ANALYZING FACTORS TOWARDS ADOPTING ICT WITHIN SUPPLY NETWORK IN THE UK

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ABSTRACT

Literature has shown that Information and Communication Technology (ICT) had been a potential source of disruption to business and at the same time ICT might be advantageous in supporting business at risk. Data from a questionnaire survey of 110 organizations across various sectors in the United Kingdom (UK) are used to answer the research question: "what are the key determinants to the adoption of ICT in an organization within its supply network?" The data collected were analyzed quantitatively, from simple analyses such as mean scores, and Spearman correlation coefficients, to more sophisticated analysis such as factor analysis, ANOVA, and logistic regression. Adoption level is predicted by a model with three (3) categories of independent variables including (i) the characteristics of ICT; including, the relative advantage, complexity, compatibility, and observability), (ii) the internal and external factors of innovation characteristics (managers' support, strategy integration, and stakeholders pressure on the innovation), and (iii) the external environment (stakeholders pressure, system openness, environmental uncertainties and supply chain complexity).

The main findings revealed that the adoption behavior in organizations within the supply chain can be understood from the model developed in this study. The most significant predictors of the adoption level of ICT are relative advantage, managers' support, and system openness.

1.0 INTRODUCTION

Previous studies on ICT have utilized various approaches, to model ICT implementation in an organization, and in a supply chain, and deal with the benefits and barriers towards adopting it. This study review previous studies on ICT that relate to its implementation within a supply chain context. From the management perspectives, ICT in a supply chain is all about inter-organizational transactional relationships and collaboration in a network environment such as trust, commitment, and adaptation (Cheng & Kam, 2008; Pramatari, 2007).

ICT-driven supply chains are seen by most scholars as connected to disintermediation, in which ICT can effectively support collaboration and new links in supply chain between suppliers and the end users (Mason, Lalwani, & Boughton, 2007), without the need for a middle man such as sales or promotion agencies. In other perspectives, e.g. a study such as Özkan et al. (2010), ICT is seen as the internet media that allows availability of electronic payment (e-payment) systems. Relating to SCM, other scholars see ICT as assisting in managing inventories using Vendor Managed Inventories (VMI), and could provide information on inventory levels, expected demand, promotes activities and product related-costs (Claassen, Arjan, & Erik, 2008).

It is important that this study will look at the contextual factors that influence the effective adoption of ICT within organizations in their supply network. As indicated in previous studies on the adoption of ICT in organization within supply network, some important points include that ICT and other complex technologies in the supply chain relate to the management of risk (Handfield & Ernest, 2002: pg 260).

The Benefits of ICT in the Supply Chain

Most theories that relate to ICT and supply chain agree that ICT facilitates the efficient flow of information in a supply chain and contributes to efficient and effective decision making in business operations. Adewole (2005) who examined challenges in which supply chains may have faced when information sharing structures were inadequate, reported that an inaccurate untimed sharing of information will lead to slow and inefficient reactions by the manufacturer.

In supply chain, ICT such as the internet plays an important role to facilitate collaboration between supply chain members to achieve better information visibility and decision making (Handfield & Ernest, 2002: pg 298). In addition, a high degree of visibility with a good management can avoid the "bullwhip effect in supply chain" that is reduces either inefficient production or excessive inventory (Handfield & Ernest, 2002: pg 295). Handfield & Ernest (2002: pg 301) in their case study, on a software system called i-supply, in an automotive supply chain showed how it enabled real-time visibility of its production planning system via the internet, to the customers or tier-1 suppliers. This allows members of the supply chain to see the benefits of system openness, and respond sooner to events as they occur.

In addition, ICT creates an efficient customer response and improves the relationship based on trust between the supplier and customers in supply chain. A long trustworthy relationship with customers will result in more loyal customers, thus secured sales (Claassen et al., 2008). Mason et al. (2007) in their study has demonstrated that Logistics Service Provider (LSPs) can improve logistics performance by creating effective collaborative capabilities, for companies to work closer together, thus reducing logistics costs and improve efficiencies.

