

**E-commerce Adoption For Supply Chain Management in U.S. Apparel Manufacturers**

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ABSTRACT

E-commerce made supply chain management (SCM) technically viable and unleashed the practice of SCM. The U.S. apparel industry, due to its own characteristics, has not utilized E-commerce for SCM as widely as it could have. The purpose of this exploratory study is to increase understanding of the determinants for adoption of E-commerce in SCM within the U.S. apparel industry, and to test the value of supply chain structure and company strategies in explaining E-commerce adoption. Mail and email surveys were conducted to collect the data. Simple regression and ANOVA were used to test the hypotheses. The results confirmed with the literature that perceived E-commerce characteristics and organization characteristics influence the E-commerce adoption level although not every factor of these two groups does so. The study also showed that one of the factors in supply chain structure, SCM integration level, was significantly related to the E-commerce adoption level.

Keywords: E-commerce, supply chain management, innovation adoption, apparel industry

The U.S. apparel-manufacturing sector continues to experience intensive competition. Challenges come from different interacting factors, such as demanding consumers, the uncertain nature of apparel demands, shifting global sourcing, and powerful retailers. These challenges result in later commitments from retailers, shrinking available lead-time, and increasing information needs. Apparel manufacturers are forced to search for ways to shorten the lead-time, cut costs, and to improve product quality and customer service.

Ideas from the Industrial Revolution pointed organizations to increase efficiency as the best way to remain competitive. Today, however, "The revolution of the 1990s is driven not by changes in production and transportation but by changes in coordination. Whenever people work together they must communicate, make decisions, allocate resources and get products and services to the right place at the right time" (Malone and Rockart, 1991, p. 128). Supply chain management (SCM), which expands the scope of the organization being managed beyond the enterprise level to include interorganizational relationships,

is an example of this management idea in practice (Strader, Lin, & Shaw, 1999).

SCM is inherently information intensive. A successful SCM approach necessitates two important technological requirements for sharing information: (1) stable and secure electronic linkages between companies; and (2) an integrated, high-bandwidth environment to provide a host of SCM support services. Electronic commerce (E-commerce) technologies are well suited to cater to these demands and as such, they have an integral part to play in creating and facilitating new forms of SCM (Nambisan, 2000, p.198). Nothing appears to have had the same effect on SCM as E-commerce, which resulted in changing the focus of SCM from engineering efficient manufacturing processes to the coordination of activities in the supply chain network through knowledge management (Tan, Shaw & Fulkerson, 2000). In other words, E-commerce technically made the SCM viable and facilitated SCM use in different industries.

E-commerce is not a new concept. Some of the necessary technology and the idea of electronically exchanging information and conducting transactions were already there before this term was made popular. An example of the earlier commercial application of computer networks is Electronic Data Interchange (EDI). However, the reach of EDI systems is limited, not only because of the demanding expertise needed and the high cost relative to the limited volume of the information involved in small companies, but also because each EDI system was different due to the lack of standardization. Web technology overcomes the problem of system incompatibility by encapsulating enterprise systems as object components that are made accessible by standardized interfaces, and by defining a protocol for transmitting documents between these components. Recently the necessary investment needed for having an electronic linkage has decreased dramatically and E-commerce continues to grow more popular. It is the trend of this E-commerce revolution, i.e., the diffusion of Internet-

based E-commerce technology, particularly within SCM among U.S. apparel companies, that is the focus of this research.

SCM also applies to the textile and apparel industry, but they are magnified because of the nature of fashion products. SCM has been given much attention by the U.S. apparel industry. Consequently, E-commerce technology, an integral part and enabler of SCM, has also become the focus of U.S. apparel companies' management.

While some organizations in the U.S. apparel industry have been taking huge steps toward building information links with their suppliers and customers to capitalize on the new approach toward organizing business processes, namely SCM, there are many issues that have arisen regarding the adoption of E-commerce within the SCM area that need to be investigated. For example, while the benefits of utilization of E-commerce for SCM are supported by many theories and empirical studies in other industries, and organizations involved with the U.S. apparel industry have worked hard to promote the idea of integrated and collaborated SCM with the help of E-commerce technology, many U.S. apparel companies are still very hesitant about adopting this innovation. This study proposes to investigate the factors that influence the adoption of E-commerce for U.S. apparel companies in their SCM.

