

E-BUSINESS AND SUPPLY CHAIN MANAGEMENT: AN OVERVIEW AND FRAMEWORK*

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The web is having a significant impact on how firms interact with each other and their customers. Past stumbling blocks for supply chain integration such as high transaction costs between partners, poor information availability, and the challenges of managing complex interfaces between functional organizations are all dissolving on the web. In this paper, we examine how the web is changing supply chain management. We present a survey of emerging research on the impact of e-business on supply chain management including descriptive frameworks, analytical models, empirical analysis, and case studies. We classify the work into three major categories: e-commerce, e-procurement, and e-collaboration.

(E-BUSINESS; E-COMMERCE; E-COLLABORATION; E-PROCUREMENT; SUPPLY CHAIN MANAGEMENT)

Introduction

Nothing has rocked the young field of supply chain management like the emergence of the Internet. While the management of information flows have always been a key aspect of supply chain management, the rapid growth of web-based information transfer between companies, their suppliers, and their customers has decidedly increased the importance of information management in creating effective supply chains. Indeed, the Internet has emerged as a most cost-effective means of driving supply chain integration. We define e-business as the marriage between the Internet and supply chain integration. This marriage is transforming many processes within the supply chain from procurement to customer management and product design.

In this paper, we explore how e-business is changing supply chains and examine the rapidly evolving research in this area. Following the framework of Lee and Whang (2002c), we divide the various forms of e-business applications into three categories: e-commerce, e-procurement, and e-collaboration (Figure 1). e-Commerce helps a network of supply chain partners identify and respond quickly to changing customer demand captured over the Internet. e-Procurement allows companies to use the Internet for procuring direct or indirect

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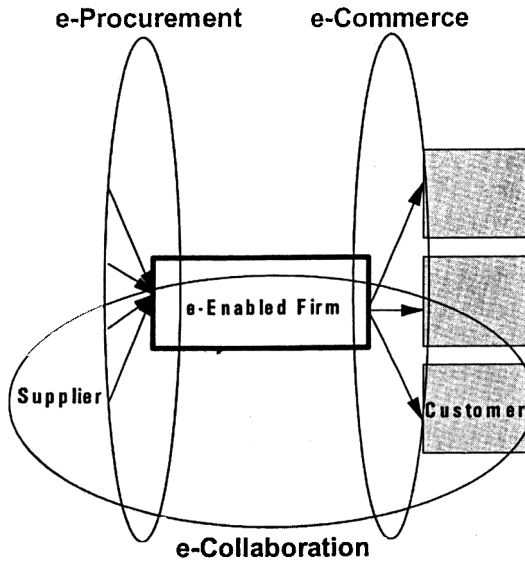


FIGURE 1. e-Business Forms and Their Impact on the Supply Chain

materials, as well as handling value-added services like transportation, warehousing, customs clearing, payment, quality validation, and documentation. e-Collaboration facilitates coordination of various decisions and activities beyond transactions among the supply chain partners, both suppliers and customers, over the Internet (e.g., coordination of engineering changes in the bill-of-materials for a product that is manufactured by an outsourced partner).

The remainder of this paper is broken into three sections examining research in these three forms of e-business. In our survey, we include a wide range of research from classical model building and empirical studies to cases and frameworks. At the end of each section, we review the papers included in this special issue of *POM*, relating them to the earlier work. Given the early stage of research in this area, much of the published research is in the form of case studies and descriptive frameworks. While we do not claim that our review is exhaustive, we do believe it provides a good snapshot of the area.

We concentrate on articles that are explicitly linked to internet-based supply chain applications. Of course, there is much pre-web-related research on information technology and supply chain management. We include only a few of these papers to provide continuity to past work. We categorize the papers by both the form of e-business and the research methodology (Table 1). In addition, we review teaching cases focused on e-business and supply chains in Table 2. The number of teaching cases focusing on this area has increased dramatically in the past few years. For the teaching cases, we limit our review to cases written in the last 3 years (2000–2002). This eliminates many of the cases focused on B2B exchanges and e-tailers that have failed. We note that a few of the cases we include in our review explicitly examine the failure of such companies. We categorize the teaching cases by e-business form and by area within supply chain management (Table 2) using the framework developed by Johnson and Pyke (2000).

