Real-Time Value Chain Management

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ABSTRACT

Value creation in the digital economy of the 21st century is characterized by the instantaneous processing and coordination of value chain activities across extended enterprises. Value chain management has evolved from automation and integration to the optimization of the entire value chain in real-time. Real-time value chain management enables organizations to be agile and responsive in a complex and rapidly changing global environment. This paper examines the real-time characteristics for each of the activities in the demand and supply value chains. A model is presented for real-time value chain management enabled by technologies in e-business, knowledge management and business intelligence.

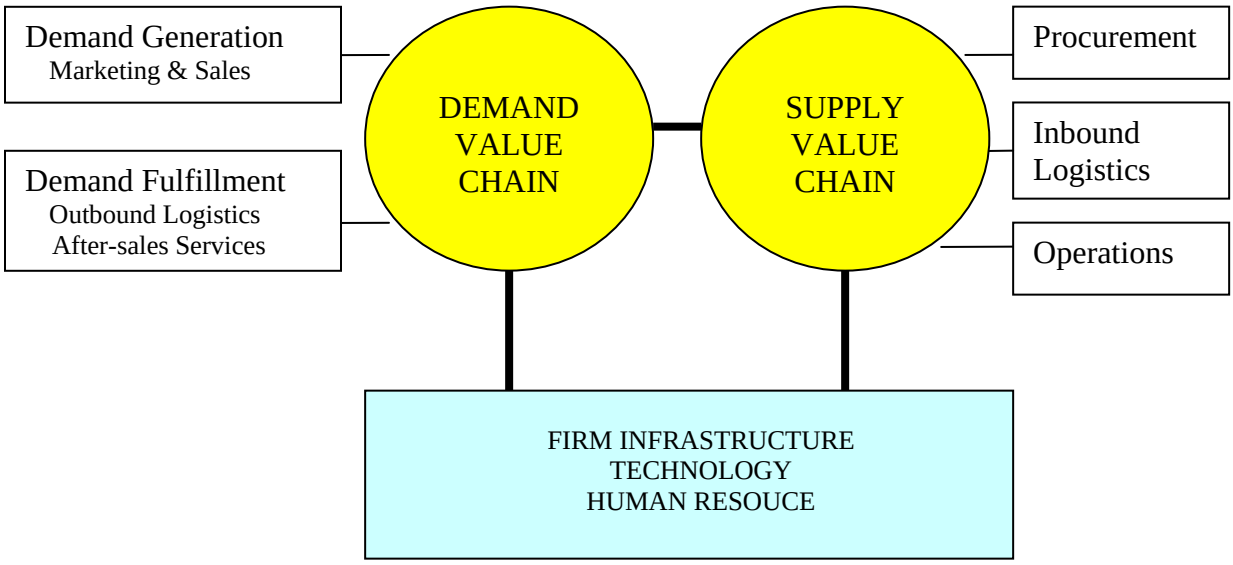
INTRODUCTION

As described by Porter (2001) the evolution of technologies in business has gone through the overlapping stages of automation of discrete transactions, functional enhancement of activities, cross-activity integration, integration of the entire value chain, and the optimization of various activities in the value chain in real-time. The digital economy of the 21st century fueled by globalization and the Internet is characterized by instantaneous processing, access and dissemination of information around the globe. The ability for organizations to be agile and responsive in an increasingly complex, rapidly changing and interconnected global environment requires real-time management and coordination of value chain activities across the extended enterprise. Real-time management of the value chain requires the capability of conducting transactions through computer networks, the capability of responding to situations with expertise and knowledge, and the capability to leverage business intelligence. This paper examines the characteristics of real-time value chain management and presents a model utilizing technologies in e-business, knowledge management and business intelligence.

CHARACTERISTICS OF REAL-TIME VALUE CHAIN

Real-time processing refers to the capability of a system that can respond immediately at the time a transaction occurs (Ralston et al. 1983). The value chain as described by Porter (1985) can be grouped into activities in the demand value chain, supply value chain, and the support activities for demand and supply (Figure 1). The demand value chain deals with demand generation in marketing and sales, and demand fulfillment in outbound logistics and services. The supply value chain deals with procurement, inbound logistics and operations. In the following, the real-time characteristics for each of the activities in the demand and supply value chains will be examined.

Figure 1: The Demand and Supply Value Chains.



