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Searching for Key Success Factors of Ubiquitous Supply Chain Management from Dual Perspectives

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ABSTRACT

There has been a little research focusing on the relationship between the key success factors and the benefits of ubiquitous supply chain management (USCM) adoption. Relying on the literature review, case analysis and interview, this research identified the key success factors and the benefits associated to the adoption of USCM. Upon collecting survey data, this research carried out an empirical examination for the relationship between key success factors and USCM adoption benefits. The results revealed that some factors in the management and technical aspects were closely associated with the benefits of USCM adoption. These findings bring us to an USCM adoption model. The current study is significant in that it provides empirical and theoretical insights for future researches and a practical guideline taking into account the adoption of USCM and ubiquitous computing.

Keywords

RFID, Ubiquitous Supply Chain Management, Key Success Factors, USCM Adoption Benefits, USCM Adoption Model, Canonical Correlation.

INTRODUCTION

Ubiquitous computing is being recognized as an emerging computing paradigm, which brings about the integration of the physical world and electronic space by reducing the gap between them (Weiser, 1993). Although the concept of ubiquitous computing has been changing continuously along with the advancement of information and communication technology, its definition can be summarized as an information activity that enables such conveniences as communication, information exchange and information sharing to take place whenever, wherever, and with whomever by installing an invisible computing and embedded computer network functionality into objects, locations and people (Roussos, 2006a).

The technical characteristics of ubiquitous computing tend to be smart, networked, mobile and embedded (Acquisti, 2006). However, these technical characteristics alone seem to be insufficient in understanding the various types of ubiquitous business models enabled by ubiquitous computing technology. The most successful application of ubiquitous computing has been applied in the supply chain field (Bose & Pal, 2005; Roussos, 2006a). A supply chain means the whole process from an organization's suppliers to its customers (Finley & Srikanth, 2005; Welch & Wietfeldt, 2005; Rai et al., 2006). Recently, ubiquitous computing technologies such as sensors, RFID, mobile devices, PDAs and global positioning system are likely to affect all facets of the supply chain management to reduce inventory and distribution costs as well as to improve supplier and customer satisfaction (Bose & Pal, 2005; Roussos, 2006a; Fish & Forrest, 2006). This research defines the supply chain management based on ubiquitous computing technologies as a Ubiquitous Supply Chain Management (USCM).

The USCM carries out a range of activities such as the planning, control and management of the supply chain based on ubiquitous computing technology. However, despite its growing adoption, research on USCM has been scant. Little attention

has been paid to the key success factors and USCM adoption benefits that an organization should consider when adopting USCM. This research aims to investigate the relationship between success factors and USCM adoption benefits. It appears that examining the factors affecting the adoption of USCM and its relationship with USCM adoption benefits, is an important challenge to provide useful academic foundation and practical information.

In the following section, this paper draws lessons from a recent study on USCM. Section 3 addresses research procedure and methods. Section 4 describes an empirical analysis and result. Finally, conclusions and the implications are discussed in Section 5.

THEORETICAL BACKGROUND

Overview of USCM

Generally, a supply chain is the process of goods from the purchase of raw materials to the finished product that reaches the hands of the consumer. That is, it means the whole process from the supplier to the consumer (Taalluri, 2000; Moberg et al., 2004). The goal of Supply Chain Management (SCM) is to minimize the cost in the supply chain, to increase the value of the supply chain, and to remove wasteful business practices (Kopczak & Johnson, 2003; Moberg et al., 2004; Ranganathan et al., 2004).

Recently, supply chain management is a digitally enabled inter-enterprise process activity that focuses on improvement and innovation of end-to-end process between enterprises and their customers and suppliers (Barua et al., 2004; Rai et al., 2006). Since SCM involves complex systems of interorganizational activities and processes relevant to the flow of products, services and information, effective SCM is influenced by information technology (Barua et al., 2004; Subramani, 2004; Ranganathan, 2004; Forman & Lippert, 2005; Nissen, 2006; Rai et al., 2006). Recently, ubiquitous computing technologies are offering firms a new opportunity in terms of supply chain management within and across companies, and integrating a number of organizational, functional, and technological issues (Bose & Pal, 2005; Fish and Forrest, 2006; Hackenbroich et al., 2006; Roussos, 2006b; Singh, 2007). As ubiquitous computing becomes more mobile and pervasive, ubiquitous supply chain management (USCM) has emerged as a key issue for organizations pursuing supply chain transaction processing accurately, quickly and efficiently. In this research, USCM is defined as the planning, control and management of the supply chain based on ubiquitous computing technologies such as RFID, sensors, mobile devices, PDAs, global positioning system and so on. An USCM encompasses a range of activities, such as purchasing, materials handling, production planning and control, warehousing, logistics, inventory management, distribution, delivery and vendor management (Ranganathan et al., 2004; Fish and Forrest, 2006). Thus, it is not surprising that more enterprises are adopting USCM.

USCM should no longer be regarded as just one of various functional systems in organization. This is because USCM serves a vital role between organizations and their suppliers' activities in the global supply chain, and furthermore supports new kinds of U-business related to the supply chain. Though the USCM play a critical role in managing global supply chain activities, however, theoretical and empirical research has been limited. The following section deals with the review of previous research on USCM.

Review of Previous Research on USCM

As previously indicated, although there have been some studies of the ubiquitous computing and SCM, there has been little research focusing on the USCM per se. Previous SCM research has been concerned with various issues including inventory management (Cohen & Lee, 1998; Mabert & Venkatraman, 1998), materials management (Turner, 1993), interorganizational capabilities (Ho et al., 2002), SCM framework (Gunasekaran and Ngai, 2005; Finley & Srikanth, 2005), SCM strategy (Vickery et al., 2003), SCM effect (Subramani, 2004; Moberg et al., 2004; Corsten & Kumar, 2005), SCM development (Rajib et al., 2002; Welch & Wietfeldt, 2005) and IT application in SCM (Barua et al., 2004; Subramani, 2004; Ranganathan, 2004; Nissen, 2006; Rai et al., 2006).

In addition to previous research studying SCM, there are a number of recent studies relating to USCM. The following review of these studies provides useful background to this research. Firstly, from the management perspective, recently, Fish and Forrest (2006) reported seven factors underling successful RFID adoptions and the reasons for launching RFID implementations, according to the their consulting experience to RFID adoption companies. They identified seven success factors as follows: 1) Develop a clear strategy with top management support; 2) Implement RFID as a project; 3) Manage a gradual rollout: 'start small, dream big"; 4) Continually improve procedures; 5) Work on negotiation and build trust among flexible partners; 6) Utilize a cross-functional team; and 7) Fully develop the technology throughout the whole supply chain. Though the seven factors suggested by this study are not verified by the empirical data, it seems that this paper provides theoretical base to further this research in selecting appropriate major variables closed to successful USCM adoption.

Moreover, Kourouthanassis and Roussos (2006) addressed the design of pervasive retail experiences brought about by the emergence of ubiquitous computing. They argued that the most important issues deriving from the development of ubiquitous retail applications are trust and privacy. This study might be meaningful in showing practical application of pervasive retail business within ubiquitous computing.

Secondly, from a technical perspective, Roussos (2006b) addressed the supply chain management standards for ubiquitous commerce. He reviewed first the history of unique identifier and product classification systems, and then an overview of the EAN.UCC system, including its recent specifications for the wireless auto-identification of products. Finally, global cataloguing schemes and standards for ubiquitous commerce are examined. Since this article tends to focus on the review of supply chain management standards, it would contribute to further research on the emerging standards for USCM.