2. e-Commerce

e-Commerce has had a profound impact on the supply chains of many products. Clearly, the supply chains of information goods have seen the most change (e.g., see Dewan, Freimer, and Seidmann 2000). Manufacturers of physical products have also turned to the Internet as a direct channel of distribution. The direct channel poses a different set of decisions and challenges from those in the existing “bricks-and-mortar” retail channel. These two channels

TABLE 1
E-Business and Supply Chain Research

Article (Author and Date)	e-Business Form			Descriptive Frameworks	Research Methodology				
	e-Commerce	e-Procurement	e-Collaboration		Analytical Models			Empirical/Simulation	Case Study
					Stochastic	Game theory	Deterministic		
Boyer and Olson (2002), "Drivers of Internet Purchasing Success"		•						•	•
Brynjolfsson and Smith (2000), "Frictionless Commerce? A Comparison of Internet and Conventional Retailers"	•							•	
Cachon, G. (2001), "Stock Wars: Inventory Competition in a Two Echelon Supply Chain with Multiple Retailers"			•		•	•			
Cachon and Fisher (2000), "Supply Chain Inventory Management and the Value of Shared Information"			•		•				
Cattani and Souza (2002), "Inventory Rationing and Shipment Flexibility Alternatives for Direct Market Firms"	•				•				
Chan, Zhao and Ball (2002), "A Model for Batch Advanced Available-to-Promise"	•							•	
Chen et al. (2000), "Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact of Forecast"			•						
Chen (2001), "Market Segmentation, Advanced Demand Information, and Supply Chain Performance"	•				•				
Dewan, Freimer, Seidmann (2000), "Organizing Distribution Channels for Information Goods on the Internet"	•					•			
Iyer and Ye (2000), "Assessing the Value of Information Sharing in a Promotional Retail Environment"		•							
Jap and Mohr (2002), "Leveraging Internet Technologies in B2B Relationships"		•		•					•
Johnson (2002), "Product Design Collaboration: Capturing Lost Supply Chain Value in the Apparel Industry"				•					•
Johnson and Meller (2002), "Performance Analysis of Split-Case Sorting Systems"	•					•			
Johnson (2000), "Supply Chain Synchronizing Through Web-Centric Product Content Management"				•					•
Kaplan and Sawhney (2000), "E-Hubs: The New B2B Marketplaces"		•		•					
Lee and Whang (2002a), "The Impact of the secondary Market on the Supply Chain"		•				•	•		
Lee and Whang (2002b), "On e-Collaboration"			•	•	•	•			
Lee, H. L. and S. Whang (2002c), "Supply Chain Integration over the Internet"	•	•	•	•					
Lee and Whang (2001), "E-Fulfillment: Winning the Last Mile of E-Commerce"	•			•					
Lee, Padmanabhan, and Whang (1997), "Information Distortion in a Supply Chain: The Bullwhip Effect"			•		•				
McAfee (2002), "The Impact of Enterprise Information Technology Adoption on Operational Performance: An Empirical Investigation"			•					•	•

TABLE 1 (cont'd)

