management methodologies were presented as process improving enablers. The remaining question is: How is the SCOR model aligned with enterprise applications? The iSCOR methodology, and the associated iSCOR toolset were developed to address the question.

6.1. General Concept

As discussed earlier, value chain intelligence is often aggregated in data warehouses and data marts. The complexity in analysis methodologies in these environments introduces a latency that can be detrimental to managers of "fast-clockspeed" supply chains. The traditional metrics used in these data warehouses are often not appropriate for end-to-end process-oriented management. Therefore we turn to the second and emerging approach for value chain analytics, referred to as distributed query management. This approach combines the business process models, OLAP servers from the enterprise applications, and real-time monitoring and analysis based on strategic objectives. The results are displayed to managers through web (HTML) front-end called iSCOR SCM-C^3 (Command & Control Center).

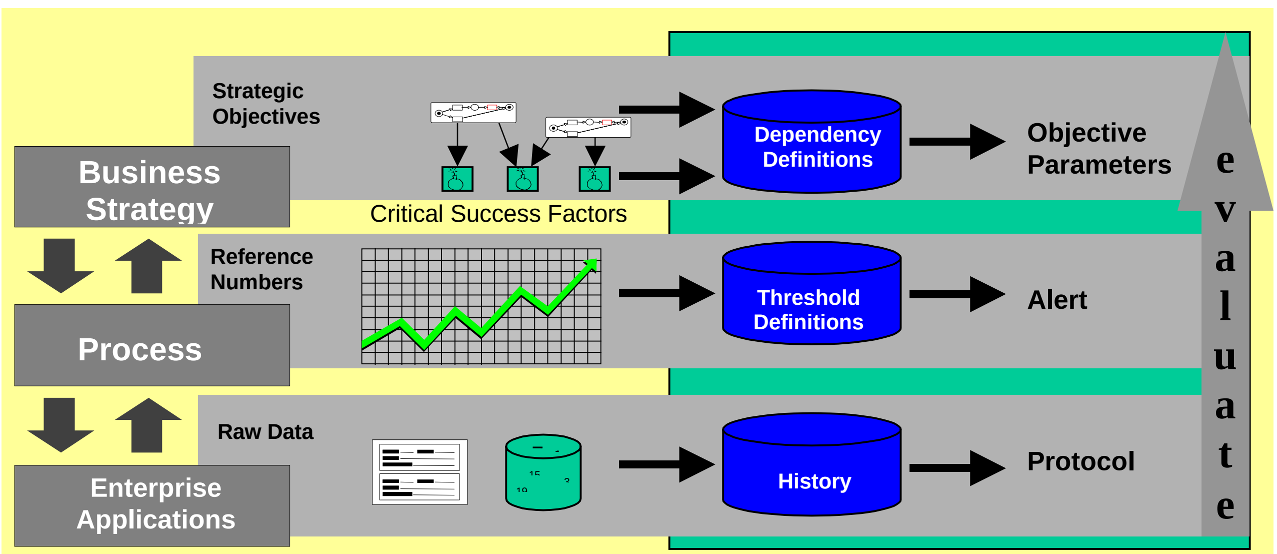

Figure 8. Business Process-oriented Strategic Enterprise Management Monitoring

Although the real-time performance monitoring is the most innovative feature of this approach, the basics of business process management still apply. Section 6.2., by specifically focusing on SCM, describes how a process design tool, combined with process Knowledge Bases, establishes the foundation for the SEM.

6.2. *iSCOR* and SCM-C[3]

iSCOR is built around INCOME Process Designer. This affords iSCOR the flexible functionality to design and manage business processes, linking organization and information models in a distributed development environment. Supply chain managers can model inter- or intra-organizational business processes. The graphical, easy-to-use, yet formally defined modeling language that is implemented in INCOME provides static and dynamic process evaluations, hence helping to identify opportunities for improvement. Such analyses provide supply chain professionals with the insight to migrate to improved supply network designs for internal and external operations. Supply chain initiatives benefit from the awareness disseminated across all levels of the organization, as well as other value chain partners.

iSCOR consists of one key Knowledge Base. This Knowledge Base is a complete representation of the SCOR model using INCOME Process Designer. All three levels of the SCOR model business processes are modeled using INCOME Process Designer. Performance metrics and best practices are linked to process objects (input/outputs) and represented in object (information) models. Organization models and related resources and roles can be populated during an implementation. The whole model can be modified as needed to represent the supply chain operations of the organization implementing the SCOR model.