The purposes of this exploratory study are: (1) to build a foundation for understanding E-commerce diffusion among U.S. apparel companies, or to increase understanding of the determinants for adoption of E-commerce in SCM; (2) to contribute to the emerging literature of high technology innovation and new forms of SCM; and, (3) to test the value of supply chain characteristics and company strategies in explaining E-commerce adoption.

Theoretical Framework

E-commerce and SCM have attracted attention from many researchers as two separate research areas, and very few

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researchers have combined them. As this paper will reveal, E-commerce and SCM are complementary in nature and need to be studied together. This study of E-commerce for SCM was based on the innovation diffusion theory.

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1995, p. 5). Adoption is a component of the diffusion process that refers to the evaluation of the results of a trial use of the innovation and a decision to continue using the innovation (Rogers, 1962). Diffusion theory is quite relevant to the adoption of a new innovation within the supply chain (Apaiwongse, 1991; Brown, Brown, and Craig, 1981), in this case, E-commerce innovation.

Throughout the organization innovation literature, organization innovativeness and rate of adoption have been the two most studied dependent variables. Organization innovativeness, i.e., how innovative an organization is, was typically measured as a composite score, composed of the scores from ten to twenty innovations (Rogers, 1995, p. 378). Rate of adoption refers to the relative speed with which an innovation is adopted by members of a social system. It is generally measured as the number of individuals who adopt a new idea in a specific period (Rogers, 1995, p. 206). These two concepts are closely related to each other--if organizations are more innovative, the rate of adoption of an innovation will be higher. Although organization innovativeness is an important concept, practically it is not very useful because measures are dependent on each specific innovation--as proved by the low relationship between the measured qualities of the organization and the organization innovativeness. The concept of rate of adoption concerns the diffusion of certain innovations through the social system during a specific time period. It is a very important measure when comparing different innovations or different social systems regarding the adoption of the same innovation, but not when testing the value of the characteristics of a specific innovation

and other factors in explaining the adoption behavior of one group of organizations within the same social system.

Considering these two concepts does not serve the purpose of this study. Instead, a new concept, E-commerce adoption level, was developed as the dependent variable and defined as the average level of utilization of E-commerce solutions or applications in merchandising, sourcing, logistics, general resource management, and decision support areas. The adoption of E-commerce is similar to these two important innovation concepts in that they all concern the organization's adoption behavior. However, E-commerce adoption level is not concerned with how many U.S. apparel companies have adopted E-commerce innovation, nor is it concerned with whether a company is innovative in general (whether variable innovativeness could be measured is still in doubt). It is only concerned with how many different E-commerce tools a company is using, and to what extent each of these E-commerce tools is used.

E-commerce adoption level developed in this study is a subjective one, which means nothing more than just a composite score that averages the utilization degrees for all the E-commerce tools included in this study. For U.S. apparel companies, how many E-commerce tools they need to adopt depends on companies' core business in addition to the four influential factor groups included in the E-commerce adoption conceptual model. For example, if a U.S. apparel company is only involved in product development and marketing functions, this company probably will not need to adopt manufacturing planning and scheduling application. Hence, it is not necessary for a company to adopt all these E-commerce tools. Yet, the average composite score calculated in this study that represents the company's E-commerce adoption level is lower than it should be because the composite score needs to be averaged by all the E-commerce tools' utilization degree, including the ones that the company does not need and will not adopt.

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There are various conceptual frameworks formulated to help understand innovation adoption. Even though none of these frameworks from literature was specifically designed to explain E-commerce adoption for SCM, they are the theoretical base when developing a conceptual framework for understanding E-commerce adoption level. Among these conceptual innovation adoption models, Sheth (1981) and Ram (1987) studied individual consumer innovation resistance and provided the basic understanding for individual consumer and organization innovation adoption. At the organization level, literature shows two general approaches to studying innovation, and one looks at the context of the innovation.

Slack resources and company size, are the two variables within organization context that have continued to receive attention in innovation adoption research. Company size has its intuitive relationship with slack resources. Due to the difficulty of measuring slack resources, only company size was used as an organization characteristic to develop the framework in this study. Technological context is quite

relevant to adoption of E-Commerce for SCM. This study assumed that each firm faced the same external technology environment. The internal technological context was viewed as one of the key context factors in this study because it provided the necessary technological base for companies to be able to adopt E-commerce. Both available infrastructure and general personnel expertise were used in the framework to describe this context. The third context group model, environmental context was also held constant in this study on the assumption that each U.S. apparel company faced the same kind of business environment (DePietro, Wiarda, Fleischer, 1990).