Article (Author and Date)	Research Methodology								
	e-Business Form			Descriptive Frameworks	Analytical Models			Empirical/Simulation	Case Study
	e-Commerce	e-Procurement	e-Collaboration		Stochastic	Game theory	Deterministic		
Moinzadeh (2002), "A Multi-Echelon Inventory Systems with Information Exchange"			•		•				
Peleg, Lee and Hausman (2002), "Short-term e-Procurement Strategies vs. Long-term Contracts"		•			•				
Pyke and Johnson (2002), "Sourcing Strategy and Supplier Relationships: Alliances vs. eProcurement"				•					
Pyke, Johnson, and Desmond (2001), "E-fulfillment: Its Harder Than It Looks"	•			•					
Sawhney and Prandelli (2000), "Communities of Creation: Managing Distributed Innovation in Turbulent Markets"			•	•				•	
Tatsiopoulou et al. (2002), "Realization of the Virtual Enterprise Paradigm in the Clothing Industry through E-Business Technology"			•				•	•	
Tempelmeier (2002), "A Simple Heuristic for Dynamic Order Sizing and Supplier Selection with Time-Varying Data"		•				•			
Wise and Morrison (2001), "Beyond the Exchange: The Future of B2B"		•	•						
Zhang (2002), "Vertical Information Exchange in a Supply Chain with Duopoly Retailers"			•		•	•			

differ in customer types, operations of order fulfillment, cost structure, profit contributions, priority in rationing, logistical requirement, expectations of service quality, degree of market segmentation, access to demand/supply information, and returns policies. Much of the early work on consumer-related e-commerce focused on the changes in channels and the downward market pressure on prices. Indeed, one of the earliest such studies (Brynjolfsson and Smith 2000) found that prices in the late 1990s for homogeneous products like books and CDs were 9–16% lower in e-channels than in conventional outlets. However, for many products, the supply chain challenges of sustained price competition became evident by 2001 with the many failed business models. Pyke, Johnson, and Desmond (2001) describe the difficulties of effectively executing e-fulfillment and develop a framework for evaluating the challenges of e-fulfillment for any specific product. Lee and Whang (2001) describe key lessons successful companies have used and present a framework for making e-fulfillment effective. Chen (2001) examines the interesting question about pricing and shipping methods. Using different prices, an e-tailer can entice some customers to wait for their order and thus obtain some advanced demand information. Using a stochastic model, he develops an optimal pricing policy for an e-tailer. Johnson and Meller (2002) develop stochastic models of logistics systems used in e-fulfillment centers. They use their model to show why some systems were effective in reducing costs while others failed.

During the late 1990s, many teaching cases were developed on (now failed) dot.com retailers such as eToys and Streamline. In this paper, we only include cases written since 2000 that have a significant supply chain component. Even so, some of the cases we include in the e-commerce category are centered on failed businesses. Indeed, the focus of these cases

