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EMPIRICAL ANALYSIS FOR SUCCESS FACTORS IN UBIQUITOUS SUPPLY CHAIN MANAGEMENT IN THE CASE OF UK COMPANIES

Changsu Kim, Yeungnam University, c.kim@yumail.ac.kr
Jongheon Kim, Auburn University Montgomery, jkim23@aum.edu

ABSTRACT

This study examines affecting factors on a successful implementation of the ubiquitous supply chain management system (USCMS) perceived by industry managers from UK companies. Upon the thorough review of existing literature on both ubiquitous computing and supply management systems, the current study classified two construct groups for those success factors and employed principle component factor analysis technique and identifies thirteen unique and crucial factors relating to perceived benefits of the USCMS. A managerial success factor construct includes seven relevant factors and a technical factor construct has six success factors. This finding expects to lead a systematic causal model to realize the benefits of USCM implementation based upon these factors suggested.

Keywords: Supply Chain Management System, Ubiquitous computing, RFID, Factor Analysis

INTRODUCTION

Today supply chain management is the crucial topic in business and the well-managed supply chain becomes competitive advantages of many companies. The lack of accurate inventory information in the supply chain management can bring the shortage or surplus of items resulting in sales loss of companies. For example, according to Corsten and Gruen's (2003) study, in the 'out of stock' case, the potential sales loss reaches 3.4% for retailers and 2.6 for suppliers. In order to solve these problems, the ideal supply chain management is targeting on integrating the flow of information, materials, and services flow through the entire supply channels and then sharing the real-time information among suppliers (Caputo et al., 2004; Hsieh & Lin, 2004, Trappey et al., 2004; Wu et al., 2004).

From the operations perspectives, resource planning and inventory control systems are highly related to supply chain management, because the ultimate goal of 'resource planning and inventory control system' is to pursue minimum inventory necessary in terms of lean production or Just-in-Time (JIT) production philosophy (Andriolo et al., 2016). To achieve this goal, accurately storing and tracking information of each item are an inevitable part. Traditionally, those works have been done through manual entry or bar code systems that have limited capabilities in certain conditions (Hou & Hoang, 2006).

Since RFID, an automatic identification method storing and capturing data, was introduced in the supply chain to overcome the limitations of traditional approaches and revolutionize supply chain management, RFID has been one of the fast growing topics in the supply chain (Spekman & Sweeney, 2006). It is considered one of the most successful adoptions of ubiquitous computing has been applied in the supply chain field (Rodriguez-Escobar & Gonzalez-Benito, 2015; Schapranow et al., 2012). A supply chain means the whole process from an organization's suppliers to its customers (Rai & Seth, 2006). Recently, ubiquitous computing technologies such as sensors, radio frequency identification (RFID), mobile devices, personal digital assistant (PDA) 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 (Findley & Srikanth, 2005; Lopez et al. 2012). USCM carries out a range of activities such as the planning, control, and management of the supply chain based on ubiquitous computing technology. Thus, it is not surprising that more enterprises are adopting USCM.

In addition to the extension of industry applications, the economic impact of a ubiquitous computing technology is rapidly increasing. For instance, the growth of the overall RFID global market of RFID is expected to reach from $965 million in 2002 to $4.6 billion by 2007 with the annual rate of 45% (Ward 2004; Wicks, Visich & Li, 2006). The sales of RFID technology in the supply chain applications will show 38% growth rate from $89million in 2002 to $448.4 million by 2007 (Hickey, 2004).

One of the typical examples is Wal-Mart case (Niederman & Mathieu, 2011) utilizing RFID as a part of USCMs. Despite the huge cost and possible risks of RFID implementation, the reason why companies such as Wal-Mart, the largest retailer in the world, try to adopt RFID in their supply chains is simply due to the benefits the RFID technology provides. Relating to resource planning and control systems, one of many advantages of RFID technology in the supply chain will be accurate resource planning and control low inventory levels which attract interests and attentions of operators in resource planning and control systems fields. Therefore, the purpose of this paper is to provide information about the benefits of the RFID technology in the supply chain to companies or practitioners which consider RFID implementation.

However, despite its growing adoption, research on USCM has been scant. Little attention has been paid to the key impact factors and USCM adoption benefits that an organization should consider when adopting USCM. This research aims to investigate the relationship between impact 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 a useful academic foundation and practical information.

In the following section, this paper draws lessons from recent studies on USCM. Section 3 addresses research procedure and methods. Section 4 describes an empirical analysis and result. Section 5 will discuss as to what the findings of statistics imply and finally, conclusions will follow in section 6.

