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ELECTRONIC COMMERCE SUCCESS THEORY: A PROPOSED MODEL FOR SUPPLY CHAIN MANAGEMENT SUCCESS

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ABSTRACT

Electronic commerce and supply chain management are becoming more interlinked everyday. The assumed benefits of electronic commerce (reduced costs, improved customer service, etc.) are understood to exist in supply chain management when electronic commerce is applied across that medium. The question becomes whether these assumed benefits are real benefits. This paper proposes an electronic commerce success model using an application of electronic commerce, supply chain management. The model incorporates the supply chain, its members and functions, and electronic commerce success measures. Future research should seek to test the proposed model, measuring electronic commerce success given the supply chain member and its function.

INTRODUCTION

Because of its strategic utilization in today's businesses, the use of electronic commerce (EC) in supply chain management (SCM) demands attention from both researchers and practitioners. Wal-Mart, Levi Strauss, General Motors, etc. are examples of organizations that have built relationships with suppliers and customers with electronic linkages (Zwass 1996). Despite the growing use of EC to foster SCM, currently no research has been conducted to determine if EC has improved supply chain (SC) operations.

This paper proposes an EC success model as it applies to SCM. The model could be used to answer the following, "Does EC in

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SCs improve their effectiveness?" Yet, to be able to answer this question, a theoretical EC success model must be established. The SC, its members and functions, and EC success measures will need to be integrated. This paper is organized as follows. First, EC and SCM will be discussed separately. Next, the theoretical combination of the two concepts will be presented (model development and operationalization). Finally, conclusions and future research possibilities will be discussed.

ELECTRONIC COMMERCE THEORY

EC is a modern business methodology that addresses the need to cut costs while improving the quality of goods and services and increasing the speed of service delivery to organizations, merchants, and consumers (Kalakota and Whinston 1996); it is commonly associated with the buying and selling of information, products, and services via computer networks (SC networks). Moreover, EC is drastically changing the way business is accomplished (Senn 1996) by allowing companies to move from the tedious aspects of business to productivity enhancements.

EC growth early on was slow, since common data formats were needed to transfer information between communities of traders. This led to the creation of standards in Europe and the U. S. and the cooperation of industry groups in defining requirements. In the 1980s, Value Added Network (VAN) services were created to provide secure communications channels for business usage. Their awareness raising activities, along with the standards, helped to start building communities of users in a variety of business sectors (Zwass 1996). Since 1990, EC has reached every industrialized continent (Smith 1997). EC activities are estimated to be growing by 200% annually (Wyckoff 1997), and it is predicted that Internet commerce will produce $1.3 trillion by 2003 (Werner 1999). Electronic transactions are becoming common in the information society, therefore EC networks will be a major factor in making the information society global. IT bolsters the organization's ability to coordinate business transactions within the organization and among organizations, such as between suppliers and manufacturers, thus, the importance of the SC.

Table 1. Electronic Commerce Framework

1. **Products and Structures**
   - **Electronic marketplaces and electronic hierarchies**
     - Electronic auctions, brokerages, dealerships, *supply chain management*, etc.
   - **Products and systems**
     - On-line marketing, infotainment-on-demand, *supplier-customer linkages*, etc.
2. **Services**
   - **Enabling services**
     - E-money, digital libraries, electronic directories, smart card systems, etc.
   - **Secure messaging**
     - EDI, e-mail, EFT, hypertext transfer protocol, etc.
3. **Infrastructure**
   - **Hypermedia/multimedia object management**
     - WWW with Java, digital video, etc.
   - **Public and private communication utilities**
     - Internet, value-added networks (VANs)
   - **Wide-area telecommunications infrastructure**
     - Guided- and wireless-media networks, telecom, etc.

A Proposed Framework. Frameworks of EC have been presented by various authors (Zwass 1996; Applegate, Holsapple, Kalakota, Radermacher and Whinston 1996). These frameworks have three functional areas: (1) products and structures, (2) services, and (3) infrastructure. The business relationships between the SC members are the rationale for the EC framework development. Consequently, there must be an identification

of SCMs placement within EC, as well as a basic understanding of the functionality of EC. Table 1 depicts a synthesis of the existing EC frameworks.

Products and structures consist of products and systems/structures, and electronic marketplaces and electronic hierarchies. There are three categories of EC products and structures: (1) customer-to-business, (2) business-to-business, and (3) intra-organization (Applegate et al. 1996; Shaw, Gardner and Thomas 1997; Technology Forecast 1997; Zwass 1996). Customer-to-business transactions involve customers learning about products through electronic publishing, buying those products using electronic cash (e-cash), etc., receiving those products by a common carrier or over the network, and receiving post-purchase support electronically. This facilitating of sales and services includes remote/home shopping, banking, and stock brokerage (Venkatraman 2000). Business-to-business transactions are the most well established category of EC. They include the use of electronic data interchange (EDI) and electronic mail (e-mail) for purchasing goods/services and information and consulting services and create new challenges for buyers and sellers (Venkatraman 2000; Wise and Morrison 2000). Corporate, government, and other organizations conduct business transactions in this way. Intra-organization transactions distribute information about customers and competitors throughout the firm (Senn 1996). In doing this, customer satisfaction becomes an ongoing objective in which all members of the firm can be involved. This is the fastest growing area of EC.

Electronic marketplaces and electronic hierarchies create business relationships and transactions between firms (*SCs*). Electronic marketplaces facilitate transactions between buyers and suppliers over telecommunications networks (Senn 1996). They allow buyers and sellers to exchange information about prices and product offerings (Bakos 1991; Strader and Shaw 1997) and provide support for all steps in the entire order fulfillment process. Electronic hierarchies are long-lasting *supplier-customer relationships* between firms.

Services consist of enabling services and secure messaging. Enabling services involve the finding and delivering of information, as well as the negotiation, transaction, and settlement. This includes digital libraries, electronic catalogs/directories, smart agents (which seek out a desired good/service), electronic authentication, copyright protection, traffic auditing, etc.

The major messaging services include EDI, electronic funds transfer (EFT), and e-mail. EDI is the "computer-to-computer exchange of standard, formatted business documents transmitted over computer networks where translation systems overcome differences in information technology used by trading partners" (Senn 1996). Industries are communicating electronically which creates a fundamental shift in the economies of information (Evans and Wurster 1997). EDI helps reduce paper expenses, compress business cycles, and intensify relationships with business partners. EFT enables interbank funds transfers in the form of information. It is the "automated exchange of money between parties in a commercial transaction or between banks representing businesses responsible for conducting the settlement portion of a business transaction" (Senn 1996). Finally, e-mail has had a profound effect on communication and is the most popular use of the Internet. With e-mail, users can create and send messages to one or more people. It helps speed messaging, thus avoiding "phone tag," and it reduces the cost of messaging in terms of postage and time invested in message preparation (Fitzgerald and Dennis 1996).

Infrastructure consists of hypermedia/multimedia object management, public and private communication utilities, and wide-area telecommunications infrastructure. That is, the hardware, software, databases, and telecommunications that provide functionality for the World Wide Web (WWW) (over the Internet), support EDI and other messaging, etc.

The technological infrastructure of EC is an "intermeshed network of wide-area telecommunications networks, extended by the metropolitan and local-area nets" (Zwass 1996). Telecommunications' capabilities are delivered by value-added networks (VANs)

and the Internet. VANs are established by vendors to deliver services over and above those of common carriers (those licensed by governments to provide public communications services). The Internet has become the major vehicle for EC, especially since the WWW's invention as a means of sharing information. It has worldwide connectivity, is growing in every segment of society, is interactive, and is relatively inexpensive to use (Pyle 1996). The Internet continues to grow with the population of the Internet doubling every year or so (Borenstein et al. 1996). Strategically the Internet was originally thought to only be for research and development, but EC extends the Internet's role into marketing and sales.