TABLE 2
E-Business and Supply Chain Teaching Cases

Case (School, Case Setting Date, Authors)	Location	Logistics	Inventory	Marketing and Pricing	Sourcing	Information			Product Design	Service	Reverse SC	Outsourcing	Metrics	Global Issues
						e-Commerce	e-Procurement	e-Collaboration						
Agile—I Want My WebTV (Dartmouth/Stanford, 2000, Eric Johnson and Hau Lee)					•	•	•	•					•	
Chempoint and Yantra (2000, Dartmouth, Eric Johnson)		•			•	•	•	•					•	
Do I Hear 5 Million Euros? The Story of a Reverse Auction: Econia.com and Scotts (A & B) (INSEAD 2000, Luk Van Wassenhove)					•		•							
EConnections: Enhancing SC Efficiencies within the Electronics Industry (Stanford, 2001, Terry Taylor)					•		•							
Eskye (Dartmouth, 2000, Eric Johnson)		•			•		•							
Extricity (Harvard, 2001, Andrew McAfee)								•						
Garden.com: At the End of the Runway (Dartmouth, 2000, Eric Johnson)			•		•	•						•	•	
Hewlett-Packard—Managing Product Returns (INSEAD, 1999, Luk Van Wassenhove)								•			•			
Home Depot: Technology for Transportation Bidding (GaTech, 2000, Wedad Elmaghraby, Pinar Keskinocak)		•			•		•							
Instill (Stanford, 2000, Jin Whang)			•		•		•							
I2 TradeMatrix (Harvard, 2001, Andrew McAfee)		•					•	•						
General Motors: Building a Digital Loyalty Network (Stanford, 2002, Hau Lee and Jin Whang)					•			•						
Lufthansa Cargo AG: Capacity Reservation and Dynamic Pricing (WHU, 2002, Arnd Huchzermeirer)		•		•				•						
Marks & Spencer and Zara (INSEAD, 2001, Michael Pich and Ludo Van der Heyden)	•							•	•					•
Papirus—The Office Depot Threat (Dartmouth, 2000, Eric Johnson)		•	•				•							
PassAct (Harvard, 2001, Andrew McAfee)								•						
Quad wants to be a Savi Player (Dartmouth, 2002, Eric Johnson and Hau Lee)		•						•			•			
Quantum (Harvard, 2001, Andrew McAfee)		•	•					•						
SeeCommerce: Enhancing SC Velocity at DaimlerChrysler (Stanford, 2000, Hau Lee)				•					•	•				•
7DREAM.COM: A Click and Mortar ECommerce Model in Japan (Stanford, 2000, Jin Whang)		•					•							
SciQuest—B2B Exchanges and Their Supply Chain Integration Role: The SciQuest Experience (Wash U, 2000, Chester Chambers and Panos Kouvelis)					•			•						
Soletron: From Contract Manufacturer to Global Supply Chain Integrator (Stanford, 2001, Hau Lee)									•			•		•
Syncra (Harvard, 2001, Andrew McAfee)			•					•						
Third-Part Logistics Service (A, B): CreoScitex, Flying Cargo (INSEAD, 2002, Enver Yucesan and Luk Van Wassenhove)		•						•				•		
Webvan (Harvard, 2001, Andrew McAfee)		•					•							

is supply chain challenges that led to the firm's failure. Table 2 shows the cases reviewed in this paper, including their e-business focus and the areas within supply chain management that are highlighted in the case. For example, the Webvan case (see Table 2) examines the challenges of rapidly building a distribution system. Garden.com examines issues of supplier management and conflicting incentives in a virtual supply chain. In both cases, the supply chain challenges led to the failure of these firms. In contrast to these cases, Chempoint illustrates a virtual supply chain for the distribution of small volume, specialty chemicals where the supplier incentives were more closely aligned—leading to a successful business model. Chempoint was able to build a nice business by both adding value to their customers through product knowledge and better order fulfillment along with carefully cultivating a set of responsive suppliers. The Papirius/Office Depot case examines the competition in Eastern Europe for the office supplies market and the role e-commerce is playing in that evolving market. Finally, the 7Dream case, based in Japan, is an interesting example of a bricks and clicks solution to the last mile problem. Customers ordering from many different vendors on the 7Dream website receive their delivery at the nearest 7-11 convenience store where they can pay in cash. Returns are also managed through the stores.

Two papers in this *Special Issue* address two questions that arise in e-commerce: “given the real-time information of supply and demand over the Internet, how can one compute available-to-promise (ATP)?” and “if customers are given the choice of a *priority* service with faster delivery at a higher price, what should be the optimal rationing policy of inventory?”

Addressing the first question, Chen, Zhao, and Ball (2002) consider the configure-to-order system operating under a batch-mode ATP whereby customer requests are collected into a batch and subsequently processed together by a model that determines the ATP commitments and resource allocation. The paper studies the supply chain performance with respect to certain ATP parameters like the batching interval. The manufacturer is expected to solve a mixed-integer program per batch interval. The program captures demand profiles and supply constraints (e.g., raw material availability, production capacity, material compatibility, and customer preference) and maximizes the operational profits. Its output includes final assembly plans for orders, order acceptance decisions, and delivery quantity over time. It sequentially runs the program on Maxtor's data and derives some insights (regarding batch size and flexibility). The model implicitly visualizes a manufacturing system that delivers customized products in an enhanced service mode (using real-time supply chain visibility)—all too realistic in the Internet age.