THEORETICAL BACKGROUND

Supply Chain Management (SCM) is an interorganizational process to minimize the cost in the supply chain, to increase the value of the supply chain, and to remove wasteful business practices (Fish & Forrest, 2006; Moberg et al., 2004). To date, 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; Rajib, Tiwari & Srivastava, 2002). Since SCM involves complex systems of cross-organizational activities and processes relevant to the flow of products, services, and information, effective SCM is influenced by information technology (Barua, 2004; Forman & Lippert, 2005; Nissen & Sengupta, 2006; Ranganathan, Dhaliwal & Teo, 2004; Rodriguez-Escobar & Gonzalez-Benito, 2015).

Little research has been solely devoted to revealing characteristics of USCM and their unique relationships by taking both supply chain and ubiquitous computing aspects into account. Prior researches in supply chain management (SCM), however, have dealt with various issues including inventory management (Cohen & Lee, 1998; Mabert & Venkataraman, 2008), materials management (Turner, 1993), interorganizational capabilities (Ho, Au & Newton, 2002), SCM framework (Gunasekaran & Ngai, 2005; Sabbaghi & Vaidyanathan, 2008), SCM strategy (Vickery et al. 2003), SCM effect (Corsten & Gruen, 2003; Morberg et al., 2004; Subramani, 2004), SCM development (Rajib, Tiwar & Srivastava, 2002), IT application in SCM (Barua, Konana, Whinston, 2004; Nissen & Sengupta, 2006), various types of SCM based on its key dimensions (Cecere, 2006) and interrelations among key factors of power, benefits and risk reduction to the performance of the supply chain (Zelbst et al., 2009).

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 (Hackenbroich et al., 2006, Schapranow et al., 2012). 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. USCM encompasses a range of activities, such as purchasing, materials handling, production planning and control, warehousing, logistics, inventory management, distribution, delivery and vendor management (Fish & Forrest, 2006; Ranganathan et al., 2004).

In addition, the review of those studies from two aspects directs a useful background to the present research. Firstly, from the management perspective, Fish and Forrest (2006) reported seven factors underlying successful RFID adoptions and the reasons for launching RFID implementations, based on their consulting experience to RFID adoption companies. The seven impact factors are 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. Although these seven factors are not verified with empirical data, it provides a theoretical base in selecting appropriate major variables for successful USCM adoption. Moreover, Kourouthanassis and Roussos (Kourouthanassis & 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 showed the practical application of ubiquitous computing to a pervasive retail business. Recently Schapranow et al. (2012) proposed RFID-based pharmaceutical architecture and compared operative factors of an on-premise and an on-demand solution from the management perspective. It showed the significance of both management and technical perspectives for an adoption of USCM in extending our insights.

Secondly, from a technical perspective, Roussos (2006) addressed the supply chain management standards for ubiquitous commerce. He reviewed first the history of unique identifiers and product classification systems, and then an overview of the European Article Numbering-Uniform Code Council (EAN.UCC) system, including its recent specifications for the wireless auto-identification of products. Finally, global cataloging 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. Hackenbroich et al. (2006) described enterprise software for supply chain management, focusing on SAP's SCM and automatic identification (Auto-ID) technology, discussing two Auto-ID pilot cases. As both RFID and Auto-ID are major technologies in USCM adoption, it would appear a good example for the better understanding of a relationship between ubiquitous technologies and U-business applications. 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. Table 1 summarizes previous researches of critical impact factors between USCM and SCM, and they are arranged together for comparison.

Table 1. Prior Researches on Comparing CSFs Between USCM and SCM

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) (2006) Fish & Forrest (2006) Finley & Srikanth (2005) Gattorna (2006) Kourouthanassis & Roussos (2003) IDTechEx (2005a) IDTechEx (2005b) KIDL (2006) Kim et al. 2008) Lee & Kim (2003) Metro Group (2004) Moberg et al. (2004) 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) Hsi & 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) Ngai et al. (2004) Moberg et al. (2004) Karkkainen et al. (2007) Hult et al. (2007)
Technical Factors	Accumulated systems development ability Development of USCM in a stable system	Carter et al. (2005) Cecere (2006)	Connectivity in quasi-real time Communication	Jeong & Hong (2008) Ngai et al. (2004)

	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 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	Crone (2006) Fish & Forrest (2006) IDTechEx (2005a) IDTechEx (2005b) Johnson (2006) 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) Hsi & Fait (2005)	Data security Hardware & software reliability Centralization of IT unit IT knowledge Integrated IT infrastructure IT-enabled supply chain integration Information intefrity Operational information exchange Strategic information exchange	Ranganathan et al. (2004) Nguyen & Harrison (2004) Moberg et al. (2004) Rai et al. (2006)

As seen in Table 1, it appears that contemporary studies on USCM focus more on exploratory approaches, whereas the past researches examined it from different perspectives: either (1) management or (2) technology. The research on the technical perspective has a somewhat narrow focus and barely considers such aspects as inter-organizational relationships which are closely associated with USCM adoption. Meanwhile, the research on the management aspect is much wider in research focus but there is a limit to its explanatory power due to its lack of technical concerns. With such a background, this study stresses the significance of a unified perspective for clear investigation of the adoption of USCM by resolving the subject from two different viewpoints: management and technical aspects.