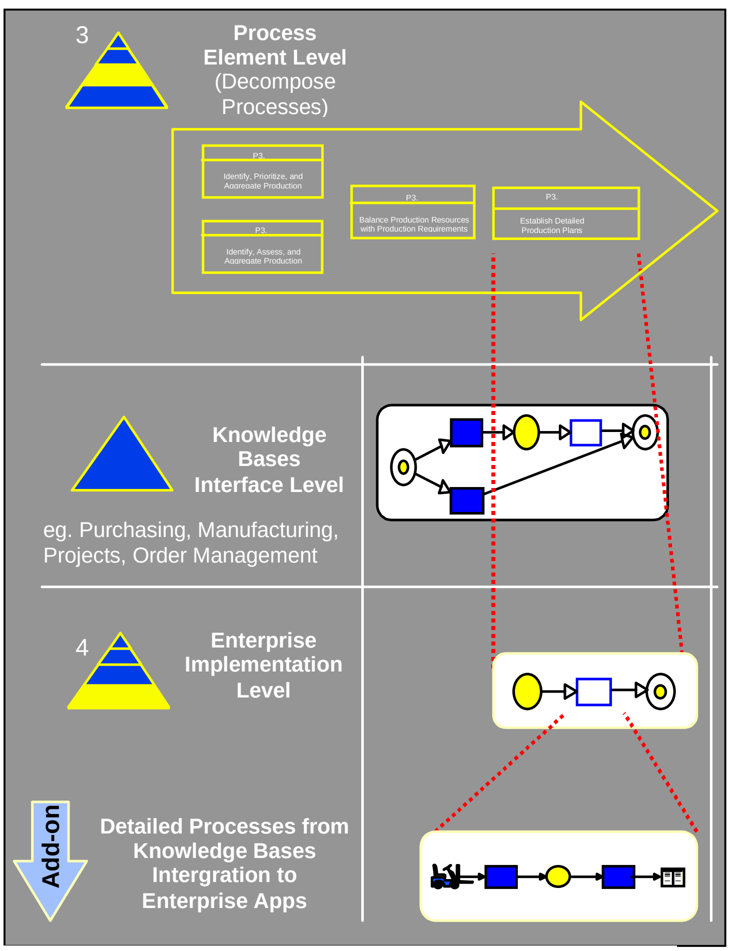

Figure 9. iSCOR: Aligning SCOR and Process Knowledge Bases

A key functionality of the iSCOR Knowledge Base (KB) is the pre-configured decomposition link to the implementation layer. That layer is referred to as Level 4 in the SCOR model, and the Supply Chain Council does not define it in detail. The iSCOR methodology requires that Level 4 be developed and linked the Levels 1-3 in the SCOR model. In the iSCOR methodology, Level 4 consists of relevant business process models from INCOME Knowledge Bases. These KBs are constructed using best practice business process models. The INCOME KBs for Oracle e-Business components that link to the SCOR model business processes are Purchasing, Manufacturing, Projects, and Order Management. Figure 9 shows, as an example, a process element (SCOR Level 3) from the SOURCE process. It decomposes into one or more process elements in the

Purchasing KB. The same structure applies when a process element from the MAKE process decomposes into Manufacturing or Projects KBs, and from the DELIVER process into the Order Management KB.

The iSCOR KB includes only the first layer of the four related KBs; however, all KBs could be bundled into iSCOR if desired. That, in turn, can produce time and cost savings in three application areas:

1. Process design and analysis through the use of existing templates, allowing managers to develop models more expeditiously than starting from scratch.
2. Performance data aggregations using the detailed business process models; i.e., the alignment of SCOR metrics with business processes enhances metric applicability and accuracy.
3. Oracle e-Business Component configuration and implementation using the INCOME KB methodology.

The monitoring engine that iSCOR uses is the INCOME Monitor. This is a process monitoring tool that:

- Manages master data, i.e. definition of performance indicators,
- Receives values to produce the indicators from various data sources, including manual and OLAP databases, and
- Supports analysis and reporting functions for the metrics gathered.

Therefore when SCOR metrics are defined based on their strategic impact on the enterprise, and related database query is defined, continuous monitoring and reporting of the SCOR metrics is possible. The monitoring can be set to discrete time intervals, or may even be real-time. Threshold levels can be established for the metrics, and when the thresholds are violated, INCOME Monitor distributes notifications via commonly used telecommunication tools. This feature provides promise to the supply chain professional. Once iSCOR is set-up with monitoring functionality, the waiting period that often renders performance data obsolete, becomes a thing of the past.