The second question is addressed by Cattani and Souza (2002). They consider two types (high versus low priority) of customer demands arriving at Poisson rates. Demands are met from a common inventory that the server replenishes at a finite speed but stops when the inventory reaches a certain level. In dealing with the distinct customer demands, the manufacturer can either adopt a first-come-first-served (FCFS) policy or a rationing policy where the firm ships only orders for the priority customers under a certain level of inventory. The benefit of direct channel manufacturer is inventory and shipping flexibility, because some online customers are more willing to wait longer than others. The paper develops models of queuing systems or birth-death processes and derives the additional value (in terms of operational profits) of the rationing policy over the FCFS policy under three scenarios of lost sales, backlog, and their combination. They offer a large number of numerical runs to derive some useful qualitative insights. This paper illustrates the additional advantages of e-commerce over the traditional retail channels, such as delivery time flexibility and logistical configurations. Regarding the latter, note that in the design of the e-commerce distribution system, the material flow and the information flow can be decoupled—the delivery process may take a different route from the order flow. One may order a book at Amazon's website, but the actual delivery may come from the warehouse of its distributor, Ingram Books. Thus, an online firm can construct a virtual logistical network that consists of its suppliers' and retailers' logistical assets as well as its own (Lee and Whang 2001).

3. e-Procurement

Modern manufacturing requires flexibility due to stiff competition, fast changing customer preferences, shortening product life cycle, and product variety proliferation. Along with dynamic capacity allocation, efficient material procurement forms a pillar to support flexible manufacturing. The Internet again offers a natural platform to facilitate efficient procurement as numerous buyers and sellers find each other and transact according to some pre-specified protocols (governed by the marketplace or traders' internal rules). While e-procurement is the mirror image of e-commerce, they have many different aspects. For example, e-commerce often faces a large number of individual consumers, whereas e-procurement usually involves dealings with companies.

Of course, many e-procurement ideas such as dynamic markets and auction theory have been long studied areas within economics (e.g., auctions, see Milgrom and Weber 1982 or Riley and Samuelson 1981). Recent work has begun to explore how online exchanges impact the procurement process and the supply chains of individual companies. For example, Kaplan and Sawhney (2000) and Wise and Morrison (2000) both develop frameworks to understand what types of exchanges would appear for different types of products and examined how exchanges may evolve. Jap and Mohr (2002) explore why some firms are successful with e-procurement strategies while others are not. Lee and Whang (2002a) model how secondary online markets impact the supply chain. Pyke and Johnson (2002) compare many e-procurement strategies to traditional strategic alliances.

In the past 3 years, there have been several interesting cases written on e-procurement (see Table 2). Five cases summarized here examine the role of industry exchanges: SciQuest is focused on the laboratory and science research community; Instill is focused on the food services industry; eConnections and PassAct in the electronic components industry; and eSkye is focused on the alcohol beverage industry. In each case, the company's original focus was that of an information intermediary—linking buyers and sellers together without ever touching the product. While all met with some degree of success, they also found significant resistance in the supply chain as they challenged the power balance between customers, distributors, and suppliers. Today, the three survivors (Instill, eSkye, and SciQuest) have all reoriented their business model toward selling procurement software, specifically oriented to their individual industry. The PassAct case examines the problems faced by exchanges and why many have failed. A related case, Quantum, examines the supply chain challenges of a digital storage device company and its reaction to the development of an industry consortium exchange (eHITEX, which later became Converge). The I2 TradeMatrix case is focused on strategy of a supply chain software maker to leverage its expertise in supply chain planning to become a major developer of both public and private exchanges.