The distinctive differences of E-commerce diffusion for SCM both from business and technological perspectives calls for its own model. Company strategies (primary competitive strategy and product strategy) and supply chain characteristics are the two new factor groups that this study brings into the E-commerce adoption model. Hence, the conceptual model of the determinants for E-commerce adoption level in SCM is developed as showed in Figure 1.

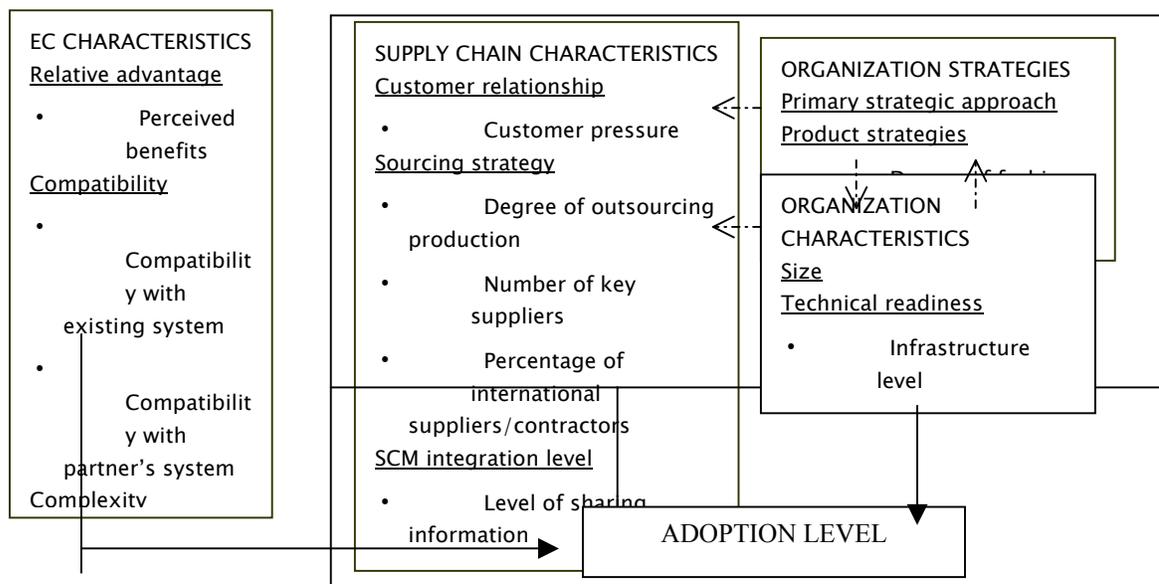


Figure 1. Conceptual model of the determinants for E-commerce adoption level in SCM.

Hypotheses

Hypotheses for the study include:

H₁: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to its size.

H₂: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to its general expertise level.

H₃: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to its infrastructure level.

H_{4a}: A U.S. apparel company's overall adoption level of E-commerce for SCM is influenced by whether the company takes brand identity strategy.

H_{4b}: A U.S. apparel company's overall adoption level of E-commerce for SCM is influenced by whether the company takes low cost strategy.

H_{4c}: A U.S. apparel company's overall adoption level of E-commerce for SCM is influenced by whether the company takes niche market strategy.

H_{4d}: A U.S. apparel company's overall adoption level of E-commerce for SCM is influenced by whether the company takes high quality strategy.

H₅: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to the degree of fashion-forwardness.

H₆: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to the frequency of new product offerings.

H₉: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to the number of its key suppliers.

H₁₀: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to the percentage of its international suppliers.

H₁₁: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to the degree of information sharing with company's suppliers.

H₁₂: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to the degree of information sharing with company's customers.

H₁₃: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to the SCM coordination level.

H₁₄: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to perceived relative advantage of E-commerce.

H₁₅: A U.S. apparel company's overall adoption level of E-commerce for SCM is positively related to the perceived compatibility of E-commerce.

H₁₆: A U.S. apparel company's overall adoption level of E-commerce for SCM is negatively related to the perceived complexity of E-commerce.

H₁₇: A U.S. apparel company's overall adoption level of E-commerce for SCM is negatively related to the perceived risk of E-commerce.

H₁₈: A U.S. apparel company's overall adoption level of E-commerce for SCM is negatively related to the perceived cost of E-commerce solutions.

Methodology

This study used surveys to investigate how perceived E-commerce characteristics

and a company's strategies influence the E-commerce diffusion within U.S. apparel companies. Because top management is assumed to have more knowledge about a company's various strategies and the decision-making process for adopting E-commerce for SCM, the company's top executives, such as CEO or CIO, were targeted as research subjects.