Commerce Model. Commerce among and within organizations supports the coordination between buyers and sellers (i.e. market transactions) and the coordination within the organization (Wigand 1997). It is about the dialog between buyers and sellers. Participants in this cycle and their roles are as follows (Young 1996): (1) Buyer (wishes to acquire a product/service by providing payment); (2) Seller (offers product/service for sale); (3) Trading Partners (financial institutions that facilitate the clearing and transfer of funds, suppliers to the merchant that provide raw materials/services to the seller, and others, such as health/safety regulators, etc.; and (4) Hostile Adversary (threatens to cause harm to business or transaction).

The life cycle model for EC is seen from a buyer-seller perspective. Figure 1 illustrates how EC can be used in all phases of a commerce transaction (Young 1996). The EC cycle/model is the entire process starting from the initial inquiry about an offering through to the "after delivery support." Information is gathered when sellers advertise their goods/services and buyers search for products to fill their needs. Ordering takes place when an offer (terms) is made and acceptance takes place. Payment of goods/services is made between the buyer and seller, and the order is fulfilled when the product/service is transferred to the buyer. Support and service is provided by answering questions regarding the products, identifying options and updates, handling complaints and returns, etc.

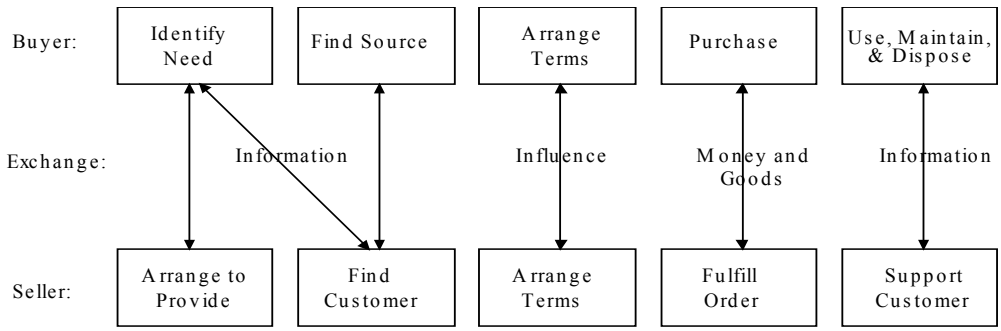

Figure 1. Electronic Commerce Transaction Model

Clarke (1993) proposes a five-phase process model of EC that is very similar to the model in Figure 1. The pre-conceptual phase (1) is concerned with gathering information about products/services and discovering the sources of supply. The contractual phase (2) forms a relationship between the buyer and seller. This includes the establishment of terms and conditions for the transaction. The ordering and logistics phase (3) takes place when purchase orders are issued and processed, goods are transported and/or services are provided, and post-delivery functions are performed. The settlement phase (4) involves invoicing, payment authorization,

etc. Finally, the post-processing (5) phase gathers and reports management information, and stores and analyzes purchase statistics.

EC adds significant value to new customer management strategies. It (1) directly connects buyers and sellers, (2) supports fully digital information exchange between buyers and sellers, (3) suppresses time and places limits, (4) supports interactivity (adapts to customer behavior), and (5) is updated in real-time.

SUPPLY CHAIN MANAGEMENT THEORY

Logistics is the process of planning, implementing, and controlling the efficient, cost-effective flow and storage of goods and information (Lewis and Talalayevsky 1997; Mabert and Venkataramanan 1998). That is the packaging, unitizing, loading/unloading/reloading, transporting, moving, storing, and sorting of products, as well as keeping track of those actions, providing data on location and storage, and improving handling, inventory, warehousing, and transit costs (Poirier and Reiter 1996). The major factors that drive logistics are shorter product life cycles, increased product proliferation, more demanding customers with higher expectations, just-in-time manufacturing, and globalization of the marketplace (Lewis and Talalayevsky 1997).

"Logistics is as much about the management and movement of information as it is about the management and movement of physical goods" (Hammant 1995). Information technology (IT) improvements have reduced logistic transaction costs and supported better communications between organizations. The integration of logistic activities has lent support to the SC concept. The integrated SC creates better information, which supports lower inventory levels and improved financial performance. Improvements in IT, such as EDI, are decreasing the workload associated with routine logistic transactions. EC represents a significant opportunity for integrated SCM efforts (Handfield and Nichols 1999). Managers can therefore focus on broader issues that have a direct impact on competitiveness and performance.

Supply chain management (SCM) "encompasses materials/supply management from the supply of basic raw materials to final product" (Tan, Kannan and Handfield 1998). It focuses on how firms utilize their suppliers' processes, technology, and capability to enhance competitive advantage (Hammant 1995; Handfield and Nichols 1999; Lewis and Talalayevsky 1997; Tan et al. 1998). By linking SC members, those members can work together to reduce prices and the costs associated with working together (Underhill 1996). The challenge of SCM is to balance the requirements of prompt customer service with management costs, therefore providing total coordination and control of all supplies.

Members of the SC. The supply chain (SC) is "groups of enterprises (suppliers, customers, producers, and service providers) that link together to acquire, purchase, convert/manufacture, assemble, and distribute goods and services to the ultimate consumers or end users" (Harrington 1995). That is, the network of members that perform the functions of product development, material movement, product manufacturing, etc. (Mabert and Venkataramanan 1998). This chain is a network of interlinked organizations that have a common purpose, to achieve the best possible means of affecting that delivery. It, broadly, encompasses all logistic activities, customer-supplier partnerships, new product development and introduction, inventory management, and facilities (Stephens, Gustin and Ayers 1997). SC product flows can be physical, monetary, and informational (Stephens et al. 1997). The basic SC consists of suppliers, manufacturers, distributors, retail outlets, and customers.

The *suppliers* are the sources that begin the SC network. They provide the basic ingredients to start the SC, such as raw materials, ingredients, commodities, and subassemblies (Holland, Lockett and Blackman 1992; Poirier and Reiter 1996). Suppliers specify order requirements, coordinate materials handling, packaging and facilities requirements, select mode and carrier, and arrange equipment interchange (Rose 1979).

The *manufacturers* build, assemble, convert, or furnish products and services (Poirier and Reiter 1996). They are responsible for product and service performance and manage a broad array of inbound materials and component parts (Bowersox, Daugherty, Droge, Rogers and Wardlow 1989), while providing the highest level of customer service and operating in an efficient, effective manner. They have the following responsibilities: managing logistics activities, contributing to the profitability of the firm, improving operating performance, and keeping on top of new technology trends (Rose 1979).

The *distributors* transport the finished products from the manufacturers to the retail outlets. They are concerned with delivering the right amounts at the appropriate time (of request) (Poirier and Reiter 1996). The distributors must provide documentation, packaging, product identification, etc., be informed about regulatory and liability conditions for product movements and storage, coordinate transportation equipment, and establish delivery and service schedules (Rose 1979).

The *retail outlets* offer the products and services to would-be purchasers. They include grocery stores, department stores, discount outlets, club stores, superstores, and mass merchandisers. Retail outlets typically stock a broad product assortment (Bowersox et al. 1989; Poirier and Reiter 1996); in general, they coordinate inventory requirements with shipment schedules, implement order processing, meet the needs of customers, obtain information feedback regarding quality of service, and facilitate claim settlements and returned merchandise (Rose 1979).

The *customers* conclude the SC. They select and purchase products from the retail outlets (Holland et al. 1992; Poirier and Reiter 1996; Williams 1994).

Many authors cite A.T. Kearney's supply chain model when discussing SCM. This model is depicted in Figure 2. This diagram includes supplier's suppliers, suppliers, the company, customers, and customers/end users. It illustrates the complete linkages of groups of enterprises that come together to design, market, acquire, convert, and distribute goods and services to ultimate consumers.