Inbound and Outbound Logistics

The Council of Logistics Management defines logistics as "the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements". Efficient and effective logistics management plays a critical role in just-in-time supply chain management. Inbound and outbound logistics are among the five primary activities in the value chain model. Porter (1985) described inbound logistics activities as those associated with the functions of receiving, storing and dissemination of inputs, such as material handling, inventory control, vehicle scheduling, and returns to suppliers. It further described outbound logistics activities as those associated with functions in the final storage of goods from the last production process to the distribution of the goods to the customers, such as collecting, storing, and physically distributing the product to buyers, warehousing, material handling, delivery vehicle operations, order processing and scheduling.

Transportation and warehousing are two key components of logistics operations. In transportation, real-time tracking utilizing a combination of technologies in GPS and mobile computing provides visibility of the carrier, the freight and the driver. Individual loads can be tracked using RFID tagged or bar-coded containers. Movements of the carrier and freight can be tracked in real-time. Route optimization based on different criteria such as distance, cost, and specific customer requirements is a classic problem in transportation where various mathematical models have been developed. In the real-time paradigm, automated optimal routing can be developed based on changes in the delivery schedules. Visual routing can be provided in real-time to calculate the shortest distance between each stop (InterGis 2006). In warehousing, RFID technology can be used for real-time tracking of inventory and the movements of items from one location to another within or between warehouses.

For inbound logistics, goods can be scanned in the receiving dock and automatically matched with the purchase orders in the database. The receipt of goods can be updated in the database in real-time which triggers the payment to the supplier. Hammer et al. (1993) described this reengineered process for Ford Motor Company that resulted in

the dramatic reduction of accounts payable personnel by 75%. Electronic signatures can be captured in real-time at receiving to provide the proof of delivery.

The speed of delivery has become a characteristic of the digital economy. In many situations, the next morning delivery may not be fast enough. Same day or even same hour delivery has become the norm for some businesses such as the delivery of urgent materials to and from hospitals, pizza delivery and the delivery of groceries ordered online (Turban et al. 2006). Real-time customer demands require real-time adjustments in delivery. Postponement strategies in logistics such as rolling warehousing, delay some delivery activities including the decision about the quantity to unload at each destination at the time of unloading based on real-time customer demand (Knaack 2001). Haughton et al. (1997) described a regression model that predicts the expected magnitude of the resulting efficiencies on a route modification strategy based on real-time customer demand. Outbound logistics supporting on-demand deliveries requires the real-time management of scheduling of shipment, route optimization, and unloading quantities at each destination.

Operations

Porter (1985) described activities in operations as those associated with the functions of transforming inputs into the final product form, such as machining, packaging, assembly, equipment maintenance, testing, printing, and facility operations. Just-in-time production is becoming the norm in the digital economy where production activities are triggered by real-time customer orders, and thereby avoiding large warehouse inventories, reducing order-to-delivery cycle time, and better responding to specific customer needs.

Rudder (2003) described the key roles played by real-time manufacturing in complex manufacturing processes particularly in regulated industries. It pointed out that in the medical device industry; real-time manufacturing allows manufacturers to accurately track manufacturing processes to ensure quality control and regulatory compliance. Real-time manufacturing requires the real-time management of inventory, material movement, manufacturing process, machine control, quality and compliance control, manufacturing intelligence, and the real-time integration of manufacturing systems to other enterprise systems.

Effective inventory management is critical to business operations, customer satisfaction and business performance. Two basic functions concerning inventory include the tracking of items in inventory and making decisions about how much and when to order (Stevenson 2005). A perpetual inventory system that tracks the inventory on a continuous basis can provide real-time monitoring of inventory withdrawals, and help management to determine an optimal order quantity (Stevenson 2005). Bar coding technology which uses a laser tracking device to read a universal product code printed on the item or package, has been widely used for inventory tracking. Emerging technology in Radio Frequency Identification (RFID) is replacing bar codes in many applications. RFID tags that utilize electronic product codes can store greater amount of information that can provide a unique code for individual items rather that a type code that is provided by bar codes. Movements of individual items can be tracked using RFID from location to location. Real-time tracking of inventory using RFID can reduce the discrepancy between physical inventory and inventory records in the computer system. Real-time tracking at point-of-sales can help suppliers to monitor inventory in a vendor-managed inventory model. In this model, as exemplified by Wal-Mart's continuous replenishment inventory model with its suppliers, a vendor obtains information regarding the depletion of inventory using real-time point-of-sales data via an extranet and continuously replenishes the inventory as required by the demand. Real-time tracking of inventory includes the tracking of inventory on-hand in the warehouse, work-in-process inventory, inventory in-transit from one location to another within the warehouse or between warehouses, distribution centers and customer locations. Real-time monitoring of inventory provides the capability of sense and response for the demand and supply value chains.