In addition, Hackenbroich et al. (2006) described enterprise software for supply chain management, focusing on SAP's SCM and Auto-ID technology, discussing two Auto-ID pilot cases. As both RFID and Auto-ID are major technologies in USCM adoption, it would appear that this study is a good example of the better understanding of the relationship between the ubiquitous technology and U-business application. Thiesse et al. (2006) described the design and adoption of a real-time identification and localization system using RFID and ultrasound sensor technologies to improve tracking visibility for inbound logistics. This article is reliable for extending our view of the RFID and ubiquitous technology applications in ubiquitous computing. Recently, Singh et al. (2007) concentrated on issues relating to information technology-enabled supply chains and their impact on organizational processes. They argued that the choice of adopting the right technology depends on the compatibility of the technology with appropriate organizational practices and policies. Table 1 presents previous researches of critical success factors between USCM.and SCM and they are arranged together for comparison.

Factors	**USCM**		**SCM**	
	CSF	Reference	CSF	Reference
Managerial Factors	Top management strong support CEO's cooperative relationship with CIO Continuous investment in the new IT Providing valuable information on supply chain for a supplier Creating a new source of profit Development of a new ubiquitous-oriented supply chain model Innovative ideas of the management board Firms' progressive image change Standardization of business and process Right view of the top management for the USCM adoption Conducting business process reengineering Process design based on the portability of ubiquitous computing Adventurous spirit ventured into an unaccustomed area User-oriented USCM development Develop a USCM strategy planning Work on negotiation and build trust among flexible partners Organization of a cross-functional project team Cultural change management End-to-end process management Cross-functional USCM planning Risk management for USCM Organizational knowledge intensity for USCM Working experience of project participator in supply chain Understanding parent-child relationship between suppliers Long-term relationship with suppliers Planning for long-term supply chain improvement Supplier performance management	Crone (2006) Dischinger et al. (2006) Fish & Forrest (2006) Finley & Srikanth (2005) Gattorna (2006) Kourouthanassis & Roussos (2003) Hillman (2006) IDTechEx (2005a) IDTechEx (2005b) KIDL (2006) Kim et al. 2008) Lee & Kim (2003) Metro Group (2004) Moberg et al. (2003) Nomura Laboratory (2003) North (2006) O'Connor (2006a) O'Connor (2006b) O'Connor (2005) O'Connor (2003) Romano & Finley (2006) SRI Consulting (2004) Tompkins et al. (2006) His & Fait (2005)	Strategic alignment Unified channel Contiguous participants Channelwide metrics Top management support Training & education Long-term focus on SCM Skill & competence SCM commitment Supply chain planning Delivery coordination Culture of competitiveness and knowledge development	Gammelgaard & Larson (2001) Christopher et al. (2003) Ngai et al. (2004) Moberg et al. (2004) O'Brain (2005) Karkkainen et al. (2007) Hult et al. (2007)
Technical Factors	Accumulated systems development ability Development of USCM in a stable system infrastructure Pursuit of technological stability Adoption of the standard client server method Improved system use efficiency Providing a convenient interface Successful connection to the existing	Carter et al. (2005) Cecere (2006) Crone (2006) Fish & Forrest (2006) Hillman (2006) IDTechEx (2005a) IDTechEx (2005b) Johnson (2006)	Connectivity in quasi-real time Communication Data security Hardware & software reliability Centralization of IT unit IT knowledge Integrated IT infrastructure	Jeong & Hong (2008) Ngai et al. (2004) Ranganathan et al. (2004) Nguyen & Harrison (2004) Moberg et al. (2004) O'Brain (2005)

	systems Successful replacement of the existing system by USCM adoption Adoption of the suitable RFID technology Utilizing the RFID technology widely Using the standardized ubiquitous technology Design and development of USCM systems with a long term view Development of user-friendly USCM systems Implement USCM as a project Gradual development of USCM : 'start small, dream big" Continually improve procedures of USCM systems Fully develop the technology throughout the whole supply chain Enacted view of technology adoption Project participant's broad skills across multiple dimensions in USCM Optimal USCM network design Security management of USCM systems CIO as a business innovator, not simply a technology manager Good network infrastructure Periodical evaluation of supply chain networks RFID tag price Standardisation for USCM Supply-chain visibility Interconnected supply chain network of firms Industry-level databases on supplier performance Inventory visibility	KIDL (2006) Kim et al. (2008) Lee & Kim (2003) Nomura Laboratory (2003) Metro Group (2004) Moody (2006) O'Connor (2006a) O'Connor (2006b) O'Connor (2005) O'Connor (2003) Roussos (2006b) SRI Consulting (2004) His & Fait (2005)	IT-enabled supply chain integration Information intefrity Operational information exchange Strategic information exchange	Rai et al. (2006)

Table 1. Prior researches on comparing CSFs between USCM and SCM

As can be seen from the table, it appears that most research relevant to USCM has been carried out recently and tends to focus on exploratory approaches. Furthermore, previous research related to USCM tends to have been carried out from two different perspectives: 1) management and 2) technology. The research on the technical perspective has a somewhat narrow focus and barely considers such aspects as inter-organization, supplier and supply chain, all of which are closely associated with USCM adoption. On the other hand, research on the management view is much wider in research focus but there is a limit to its explanatory power due to its lack of technical concern.

Firstly, critical success factors of ubiquitous supply chain management (USCM) includes more factors relevant to relationship management and new supply chain models with emerging technologies, while CSFs of SCM have more things to do with organizational level (Hult et al, 2007; Karkkainen et al, 2007). It revealed that agenda of the recent SCM researches have shifted to how take advantage of the emerging technologies into creating a new business model and innovating business processes. More precisely, CSFs of SCM in organizational level focused on optimization of a series of value chain from suppliers to customers. Meanwhile, USCM, encompassing relationships and interactions with external alliances as well as suppliers and clients, suggests a broad and holistic paradigm changes (Rai et al, 2006).

In technical aspect, secondly, researches on SCM emphasized on internal factors, such as communication, reliability of hardware and software, and integration of IT infrastructure that can facilitate supply chain management (Ranganathan et al, 2004; Nguyen & Harrison, 2004; O'Brain, 2005; Rai, 2006), whereas USCM are more interested in factors of ubiquitous computing network foundation and ubiquitous technology applications. That is because USCM requires a comprehensive control of information and material flows throughout a value chain using ubiquitous technologies. It is also noted that a focus shift in technical aspect is similar to what we saw in managerial aspect. It is the shift from optimizing efficiency of the internal supply chain process to technology applications or network infrastructure that seamlessly connect all relevant stakeholders in the value chain. These shifts together require high level of trust among suppliers, manufacturers, distributors, and customers so that a company to strategically align itself among supply chain participants through a long term partnership or alliance (Hult et al, 2007).

The comparison clearly depicted a departure of research foci from prior domain. Attaining the efficiency of its own internal value chain, a company rather had an initiative on a competitive advantage over its competitors in the same industry. Under new converging economy, however, it is more important that a company sustain a competitive edge with 'inter-industry alliances' by effectuating communication and information flows and shortening a market response time.

Based on this review, it can be argued that further researches on USCM would be meaningful if it deals with a in-depth analysis considering both management and technology issues, according to empirical data, because both perspectives together may help explain and analyze the phenomenon of USCM adoption more adequately.

RESEARCH MODEL AND METHODS

This research attempts to investigate the relationship between the key success factors and the benefits of USCM adoption in the UK. Though there are various success factors affecting USCM benefits, we cannot imagine the USCM without the application of information technology. Recently, ubiquitous computing technologies have changed supply chain processes across inter-organizations, increased collaboration with suppliers and customers, and improved competitiveness (Bose & Pal, 2005; Fish and Forrest, 2006; Hackenbroich et al., 2006; Roussos, 2006b; Singh, 2007). With regards, the significance of information technology and management related to USCM adoption, we classify the key success factors into management factors and technical factors and then analyze their implications for the USCM adoption benefits. We provide a research model illustrated in Figure 1.