Two other cases examine how electronic bidding and Internet auctions have changed the procurement process. The Home Depot case examines how Home Depot applies a bidding process and smart optimization algorithms to award large transportation contracts to freight carriers. "Do I Hear 5 Million Euros?" details the use of reverse auctions for procurement and the impact of such procurement solutions on the supply chain of a company like Scotts.

This *Special Issue* has three papers on e-procurement—"Short-Term e-Procurement Strategies Versus Long-Term Contracts" (Peleg, Lee, and Hausman 2002), "Drivers of Internet Purchasing Success" (Boyer and Olson 2002), and "A Simple Heuristic for Dynamic Order Sizing and Supplier Selection with Time-Varying Data" (Tempelmeier 2002).

The first paper (Peleg, Lee, and Hausman 2002) studies and compares three different procurement strategies for a manufacturer. The first strategy (called Strategic Partnership) is to develop a long-term supply relationship with a specific supplier, and the second strategy (called Online Search strategy) is to shop online for a better price. The third is to combine both—sign a long-term purchase contract with a supplier up to a certain level, but if necessary, additional quantity may be purchased online. The tradeoff between Strategic

Partnership and Online Search is the lower price fixed in advance versus the random opportunity for a lower price. The combined strategy involves a minimum quantity commitment, so an irrevocable quantity commitment is traded with the advantage of stratification. The paper offers the conditions under which one strategy is superior to others. These authors also study the optimal number of suppliers to contact when a fixed search cost is accrued per potential supplier contacted. The analysis underlines the fact that e-procurement opens up the possibility of the combined strategy and derives the optimal solution in the combined strategy. It also demonstrates how the lower search cost and other factors (driven by the Internet) can affect the procurement strategy. Indeed we find various software packages that support such dynamic procurement strategies. These products (e.g., Broadvision, Manugistics, Tradec, and Instill) take real-time data (e.g., inventory levels, sales data, and market price at electronic exchanges) and provide a nice presentation of the operational status and limited optimization capabilities.

The second paper (Boyer and Olson 2002) conducts a survey of 416 e-procurement users (of Office Depot) and studies the success factors in procurement of indirect material. The data and its step-wise regression analysis supports that buying companies indeed realize performance benefits from e-procurement and identifies drivers of success. Well summarized in Figure 1 of the paper, the drivers of performance success are categorized into the characteristics of the purchasing company (strategy and environment) and Internet factors (Internet-related and site-specific). Combined with the work by Peleg, Lee, and Hausman, this work presents a very useful future research into the status and impact of e-procurement of *direct* materials.

The last paper on procurement (Tempelmeier 2002) considers an optimization tool to help in dynamic supplier selection. The author considers the case of a company facing dynamic demand and multiple suppliers offering various quantity discount schemes that vary over time. The problem is formulated as a mathematical program and a fast solution heuristic is proposed and tested. The author describes how the solution procedure was implemented as part of SAP's Advanced Planner and Optimizer (APO) software.

4. e-Collaboration

While e-commerce and e-procurement have captured most of the business press headlines over the past 5 years, the promise of e-collaboration may be far greater. We define e-collaboration as business-to-business interactions facilitated by the Internet. These interactions go beyond simple buy/sell transactions and may be better described as relationships. These include such activities as information sharing and integration, decision sharing, process sharing, and resource sharing. Lee and Whang (2002b) provide this taxonomy of e-collaboration and link the idea to earlier research in supply chain management. Of the three areas, information sharing has seen the most research. With widespread interest in the bullwhip effect (Lee, Padmanabhan, Whang (1997)), many researchers have worked to quantify the impact of the bullwhip (Chen, Drezner, Ryan, and Simchi-Levi 2000) and examine the benefits of sharing information (for examples, see Cachon and Fisher 2000; Iyer and Ye 2000; Moinzadeh 2002). There has also been significant work to understand the benefits of IT investments within an enterprise (for example, the impact of ERP; McAfee 2002).