A study of Vendor Managed Inventory (VMI) by Claassen et al. (2008) asserted that VMI leads to three performance outcomes; higher customer service levels, improved supply chain control, and reduce costs in transport and inventories. For suppliers, implementation of VMI can align production processes with demand from customers. This can be achieved by providing the right information at the earlier stages, such as stock levels and demand, which allow suppliers to respond proactively to the need, hence reducing the bullwhip effect (Claassen et al., 2008).

The Limitations of ICT

One of the limitations of innovative products such as ICT is that they have short life cycles with volatile demand that is difficult to predict (Walters, 2006). Some of them are also reported to be expensive and too complicated (Pramatari, 2007; Saatçioglu, 2009). Pramatari (2007) reported that EDI cost more in comparison to other reliable communication in the internet. One of the barriers to EDI is its characteristics of exchanged information due to its type. The EDI users do not collaborate with trading partners which mostly use internet formats such as XML format (Pramatari, 2007). ERP as reported in (Saatçioglu, 2009) require heavy investments, with many barriers to its implementation, such as difficulty in changing to new systems, difficulty in estimating project requirements, resistance from staff, and poor reporting procedures. In addition, ERP seems to have received a lack of commitment from top leadership due to unclear strategic direction (Saatçioglu, 2009).

Research Questions and Objectives

This study attempts to answer the question "what are the key determinants of the adoption of ICT in an organization within their supply network?" This question will be addressed by addressing the following sub-questions:

1. Do the characteristics of ICT affect the organization's adoption of this innovation?
2. Do the internal and external factors of ICT characteristics; significantly influence the organization's adoption of this innovation?
3. Do the characteristics of the external environment significantly influence the organization's adoption of ICT?

The research objectives below are the major topics of investigation of this study following the above research questions:

1. To explore key determinants of the adoption of ICT in an organization within its supply network.
2. To empirically examine the proposed framework, and assess the influence of various factors in this framework, which will affect the adoption level of ICT in an organization within its supply network.
3. To identify contributions to research on innovation, and to explore practical implications and guidelines for managers, in order to help them enhance their understanding of the adoption of ICT, in their organization, and in a supply chain context.

To pursue the research summarized above, a generalized model is developed, that includes factors that are expected to influence the adoption of innovation in organizations within the supply network in the context of developed countries.

Hypothesis and Theoretical Framework

Roger's Innovation Characteristics

1. Relative Advantage

Rogers (1995: pg 15) defined relative advantage of an innovation as "the degree to which the innovation is perceived as better than the idea it supersedes". Through adopting innovation, organizations is expected to achieve many benefits such satisfying customers, reduce unsafe conditions, avoiding future accidence, etc (Tomlin, 2006). Studies such as Premkumar & Roberts (1999b) have found it to be a significant variable, positively related to the adoption of innovation. Consequently, the following hypothesis is proposed:

H1: The more Relative Advantage of ICT, the more likely the adoption of it in an organization within a supply network.

2. Complexity

Rogers (1995: pg 16) defined complexity as the degree of difficulty associated with understanding and learning to use an innovation. The complexity of the technology creates greater uncertainty for successful implementation and therefore increases the risk in the adoption decision. The studies by Cooper & Zmud (1990) and Grover (1993) claimed that complexity is negatively associated with adoption. Consequently, the following hypothesis is proposed:

H2: The more Complexity of ICT, the less likely the adoption of it in an organization within a supply network.

3. Compatibility

Rogers (1995: pg 15) defined innovation's compatibility as "the degree to which it is perceived as being consistent with the existing values, past experiences and needs of the potential adopter". A company seeks to adopt innovations, which are compatible with the nature of its work, processes and activities. According to Premkumar and Roberts (1999b), it is important that changes resulting from innovation adoption are compatible with the values and the belief innovations of the company. Further, Borchers (2005) who studied uncertainties and risks in forest resource value suggested that compatibility with existing values, past experiences and needs are vital in organization technological innovation. He claimed that the incompatibility may cause failure in adopting new technologies and lost opportunities.

Consequently, the following hypothesis is proposed:

H3: The more Compatibility of ICT with the existing innovations and activities, the more likely the adoption of it in an organization within a supply network.