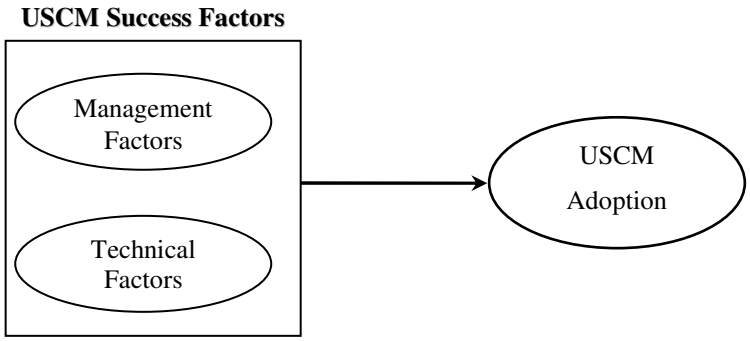

Figure 1. Conceptual Research Model

The research procedure is as follows. First, the key success factors and benefits of USCM adoption were selected through literature review, case analysis and interviews. Second, a five-point scale survey questionnaire was developed to collect empirical data and then elaborated by interviews with academics and practical experts. Third, data collection work was carried out in the UK. Fourth, an in-depth analysis was conducted for investigating the relationship between key success factors and USCM adoption benefits. Finally, the research results were summarized and major implications were addressed in the conclusion.

For an empirical test, 33 items for management factors, 31 for technical factors and 27 benefit issues related to USCM adoption were measured and collected through literature review, case study and interviews with experts. According to these selected items, the survey questionnaire was developed to conduct data collection. To elaborate the survey questionnaire, the interview with academics and practical experts was executed in order to correct any obscure and unclear survey items, and to add new ones. As results of the interviews, some items were dropped and words were changed. All the survey items were contained within a five-point Likert scale. After this, a survey approach was used for collecting empirical data.

The representative analysis methods used in this study are as follows: First, the demographic characteristics of the samples are examined by applying the descriptive statistic approaches. Second, the reliability and validity of the collected data are executed to evaluate whether the survey items are reliable and the survey items are consistently valid. A factor analysis is performed for the validity analysis, and Cronbach's-α is used for the reliability analysis. A correlation analysis is applied to investigate the relationship with key success factors and the benefits of USCM adoption.

EMPIRICAL ANALYSIS AND RESULTS

Descriptive Analysis

The elaborated questionnaire was delivered by web-based survey, directly delivered survey and email surveys to 930 samples in the UK. A total of 133 usable questionnaires were returned for final analysis, revealing a 16% response rate as measured by the ratio of the number of the completed surveys returned to the number of the surveys initially distributed. The descriptive analysis of survey respondents (sample size 133) is given in Table 2, displaying industry area, number of

employees, annual turnover, function area and USCM technology adoption area. Thirty-nine were IT directors or managers and attributed to a major job position among the 133 respondents.

IT and Telecommunication was the most represented industry that revealed 22% of all respondent companies and was followed by Logistics & Delivery and Wholesales & Retail Industries with 16.5% and 11.3%, respectively. The sizes of companies were evenly distributed from less-than-50 to more-than-3000. The demographic results indicated that there were no industries disregarded or excluded in the present study. Likewise, the study tried to include responses from various sizes of firms and functional units regarding to realization of USCM technology.

Division		Frequency	Percent	Division		Frequency	Percent
Industry Area	Logistics & Delivery	22	16.5%	Function Area	Logistics	29	15.8%
	Manufacturing	12	9.0%		Manufacturing	8	4.5%
	Electricity, Gas & Water	3	2.3%		Marketing/Sales	20	10.9%
	Constrution	6	4.5%		Customer Service	24	13.1%
	Wholesale & Retail	15	11.3%		IT/IS	41	22.4%
	Hotels & Restaurants	5	3.8%		General Management	35	19.1%
	IT & Telecommunication	29	21.8%		Procurement	11	6.0%
	Transport	9	6.8%		HRM	12	6.6%
	Banking & Finance	8	6.0%		Others	3	1.6%
	Public Administration	9	6.8%	USCM Technology Adoption Area	Inbound Logistics	33	17.7%
	Education & Health	6	4.5%		Production (Operations)	21	11.3%
	Social & Personal Service	9	6.8%		Outbound Logistics	30	16.1%
Number of Employee	50 or less	39	29.4%		Sales & Marketing	15	8.1%
	51-500	32	24.1%		Customer Service	22	11.8%
	501 ~ 3000	23	17.3%		Administrative Infrastructure	16	8.6%
	3001 or more	39	29.3%		Human Resources Management	7	3.8%
Annual Turnover	Less than 500 thousand £	27	20.3%		Technology Development	13	7.0%
	500 thousand ~ 25 million	37	27.8%		Procurement	10	5.4%
	25 ~ 200 million £	32	24.1%		Information Systems	19	10.2%
	More than 500 million £	37	27.8%		Others	0	0.0%

Table 2. Descriptive Analysis of Survey Respondents (N= 133)

Factor Analysis and Reliability Test

The validity and reliability of collected data are used to judge its quality for further analysis. The purpose of the paper is to examine relationships between proposed managerial CSF and technical CSF, and the attainable adoption benefits of USCM. To this end, we firstly needed to draw relevant factors from measurement items for these three constructs through exploratory factor analysis technique. We employed principle component analysis with varimax rotation technique as a method in factor analysis and applied the Kaiser criterion (eigenvalues > 1.0) in extracting relevant factors.

Table 3 summarizes the anatomy of construct validity for the all of key success factors in management aspects. After removing variables cross-loaded, we were able to obtain 7 key success factors of management aspects that have higher construct validity as shown in Table 3. All factor loadings are above .5 and, combined together, account for 66.85% of total variance.

Measurement Items	M	SD	Eigenvalue	% of variance	Internal reliability (α)	Factor Loadings
1. Internal Process Management			5.471	15.856	.827	
Risk management for USCM	3.40	1.11				.718
Cross functional USCM planning	3.32	.95				.709
Cultural change management	3.35	1.08				.697
End-to-end process management	3.70	1.04				.639
Trust building among business partners	3.81	1.07				.623
Organizational knowledge level	3.44	.92				.621
Working experience	3.47	.92				.568

2. Strategic Relationship Management			2.196	14.258	.797	
Planning for long-term supply chain improvement	3.80	.87				.816
Long-term relationship with suppliers	3.77	.96				.762
Strategic alignment	3.50	.91				.711
High level of trust	3.86	.93				.697
3. Managerial Support			1.497	8.905	.710	
Top Management Support	4.17	.86				.863
CEO & CIO Relationship	3.66	1.08				.753
4. Business Process Reengineering			1.410	8.215	.527	
Process design on the portability	3.19	.93				.820
Conduct of BPR	3.32	.91				.691
5. Adaptation to Environmental Change			1.305	7.261	.480	
Supplier performance management	3.57	.86				.646
Entrepreneur Spirit	3.30	1.06				.545
Firm's USCM environment awareness	3.41	1.02				.538
6. USCM Realization			1.114	6.742	.393	
Adoption of Payment Model	3.47	1.10				.791
Creation of a new source of profit	3.46	1.14				.575
7. Relationship with Current Suppliers			1.046	5.654	N/A	
Strong cooperation	3.81	2.73				.772

Table 3. Results of Principle Component Analysis for Management Aspects

The first factor comprises the first seven items shown in the Table 3, and these together may be labeled as "Internal Process Management". The second factor is composed of four items after the first factor. This factor may represent "Strategic Relationship Management" as we may call them. The third factor includes two items, 'top management support' and 'relationships between CEO and CIO.' The factor can be categorized as "Managerial Support". The fourth factor was also measured by two items and may be named as "Business Process Reengineering toward USCM." The fifth factor has three items and might be interpreted as "Adoption to Environmental Change".

USCM Realization is recognized as a sixth factor, which stands by 'adoption of payment model on convenience' and 'creation of a new source of profit.' Finally, we have a single itemed factor that is Relationships with current suppliers. Table 4 summarizes the grouping results for the categorized seven factors.