Real-time process control is used in manufacturing across many industries to optimize performance, minimize unscheduled downtime and improve quality. Data collected from the shop floor can be turned into useful information to optimize the production process. Smith (2002) described the "always on" connection over a high-speed communications network that allows the monitoring of production data around the clock to gain real-time manufacturing intelligence. Statistical process control is commonly used during production in the quality control process. Real-time process control allows prompt corrective actions to be made during the production process. It utilizes a combination of technologies in infrared spectroscopy, telecommunications and artificial intelligence

(Zilberman et al. 1996). Other systems that support real-time operations include business process management and business activity monitoring, which enable businesses to make adjustments in real-time as conditions changes and allow real-time detection of situations and the formulation of speedy responses (Turban 2005).

Marketing and Sales

Porter (1985) described activities in marketing and sales as those associated with the functions of providing the means by which buyers can purchase the product and inducing them to do so, such as advertising, promotion, quoting, pricing, channel and sales force management. In marketing, mass advertising and direct mail advertising are supplemented or replaced by interactive advertising enabled by the Internet, where advertisers can interact with customers in real-time. Goldenberg (2006) described the characteristics of real-time marketing to include automatic re-segmentation of markets based on real-time information, auction-based pricing, collaboration in real-time product testing and feedback. Real-time marketing leveraging the Internet, wireless and GPS technologies can deliver mass customization of contents and location-based advisements. Market research can be done in real-time utilizing interactive Web-based surveys and online focus groups. Using technologies such as cookie files and clickstream analysis software, customer movements on the Web can be tracked in real-time. Based on purchasing history and browsing patterns, dynamic and personalized contents can be generated in real-time as exemplified by Amazon.com's use of collaborative filtering software to make dynamic and personalized book recommendations (Laudon et al. 2006). Real-time sales include the elements of real-time inventories, up-to-the-minute information about customers, real-time configuration of products and services, sharing of real-time information between manufacturers and sales channel partners, real-time monitoring of point-of-sales and inventory information across the supply chain (Chan 2006, Goldenberg 2006, Longworth 2003).

Services

Porter (1985) described activities in services as those associated with the functions of providing service to enhance or maintain the value of the product, such as installation, repair, training, parts supply, and product adjustment. In a market saturated with product offerings, quality value-added service can be a key differentiator for businesses. Value-added service goes beyond the support of products; it covers many other aspects of customer relationship management in providing information, resolving issues, providing account and technical support. The 21st century is characterized by the demand of instantaneous delivery of information and services. The long lines to see a teller at the bank are replaced by ATM machines and online banking. Online shopping eliminates the trips to physical stores. Real-time service is becoming the norm in many industries. Babcock (2005) described real-time service in the insurance industry including the use of a rules engine in automatic underwriting, the use of mobile technologies to sign-up new customers, and the use of wireless technologies to provide quick responses to hurricane victims. Bucholtz (1998) described the customers' demand for rapid service deployment and instant data delivery in the telecommunications industry. Real-time Internet-focused billing and customer care can provide a strategic competitive advantage. Bacheldor (2002) described in-store services for online shopping which include real-time chat service that connects online shoppers with customer service representatives, e-mail service that uses routing technology to deliver messages to the most appropriate operator, and self-service FAQ. Rogers (2002) described the online reference service for libraries that provides real-time interaction with users via e-mail and online chat. Wall Street Journal Online provides real-time service by sending business coverage, global market updates and articles from the journal to BlackBerry devices (Information Today 2005). Gilroy (2005) described real-time traffic service which delivers traffic updates every few minutes to a navigation system.

Procurement

Porter (1985) described activities in procurement as those associated with the functions of purchasing inputs used in the firm's value chain which include raw materials, supplies, and other consumable items as well as assets such as machinery. Although procurement has been traditionally viewed as a tactical activity supporting the operations of a firm, it is becoming more strategically significant in the digital economy. With the emergence of Internet-based e-procurement systems in the 1990s, buyers and supplies can be tied to a unified open platform through public and private e-marketplaces and exchanges. E-procurement systems provide online real-time procurement services that support e-sourcing, e-catalog, automated requisitions and purchase orders, reverse auctions, receiving, billing and

payment. Pallatto (2002) described e-procurement as bringing together all supplier information and automating the process of requisitioning supplies, obtaining PO approvals, and dispatching orders to the appropriate suppliers. Levin (2002) described an integration platform that connects the supplier's systems over the Internet to its customers' e-procurement systems and also hooks into the company's own legacy systems providing customers with current information, live pricing, and up-to-date inventory figures. Automating the purchase order process, Ford Motor Company eliminates the manual 3-way matching of purchase orders, receiving documents and invoices by reconciling in real-time goods received with outstanding purchase orders in the online database, and thus generating the authorization for payment (Hammer 1993). Internet technologies including XML, Java, and streaming data are utilized to create global procurement networks that provide online, real-time services such as catalog and request for quote (Waters et al. 2001). Wireless technologies are utilized in e-procurement software to provide remote real-time routing and approval of RFQs (Ferguson 2001).