Membership directories from the American Apparel & Footwear Association (AAFA) and *<a midwest apparel manufacturer's directory—revealed after the blind peer review is completed>* were used for the sampling frame. Even though most apparel companies in the U.S. are too small to be able to actually capitalize on the E-commerce technology, a company having 50 or more employees was considered sufficiently large to be included in the sample. In addition, since E-commerce adoption is a company-wide decision that is most likely made by the corporate office, only headquarters were selected when more than one location (branches) was listed for the same company. The first choice of respondent was the Chief Information Officer (CIO). If a company did not have a CIO listed, the CEO or Vice President of Manufacturing was selected. Survey instruction stated in the cover letter that the recipient might need to forward the questionnaire to a more appropriate person within the company.

Two hundred and twenty-five questionnaires were mailed. Enclosed with each questionnaire was an individualized cover letter, the informed consent form, and a business reply envelope. In the cover letter, subjects were informed of the purpose and importance of the research project, a brief description of the content of the survey, and the approximate time needed to complete the survey. A summary of the study's findings was offered as an incentive for subjects to assist in this research project.

The initial mailing was followed two weeks later by a telephone reminder rather than another mailing of the survey package. As predicted, phone calls were effective in

getting responses because of the personal attention phone calls brought and the indication of the researcher's seriousness. Finally, email messages with attachments were sent to try to solicit any additional responses. A total of 46 questionnaires were completed and returned to the researcher by October 1, 2002, which resulted in a total response rate of 15.8 percent.

Hypothesis Testing

Regression analysis was used to examine the effects of interest. Although the response size (n=46) is not desirable for a test of the full measurement model, which includes eighteen constructs consisting of seventy-four items, this study was an exploratory investigation toward the effects of supply chain characteristics and company strategies on the overall E-commerce adoption level. Most of the variables used formative multi-item scales. The composite reliability index (coefficient) for the only reflective scale for *customer pressure* was 0.76. This coefficient number exceeds the 0.70 threshold for acceptable reliability and indicates that the measure for *customer pressure* is internally consistent (e.g., Fornell & Larcker, 1981).

The relationships between three of the company's characteristics, company size, personnel expertise and infrastructure level, and the overall level of E-commerce adoption were tested under H1, H2 and H3. As shown in Table 1, only one of the hypotheses, H2 was supported. In other words, only *general personnel expertise* showed significance in explaining E-commerce adoption level ($\beta=0.303$, $t=2.111$, $p=0.04$). It could be confirmed that company size was positively related to the overall E-commerce adoption level if the chosen significance level was 0.1 rather than 0.05 ($\beta=0.264$, $t=1.817$, $p=0.076$). Hence, to some degree, H1 was supported. As stated in the literature review, company size has always had intuitive appeal as a variable with regard to innovation but has yet to be debated about its power of explanation in innovation research because of the contradictory factors this variable indirectly

represents. The reason that infrastructure level was not significantly related to the overall E-commerce adoption level was probably because computer and network infrastructure has been well developed since

1990s among industries, including the U.S. apparel industry, and therefore companies do not see it as a barrier to adopting E-commerce for SCM.

Table 1
ANOVA Analysis of the Effects of Primary Strategy on the Overall E-commerce Adoption Level

Strategy	Hypothesis Number	Category	N	Mean	F-value	Sig.
Brand Identity	H4a	0	28	1.767	8.073	0.007
		1	18	2.222		
Low Cost	H4b	0	36	1.951	0.016	0.900
		1	10	1.925		
Niche Market	H4c	0	32	1.976	0.315	0.578
		1	14	1.873		
High Quality	H4d	0	22	1.885	0.462	0.500
		1	24	2.000		

Each item of the answer for the question regarding companies' competitive primary strategies was treated as a dependent variable and one-way ANOVA analysis was performed to test whether using each primary strategy affects the overall E-commerce. As Table 1 shows, only brand identity (H4a) was confirmed to have influence on companies' overall E-commerce adoption level with F=8.073. This study also proposed that product strategies, specifically the degree of fashion-forwardness and the frequency of new

offerings, were related to the overall E-commerce adoption level. The results presented in Table 2 show that both hypotheses 5 and 6 were rejected. This means that companies with low fashion products, or basic products might not adopt E-commerce tools for their SCM less than companies with high fashion products. It also shows that companies that offer fewer seasons for their products might use E-commerce tools as much as or more than those that offer many seasons.