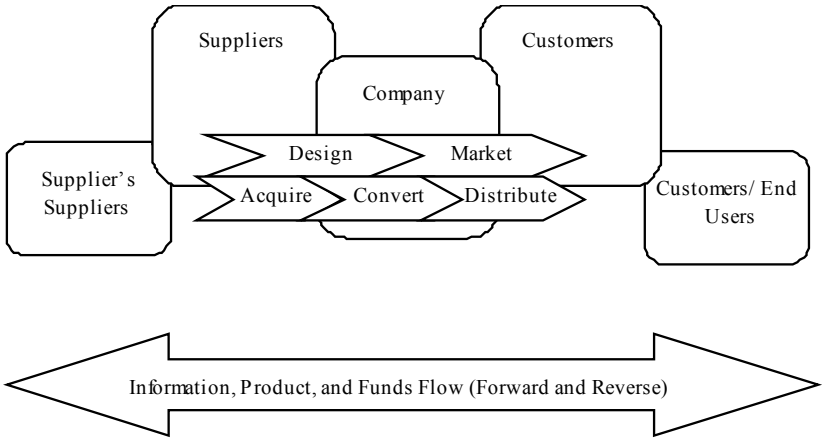

Figure 2. Supply Chain Model

Functions of the SC. An integrated SC works with the coordination of all activities concerned with planning, coordinating, and controlling material, parts, and finished goods from suppliers to customers (Harrington 1987; Stevens 1989). Therefore for each of the SC members, some of the same basic activities are performed. Six basic functions exist in

logistics (Harrington 1987): customer service, inventories, warehousing, transportation, order entry, and production setup. Figure 3 presents the traditional view of logistics for each member of the SC (Harrington 1987). Each of the components in Figure 3 is dedicated to the fulfillment of physical and informational flows. Also, each component is interrelated to all the others. Therefore, the supplier, manufacturer, distributor, retail outlet, and customer could individually contain each portion of Figure 3. It must be determined whether each member of the SC must make decisions with regard to customer service, inventories, transportation, warehousing, order entry, and production setup (Rose 1979).

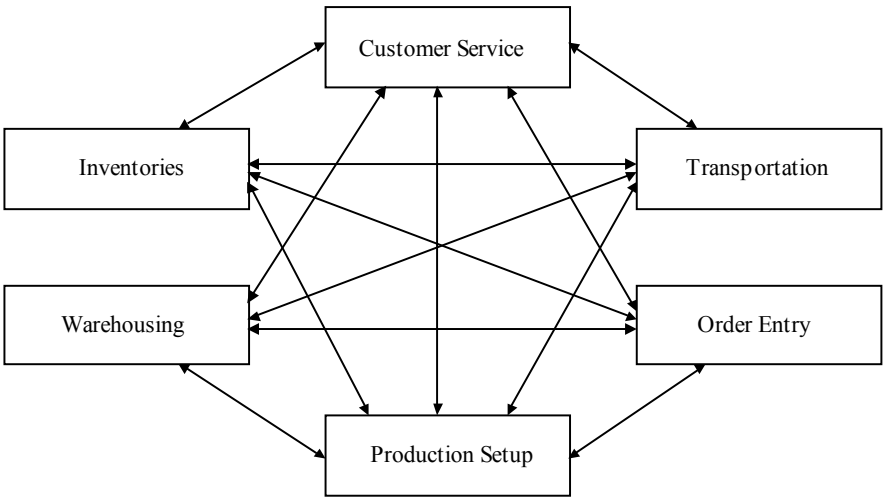

Figure 3. Traditional View of Supply Chain Member Functions

Customer service can be seen as a series of functions (order filling; maintaining inventory records) or as a performance measure (X% of scheduled orders shipped on the assigned date; X% of all orders filled accurately) (Rose 1979). Customer service is the responsibility of all members of the SC, and many customer service elements are important. Product availability is the most important element to the users (Rose 1979). Getting the right products to the right place at the right time is critical for good customer service. Other elements of customer service are order cycle, information services, order and shipment flexibility, order and damage adjustments, and product parts and services.

Inventory control/management is concerned with carrying the appropriate inventory level (Bowersox 1974; Bowersox et al. 1989; Rose 1979). Too high an inventory level causes high carrying cost, while too low causes high restocking and production costs as well as lost sales and customer goodwill. The objective of inventory control is to carry the minimum quantities needed to have the desired delivery capability and total cost expenditure. Therefore, the management of inventory is seen as balancing stock shortage and stock excess within a planning environment.

Warehousing is a very important function of SC members (Bowersox et al. 1989; Rose 1979). In fact, it is generally second only to transportation. A warehouse is a specialized fixed facility for delivering a certain level of service at the lowest total cost (Bowersox 1974). Minimal transportation costs, customer services, inventory levels, and company warehouses versus public warehouses are matters that must be determined with regard to optimal location of the warehouses. Strategic location of the warehouses is needed to provide better customer service. It also can help reduce transportation costs by moving truckload quantities into the warehouses for later distribution in smaller quantities.

Transportation is the most common component of the SC (Bowersox et al. 1989; Taff 1984). Since transportation expenditures

are the most significant component/function in physical distribution, distribution managers must have knowledge of modes of transportation and routing information. The company must establish the ability to move materials and finished inventories between facilities. There are three primary factors that establish transport capability: cost of service, speed of service, and consistency of service (Bowersox 1974).

Order entry and processing is receiving greater attention by companies since there is a need for careful interdepartmental coordination. Effective information flow begins with the transmission of the customer order and credit check, and continues with the paper processing, the withdrawal from the warehouse, the assembling and packing, the transportation, the inventory adjustment, and the information transmission to production planning (Bowersox et al. 1989; Rose 1979; Taff 1984). If order entry and processing are not managed efficiently, then other managerial efforts will be wasted.

Finally, *production setup* is concerned with the physical arrangement of information/materials/equipment for production of goods (Harrington 1987). It can involve site selection, packaging, materials handling, information, etc., as they apply to the production process.

MODEL DEVELOPMENT FOR EC-SCM

Having examined the EC and SCM theories, the appropriate SC members (supplier, manufacturer, distributor, retail outlet, and customer) and functions (customer service, inventories, warehousing, transportation, order entry, and production setup) are established. EC is a new enabling tool of modern SCs. SCM exists without EC, but EC could improve the management of the entire SC, from supplier to customer, and of the SC member functions. In the following section, the information system (IS) (i.e. EC) success measures are presented. The EC success model incorporates the components of SCM by focusing on EC success measures within each SC member and function. In this way, the EC success/effectiveness model is established.

IS/EC Success Measures. The IS field addresses the use of computer technology in business. DeLone and McLean (1992) present a ISs success model that has been cited many times over the years. DeLone (1988) and Lucas (1975) also include many of the same variables as DeLone and McLean (1992). DeLone and McLean's (1992) model is presented in Figure 4 and is used in this study to measure EC (a IS) success. The model encompasses six dimensions of IS success – system quality, information quality, user satisfaction, system usage, individual impact, and organizational impact.

IS success has been discussed in terms of production, products, receipt of products, influence on recipient, and influence on system (Mason 1978). These variables relate to the SC system. DeLone and McLean's (1992) variables directly correspond to Mason's variables as follows: production – system quality; product – information quality; receipt of product – use; influence on recipient – user satisfaction and individual impact; and influence of system – organizational impact. Therefore, DeLone and McLean's IS success model is appropriate when studying SCM as an application of EC.

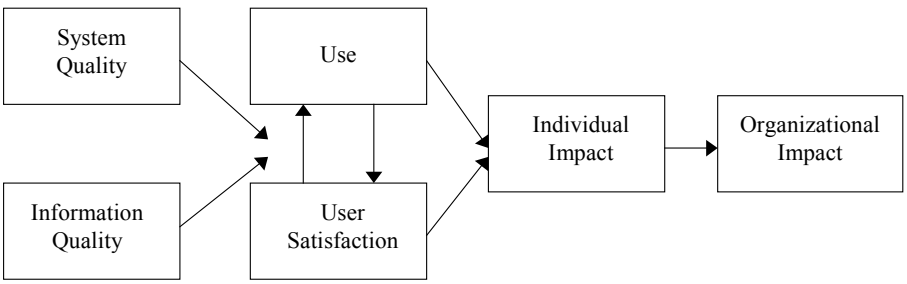

Figure 4. IS Success Model

System quality is a measure of the information processing system that evaluates the contribution of the IS(s) to the organization (DeLone and McLean 1992). It has been measured in terms of resource utilization (Kriebel and Raviv 1980, 1982), hardware utilization (Alloway 1980), ease of terminal use and reliability of the computer system (Swanson 1974), system accuracy and response time (Emery 1971; Hamilton and Chervany 1981), etc. (refer to DeLone and McLean 1992).