Factor Name	Items
Internal Process Management	- Risk management for USCM - Cross functional USCM planning - Cultural change management - End-to-end process management - Trust building among business partners - Organizational knowledge level for USCM - Working experience of USCM project participants
Strategic Relationship Management	- Planning for long-term supply chain improvement - Long-term relationship with suppliers - Strategic alignment among supply chain participants - High level of trust with suppliers and customers
Managerial Support	- TOP Management Support - CEO & CIO Relationship
Business Process Reengineering	- Process design on the portability - Conduct of BPR
Adaptation to Environmental Change	- Supplier performance management - Entrepreneur spirit to enter into a new business - Firm's USCM environment awareness
USCM Realization	- Adoption of payment model on convenience - Creation of a new source of profit
Relationship with Current Suppliers	- Strong cooperation with supplier on USCM

Table 4. Summary of Key Factors in the Managerial Aspect

According to the factor analysis of removing cross-loading variables and redundant information, we also found that six factors were extracted for the key success factors in the technical aspects as provided in Table 5. All factors provide strong

construct validity, as all factor loadings were above 0.5 and the explanatory power of the factors has exceeded 63%. More detailed explanations on the five categorized factors are as follows.

Measurement Items	Component					
	M	SD	Eigenvalue	% of variance	Internal reliability (α)	Factor loadings
1.USCM Technology Application			8.570	16.661	.852	
Utilization of the RFID technology	3.20	1.10				0.792
Adoption of the suitable RFID technology	3.31	1.03				0.772
Project participant's broad skill	3.29	.96				0.660
Adoption of the standardized ubiquitous technology	3.38	.97				0.637
Enacted view of technology adoption	3.15	.86				0.615
Selection of the best outsourcing provider	3.19	.95				0.608
Ubiquitous technology price	3.41	.94				0.535
2. USCM System Design			2.466	11.735	.814	
USCM design with a long term view	3.77	.86				0.702
User friendly USCM adoption	3.80	.93				0.664
Consideration of customer information	3.65	1.04				0.630
Continual improvement of USCM	3.79	.80				0.595
Full development of the technology throughout the whole SCM	3.73	.83				0.570
USCM adoption as a project	3.55	.76				0.558
Security management of USCM	3.72	.91				0.550
3. USCM Network Foundation			1.607	10.729	.739	
Industry-level databases on supplier performance	3.32	1.06				0.689
Inventory visibility	3.60	1.13				0.608
Interconnected supply chain network of firms	3.31	1.03				0.607
4. Compatibility with Existing Systems			1.435	8.462	.735	
Successful connection to the existing systems	3.94	1.00				0.745
Successful replacement of the existing system	3.74	.97				0.623
Standardization for USCM	3.51	1.00				0.535
5. Efficient Use of USCM			1.250	7.992	.716	
System use efficiency	3.52	.90				0.706
Adoption of the standard client server method	3.18	1.02				0.679
Technological stability	3.65	.91				0.631
6. USCM Sustainability			1.102	7.609	.567	
CIO as a business innovator	3.52	1.03				0.722
Gradual development of USCM	3.33	.94				0.661
Periodical evaluation of supply chain networks	3.57	.84				0.512

Table 5. Results of Principle Component Analysis for Technical Aspects

The first factor contains seven items, 1 through 7 in Table 5. These variables may be jointly labeled as "USCM Technology Application." The second also comprises seven items, 8 through 14 in Table 5. The factor may be labeled as "USCM System Design." The third factor consists of three items, which may be interpreted as "USCM Network Foundation". The fourth also holds three items, 'successful connection to the existing systems', 'successful replacement of the existing systems', and 'standardization for USCM.' The factor can be referred as "Compatibility with Existing Systems". The fifth factor includes three items. Those items presumably represent "Efficient Use of USCM." The last factor extracted includes the three measurement items as well. Those can be seen as "USCM Sustainability." The categorization results for the five factors are summarized in Table 6.

Factor Name	Item
USCM Technology Applications	- Utilization of the RFID technology widely - Adoption of the suitable RFID technology - Project participant's broad skill

	- Adoption of the standardized ubiquitous technology - Enacted view of technology adoption - Selection of the best outsourcing provider - Ubiquitous technology price
USCM System Design	- USCM design with a long term view - User friendly USCM adoption - Consideration of customer information as the most important element - Continual improvement of USCM - Full development of the technology throughout the whole SCM - USCM adoption as a project - Security management of USCM
USCM Network Foundation	- Industry-level databases on supplier performance - Inventory visibility - Interconnected supply chain network of firms
Compatibility with Existing Systems	- Successful connection to the existing systems - Successful replacement of the existing systems - Standardization for USCM
Efficient Use of USCM	- Efficiency improvement in system use - Adoption of the standard client server method - Pursuit of technological stability
USCM Sustainability	- CIO as a business innovator - Gradual development of USCM - Periodical evaluation of supply chain networks

Table 6. Summary of Key Factors in the Technical Aspect

Finally, the construct validity test on USCM adoption benefits was carried out for all of the measurement items in the same manner as other factor analyses. The suggested five factors show strong evidence of construct validity, with a factor loading well above 0.5 and with an explained variance of over 67%. More detailed explanations on the six categorized factors are as follows.

The first factor comprises eight items from item 1 through 8 in Table 7. The encompassing factor may be named as "Cost Savings from USCM." The second factor consists of five measurement items. It may be categorized as "Creation of Competitive Edge." The remaining three factors are all represented by three measured items.

	Component					
	M	SD	Eigenvalue	% of variance (α)	Internal reliability	Factor loadings
1. Cost Savings			7.055	21.132	.887	
Cost savings	3.57	1.07				0.775
Against business counterfeiting or theft	3.38	1.15				0.765
Eliminate packing and shipping errors	3.47	1.22				0.761
Eliminate excess inventory	3.46	1.04				0.707
Reduce stock-outs	3.38	1.15				0.593
Reduce procurement costs	3.61	1.11				0.584
Establish real-time supply chain intelligence	3.63	.85				0.567
Reduce logistics cost	3.66	1.05				0.565
2. Creation of Competitive Edge			1.729	14.636	.801	
Create new market opportunities	3.51	.98				0.761
Enhance customer responsiveness	3.84	.92				0.728
Improve the organization conduct business	3.85	.93				0.692
Enhance employee productivity	3.86	.81				0.641
Improve data collection accuracy	3.86	.87				0.581
3. Process Efficiency			1.591	10.813	.708	
Save money	3.51	1.21				0.811
Eliminate a lot of the manual intervention	3.89	.97				0.789
4. Facilitating Partnership			1.302	10.605	.620	
Improve supplier relationships	3.87	.96				0.745
Better response to partners	3.72	.93				0.678
5. Improvement in Inventory Control			1.084	9.974	.713	

Enable track and trace authentication	3.80	1.01	0.745
Improve supply-chain visibility	3.78	.96	0.743

Table 7. Results of Principle Component Analysis for Perceived Adoption Benefits of USCM

The third factor includes items 'Save money by avoiding the need of additional workforce' and 'eliminate many labor intervention' so that it may be labeled as "Process Efficiency". The fourth factor is represented by 'Improve supplier relationships' and 'Better response to partners in the supply chain' and can be named as "Facilitating partnerships."

Factor Name	Item
Cost Savings	- Cost savings in lost, stolen or wasted products - Against business counterfeiting or theft - Eliminate packing and shipping errors - Eliminate excess inventory - Reduce stock-outs - Reduce procurement costs - Establish real-time supply chain intelligence - Reduce logistics cost
Creation of Competitive Edge	- Create new market opportunities - Enhance customer responsiveness - Improve the organization conduct business - Enhance employee productivity - Improve data collection accuracy
Process Efficiency	- Save money by avoiding the need to increase the work force - Eliminate a lot of the manual intervention
Facilitating Partnerships	- Improve supplier relationships - Better response to partners in the supply chain
Improvement in Inventory Control	- Enable track and trace authentication - Improve supply-chain visibility

Table 8. Summary of Key Factors in Adoption Benefits of USCM

The final factor may be labeled as "Improvement in Inventory Controls" because it includes measurement items such as 'Enable track and trace authentication', and 'Improve supply chain visibility.' These grouping results for all five categorized factors are provided in Table 8.