Real-time Coordination of Cross Value Chain Activities

Real-time optimization of the value chain requires the real-time coordination of value chain activities across the extended business enterprise. Real-time changes in demand affect activities in production, procurement and logistics. Real-time reconciliation of purchase orders, receiving documents and invoices can dramatically reduce labor costs (Hammer 1993). Real-time coordination of return goods and billing can increase customer satisfaction. Just-in time and continuous replenishment supply methods can be implemented through the real-time collaboration between suppliers, manufacturers and retailers. Hagel (2002) pointed out that the leveraged growth of a company requires the coordinated mobilization of resources supplied by many enterprises operating at many levels of the value chain. Real-time optimization of the value chain requires cross-functional and cross-organizational integration and coordination of real-time value chain activities.

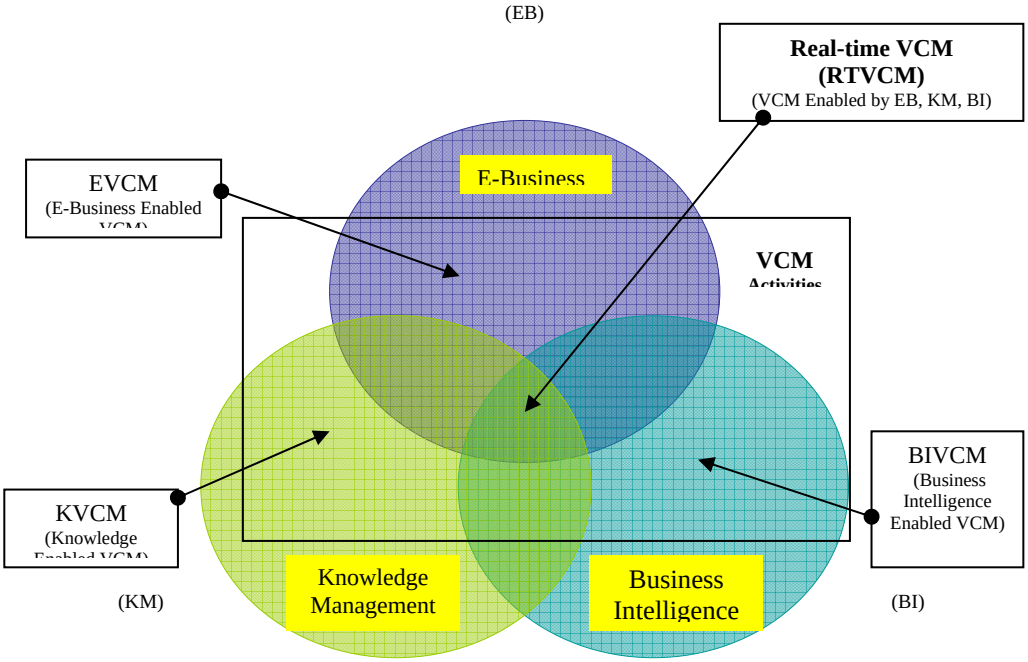
A MODEL FOR REAL-TIME VALUE CHAIN MANAGEMENT

Real-time value chain activities can be enabled by technologies in e-business, knowledge management and business intelligence. The model for real-time value chain management described in this paper provides an extension of the model for real-time customer relationship management presented in Chan (2006) to other value chain activities. The model describes the enablement of value chain activities by technologies in e-business, knowledge management and business intelligence (Figure 2). E-business enabled value chain management (EVCM) uses computer networks and other information technologies to perform value chain functions. Knowledge enabled value chain management (KVCM) represents the use of knowledge management and artificial intelligence technologies to support value chain activities. Business intelligence enabled value chain management (BIVCM) uses business intelligence technologies to support value chain activities. Real-time value chain management (RTVCM) utilizes all three dimensions in EVCM, KVCM and BIVCM.

E-business Enabled VCM (EVCM)

E-business technologies are used in many aspects of value chain management. E-enabled marketing and sales include direct e-marketing, e-order processing, e-advertising, online marketing campaigns, online surveys, online marketing research, e-marketplaces and e-CRM. E-enabled operations include collaborative product design and development, tracking movement of materials using RFID, and inventory management using wireless devices. E-logistics supports the material acquisition, warehousing and transportation processes; and enables distribution to couple routing optimization with inventory tracking information (Turban et al. 2006). E-business technologies have enabled the transformation of the inefficient and labor intensive procurement process to e-procurement where procurement activities can be conducted via computer networks in real-time. Customer service and support can be provided in real-time via the Internet in a self-service mode supplementing traditional touch points such as phone, fax and mail. In EVCM, the e-business platform, via the use of computer networks and other information technologies, provides the means for real-time communications, business transactions and collaboration for real-time value chain management.