Information quality is a measure of information system output. It focuses on the quality of the information that the system produces, primarily in the form of reports (DeLone and McLean 1992). Information quality (user satisfaction) has been measured through information accuracy, output timeliness, reliability, completeness, relevance, and precision and accuracy (Bailey and Pearson 1983). Information value has also been measured through accuracy, timeliness, relevance, aggregation, and formatting (Ahituv 1980). Numerous other studies have developed criteria related to information quality (refer to DeLone and McLean 1992).

The recipient response to the use of the IS output is *user satisfaction*. It is the most widely used measure of IS success (DeLone and McLean 1992). Bailey and Pearson (1983) developed a full instrument to measure user satisfaction. Swanson (1974) measures IS appreciation, and many other studies (refer to DeLone and McLean 1992) measure overall user satisfaction. Grover, Jeong and Segars (1996) also discuss user satisfaction perceptual measures for IS effectiveness.

The *use* of an IS is the recipient consumption of the output of that IS. This can be in terms of the use of IS reports or operations research models (DeLone and McLean 1992). Use can be reported as actual use or reported use. Actual use can be captured as the number of computer inquiries (King and Rodriguez 1981), where as reported use can be captured as a subjective/perceived measure of the IS's use (DeLone and McLean 1992). Grover, et al. (1996) outline usage measures for IS effectiveness, such as use, usage, user expectation, user satisfaction, user performance, and utilization.

Individual impact is the effect of information on the recipient's behavior. Impact is closely related to performance, but it is also an indicator of better understanding in the decision process, improved decision making productivity, etc. (DeLone and McLean 1992). Individual impact can be measured in terms of personal effectiveness (Millman and Hartwick 1987), productivity improvement (Rivard and Huff 1984, 1985), etc.

Organizational impact is the information's effect on organizational performance (DeLone and McLean 1992). In IS studies, organizational impact has been measured primarily with cost and revenue calculations, such as return on investment, return on assets, and market share (Cron and Sobol 1983; Kaspar and Cerveny 1985), but since organizational impact is a performance variable, other performance measures related to the application in question (SCM) may be used. Therefore, historical data could be employed to measure SC dimensions.

Many of the measures for information quality, system quality, and user satisfaction overlap. In fact, many of the measures are concerned with user satisfaction with the system. The measures for system quality and information quality are part of the instrument items for user satisfaction (e.g. Bailey and Pearson 1983; Ives, Olson and Baroudi 1983; Doll and Torkzadeh 1988). Figure 5 illustrates the combination of information quality, system quality, and user satisfaction into one construct, satisfaction. The theoretical combination of the three variables into one variable (as tested by Glorfeld 1994) found that the three variables (information quality, system quality and user satisfaction) result in a single dimension, satisfaction. Therefore, information quality, system quality, and user satisfaction are combined into one construct, *satisfaction*.

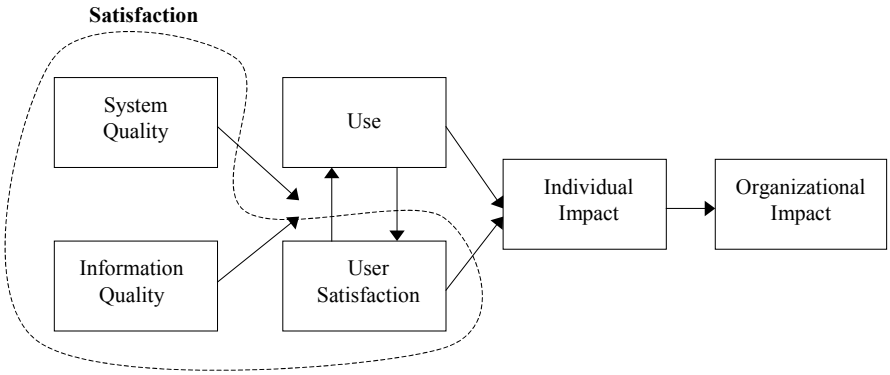

Figure 5. Satisfaction Measure

When discussing organizational impact, the IS literature and the logistics literature use different terminology. Organizational impact in the IS literature is a success or effectiveness measure. *Organizational impact*, *success*, and *effectiveness* are treated by some as synonyms for one another in IS research (DeLone 1988; DeLone and McLean 1992; Grover et al. 1996; Lucas 1975). In the logistics literature, organizational impact is defined in terms of performance (Bowersox 1974; Chow, Heaver and Henriksson 1994; Poirier and Reiter 1996; Rose 1979; Sharma, Grewal and Levy 1995). Therefore, *organizational performance* also becomes a synonym. In this research, *organizational impact*, *success*, *effectiveness*, *performance*, and *organizational performance* are referenced interchangeably in various discussions.

Satisfaction, *use*, and *individual impact* all focus on individual impact/performance and measure recipient behavior. Consequently, the three variables together will be addressed as a measure of *individual performance*.

SC Members and Functions. The supply chain begins with sources that can provide the supplies (i.e. raw materials, ingredients, commodities). These are the suppliers and the supplier's suppliers. Next, the manufacturer builds, assembles, converts, or furnishes products or services, the distributor transports the finished products from manufacturers through warehouses or distribution centers and delivers the products to the retail outlets, and retail outlets offer the products to potential consumers. Finally, consumers select products and make purchases to conclude the chain (Poirier and Reiter 1996). The basic SC is presented in Figure 6.

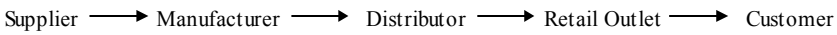

Figure 6. The Supply Chain

It must be determined, at this point, which functions (of those previously presented) apply to which SC members. Logistic functions have been identified by category or member of the SC (Bowersox et al. 1989; Rose 1979). The supplier, manufacturer, and distributor are concerned with all functions/components of the SC. That is, customer service, inventory control, transportation, warehousing, order processing, and production planning. The retail outlet is not concerned with production setup, but it does focus on the other five components. Production setup is concerned with the production of goods, therefore by the time the retail outlet receives a good, the production

setup has already been completed. Finally, the customer is ultimately concerned with being provided good customer service and having the item of their choice available (inventories). The customers become involved in the SC once the goods reach the retail outlet. Figure 7 visually displays the functions for each SC member.