To sum up, based on this reasonable construct validity observed, all items were used for reliability tests. The reliability tests on the five groups of management success factors of USCM adoption, the five groups of technical success factors of USCM adoption and the three groups of USCM adoption benefits were conducted. The reliability of each group factors is determined by Cronbach's α. In order to maintain highest consistency of the dimension for proposed constructs, we eliminated factors having lower reliability than 0.7, even though they presented high factor loadings. In this light, four factors from Management Aspect, one from Technical Aspect and one from Adoption Benefit were removed from further analysis.

Canonical Correlation Analysis

Based on the extracted components from the previous section, we combined the scores of variables in each component using summated scaling. With the components identified in previous analysis we further performed two canonical correlation analyses to examine the relationships among the latent constructs, management aspects, technology aspects, and the adoption benefits. That is, a relationship between management aspects and the adoption benefits perceived by USCM was firstly assessed and then one between technology aspects and the adoption benefits perceived by USCM was also analyzed using the same technique. The reasons employing canonical analysis over other advanced methods, such as regression analysis or PLS are two-fold. First of all, this study focused on the exploring the relationships among those latent factors, not to predict the impact of independent variables on dependent variable(s). Secondly, little prior studies have empirically proved the causation among those variables. It would identify all relevant factors for these three constructs through exploration factor analysis. However, directions of impact and importance (loading) of each factor are unknown when all of them are pooled together for a multidimensional analysis.

For the first canonical correlation, the management aspects set was entered as the predictor variable and included "Internal Process Management", "Strategic Relationship Management", and "Management Supports" after eliminating inconsistent factors. The benefits of USCM adoption set was entered as the criterion variable and was measured "Cost savings", "Creation of Competitive Edge", "Process Efficiency", and "Improving Inventory Control." Table 9 reports the significance of the correlation relationships between canonical variates.

	Canonical Correlation	% of Variance	Cum. % Variance	Sq. Can. Correlation	Eigenvalue	Approximate F (df, df)	Pr > F
Management Aspects							
1	.427	61.461	61.461	.182	.223	F(12, 333.66) = 3.757	<.0001
2	.298	26.840	88.301	.089	.097	F(6, 254) = 2.940	=.009
3	.202	11.699	100.00	.041	.042	F(2, 128) = 2.712	=.070
Technology Aspects							
1	.580	79.426	79.426	.337	.508	F(20, 412.21) = 3.614	<.0001
2	.322	18.081	97.507	.104	.116	F(12, 331.01) = 1.337	=.196
3	.121	2.310	99.827	.015	.015	F(6, 252) = .334	=.919
4	.033	.173	100.00	.001	.001	F(2, 127) = .070	=.932

Table 9. Canonical Correlations for Management and Technical Aspect toward Adoption Benefits

The table shows that only the first two sets of variables are significant for the multivariate relation among management aspects and the adoption benefits, as indicated Wilks' $\lambda = .715$ and $F(12, 333.66) = 3.757$ that is $p < .0001$ and the first canonical correlation emerged with $r_{can} = .427$ (61.46% overlapping variance); and a second set emerged with canonical correlation of .298 and overlapping variance of 26.84% that are consider significant and meaningful suggested by Tabachnick and Fidell (2006).. However, the third one was effectively zero because its p-value (.070) is greater than .05. Since the first canonical correlation showed the largest correlation, it may be interesting to express it in two linear equation forms, one for management aspect and the other for adoption benefits. Table 10 summarizes these coefficients and their significance, and Figure 2 illustrates the linear relationships of two canonical pairs.

Management Aspect = .857(Internal Process Management) + .564(Strategic Relationship Management + .333(Management Support)

Adoption Benefits = .635(Cost Savings) + .832(Creation of Competitive Edge) + .021(Process Efficiency) + .133(Improving Inventory Control)

a) First Canonical Variate Pair b) Second Canonical Variate Pair

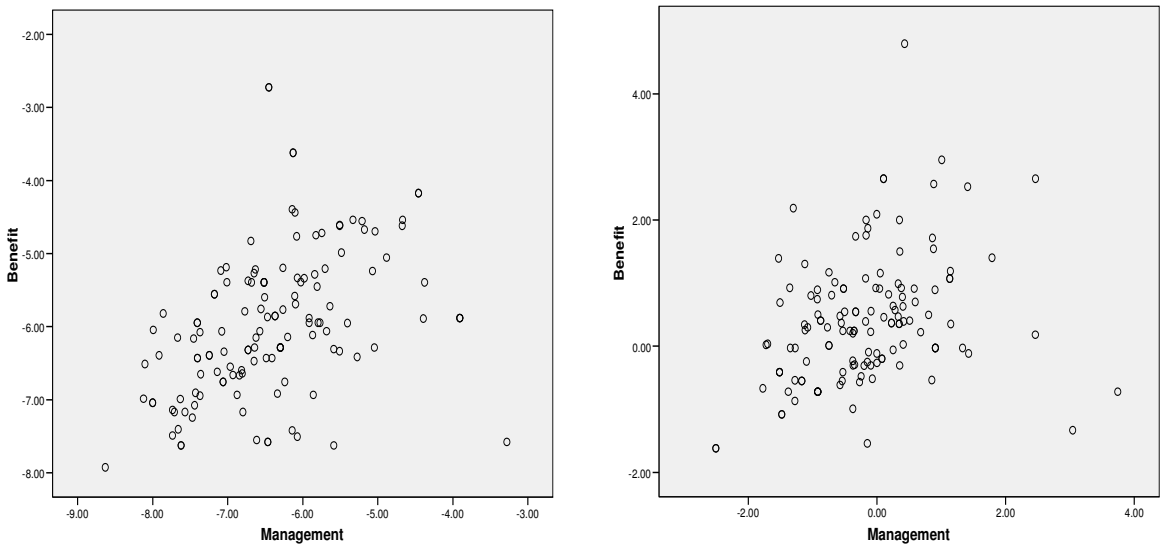

Figure 2. Scatter plots of the First and the Second Canonical Variate Pairs for Management Aspects and Adoption Benefits of USCM.

Descriptively this first canonical function tells that Internal Process Management (.857) and Strategic Relationship Management (.564) are jointly and positively associated with Cost Saving (.635), Creation of Competitive Edge (.832) as of

perceived benefits of USCM adoption set with applying a cutoff value of correlation, 0.5 (Tabaschnick and Fidell, 2006). The relationships between management aspects and perceived benefits of USCM adoption is illustrated in Figure 3 which also presents loadings and canonical correlations for the first canonical variates pairs for the data in Table 10.