Firstly, critical success factors (CSFs) 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, Ketchen & Arrfelt, 2007; Karkkainen et al., 2007). The recent SCM researches have shifted to how to 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 the 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, Patnayakuni & Seth, 2006).

In technical aspect, secondly, researches on SCM emphasized on internal factors, such as communication, a reliability of hardware and software, and integration of IT infrastructure that can facilitate supply chain management (Nguyen & Harris, 2004; Rai, Patnayakuni & Seth, 2006), whereas USCM is 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 the 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 a 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, Ketchen & Arrfelt, 2007).

The comparison clearly depicted a departure of research foci from the 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 an 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 METHODS

This research attempts to find the key success factors of USCM adoption in the UK. Though there are various factors affecting USCM benefits, we cannot imagine USCM without the application of information technology. Recently, ubiquitous computing technologies have changed supply chain processes across interorganizations, increased collaboration with suppliers and customers, and improved competitiveness (Hackenbroich et al., 2006). With regards to 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.

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 to reduce the number of success factors that are most relevant and grouped them together accordingly. 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.

EMPIRICAL ANALYSIS AND RESULTS

Descriptive Analysis

The descriptive analysis of survey respondents (n=133) is given in Table 2, displaying industry area, a 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 were the most represented industry that revealed 22% of all respondent companies. The sizes of companies were evenly distributed from less-than-50 to more-than-3000. The demographic results indicated that there was no serious bias among industries. Likewise, the study tried to include responses from various sizes of firms and functional units in the realization of USCM technology.

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

Division		Frequency	Percent	Division		Frequency	Percent
	Logistics & Delivery	22	16.5%		Logistics	29	15.8%
	Manufacturing	12	9.0%		Manufacturing	8	4.5%
	Electricity, Gas & Water	3	2.3%		Marketing/Sales	20	10.9%
	Construction	6	4.5%		Customer Service	24	13.1%

Industry Area	Wholesale & Retail	15	11.3%	Function Area	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 Techn-ology 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%

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 CSFs and technical CSFs, and the attainable adoption benefits of USCM. To this end, we firstly needed to draw relevant factors from ninety-one measurement items for these three constructs through exploratory factor analysis technique. We employed principle component analysis with varimax rotation as a method in factor analysis and applied the Kaiser criterion (eigenvalues>1.0) in extracting relevant factors (Tabaschnick & Fidell, 2006).

Table 3. Results of Principle Component Analysis for Management Aspects

Measurement Items	M	SD	Eigen-value	% of variance	Cronbach's α	AVE	CR	Factor Loadings
1. Internal Process Management			5.471	15.856	.827	.496	.872	
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	.622	.868	
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	.782	.878	
Top Management Support	4.17	.86						.863
CEO & CIO Relationship	3.66	1.08						.753
4. Business Process Reengineering			1.410	8.215	.527	.678	.808	
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	.496	.746	
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	.619	.763	
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	N/A	N/A	
Strong cooperation	3.81	2.73						.772

Table 3 summarizes the anatomy of construct validity for the all of the key success factors in management aspects. Adequacy of the sample used for PCA was measured by Kaiser-Meyer-Olkin index (KMO) and Bartlett's sphericity tests whether the correlation matrix is an identity matrix. For management factors, KMO (0.743) showed the adequate fit of data for factor analysis and Bartlett's test of sphericity ($\lambda 2$=932.10, d.f.=190, p<=0.0001), suggesting the correlation matrix was not an identity matrix so that it could be good to proceed to further analysis. After removing variables cross-loaded, we were able to obtain seven key success factors comprising twenty-one measurement items for 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. The measurement items and their construct naming are summarized in Table 3.

Through similar validation process with twenty-four technical aspects items, we extracted six key success factors as presented in Table 5. Factor analysis was also suitable for the factor extraction in technical aspects as suggested by KMO=0.82 and Bartlett's sphericity test ($\lambda 2$=1672.44, d.f.=325, significance=0.000). 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 seven categorized factors are shown in Table 4.