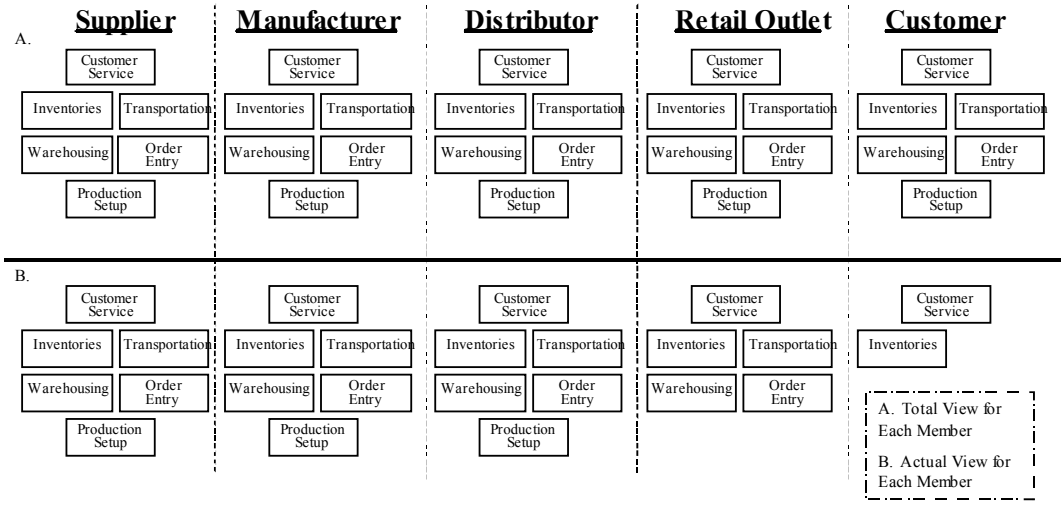

Figure 7. Supply Chain Members' Functions

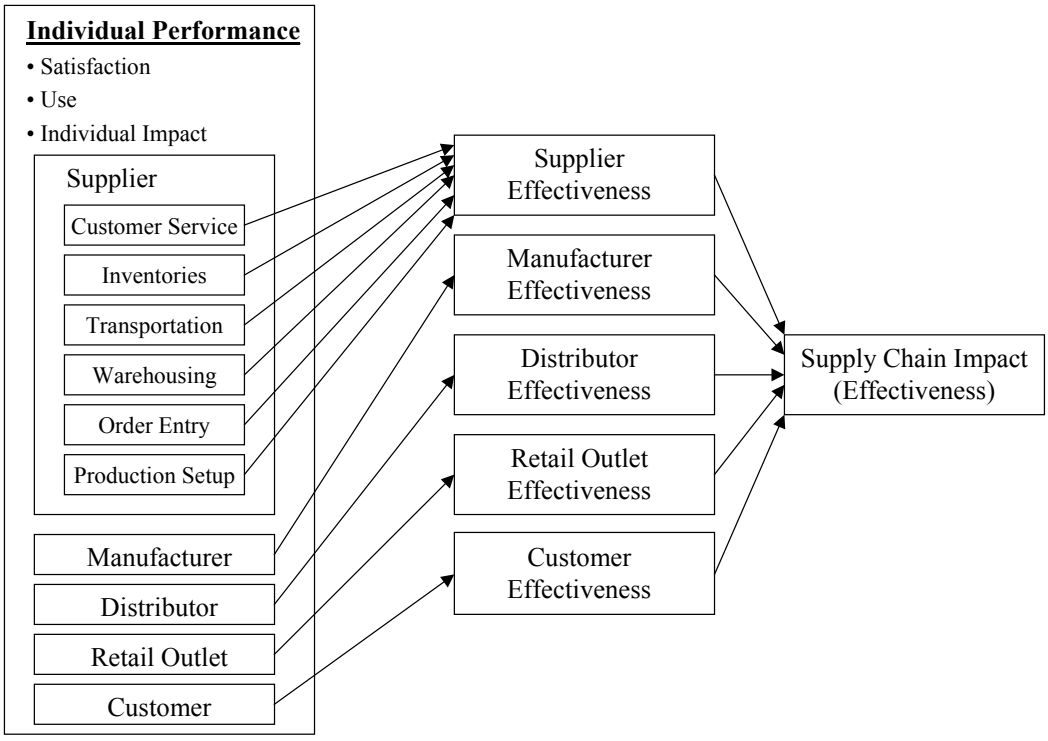

Figure 8. EC Success/Effectiveness Model

IS (EC) and SCM Interface. A model is developed that incorporates the SC members and their functions into the IS/EC success model. Figure 8 contains that model. The SC in Figure 6 contains five SC members -- supplier, manufacturer, distributor, retail outlet, and customer. Each of these members has various functions as stated in Figure 7. Each of the member functions is first placed with that member (Bowersox et al. 1989; Rose 1979). Table 2 summarizes each member's functions. As previously discussed, the supplier, manufacturer and distributor are concerned with all functions (customer service, inventories, transportation, warehousing, order entry, and production setup) in the SC. The retail outlet is concerned with all functions also except for production setup, and the customer is ultimately concerned with customer service and inventories.

Table 2. Supply Chain Member Functions

	Customer Service	Inventories	Transportation	Warehousing	Order Entry	Production Setup
Supplier	X	X	X	X	X	X
Manufacturer	X	X	X	X	X	X
Distributor	X	X	X	X	X	X
Retail Outlet	X	X	X	X	X	
Customer	X	X				

Next, as theorized, the individual performance of each SC member's function must be measured in terms of satisfaction, use and individual impact, as taken from the IS success model in Figure 5. For example (refer to Figure 8), the supplier's customer service will be measured for satisfaction, use, and individual impact; the manufacturer's customer service will be measured for satisfaction, use, and individual impact; the supplier's inventories will be measured for satisfaction, use, and individual impact; the manufacturer's inventories will be measured for satisfaction, use, and individual impact; etc. (Note: Measurement is described in the Model Operationalization section.)

Each SC member's effectiveness (organizational performance/impact) is measured separately. Depending on the SC member, effectiveness could have different dimensions (significant variables) (Chen 1997; Rose 1979). Therefore (refer to Figure 8), each supplier function (customer service, inventories, transportation, warehousing, order entry, and production setup) impacts the supplier effectiveness; each manufacturer function (customer service, inventories, transportation, warehousing, order entry, and production setup) impacts the manufacturer effectiveness; etc. (refer to the Supply Chain Member Functions in Table 2).

Effectiveness of the entire SC can only be achieved when each member in the chain is contributing to the maximum effectiveness of the SC (Chen 1997). Therefore, each individual member's effectiveness in turn impacts the overall supply chain effectiveness. Referring to Figure 8, each individual SC member impacts the overall SC and therefore the ultimate effectiveness of that SC.

In summary, the individual performance (satisfaction, use, and individual impact) pertains to each SC member and its functions. For each supply chain member, various functions exist, customer service, inventories, transportation, warehousing, order entry, and production setup (Bowersox et al. 1989; Rose 1979). Each member's functions are theorized to impact that member's effectiveness, which impacts the chain's effectiveness (Chen 1997;

DeLone and McLean 1992; Rose 1979). Figures 9 through 14 provide a more detailed look at each member of the SC. Figure 9 illustrates the supplier model. The supplier effectiveness model incorporates all functions of the SC. Figure 10 presents the manufacturer model and Figure 11 presents the distributor model. The manufacturer effectiveness model and the distributor effectiveness model also incorporate all functions of the SC. In Figure 12, the retail outlet effectiveness model includes five of the six functions of the SC. All functions except production setup are included. Figure 13 contains the customer model. The customer effectiveness model includes only the customer service and inventory functions of the SC. Thus to illustrate the retail outlet (Figure 12), five of the six functions (excluding production setup) pertain to retail outlets. Therefore, the satisfaction, use, and individual impact of the customer service element of conducting business through the use of EC impacts the retail outlet's effectiveness; the satisfaction, use, and individual impact of the inventories element of conducting business through the use of EC impacts the retail outlet's effectiveness; etc.

Finally, Figure 14 presents the SC model. The SC effectiveness model indicates the supplier, manufacturer, distributor, retail outlet, and customer affect on the entire SC. As stated before, the effectiveness of the entire SC can only be achieved when each member in the chain is contributing to the maximum effectiveness of the SC (Chen 1997).