Figure 2: Real-Time Value Chain Management (adapted from Chan 2006).



Knowledge Enabled VCM (KVCM)

Response and resolution to problems in a complex environment require a drastic increase in human resources including experts and trained personnel. In KVCM, knowledge management leveraging artificial intelligence technologies, such rule-based expert systems, intelligent agents, case-based reasoning, artificial neural networks and genetic algorithms, provides the means of creating and reusing relevant knowledge and automating human expertise. Knowledge-based systems are widely used in many areas of the value chain that include marketing decision support, one-to-one marketing via the Web, logistics strategy, inventory management, procurement, manufacturing, system configuration, monitoring of computers and quality assurance of information systems (Yavuz et al. 2005, Mussi 2003, Chow et al. 2005, Cheung et al. 2005, Cheung et al. 2004, Lau et al. 2005, Sunnapwar et al. 2006, Stumptner 1997, Jones et al. 2006 and Nookabadi et al. 2001). In customer relationship management, many critical processes in marketing, sales and services can be enabled by knowledge management (Chan 2006). Examples include the use of knowledge management in marketing resource management and field sales, the use of case-based reasoning in the automation of help desks and the use of neural networks in customer satisfaction surveys (Gartner 2003, Turban et al. 2005, Bolloju 1996 and Lee et al. 2005). Goldenberg (2006) characterized real-time service by the pervasive use of self-service that builds off extensive real-time knowledge bases. Intelligent agents are playing increasingly important roles in many areas of the value chain that include e-service, marketing decision support, B2B and B2C e-commerce, network management and monitoring (Aliev et al. 2000, Tillett 2000, Turban et al. 2005, Turban et al. 2006).

Business Intelligence Enabled VCM (BIVCM)

Business intelligence is an enabler in decision-making by accessing and analyzing relevant data from a wide variety of sources. Analytic models utilizing quantitative and qualitative methods can be used for data analysis to generate the intelligence to enhance business operations. The application of business intelligence in value chain management spans across many value chain activities. It can enable marketing and sales in the determination of product mix by market segments and sales channels, cross-selling and up-selling strategies, and marketing campaign effectiveness. In procurement, business intelligence can help in supplier selection and determining the optimal criteria for the quantity, price and time to purchase. Business intelligence can enhance production operations in capacity planning, preventing stock-out, automatic replenishment and preventative maintenance (Malykhina 2005, Harney 2003). In logistics, business intelligence can enhance carrier capacity planning, scheduling, route optimization and warehouse inventory control. Leveraging business intelligence, quick and relevant responses can be provided by anticipating and preventing potential customer and product problems and thus providing better customer services. Business intelligence for real-time value chain management requires real-time analytics which is the capability of applying analytic processing based on real-time data combined with analytical results from historic data to create real-time intelligence to support time-sensitive decisions (Chan 2006). Technologies in data warehousing and analytical processing are key components in the architecture for business intelligence. Data warehouses which source data from various transactional systems and operational data stores are the basic data constructs for analytical processing. Analytics utilizing statistical methods, OLAP, and data mining creates business intelligence to support value chain activities. In the realm of real-time business intelligence, virtual data warehouses and real-time analytics can be deployed. Virtual data warehouses allow the real-time processing of queries to distributed data sources bypassing the physical constructs of data warehouses. Real-time analytics utilizing virtual data warehousing can create the business intelligence required for real-time value chain management.

CONCLUSION

Value creation in the new economy of the 21st century fueled by the ubiquity of the Internet is characterized by the real-time management of value chain activities and the real-time optimization of the entire value chain across extended enterprises. Real-time processing is embedded in and across all activities in the demand and supply value chains. E-business technologies that utilize computer networks and other digital technologies provide the platform for real-time communication and business transactions. Real-time value chain management has great practical significance for the management of the demand and supply value chains. It provides organizations the agility to sense and respond with capabilities in just-in-time sourcing, production and distribution. The real-time coordination of value chain activities will enhance customer and supplier relationships and reduce operation costs. Real-time responses and resolutions in an environment with increased complexity and intensity require knowledge, expertise and intelligence. This paper examines the characteristics of real-time value chain management and its enablement by technologies in e-business, knowledge management and business intelligence.

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