The benefits of monitoring are not limited to internal operations. The extended enterprise map (i.e., the value chain network model) is the geographic product flow diagram generated using INCOME Process Designer. SCOR metrics and other Collaborative, Planning, Forecasting, and Replenishment (CPFR) performance measures can be identified, implemented, and monitored. The benefits of this type of value chain intelligence and visibility empowers supply chain managers to be proactive.

All implemented functionality is accessed through a web interface called the iSCOR SCM-C^3. Executives and other stakeholders can personalize this web portal for supply chain visibility.

6.3. Proactive Value Chain Management with the ORACLE e-Business Suite and other Enterprise Applications

As noted, the INCOME KB methodology facilitates effective deployment of end-to-end business processes that are implied by Oracle e-Business Components. We also discussed the value that integrated packaged software provides in terms of tracking resources and planning how resources should be utilized. The iSCOR methodology provides SEM and decision support functionality using reliable, real-time data extracted from enterprise applications. When enterprise applications are Oracle e-Business Components, the INCOME KB provides a direct mapping to the relevant data sources. The business processes in other standard software or legacy systems could be mapped to their relevant data source, hence offering similar benefits.

However, the monitoring engine must be configured, and this is a challenge. In both cases, Business Process Management is supported by process-based performance metrics at the SCOR level.

7. INTRODUCTION TO AN *iSCOR* IMPLEMENTATION

Amazon.com's rise to fame in the e-Business revolution is legendary. Unparalleled customer service commitment and a huge variety of books offered for sale brought Amazon well deserved recognition. One source of Amazon's success is the Ingram Book Group, the largest U.S. book wholesaler. In 1997 Amazon was only shipping 5% of its orders from its own stock. Ingram, on the other hand, fulfilled 60% of Amazon's orders (Biancho, 1997). Ingram's success is derived from operational excellence using economies of scale to generate revenue. Not only Amazon, but also many Internet bookstores, libraries, brick-and-mortar bookstores benefit from Ingram's supply chain competency. At times being the leader in a field is not an easy task, since many competitors have their eyes on that position. Changing marketplace trends can hurt the leader if not counteracted in a timely manner.

Consequently, Ingram is cognizant of the need to maintain its competitive edge, and is continually looking for ways to improve its performance. Performance measurement, benchmarking, and internal process improvement initiatives are included in Ingram's competitive strategy. Company executives, noting the necessity to play an active role in the SCC's Special Industry Group for Retail & Consumer Goods, have decided that the iSCOR methodology aligns with their strategic objectives.

At the time this paper was written, efforts were underway to implement improved business process designs in Ingram's Logistics Division. The goal is to implement the iSCOR framework in the logistics operations, setting the stage for process-oriented performance monitoring, benchmarking and continuous improvement. Within the context of the current project, the success of the methodology and the research question will be evaluated using the results of Ingram's implementation.

8. CONCLUSIONS

Our goal was to introduce our ongoing research project. We presented a conceptual framework for value chain management, which includes SCM. Challenges in this field of management affect both the practitioners and the academe. Key issues, such as supply chain design, information and metrics based management, bottleneck management, lack of strategic alignment with IT initiatives were discussed. Then we introduced components that guide our research efforts: the SCOR model, enterprise software applications, and Business Process Management concepts. Finally, the iSCOR methodology and associate toolset were discussed.

Since we are in the early implementation stages of the Ingram Book Group iSCOR implementation project, we are not able show empirical evidence to answer our research question. However we offer a conceptual argument though literature survey, where we have shown that:

1. Business Process Management benefits the enterprise,
2. Tools that enable business process management improve its effectiveness,
3. Reference business process models can be and are used improve process management efficiencies,
4. Managing by process-oriented performance measures improves end-to-end enterprise management,

5. Enterprise applications, from traditional ERP systems to state-of-the-art SCM Applications, are powerful management solutions, if they are implemented correctly, and
6. Supply chain success depends on network design, information sharing, visibility and proactive measurement to respond quickly.

The iSCOR methodology addresses all of these issues. Conceptually, therefore, the iSCOR methodology should enable managers to better align their supply chain applications with their business processes and strategic objectives. This implies that the organization can also implement more effective SCM process improvement initiatives.

As the project at Ingram Book Group is completed and other industry applications use iSCOR, we will analyze, disseminate and improve upon the concepts discussed in paper. We are also committed to improve the technology tools, iSCOR and others, that will empower managers to make better SCM decisions.

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