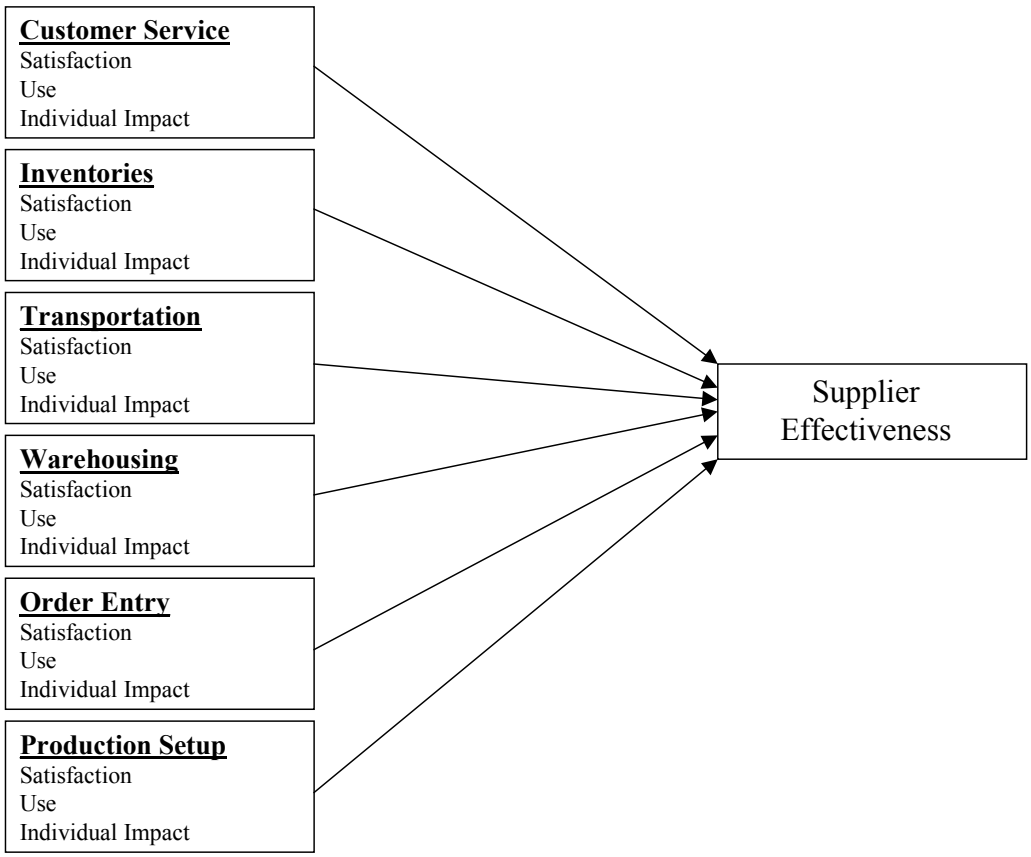

Figure 9. Supplier Effectiveness Model

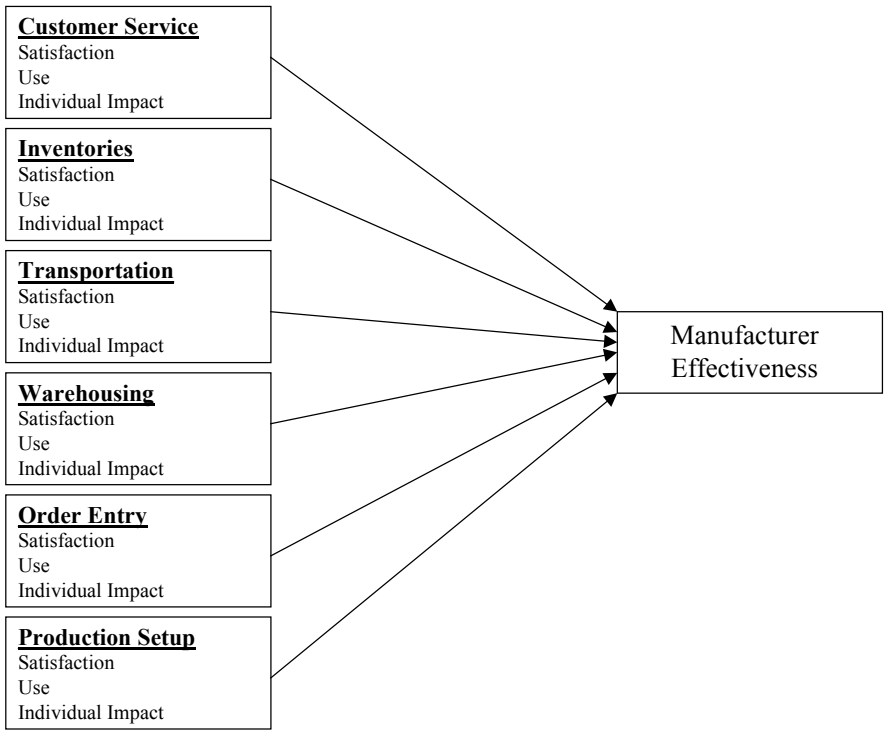

Figure 10. Manufacturer Effectiveness Model

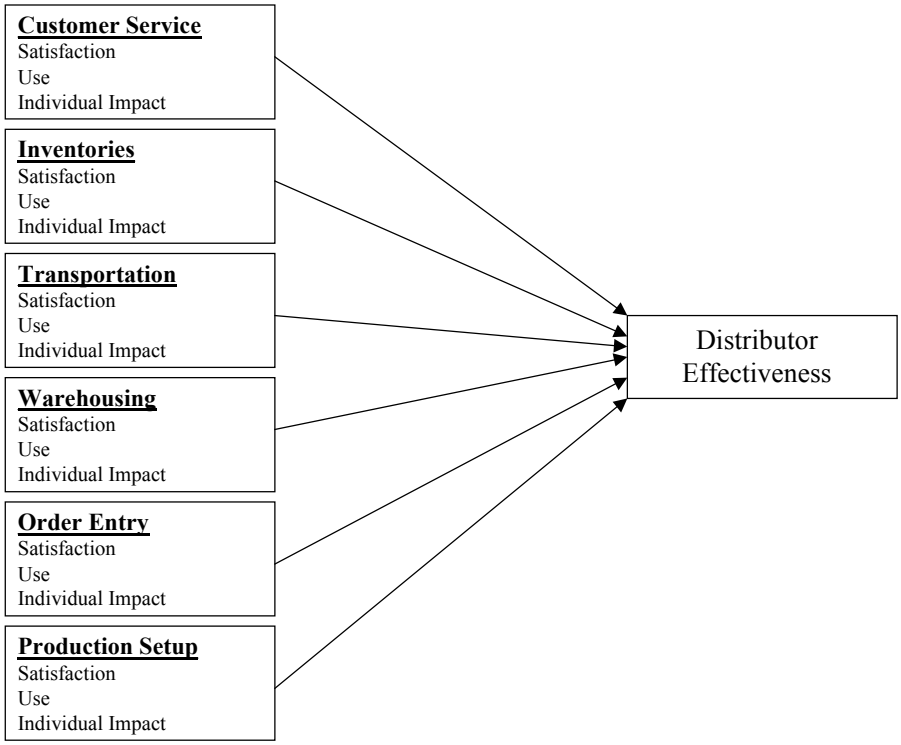

Figure 11. Distributor Effectiveness Model

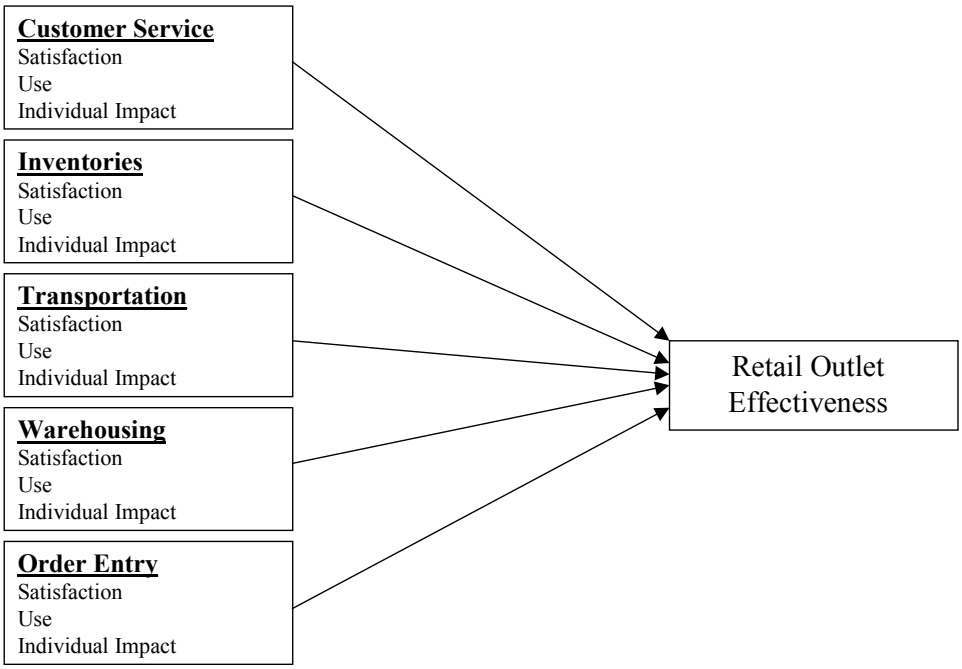

Figure 12. Retail Outlet Effectiveness Model

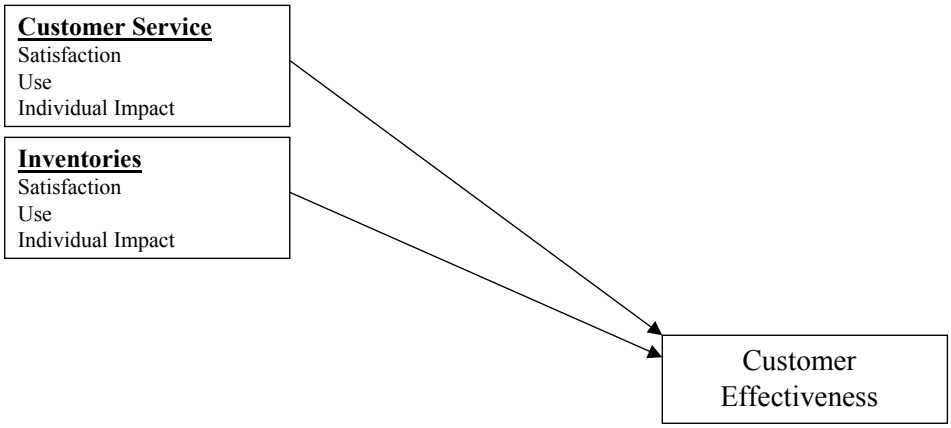

Figure 13. Customer Effectiveness Model

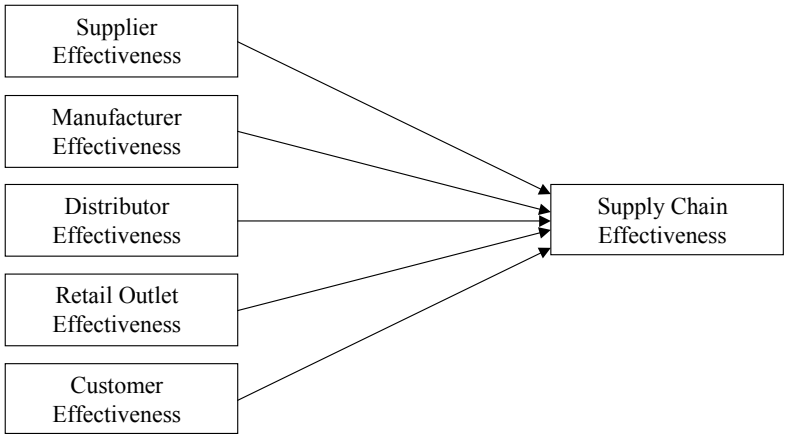

Figure 14. Supply Chain Effectiveness Model

Model Operationalization. Based on the model formulation, the dimensions of the EC success/effectiveness model must be operationalized. Individual performance (satisfaction, use, and individual impact) and organizational performance must be measurable for each SC member and function. The model (Figure 8) indicates that the individual performance of the SC member's functions impacts the organizational performance. Figure 8 is illustrated mathematically as follows, where Equation 1 indicates that the SC organizational performance (SCOP) is measured by the member's organizational performance (MOP) and Equation 2 indicates that the member's organizational performance (MOP) is measured by the individual performance (IP) (for each SC member and/or function):

SCOP = MOP (Equation 1)

MOP = IP (Equation 2)

where

SCOP = price + availability;

MOP = inventory level + inventory carrying cost + stockouts + order cycle + fill rate;

IP = S + U + II;

S = US + SQ + IQ;

OP = organizational performance (effectiveness);

IP = individual performance;

II = individual impact;

S = satisfaction;

U = use;

US = user satisfaction;

SQ = system quality; and

IQ = information quality.

This mathematical model is assumed to be a linear association, therefore stating that organizational performance can be explained in terms of variations in individual performance. The linear association between organizational performance and individual performance permits the estimation of organizational performance (dependent variable) from the values of individual performance (independent variable) (DeLone and McLean 1992). First, individual performance is the additive combination of satisfaction (S), use (U), and individual impact (II). Satisfaction, use, and individual impact are theorized (DeLone and McLean 1992) to jointly impact organizational performance, therefore, the additive combination is individual performance. Second, satisfaction is the additive combination of user satisfaction (US), system quality (SQ), and information quality (IQ). Satisfaction is the combination of user satisfaction, system quality, and information quality (Glorfeld 1994). Member organizational performance is the additive combination of inventory level, inventory carrying cost, stockouts, order cycle, and fill rate. Inventory level, inventory carrying cost, stockouts, order cycle, and fill rate are an aggregate measure of member organizational performance (Chow et al.

1994; Poirier and Reiter 1996). Finally, SC organizational performance is the additive combination of price and availability. Price and availability are an aggregate measure of the ultimate SC effectiveness (Chow et al. 1994).