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Table 2
Effects of Organization Characteristics, Product Strategy, Supply Chain Characteristics and, E-commerce Characteristics on the Overall E-commerce Adoption Level

Independent Variables	Hypothesis Number	Predicted sign	Parameter Estimate	t-value	P-value	R-Square	Adjusted R Square
Company Size	H1	+	0.264	1.817	0.076	0.070	0.049
Personnel Expertise	H2	+	0.303	2.111	0.040	0.092	0.071
Infrastructure Level	H3	+	0.049	0.322	0.749	0.002	-0.020
Degree of Fashion-forwardness	H5	+	0.059	0.394	0.696	0.004	-0.019
Frequency of New Product Offerings	H6	+	0.083	0.551	0.584	0.007	-0.016
Customer Influence	H7	+	-0.002	-0.011	0.991	0.000	-0.023
Degree of Outsourcing	H8	+	0.129	0.862	0.393	0.017	-0.006
Number of Key Suppliers	H9	+	0.091	0.604	0.549	0.008	-0.014
Percentage of International Suppliers	H10	+	-0.010	-0.070	0.946	0.000	-0.023
Information Sharing with Suppliers	H11	+	0.303	2.106	0.041	0.092	0.071
Information Sharing with Customers	H12	+	0.251	1.722	0.092	0.063	0.042
SCM Coordination Degree	H13	+	0.485	3.678	0.001	0.235	0.218
Relative Advantage	H14	+	-0.008	-0.060	0.956	0.000	-0.023
Compatibility	H15	+	0.346	2.449	0.018	0.120	0.100
Complexity	H16	-	-0.333	-2.340	0.024	0.111	0.091
Perceived Risk	H17	-	-0.006	-0.040	0.967	0.000	-0.023
Cost	H18	-	-0.275	-1.900	0.065	0.076	0.055

Several supply chain characteristics were tested about the relationships between a company's supply chain structure and its overall E-commerce adoption level, including the relationship between a U.S. apparel company and its customer (customer influence, H7), company's sourcing strategies (outsourcing degree, H8; number of significant suppliers, H9; percentage of international suppliers, H10), and a

company's SCM integration level (degree of information sharing with suppliers, H11; degree of information sharing with customers, H12; SCM coordination degree, H13). As Table 2 shows, among these seven hypotheses, H11 and H13 were supported. Degree of information sharing between a company and its suppliers was confirmed as positively related to the overall E-commerce adoption level ($\beta=0.303$, $t=2.106$, $p=0.041$),

and SCM coordination degree ($\beta=0.485$, $t=3.678$, $p=0.001$) showed a significant and positive relationship with the overall E-commerce adoption level. Customer influence was not supported as an influential factor in overall E-commerce adoption, probably because very few customers are large and significant enough to influence companies' E-commerce adoption decision-making. As proposed, the SCM integration level was an important factor in explaining E-commerce adoption, except for one of the variables, the degree of information sharing between a company and its customers, which did not show statistical significance.

Five hypotheses were used to test the relationships between five perceived characteristics (i.e., *relative advantage*, *compatibility*, *complexity*, *risk* and *cost*) of E-commerce tools and the overall E-commerce adoption level. H14 and H17 were rejected. H15 and H16 were confirmed at 0.05 significance level--both perceived compatibility and complexity of using E-commerce tools showed significant relationships with the company's overall E-commerce adoption level. While compatibility is positively related to the overall E-commerce adoption level ($\beta=0.346$; $t=2.449$; $p=0.018$), the relationship between complexity and overall E-commerce adoption is negative ($\beta=-.333$; $t=-2.342$; $p=0.024$). The relationship between perceived cost and the overall E-commerce adoption level (H18) was confirmed at 0.10 significance level. One of the issues that needs to be considered in explaining this relationship between perceived cost and the E-commerce adoption level is that there is high correlation between perceived cost and compatibility (-0.33), and between perceived cost and complexity (0.45). How these correlations affect the relationship between perceived cost and E-commerce adoption level needs to be investigated in the future research.

The hypothesis about perceived relative advantage (H14) was not confirmed, which might be because relative advantages were not significant enough to increase the

adoption level at the time the survey was taken, or because an aggregate measure might not provide a meaningful interpretation of the perceived relative advantage of using E-commerce for a particular company. Some benefits might be important to one company; they might not be to the other. In this case, composite score for the relative advantage, weighted by the importance rating, would probably provide a more accurate indicator of the relative advantage to the companies. The hypothesis regarding the perceived risk (H17) and the overall E-commerce adoption level was not supported indicating that risk was not an issue in adopting E-commerce tools.