4. Observability

Observability gives the adopter an opportunity to assess and observe the innovations, which may facilitate its adoption (Kim & Srivastava, 1998). It is notable that a company may better assess an innovation through observing the results of adopting it rather than observing the innovation itself (Rogers, 1995: pg 16). Zaltman et al. (1973: pg 37) stated that observability (or communicability) is about how the effectiveness of the innovation can be disseminated to others and influence its adoption. Rogers (1995: pg 244) reported that observability is positively related to the adoption of innovations. Consequently, the following hypothesis is proposed:

H4: The more Observability of ICT, the more likely the adoption of it in an organization within a supply network.

Internal and External Factors of Innovation Characteristics

1. Manager's support

Many studies consider manager's support as a key determinant to the adoption of innovation (Čudanov & Jaško, 2012). This is because the top management possesses power and authority to make decisions in organization. The top management plays essential roles in the process of adoption of innovation since it possesses the power and authority to make decisions concerning the adoption (Siddiqui, 2013). Moreover, it creates a supportive climate and provides resources needed in enhancing the process (Robert, 1984). Consequently, the following hypothesis is proposed:

H5: The more top management support for ICT, the more likely the adoption of it in an organization within a supply network.

2. Strategy Integration

Patterson et al. (2003) agreed that in order to succeed, organizations should align their organizational structure and the management processes. Moreover, the strategy integration applied within the supply chain when integrated to the overall firm's strategy will ensure successfulness to the organization (Patterson et al., 2003). Consequently, the following hypothesis is proposed:

H6: Organizations that have more comprehensive strategy for ICT, the more likely the adoption of it within a supply network.

3. Stakeholder Pressure on Innovations

The study by Premkumar et al. (1997) considered stakeholder pressure as one of the factors for organizations to adopt a specific technology. Patterson et al. (2003) claimed that with greater pressure from stakeholders, organizations are tending to adopt the innovation. Consequently, the following hypothesis is proposed:

H7: The higher stakeholder pressure for ICT, the more likely the adoption of it in an organization within a supply network.

The External Environmental Characteristics

1. Organization Stakeholders Pressure

The study by Premkumar et al. (1997) considered pressure from stakeholders as one of the factors for an organization to adopt technology

in general. Patterson et al. (2003) claimed that with greater pressure from stakeholders, organizations are tending to adopt innovation. Rueda-Manzanares et al. (2008) claimed that companies need to be able to manage pressures from their stakeholders in order to improve their competitive posture and balance conflict of interests among the stakeholders. Further, they reported the service firm's adoption of a proactive environmental strategy based on their stakeholders' concern for various risk factors that may affect the smooth operations in the ski resorts.

Consequently, the following hypothesis is proposed:
H8: The higher stakeholders' pressure on the organization, the more likely the adoption of ICT in the organization within a supply network.

2. System Openness

System openness refers to the extent on how organization is establishing its networking to the outsider. Rogers (1995: pg 377) suggested positive relationship between system openness (or interconnectedness) to the adoption of innovations. In addition, Russell and Hoag (2004) suggested a possible link between system openness and the adoption process, and confirmed a positive relationship between system openness and the adoption of IT. They suggested that supply chain organizations that are "open" should have been socialized with their stakeholders. In supply chain management as reported by Handfield & Ernest (2002: pg 296), system openness (or information visibility as described by most scholars in information technology risks studies) is vital to ensure collaborative efforts in which each member in a supply chain specializes in the functional areas that best aligns with its information-sharing efforts. Information that is shared across multiple tiers of participants in supply chain will benefit cost reduction, asset utilization and revenue growth. Consequently, the following hypothesis is proposed:
H9: Where an organization is in high degree of System Openness, it is more likely to adopt ICT in the supply network.

3. Environmental Uncertainty

Environmental uncertainties include the unpredictable changes in customer demand, supply, fluctuation of prices and competition (Dröge & Germain, 1998). These uncertainties exist as an organization does not have sufficient information when making decision, and this leads organizations to adopt innovations for business survival (Grover, 1993).

Literature on innovation such as Dröge & Germain (1998) and Grover (1993) claimed that in order to survive, organizations tends to adopt innovations when the uncertainties exist as the organization does not have sufficient information when making decisions. The environmental uncertainties in supply chain include customer uncertainties, supplier uncertainties and technology uncertainties. Consequently, the following hypothesis is proposed:

H10: Where an organization is in a high degree of environmental uncertainty, the more likely the adoption of ICT in their organization within a supply network.