Each dimension of the model is operationalized by utilizing collected inventory (historical) data and various existing (survey) measures. The *organizational impact* dimension involves measures for SC member effectiveness and overall SC effectiveness. Effectiveness is measured through the collection of inventory data concerning performance. Organizational impact/success has historically been measured using effectiveness, "a measure of the relative success of a firm's products in relation to competitors" (Bowersox and Daugherty 1995). Depending on the company, different definitions and/or appropriate models are used to describe organizational effectiveness (Cameron 1986). Since effectiveness is defined in relative terms, it often requires some subjective means of combining multiple measures or a judgment to use a single aggregate measure. When the performance criteria are subjective, historical information can be used in performance evaluation. Therefore, relative measures of performance may be used to compare the company's performance over time or to compare the performance of the company to other similar companies (Lewin and Minton 1986).

Chow, et al. (1994) summarize various conceptual and theoretical studies of logistics performance measures. Poirier and Reiter (1996) also discuss optimizing SC performance. From their research, SC member effectiveness (*organizational performance*) is theorized to be a product of (1) inventory level, (2) inventory carrying cost, (3) stockouts, (4) order cycle, and (5) fill rate, and overall SC effectiveness is theorized to be a product of (1) price and (2) availability. The cost of implementing EC is extensive, but EC purports substantial savings both financially and in terms of overall efficiency and time saving for all SC members because of the increased information available.

"Inventories are stockpiles of raw materials, supplies, components, work in process, and finished goods that appear at numerous points throughout a firm's production and logistics channel" (Ballou 1999). *Inventory levels* will be reduced as a result of reduced lead times and reduced lead-time variability (Harrington, Lambert and Christopher 1991; Varley 1998). The inventory level of the SC affects the effectiveness of the SC (Bowersox et al. 1989; Cooper, Browne and Peters 1990; Harrington 1996; Konsynski 1996; Narasimhan and Jayaram 1998). Lower inventory levels improve the performance of an organization (Kekre and Mukhopadhyay 1992). The (increased amount of) information becomes a substitute for inventory (Strader, Lin and Shaw 1999), and the improved control over inventory leads to reduced inventory, improved productivity, and better service to customers (i.e. availability) (Sykes 1994).

Inventory carrying costs (inventory holding costs) occur as a result of storing goods for a period of time (Ballou 1999). There is a tremendous cost of having products sit on the shelves or in storage. Again with the optimal stocking level, inventory carrying costs and stockouts can be minimized while maintaining acceptable order cycles (Strader et al. 1999), which will increase the effectiveness of the SC (Bowersox et al. 1989; Poirier and Reiter 1996).