		Coefficient	Standard Error	t	p-value
First Pair	Management Aspect				
	Internal Process Management	.858	.310	2.77	0.006
	Strategic Relationship Management	.564	.281	2.01	0.047
	Management Support	.333	.238	1.40	0.165
	Adoption Benefit				
	Cost Savings	.635	.306	2.07	0.040
	Creation of Competitive Edge	.832	.347	2.40	0.018
	Process Efficiency	.021	.216	0.10	0.921
	Improving Inventory Control	.133	.252	0.53	0.598
Second Pair	Management Aspect				
	Internal Process Management	-.183	.469	-.39	0.697
	Strategic Relationship Management	1.107	.425	2.61	0.010
	Management Support	-.849	.361	-2.36	0.020
	Adoption Benefit				
	Cost Savings	.823	.463	1.77	0.049
	Creation of Competitive Edge	-1.222	.525	-2.33	0.022
	Process Efficiency	-.489	.327	-1.49	0.138
	Improving Inventory Control	.826	.381	2.17	0.032

Table 10. Linear Combination of the First and Second Canonical Variate Pair for Management Aspects and Adoption Benefits

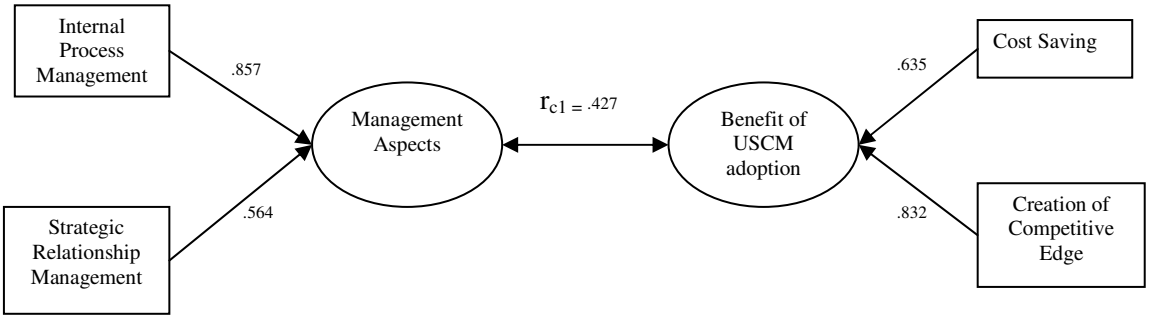

Figure 3. First Pair of Canonical Relationship between Management Aspects and Adoption Benefits.

Interestingly, the second canonical variate pair delivered different factors or attributes statistically significant in both Management Aspects and Adoption Benefits of USCM. That is, as provided in the lower part of Table 10, Strategic Relationship Management (1.107) and Management Supports (-.849) from Management Aspects are qualified for the cutoff value of canonical correlation. The matching factors are Cost Savings (.823), Creation of Competitive Edge (-1.222), and Improving Inventory Control (.826) from Adoption Benefit of USCM. The second pair of canonical variate is depicted in Figure 4.

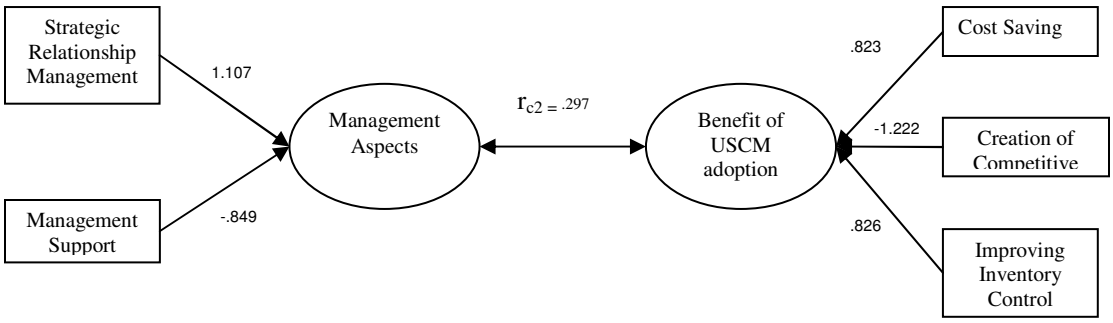

Figure 4. Second Pair of Canonical Relationship between Management Aspects and Adoption Benefits.

In the same manner we examined canonical correlations of the Technical Aspects set which includes "USCM Technology Application", "USCM System Design", "USCM Network Foundation", "Compatibility with Existing Systems", and "Efficient Use of USCM" with the Adoption Benefits of USCM set. Shown in the bottom part of Table 9 are canonical correlations and eigenvalues for the canonical variates. As indicated here, only the first pair of canonical variates is meaningful and can be interpreted in the same way as done previously. For Technical Aspects toward benefits of USCM adoption, only the first canonical correlation, r_{can} =.580, showed significance with Wilks' λ = .585, F(20, 412.21) = 3.6143 and p-value less than 0.001, accounting for 79.43% overlapping variance for this canonical pair. Although the second canonical correlation, r_{can} is .322, representing about 18% overlapping variance for the second pair of canonical variates, its F statistics (F(12, 331.01) = 1.3370) revealed that the second pair of canonical variates is not significant at .05 level. The result of the canonical correlation can be interpreted that Internal Process Management and Strategic Relationship Management.

Table 11 shows a summary of information on the first pairs of canonical variates for both management aspects and technology aspects. Shown in the table are correlations between the variables and the canonical variates, standardized coefficients, percent of variance explained by canonical variates, redundancies, and canonical correlations. Total percent of variance and redundancy suggest that only the first pair of canonical variates was highly related.

	Coefficient	Standard Error	t	p-value
Technical Aspect				
USCM Technology Applications	.447	.240	1.86	0.065
USCM System Design	.391	.263	1.48	0.140
USCM Network Foundation	.146	.171	.86	.394
Compatibility with Existing Systems	.204	.207	.96	.325
Efficient Use of USCM	.562	.209	2.69	.008
Adoption Benefit				
Cost Savings	.594	.203	2.93	0.004
Creation of Competitive Edge	.372	.230	1.62	0.108
Process Efficiency	.362	.143	2.53	0.013
Improving Inventory Control	.331	.167	1.99	0.049

Table 11. Linear Combination of the First Canonical Variate Pair for Technical Aspects and Adoption Benefit.

In the first pair of canonical variate, technology aspect variables of USCM Technology Applications (.447), USCM System Design (.391), USCM Network Foundation (.146), Compatibility with Existing Systems (.204), and Efficient Use of USCM (.562) are collectively related to combined variables of USCM Adoption Benefits in which Cost Savings (.594), Creation of Competitive Edge (.372), Process Efficiency (.362), and Improving Inventory Control (.331) are included. Figure 5 illustrates relationships of Technical aspects and Benefits of USCM Adoption among the variables, their correlations, and canonical variates for the first pair after removing non-significant variables from these canonical variates.

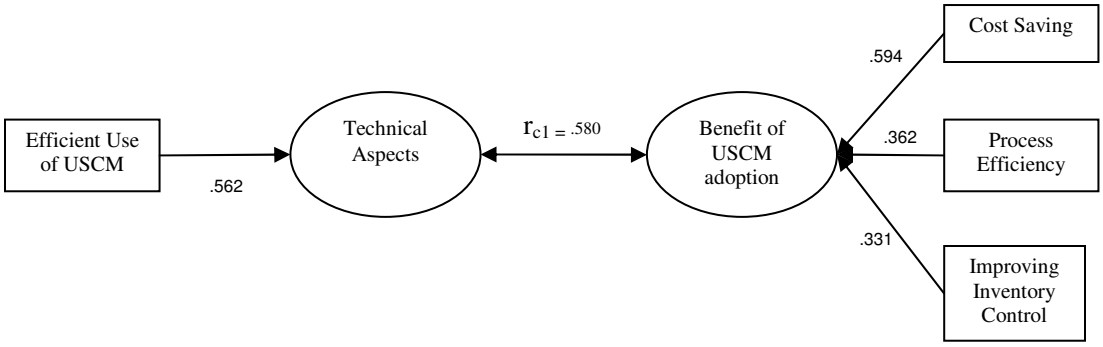

Figure 5. First Pair of Canonical Relationship between Technical Aspects and Adoption Benefits.

As we have examined, canonical correlation on the collected data suggested that three dimensions of Management Aspect, "Internal Process Management", "Strategic Relationship Management" and "Management Support" are found to be correlated to Adoption Benefit of USCM that also has three dimensions of "Cost Savings", "Creation of Competitive Edge", and "Process Efficiency." Meanwhile, the correlation set between Technical Aspect and Adoption Benefit of USCM only suggested the first canonical variate pair is statistically significant but erected different sets of factors involved in the relationship. Those are one factor, "Efficient Use of USCM" from Technical Aspects and three factors, "Cost Savings", "Process Efficiency", and "Improving Inventory Control" from Adoption Benefits of USCM.