4. Supply Chain Complexity

Previous research such as Gilmour (1999), viewing ICT development as an innovation, has caused increment of partnerships within the supply chain and has resulted in greater complexity of the supply chain. With a greater supply chain complexity, there will be an increased need for coordination and interdependence in the process, as well as the amount of information to be disseminated throughout the supply chain (Saraph & Sebastian, 1992). With the greater need of such, it influences the likelihood of the organization to adopt innovation. Consequently, the following hypothesis is proposed:

H11: Where an organization is in a complex supply chain, the more likely the adoption of ICT in their organization within a supply network.

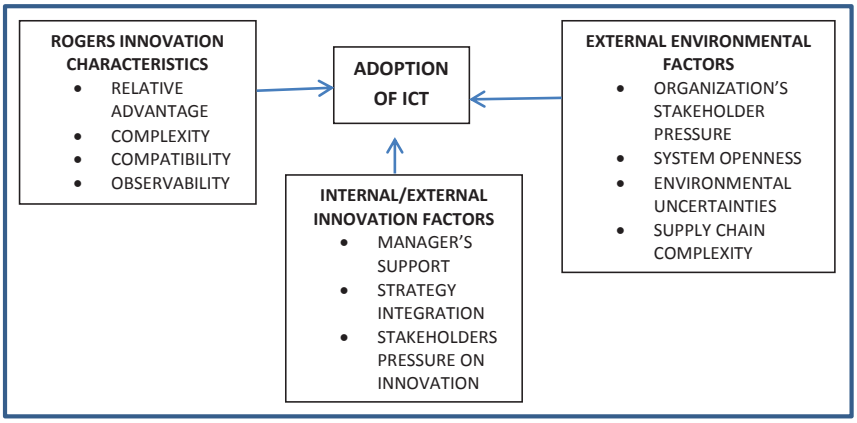

Figure 1: Theoretical Framework of Factors and the adoption of ICT within supply network

Methodology

A self-completion questionnaire was employed for data collection. A pilot test was carried out among the 11 senior manufacturing managers who

tested the questionnaire and the main survey was mostly administered using online via BOS website. In addition, postal questionnaire, delivery and collection questionnaires, and telephone questionnaire was also applied in administering the survey. The target population for the present study is limited within UK companies in any size, and whether or not they are adopting ICT within their company and supply network. 542 different organisations across UK from variety of groups such as wholesaler, risk managers, SCM groups, Auto OEM, consumer groups were contacted by networking connection, and a questionnaire distributed to a number of personal contacts. Logistic regression is used for analyzing the collected data.

The data collected in this study were analyzed quantitatively, using Statistical Package of Social Sciences (SPSS) version 17.0. The main objective of this data analysis is to determine the factors that contribute to the adoption of ICT. 195 questionnaires were received to proceed with the analysis. A total of 85 questionnaires were discarded with many reasons such as incomplete, unsatisfactory (majority of the answers given are "neutral"), too many unanswered questionnaires, and organizations that's not in UK (Mexico and Canada). The total response of 110 was sufficient to carry out further data analyses.

The sample were included UK owned-organizations, foreign own organizations and a joint venture organizations (64.5%, 29.1% and 6.4% respectively). The responding organization represent a wide range of industries from Electrical and Electronic/mechanical/ automotive components to Services (IT/Finance).

The result shows that the highest number of respondents are Directors with 38 (34.5%), followed by senior managers with only 3. This result is expected as top management tends to have more knowledge on ICT to responds to the survey.

The majority of company's primary product is "ICT services" that include services such as web design, solutions/ICT support/software/ internet marketing with more than 14% organizations (16 companies). This is followed by Electrical and Electronic/mechanical/automotive components & equipment; and Consultation/audit with 14 and 13 companies' altogether.

Data Analysis and Findings

Profile of Responding Organisation

The characteristics of the sample are shown in Table 1. The sample includes UK-owned organisations, foreign-owned organisations and joint venture organisations (64.5%, 29.1% and 6.4% respectively). The responding organisation also represents a wide range of industries from Electrical and Electronic/mechanical/automotive components to Services (IT/Finance).