Stockouts occur when the inventory level reaches zero. This can be the result of poor ordering, promotions, sudden peaks in demand, etc. Reaching the optimal stocking level will improve the effectiveness of the SC and therefore reduce stockouts (Bowersox et al. 1989; Konsynski 1996).

Order cycle is the time between when an order is placed and when the order is received (Ballou 1999). This includes all the time-related events that make up the total time required to receive an order. Shorter order cycles are a result of increased inventory turns from more efficient information sharing (Iyer and Bergen 1997; Strader et al. 1999). The shorter order cycle times will increase the effectiveness of the SC (Bowersox et al. 1989; Gassenheimer, Sterling and Robicheaux 1989; Lewis and Talalayevsky

1997; Poirier and Reiter 1996; Quinn 1997; Schmahl 1996; Swaminathan, Smith and Sadeh 1998).

Fill rate is the amount of the order that is filled, as compared to the amount that is requested. With higher fill rates, lead times can be reduced as well as review cycles (Bowersox et al. 1989; Gassenheimer et al. 1989; Poirier and Reiter 1996; Quinn 1997; Swaminathan et al. 1998), therefore improving the effectiveness of the SC.

The best measure of overall efficiency of the SC (impact/effectiveness) is the least cost measure that yields maximum benefits to the customers (Billington 1994; Chen 1997). Ultimately, customers want the product *available* at the lowest possible *price* when they wish to purchase it (Bowersox 1974; Rose 1979; Sharma et al. 1995). Keeping inventory as low as possible while maintaining sufficient in-stock levels to meet customer demand is a very difficult task. An effective SC link will improve the availability of products while reducing the price of products (Hausman and Hersch 1998). If customers are pleased (availability and price), then the SC has been effective. "Managing a supply chain effectively comes down to a balancing act between customer service and cost" (Freeman 1997). EC over the SC is driven by the need to meet/exceed customer service demands (Cottrill 1997).

The *individual performance* dimension is measured using the collection of survey information (that has been previously validated) for *satisfaction*, *use*, and *individual impact* (refer to the Appendix). *Satisfaction* is a combination of information quality, system quality, and user satisfaction (Glorfeld 1994). Doll and Torkzadeh's (1988) end user computing satisfaction 12-item instrument measures information content, system accuracy, format of output information, timeliness of information, preciseness of output information, currency of information, and ease of use. Davis' (1989) six items measure perceived system usefulness. The *satisfaction* dimension is therefore operationalized by an 18-item instrument.

The *use* dimension is captured from three questionnaire items. Number of queries information (DeLone and McLean 1992) is obtained from one question, and frequency and voluntariness of querying is obtained using two questions from Kim and Lee's (1986) measures of system usage.

The *individual impact* dimension is operationalized from Millman and Hartwick's (1987) instrument. Thirteen items assess whether a specific instance of IT (in this case, EC) has increased, decreased, or had no effect on various aspects of users' work.

DISCUSSION AND CONCLUSIONS

EC is cutting across every functional field of business. Companies are making large investments in EC endeavors, especially when it comes to SCM. The theoretical model presented is the start of future research to establish the success measures of EC.

The EC success/effectiveness model presents a framework for organizations to use when determining whether their EC activity(s) (Internet, EDI, etc. over a SC) has benefited the organization. Each individual member of the SC can be examined, as well as each member's function with regard to individual performance and organizational performance. The testing of the model will provide an organization with a guide for measuring the success of their EC endeavor, as well as determine if improvements have occurred as a result of the use of EC.

The proposed model allows for an organization to select all or a piece of the model to use to measure EC success, given the type of organization and its function(s). Therefore, a retail outlet organization would use only Figure 12 (retail outlet effectiveness model) when determining EC success. The retail outlet may wish to discover the (individual) effectiveness of its customer service element (one of its functions), its inventories element, etc., and/or its overall organizational effectiveness. That retail outlet organization may choose to also look at one of its SC partners, such as a supplier. The retail outlet may want to know how effective its supplier is, especially as the supplier's functions relate to the retail outlet. Satisfaction, use, individual impact, and organizational impact can essentially be measured for many different

aspects in a SC, based on functions, supply chain member, and the overall supply chain. This gives an organization a number of options for determining EC success for itself and for the entire SC. An organization could therefore review any portion of its operation with regard to EC effectiveness. How are the *inventories* (EC system) being *used* by the *manufacturer*? How *satisfied* is the *supplier* with the *customer service* (EC system)? How does the *satisfaction* in *inventory levels* at the *supplier* impact the *effectiveness of the entire SC*? Etc.?

Future research should seek to test all aspects of Figure 8. Both survey instruments (for satisfaction, use and individual impact) and historical data (for organizational impact) may be employed to measure the performance of EC along a SC. For example, historical data related to inventory level, order cycle, etc. should be investigated to determine if electronic SCs are truly beneficial (i.e. lower inventory levels, shorter order cycles, etc.) over manual SCs or other electronic SCs, and if they are found to be beneficial, how much of an improvement are they? Appropriate SCs within organizations should be pinpointed for analysis, so that electronic SCs can then be compared to manual SCs, or to other electronic SCs, identifying any differences in performance (individual and/or organizational) (i.e. identifying any improvements EC has introduced). For an organization, knowing if their electronic undertakings are truly beneficial is extremely important given the costs of such activities.

The future of EC is not known, making the measurement of the impacts of current EC endeavors ever more important. The proposed model gives an organization "a measure" for its EC endeavors as they impact the organization's SC.

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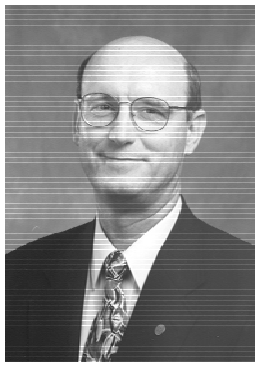

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APPENDIX

Satisfaction Instrument

Strongly Disagree **1 2 3 4 5 6 7** ***Strongly Agree***

1. Using the system in my job has enabled me to accomplish tasks more quickly.
2. Using the system has improved my job performance.
3. Using the system has decreased my productivity.
4. Using the system has enhanced my effectiveness on the job.
5. Using the system has made it easier to do my job.
6. I find the system useful in my job.

(Davis 1989)

1=Almost Never, 2=Some of the Time, 3=About Half the Time, 4=Most of the Time, and 5=Almost Always

1. Does the system provide the precise information you?
2. Do you think the output is presented in a useful format?
3. Does the system provide reports that seem to be just about exactly what you need?
4. Does the system provide up-to-date information?
5. Is the system easy to use?
6. Are you satisfied with the accuracy of the system?
7. Do you get the information you need in time?
8. Is the information clear?
9. Does the information content meet your needs?
10. Does the system provide sufficient information?
11. Is the system user friendly?
12. Is the system accurate?

(Doll and Torkzadeh 1988)

Use Instrument

1. How many times have you queried (asked questions of) the system?

2. Which of the following best describes the frequency of your using the system?

Much Less Frequent Use 1 2 3 4 5 6 7 Very Frequent Use

3. Which of the following best describes the voluntariness of your using the system?

(Kim and Lee 1986)

Completely Mandatory Use 1 2 3 4 5 6 7 Completely Voluntary Use

Individual Impact Instrument

1=Increased 2=Decreased 3=No Effect

1. How has the importance of your job been affected?
2. How has the amount of work required on your job been affected?
3. How has the accuracy demanded on your job been affected?
4. How has the skill needed on your job been affected?
5. How has the interest of your job been affected?
6. How has the knowledge of performance on your job been affected?
7. How has the responsibility for results of your work been affected?
8. How has freedom in how to do your job been affected?
9. How has the supervision received on your job been affected?
10. How has your opportunity for advancement been affected?
11. How has your job security been affected?
12. How have your relationships with fellow employees been affected?
13. How has your personal effectiveness been affected?

(Millman and Hartwick 1987)

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