CONCLUSION AND IMPLICATIONS

In this present study, we identified key success factors in the relationships among management aspects, technology aspects, and perceived USCM adoption benefits by examining the holistic relations among those latent factors. The results concerning the relationships between key success factors and USCM adoption benefits in the UK data are summarized in Table 12. That is, major results arising from the survey data in the UK are illustrated to increase better understanding for each of the factors and benefits. As can be seen from Table 12, a number of relationships between the key success factors and USCM adoption benefits have been summarized. The following attempts to discuss the results of the empirical analysis regarding the relationship between the thirteen key success factors and the five benefits of USCM adoption.

Division	Factors	USCM Adoption Benefits			
		Cost Savings	Creation of Competitive Edge	Process Efficiency	Improving Inventory Control
Management Aspect	Internal Process Management	+	+		
	Strategic Relationship Management	+	+		+
	Management Support	+	+		+
Technical Aspect	USCM Technology Applications				
	USCM System Design				
	USCM Network Foundation				
	Compatibility with Existing Systems				
	Efficient Use of USCM	+		+	+

(+: Significance level at < 0.05)

Table 12. Research Summary on Key Success Factors and USCM Adoption Benefits.

Among the seven success factors in the management aspect, only three factors were empirically associated with three types of benefits of USCM adoption such as Cost Savings, Creation of Competitive Edge, and Improving Inventory Control. Particularly, Cost Saving and Creating Competitive Edge were most crucial benefits that can be realized with three key success factors: Internal Process Management, Strategic Relationship Management and Management Supports. The results

were also consistent with what predicted by Lee and Özer (2007). In their study, they provided an analytic justification of cost saving by RFID in terms of labor costs, inventory reduction and out-of-stock reduction. Analyzing Management Aspects factor provided two canonical variate sets, each of two highlighted different managerial factors significant in relation to the adoption benefits. However, Strategic Relationship Management appeared in both sets of a canonical function so that it may be believed the most imperative to realizing benefits of USCM. As it is suggested in the literature review, ubiquitous computing environment requires more pervasive relations among stakeholders. The importance of efficiency of internal value chain is now replaced by seamless flows of information, communication, and materials and goods among interesting partners (Ho, 2002).

In addition, from the technical standpoint, only one key success factor was identified significantly relating to the three types of USCM adoption benefits, which is Efficient Use of USCM. Three key success factors may be attained by this technical factor. Those are Cost Savings, Process Efficiency, and Improving Inventory Control. Based on this result, we can conclude that Efficient Use of USCM technology can be the one biggest concern of UK USCM adoption firms. Even though three other technical factors fail to show a significant relation with adoption benefits, all of them may be considered as closely relating factors toward an efficient use of USCM applications. For instance, compatibility with existing systems is obviously one of ensuring factors to achieve the effective usage of USCM applications. Likewise, USCM Network Foundation and Design may all be relevant issues to USCM usage. This relevance is statistically supported. That is, the correlations between four factors, the insignificant canonical variables, and Efficient USCM Use, the only statistically significant technical factors are all above 0.45, suggesting strong relationships.

Hence, although it appears that there was a weaker canonical relationship between technical key success factors and competitive advantage of USCM adoption in the UK, we inferred that the technical success factors should not be regarded as less important issues for the competitive advantage of USCM adoption. Rather, they should be seen as a fundamental and collectively related to the USCM competitiveness.

To sum up, according to the empirical data analysis so far, the relationship between key success factors and USCM benefits can be symbolized into an USCM adoption model, which consists of management factor and technical issues, as shown in Figure 6.

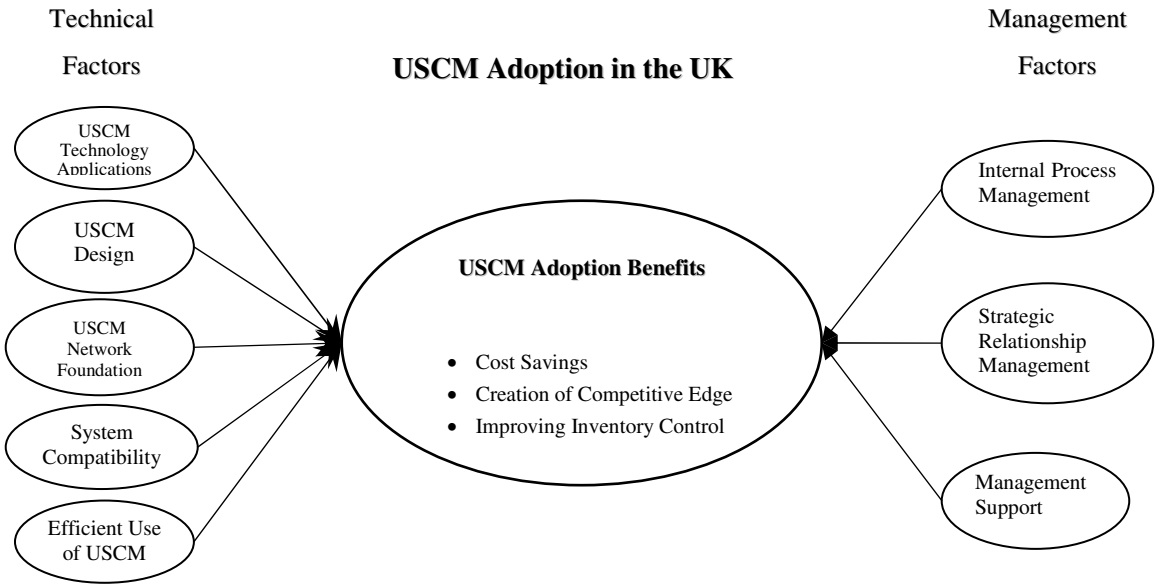

Figure 6. USCM Adoption Model in the UK

As can be seen from Figure 3, the USCM adoption model derived from the UK data includes three management factors such as Internal Process Management, Strategic Relationship management and Management Support as well as five technical issues such as USCM Technical Applications, USCM System Design, USCM network foundation, Compatibility with existing Systems and Efficient Use of USCM. Moreover, the USCM adoption model contains three USCM adoption benefits such as Cost Savings, Creation of Competitive Edge and Improving Inventory Control. It appears that the three management

factors and one technical factor can be seen as core driving forces for USCM adoption in contemporary UK USCM circumstances.

Conclusively, it is argued that the adoption of USCM in the UK can be seen as a shaping process facilitated by both management factors and technical issues in a current ubiquitous computing environment. In addition, one can take the position that the UK enterprise tends to adopt the USCM to reap the benefits of cost saving, achieving competitive advantage, inventory management and process efficiency.

Since ubiquitous computing technology is increasingly applied to the USCM, the USCM adoption model proposed by this research is useful for both researchers and practitioners because it is framework that illustrates the current nature of the issues that are in a chaotic state. Finally, the theoretical and practical findings addressed in this research have given new insights for further research. As an extension of this study, it would be worthwhile to attempt to apply the USCM adoption model and revalidate them within a broader USCM and ubiquitous computing research context.