Table 1: The Sample Characteristics

Characteristics	Number N=110	Percentage
1. Type of Ownership • UK-owned	71	64.5
• Foreign-owned	32	29.1
• joint venture (UK and foreign own)	7	6.4
2. Type of Industry • Electrical and Electronic/mechanical/ automotive components, equipment	14	12.7
• Food/Beverages/Tobacco	10	9.1
• Financial/Insurance/Unit Trust	11	10.0
• Consultation/Audit	13	11.8
• Legal/Law	3	2.7
• Engineering/Construction Services	4	3.6
• Clothing/fabrics/fashions/textiles/jewellery	4	3.6
• Healthcare/sports therapy/personal care	4	3.6
• ICT services	16	14.5
• Logistics/warehousing/transportation	6	5.5
• Communication services	10	9.1
• Retailing/wholesale	4	3.6
• Others	11	10.0
3. Type of Sector • manufacturing & production	35	31.8
• wholesale & retail	18	16.4
• transport & logistics	12	10.9
• services (IT/finance)	45	40.9
4. Respondents Managerial Level • director	38	34.5
• senior manager	35	31.8
• middle manager	20	18.2
• junior manager	8	7.3
• other	9	8.2

The Adoption Levels

The measurement of adoption levels comprised six categories. As shown in Table 2, the largest group of organisations have fully adopted ICT (60 companies, 54.5).

Table 2: Adoption Levels of ICT

Level of adoption of ICT	Percentage (%)
Has not adopted and is not considering	5.5
Is considering the adoption	5.5
Has decided to adopt in future	2.7
Is adopting	13.6
Has partially adopted	18.2
Has fully adopted	54.5
Total	100.0

Much of the literature deals with the situation on a binary basis, whether the organisation has adopted or not. In line with this the six innovation adoption categories are grouped into two, whether the organisation is adopting the innovation or not adopting the innovation. With the three categories "Has not adopted and is not considering", "Is considering the adoption" and "has decided to adopt in future" classified as not adopting the innovation, and the innovation is considered to be adopted if the organisation is categorised as "is adopting", "has partially adopted" or "has fully adopted" the innovation. This gives the level of adoption as 86.3% for ICT.

Reliability test

The calculated Cronbach alpha obtained for each construct is exhibited in Table 3 below. The alpha values obtained were above 0.70, indicating that the constructs had internal consistency reliability (Bagozzi, 1994: pg 18). The alpha value of 0.68 of Organization Stakeholder Pressure and Supply Chain Complexity were still in the acceptable region.

Table 3: Reliability Test

Construct/Variables	Cronbach alpha
ICT Relative Advantage	0.90
ICT Complexity	-
ICT Compatibility	0.93
ICT Observability	0.97
ICT Manager's support	0.93
ICT Strategy Integration	0.86
ICT Stakeholder Pressure	0.82
Organisation Stakeholder Pressure	0.68
System Openness	0.76
Environmental Uncertainties	0.72
Supply Chain Complexity	0.68

**note: ICT complexity is not present as it only constructed by a single question

Validity

As shown in Table 4 below, all KMO values for the three (3) sets of factor analysis range from 0.65 to 0.82, which are considered acceptable according to Hair et al. (1998). Regarding Bartlett's test of sphericity, Pallant (2005: pg 182) points out that this test should be significant ($p>0.05$) indicating that the factor analysis is considered appropriate. The results reveal that all the Bartlett's test of sphericity for the three (3) sets of factor analysis are significant ($p>0.01$). Given the above, it can be concluded that the data are appropriate for running the factor analysis.

Table 4: The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy

FACTOR ANALYSIS	KMO
1. ICT Characteristics	0.82
2. ICT Internal and External Factors	0.78
3. External Environmental Characteristics	0.65

Analysis and Findings

The logistic regression technique was used to test all hypotheses. The details of this test are summarised in Table 5. The results of the logistic regression indicated a good model fit using Homer & Lemeshow's goodness-of-fit test and shows that the model does not differ significantly from the observed data; and the data analysis could be continued. Results show that relative advantage, manager's support and system openness are positively related to the adoption of ICT. These findings support hypotheses H1, H5 and H9. On the other hand, complexity, compatibility,

observability, strategy integration, innovation stakeholder pressure, organisation stakeholders pressure, environmental uncertainties, and supply chain complexity, have insignificant relationships with the adoption of ICT. Accordingly, hypotheses H2, H3, H4, H6, H7, H8, H10, and H11 are refuted.