Process sharing like collaborative innovation and product design is also another exciting opportunity. Many researchers are wondering how the web will change innovation within and between companies (Sawhney and Prandelli 2000). In a pair of papers, Johnson (2000, 2002) examines webcentric collaboration for product design in both the high-tech and apparel industries. He develops a framework for understanding the supply chain benefits of design collaboration.

There are many new cases that examine different elements of collaboration, from infor-

mation sharing and integration to process and resource sharing (see Table 2). Several of these cases examine new web-native software companies who have developed new applications for different types of collaboration. For example, Agile looks at the role of collaboratively managing product design and engineering changes over the web; Extricity looks at software designed to aid in information integration between enterprise systems; SeeCommerce illustrates an application of information integration at DaimlerChrysler to facilitate supply chain metrics; Quad explores the value of supply chain visibility to each supply chain partner provided by RFID tracking of materials traveling through a supply chain; and Syncra focuses on collaborative forecasting and replenishment between a buyer and seller.

Several other cases have highlighted the impact of information integration on some particular aspect of the supply chain. Some of the cases are focused on managing supply while others are more focused on the customers. For example, the Solectron case focuses on how the use of information has transformed Solectron from a simple contract manufacturer into a full service supply chain integrator. Likewise, the "Third-Party Logistics Services" case examines how companies like transportation provider Flying Cargo are using information to enhance their service offerings in a near commodity business. On the other hand, cases like General Motors and Lufthansa illustrate how information can be used to increase customer loyalty and manage the prices. Hewlett-Packard examines the reverse supply chain and the information integration issues of managing returns. Finally, Marks & Spencer and Zara examine competition between two apparel companies, including the role of integrated design and manufacturing.

In this *Special Issue* we have two papers related to e-collaboration. The first paper (Tatsiopoulos, Ponis, Hadziliadis, and Panayiotou 2002) describes a methodology for implementing product collaboration within the Greek apparel industry. The methodology, based on structured modeling and simulation, examines the potential benefits of a web-based system prior to implementation. The authors extensively describe one of several company cases that illustrate the methodology at Mass Fashion, a Greek apparel company. They include many details of the actual implementation and resulting changes to the overall product generation process.

The last paper (Zhang 2002) considers the incentives for firms to share demand information. The author's research follows a substantial stream of work on information and incentives in multi-echelon supply chains (for example, Cachon 2001). The paper develops a model for a two-echelon system of a manufacturer and two downstream retailers who are engaged in either Cournot or Bertrand competition. The authors examine the problem of information leakage in the sharing relationship and show that the optimal price of the manufacturer does not depend on the type of downstream competition but only on the information sharing arrangement.

5. Conclusion

It is true that Internet-based software products developed by start-up companies have recently experienced a major setback. However, while the Internet bubble may have burst as an opportunity to make quick money, we believe the influence of Internet on supply chain management is still alive and well. Rather than disappearing, it is expanding in breadth and depth alike. More companies are opening Internet channels and more buyers are ordering over the Internet. Also, applications are getting more sophisticated. For example, industry exchanges do not only handle transactions, but also generate data. This in turn creates a whole new stream of research and a new breed of "execution" software products that enable a company to take real-time data and make dynamic decisions. They complement traditional "planning" systems such as ERP. Indeed, SAP recently unveiled plans to enhance manufacturing applications to better interact with their planning systems and added a freight-tracking program to its transportation management system (Gilbert 2002).

At the same time, the huge amount of data coming from Internet transactions leads to information "overload." This also creates an opportunity to develop solutions to aggregate, summarize, and interpret them in a manager-friendly manner. Indeed software products and solution providers have emerged to address the needs in various terms like "dashboard," "cockpit," and "command center" (e.g., Broadvision, Powermarket, part of Tradec, and Manugistics). Given the numerous challenges in global supply chain management and the unlimited creativity in the business community, it is only a cliché to say that the new powerful tool called the Internet would find its way to more and better applications for a long time. So too, would research, as a corollary.

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