Implications and Discussion

This study offers several theoretical implications. Results suggested that organization characteristics and innovation characteristics, in this case Internet-based E-commerce characteristics, are successful in explaining the E-commerce adoption level for SCM among U.S. apparel companies. Findings not only offered empirical evidence to confirm the validity of innovation adoption theory, but also contributed to the growing literature on high technology innovation adoption. The fact that SCM strategies, especially SCM integration level, showed significant relationships with the overall E-commerce adoption level confirmed the importance of a company's strategies as influential factors. Recommends are that at each specific time for each specific high technology innovation adoption, the innovation adoption model needs to be adapted. Five characteristics were accepted in the E-commerce adoption framework, among these five characteristics, only *compatibility* and *complexity* were found to be significantly related to overall E-commerce adoption level, and *cost* was found to be significantly related to the overall E-commerce adoption level at the significance level of 0.1. These findings do not necessarily mean that Internet-based E-commerce does not have enough relative advantages for companies to adopt; it only suggests that the E-commerce adoption level was not affected by E-commerce's relative

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advantage at the specific time period when this research was conducted.

Several limitations need to be considered. First, E-commerce as an innovation evolves through different stages of its life cycle. At different stages, the perceptions of E-commerce characteristics change. Measuring the perceived characteristics of innovation cross-sectionals at one point in time provides only a partial picture of the relationship of such characteristics to an innovation's rate of adoption (Rogers, 1995, p.213). This study was conducted at a fixed point in time and only provides a snapshot of E-commerce adoption. It is a study conducted within the U.S. apparel industry, so the results should not be applied to other industries or countries. Secondly, the sample for this study was selected partly on convenience, so the findings can not be generalized without caution. Thirdly, a summary of the product categories that the surveyed companies conduct their business in showed that the biggest category is work wear, protective wear and military clothing, which accounts for 20 percent of the respondents. This percentage very likely does not represent the whole U.S. apparel industry. Fourthly, due to limited resources, even after repetitive attempts to get subjects to complete the questionnaires, the total number of responses is not satisfactory. The small amount of completed questionnaires prevented a more comprehensive statistical analysis and precluded some in-depth findings. Fifthly, limitation comes from the methodology involved in questionnaire development. The questionnaire was developed based on the theories and existing related instruments. It was pre-tested, but no interviews or other means were used to solicit the measurement items before the pretest. The sixth limitation arises from the differences among actual respondents. Different groups might perceive the same innovation in different ways. The questionnaire was designed to target a company's upper management in an attempt to keep the respondents at a similar level in terms of hierarchy, seniority, experience, and unit affiliations (Kossek, 1989).

However, in reality, some questionnaires may have been answered by employees at completely different management levels, which might cause the data received to be non-comparable.

While innovation study has a history since the 1940's, the study of E-commerce for SCM innovation is new. The proposed E-commerce for SCM adoption model was exploratory, which leaves much room for further study. For example, the influences of specific key players carried out by members of the organization have been studied widely and proved to be significant in explaining the innovation adoption process. Although previous research showed that the impact of the key players mainly lies in the adoption decision-making process, it is also obvious that they will assume the important responsibilities throughout the adoption process, including the adoption assimilation process. Future research needs to study how these significant key players impact the diffusion of E-commerce, and put the user at a more important place in the adoption process by asking their perceptions about E-commerce innovation characteristics and other related issues. The present paper only discussed E-commerce adoption as it happened at a very specific time within a very specific external environment and at an early stage of diffusion. The adopters were most likely to be the early adopters if not first adopters. With this in mind, a time series analysis is needed to trace the changes in perceived E-commerce characteristics and supply chain structure as well as to provide comparable results so that a more comprehensive understanding of E-commerce adoption emerges.

Conclusion

This study proposed an E-commerce adoption model based on innovation adoption literature with four influential factor groups, *organization characteristics*, *company primary strategy* and *product strategy*, *supply chain structure* and *perceived E-commerce characteristics*. The hypotheses were tested within the U.S. apparel industry. The results confirmed the

explanatory power of perceived E-commerce characteristics and organization characteristics in E-commerce adoption as in other innovation adoptions. Supply chain structure as a new factor group was proved to have significant power in explaining E-commerce adoption level among U.S. apparel companies. With several limitations of this study, future research is mainly directed to a time series analysis, and refining the theoretical framework and survey instrument.

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