Table 5: Logistic Regression Analysis Models for determining the Relationship between the independent variables and the Adoption level ICT

Variables		**Logistic Regression Models**	
		Adoption level of ICT	
		B	**Sig**
Roger's Innovation Model	(H1) Relative advantage	1.500	.015*
	(H2) Complexity	.596	.254
	(H3) Compatibility	.322	.513
	(H4) Observability	.465	.247
	2-log likelihood	70.36	
	Model Chi-square	17.27***	
	Predicted Observations (%)	88.2	
	Homer & Lemeshow's goodness-of-fit test	X^2= .91, df=8, sig.=0.77	
Internal / External Factors	(H5) Manager's support	.924	.015**
	(H6) Strategy Integration	.355	.346
	(H7) Innovation Stakeholder pressure	.063	.880
	2-log likelihood	72.24	
	Model Chi-square	15.38***	
	Predicted Observations (%)	85.5	
	Homer & Lemeshow's goodness-of-fit test	X^2=10.809, df=8, sig.=0.21	
External Environmental Factors	(H8) Organisation Stakeholder Pressure	.287	.463
	(H9) System Openness	.744	.093*
	(H10) Environmental Uncertainty	-.022	.962
	(H11) Supply Chain Complexity	.238	.567
	-2 log likelihood	70.34	
	Model Chi-square	17.29***	
	Predicted Observations (%)	85.5	
	Homer & Lemeshow's goodness-of-fit test	X^2=8.25, df=8, sig.=0.41	

*significant at 0.1 level
**significant at 0.05 level
***significant at 0.01 level

Conclusion

The findings in the present study refuted earlier scholars in innovation for complexity (Cooper & Zmud, 1990; Grover, 1993), for compatibility (Premkumar & Roberts, 1999b) and observability (Kim & Srivastava, 1998); who all supported Rogers (Rogers, 1983, 1995, 2003) in his innovation characteristics model of adoption. The possible explanation for the insignificant result may be due to the general questions asked regarding ICT in the study survey that lead into multiple answers from the respondents who might have a particular ICT in mind.

Relative advantage on the other hand is found to be the most significant factor to the adoption of ICT. ICT is a technical innovation (new technologies, product, and service). The empirical evidence in the present study shows positive relationships to the adoption of ICT hence supporting the findings by Tomlin (2006), Premkumar & Roberts (1999b) and Devargas (1999) when supporting Rogers (1995: pg 15).

With regard to the internal & external innovation factors of ICT, both strategy integration and stakeholder's pressure for ICT show insignificant relationship with the adoption of the innovation in both stages of analysis. This is contradicted with earlier studies in innovation by Patterson et al. (2003). As anticipated, manager's support appears to be the most significant factor to the adoption of ICT in organisations within the supply network.

With regard to the External Environmental characteristics, organisational stakeholder pressure, environmental uncertainties and supply chain complexity show insignificant relationship with the adoption of ICT. These findings suggest that an organisation may adopt ICT regardless of its organisational stakeholder pressure, environmental uncertainties and supply chain complexity; and contradicted earlier studies.

System openness shows significant relationship with the adoption of ICT in an organization. This confirms earlier studies by Russell & Hoag (2004) when supporting Rogers (1995: pg 377). This suggests that organisations in a supply chain seek to ensure that innovation is adopted when more information is available to be shared with members within supply chain.

Future Recommendations

This study has been conducted in one country (UK) and the data were collected from a variety of sectors. The methodological consideration behind choosing various sectors and different sizes emerged from the pilot study carried out among the managers of manufacturing companies in the UK before collecting the data through the main questionnaire survey. The findings of the study are consistent - to a certain extent - with the results of other innovation studies conducted in different contexts. It is suggested that the results of this study could be generalized to other countries with similar context.

Acknowledgement

This work is supported by Faculty of Technology Management and Technopreneurship, Universiti Teknikal Malaysia Melaka.

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