REFERENCE

1. Acquisti, A. (2006) Ubiquitous Computing, Customer Tracking, and Price Discrimination. In *Ubiquitous and Pervasive Commerce* in George Roussos (Eds.) 1115-1132, Springer, London, UK.
2. Barua, A., Konana, P., Whinston, A. and Yin, F. (2004) An empirical investigation of net-enabled business value. *MIS Quarterly*, 28, 4, 585-620.
3. Bose, I and Pal, R. (2005) Auto-ID: managing anything, anywhere, anytime in the supply chain. *Communications of the ACM*, 48, 8, 101-106.
4. Butz, A. (2004) Between Location Awareness and Aware Locations: Where to Put the Intelligence. *Applied Artificial Intelligence*, 18, 501-512.
5. Christopher, R. M., Speh, T. W. and Freese, T. L. (2003) SCM: Making the Vision a Reality. *Supply Chain Management Review*, September/October, 34-39.
6. Cohen, M. and Lee, H. L. (1998) Strategic analysis of integrated production-distribution systems: models and methods. *Operations Research*, 36, 2, 216-228.
7. Corsten, D. and Kumar, N. (2005) Do suppliers benefit from collaborative relationships with large retailers? An empirical investigation of efficient consumer response adoption. *Journal of Marketing*, 69, 80-94.
8. Cronbach, L. (1951) Coefficient alpha and the internal structure of tests. *Psychometrica*, 16, 3, 297-334.
9. Edwards, W. K. (2006) Discovery Syatems in Ubiquitous Computing. *Pervasive Computing*, April-June, 70-77.
10. Field, A. (2005) *Discovering Statistics Using SPSS*, SAGE Publications.
11. Findley, F. and Srikanth, S. (2005) Imperatives for successful collaboration. *Supply Chain Management Review*, January/February, 30-37.
12. Fish, L. and Forrest, W. (2006) The 7 success factors of RFID. *Supply Chain Management Review*, September, 26-32.
13. Forman, H. and Lippert, S. (2005) Toward the development of an integrated model of technology internalization within the supply chain context. *The International Journal of Logistics Management*, 16, 1, 4-27.
14. Gammelgaard, B. and Larson, P. (2001) Logistics Skills and Competencies for Supply Chain Management. *Journal of Buisness Logistics*, 22, 2, 27-50.
15. Gunasekaran, A. and Ngai, E. W. T. (2005) Build-to-order supply chain management: a literature review and framework for development. *Journal of Operations Management*, 23, 423-451.
16. Hackenbroich, G., Bornhovd, C., Haller, S. and Schaper, J. (2006) Optimizing Business Process by Automatic Data Acquisition: RFID Technology and Beyond. In *Ubiquitous and Pervasive Commerce*, in George Roussos (Eds.) 33-51, London, UK: Springer.
17. Hall, T. and Bannon, L. (2006) Designing Ubiquitous Computing to Enhance Children's Learning in Museums. *Journal of Computer Assisted Learning*, 22, 231-243.
18. His, S. and Fait, H. (2005) RFID enhances visitors' museum experience at the exploratorium. *Communications of the ACM*, 48, 9, September 60-65.
19. Ho, D. C. K., Au, K. F. and Newton, E. (2002) Empirical research on supply chain management: a critical review and recommendations. *International Journal of Production Research*, 40, 17, 4415-4430.
20. Hong, C.P., Weems, C. C. and Kim, S.D. (2008) An Effective Vertical Handoff Scheme Based on Service Management for Ubiquitous Computing. *Computer Communications*, 31, 1739-1750.
21. Hult, G. T., Ketchen, D. J. and Arrfelt, M. (2007) Strategic Supply Chain Management: Improving Performance through a Culture of Competitiveness and Knowledge Development. *Strategic Management Journal*, 28, 1035-1052.
22. Jeong, J. S. and Hong, P. (2007) Customer Orientation and Performance Outcomes in Supply Chain Management. *Journal of Enterprise Information Management*, 20, 5, 578-594.

23. Karkkainen, M., Laukkanen, S., Sarpola, S. and Kemppainen, K. (2007) Roles of Inter-firm Information System in Supply Chain Management. *International Journal of Physical Distribution & Logistics Management*, 37, 4, 264-286.
24. Kopczak, L. and Johnson, M. (2003) The supply-chain management effect. *MIT Sloan Management Review*, Spring, 27-34.
25. Kourouthanassis, P. and Roussos, G. (2006) The Design of Pervasive Retail Experiences. In *Ubiquitous and Pervasive Commerce* in George Roussos (Eds.) 133-153, Springer, London, UK.
26. Lee, H. and Özer, Ö. (2007) Unlocking the Value of RFID. *Production and Operations Management*, 16, 1, 40-64.
27. Lyytinen, K. and Yoo, Y. (2002) Issues and Challenges in Ubiquitous Computing. *Communications of the ACM*, 45, 12, 63-65.
28. Moberg, C. R., Whipple, T. W., Cutler, B. D. and Speh, T. W. (2004) Do the Management Components of Supply Chain Management Affect Logistics Performance? The International *Journal of Logistics Management*, 15, 2, 15-30.
29. Ngai, E. W. T., Cheng, T. C. E. and Ho, S. S. M. (2004) Critical Success Factors of Web-Based Supply-Chain Management Systems: an Exploratory Study. *Production Planning & Control*, 15, 6, 622-630.
30. Nguyen, H. M. and Harrison, N. J. (2004) Electronic Supply-Chain Orientation and Its Competitive Dimensions. *Production Planning & Control*, 15, 6, 596-607.
31. Qureshi, K. A. and Dawood, M. (2008) Intelligent Ubiquitous Compuitng and e-Business Solution. *International Journal of Information Management*, 28, 128-135.
32. Rai, A., Patnayakuni, R. and Seth, N. (2006) Firm performance impacts of digitally enabled supply chain integration capabilities. *MIS Quarterly*, 30, 2, 225-246.
33. Rajib, P., Tiwari, D. and Srivastava, G. (2002) Design and development of an integrated supply chain management system in an internet environment. *Journal of Services Research*, 2, 1, 75-93.
34. Ranganathan, C., Dhaliwal, J. S. and Teo, T. S. H. (2004) Assimilation and diffusion of web technologies in supply-chain management: an examination of key drivers and performance impacts. *International Journal of Electronic Commerce*, 9, 1, 127-161.
35. Roussos, G. (2006a) Ubiquitous Computing. In *Ubiquitous and Pervasive Commerce*, in George Roussos (Eds.) 1-12, Springer, London, UK.
36. Roussos, G. (2006b) Supply Chain Management Standards in Ubiquitous Commerce. In *Ubiquitous and Pervasive Commerce*, in George Roussos (Eds.) 15-31, Springer, London.
37. Russell, D. M., Streitz, N. A. and Winograd, T. (2005) Building Disappearing Computers. *Communications of the ACM*, 48, 3, 42-48.
38. Santon, N. A. (2001) Introduction: Ubiquitous Computing: Anytime, Anyplace, Anywhere? *International Journal of Human-Computer Interaction*, 13, 2, 107-111.
39. Schwartz, K. D. (2004) Embedded Connectivity Reaches Out. *Electronic Business*, November, 10-11.
40. Singh, N., Lai, K. and Cheng, T. (2007) Intra-organizational perspectives on IT-enabled supply chains. *Communications of the ACM*, 50, 1, 59-65.
41. Subramani, M. (2004) How do suppliers benefit from information technology use in supply chain relationships? *MIS Quarterly*, 28, 1, 45-73.
42. Nissen, M. and Sengupta, K. (2006) Incorporating software agents into supply chains: experimental investigation with a procurement task. *MIS Quarterly*, 30, 1, 145-166.
43. Tabaschnick, B. G. and Fidell, L. S. (2006) *Using Multivariate Statistics* 5th Ed., Allyn & Bacon, Boston, MA.
44. TThiesse F, Fleisch E and Dierkes M (2006) LotTrack: RFID-based process control in the semiconductor industry. *Pervasive Computing*, January-March, 47-53.
45. Turner, J. R. (1993) Integrated supply-chain management: what's wrong with this picture? *Industrial Engineering*, 25, 12, 52-55.

46. Vickery, S. K., Jayaram, J., Droge, C., Calantone, R. (2003) The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships. *Journal of Operation Management*, 21, 523-539.

47. Weiser, M. (1993) Some computer science issues in ubiquitous computing. *Communications of the ACM*, 36, 7, 75-84.

48. Welch, J. and Wietfeldt, P. (2005) How to leverage your systems investment. *Supply Chain Management Review*, November, 24-30.