Table 4. Results of Principle Component Analysis for Technical Aspects

Measurement Items	Component							
	M	SD	Eigen-value	% of variance	Cronbach's α	AVE	CR	Factor loadings
1.USCM Technology Application			8.570	16.661	.852	.532	.888	
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	.477	.864	
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	.662	.854	
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	.654	.849	
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	.641	.842	
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	.537	.777	
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

Finally, the construct validity test on USCM adoption benefits was carried out for all of the measurement items in the same manner. Both KMO (0.843) and Bartlett's sphericity (λ^2=1192.37, d.f.=171, p<=0.0001) were meritorious to the adequacy of factor analysis for the adoption benefit construct. The suggested five factors, measured by nineteen items showed strong evidence of construct validity, with a factor loading well above 0.5 and with an explained variance of over 67%. Table 5 provides more detailed explanations on the five categorized factors are as follows.

Table 5. Results of Principle Component Analysis for Perceived Adoption Benefits of USCM

	Component							
	M	SD	Eigen-value	% of variance	Cronbach's α	AVE	CR	Factor loadings
1. Cost Savings			7.055	21.132	.887	.564	.911	
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	.557	.862	
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	.774	.873	
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	.722	.838	
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	.727	.842	
Enable track and trace authentication	3.80	1.01						0.745
Improve supply-chain visibility	3.78	.96						0.743

After having the construct validity observed, all items were collectively tested for the reliability. The reliability of each group factors is determined by Cronbach's α and composite reliability (CR). As seen in Table 3, 4 and 5, this study also reported CR and average variance extracted (AVE) for more concrete reliability result. The threshold value for CR is greater than 0.7 (Fornell & Larker, 1981) or even 0.6 acceptable (Bagozzi & Yi, 1988). Fornell and Larcker (1981) suggested AVE above 0.5 is a good indication of convergent validity. As appeared in the Tables, all extracted factors for management aspects, technical aspects, and adoption benefits meet this requirement suggesting adequacy of utilizing all of these factors for further analysis.

DISCUSSIONS AND CONCLUSION

The objective of this paper is to identify the key success factors of ubiquitous supply chain management (USCM) adoption. This study elaborated to extract these factors in the relationships among management aspects, technology aspects, and USCM adoption benefits by examining the holistic relations among those latent constructs. To this end, the study employed principle component analysis to extract most relevant factors from the pool of candidate factors that are previously proposed. In this sense, this paper contributes to the literature in two-folds: (1) by empirically providing key impact factors of USCM from two different perspectives, and (2) suggesting a possible interrelation among the predictor variables and enhancing the views of the development of a USCM adoption model.
It successful reduced the number of relevant factors and grouped them into two causal constructs to USCM benefit construct. There are seven success factors were extracted for managerial construct and they are Internal Process Management, Strategic Relationship Management, Managerial Support, Business Process Reengineering, Adaptation to Environmental Change, USCM Realization, and Relationship with Current Suppliers. In addition, six factors were identified for technology construct. They are USCM Technology Application, USCM System Design, USCM Network Foundation, Compatibility with Existing Systems, Efficient Use of USCM, and USCM Sustainability.

Moreover, the USCM adoption model formulates these two constructs with perceived benefits quantified by Cost Savings, Creation of Competitive Edge, Process Efficiency, Facilitating Partnership, and Improving Inventory Control. It appears that both the management factors and the technical factors are significantly associated with USCM adoption and may make potential antecedent relationships between managerial and technical factors to the adoption benefits 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 USCM to reap the benefits of cost saving as a short term gain, achieving competitive advantage, facilitating partnership with suppliers and improving its inventory management as long-term leverage.

Since ubiquitous computing technology is increasingly applied to the supply chain management, the critical success factors and their structural scheme proposed by this research is useful for both researchers and practitioners because it is a framework that illustrates the current nature of the issues that are in a chaotic state. The theoretical and practical findings addressed in this research have given new insights for future researches. For practitioners, the present study reviewed previous literatures about impact factors in SCM and pinned down several relevant factors in the context of ubiquitous SCM environment, which helps decision makers prioritize areas of the investment in implementing USCM depending on their short- or long-term objectives. For academia, the findings of this research suggest possible procuring effects of technological factors toward managerial factors and in turn, lead to the adoption benefit. This insight casts rooms for future research to delve into more accurate relationships among those measurement factors. As an extension of this study, hence it would be worthwhile to attempt to apply the USCM adoption model and revalidate them within a broader USCM and ubiquitous computing research context.

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