THE PERCEPTIONS OF ADOPTERS AND NON-ADOPTERS OF CLOUD COMPUTING: APPLICATION OF TECHNOLOGY-ORGANIZATION-ENVIRONMENT FRAMEWORK

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ABSTRACT

The purpose of this research is to explore the differences between cloud computing adopters and non-adopters. This study used technology-organization-environment (TOE) framework to investigate the perceptions of IT staff towards cloud computing adoption. The specific factors in the TOE framework are relative advantage, complexity, compatibility, top management support, organizational readiness, competitive pressure, and business partner pressure. An online-based survey was employed to collect data from IT managers, IT consultants, and IT professionals working at Saudi organizations. The findings revealed that adopters have higher perceptions to cloud computing than the non-adopters, except for complexity. The findings offer organizations and cloud computing service providers with better understanding of factors to be considered when making decisions about the adoption of cloud computing. The findings would also help organizations to consider their information technologies investments when implementing cloud computing.

Keywords: Cloud computing, **t**echnology-organization-environment model, technology adoption.

INTRODUCTION

The National Institute of Standards and Technology (NIST) defines cloud computing as "A model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [8, p.11). The emergence of cloud computing services is considered a major development in the provision of information technology (IT) resources to organizations. Cloud computing helps organizations to better leverage their investment in IT resources and allows them to respond more quickly to changing business needs for IT services [13]. However, cloud computing can have greater positive impact on organizational performance only if managed effectively.

Cloud computing are normally delivered through three service models [6] [25] [26]: 1) Software as a Service (SaaS), 2) Platform as a Service (PaaS), and 3) Infrastructure as a Service (IaaS). These service delivery models suit different types of business needs for IT services. Since IT proved to have enabled competitive advantages for business organizations, effective adoption of cloud computing is becoming more important. In addition, the decision making process involved in the planning for and management of adopting cloud computing is becoming more complex. The reason for this is that a number of organizational issues such as strategic alignment with business plans, people acceptance/resistance, culture, security risk, data privacy, and cost can affect the successful adoption of cloud computing in organizations.

According to Gartner, enterprise's spending on cloud computing is growing faster than overall IT spending and it is expected to grow by over 100% to become a $207 billion industry by 2016 whereas the overall global IT market is forecast to grow at 3% [18]. Owing to the potential for cloud computing, more research is needed to understand the different factors influencing its adoption. The proposed research, therefore, is aimed to explore the different perceptions of adopters and non-adopters of cloud computing adoption. The results of this research project are expected to help both cloud computing providers and business organizations to focus more on the key issues of cloud computing adoption and thus lead them to make more effective decisions. It is envisaged that the findings will inform business organizations, especially from those who just have started their journey to cloud applications and platforms, to effectively manage the adoption of, and investment in, cloud computing services. This remaining sections of this paper are organized as follows. Next sections provide a brief description about cloud computing, followed by the research variables and hypotheses, then the methodology, results, discussions and implications. The last section addresses the conclusions, limitations and future directions.

OVERVIEW OF CLOUD COMPUTING

Cloud computing is a new paradigm shift that allows customers to choose from a pool of computing resources including hardware, software, and networking infrastructure. These computing resources provide on-demand and instant services and charges customers on a pay-per-use basis [3] [9]. NIST defines cloud computing by describing five essential characteristics, three cloud service models, and four cloud deployment models [14]. The characteristics, service models, and deployment models are depicted in Figure 1.

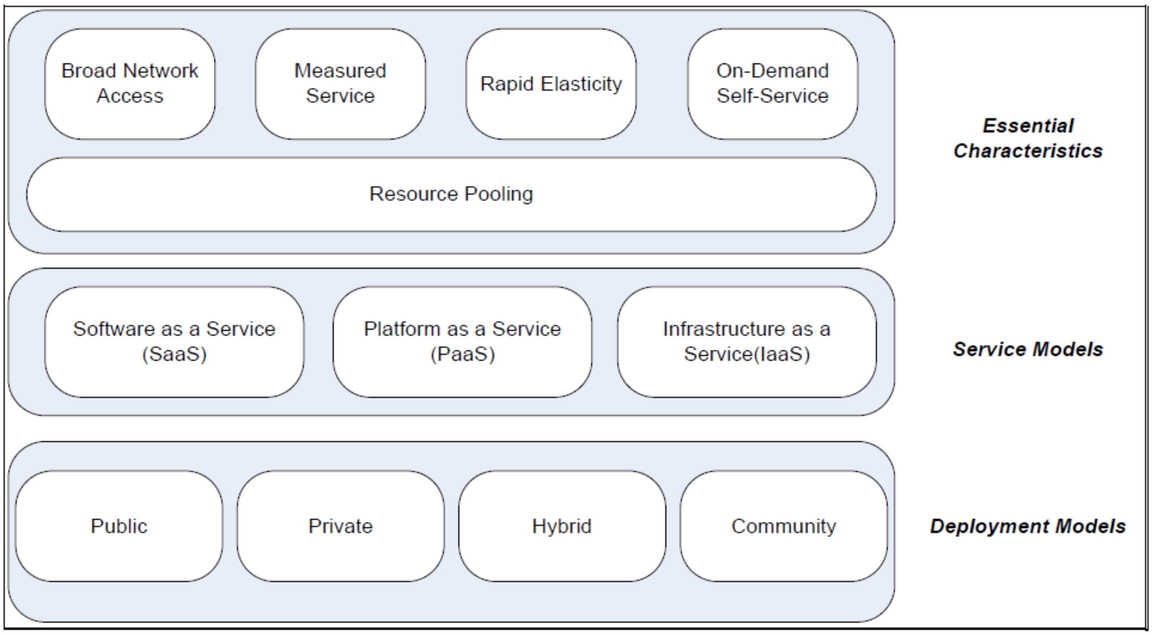

Figure 1. Cloud Computing Characteristics, Service Models and Deployment Models [2]

Cloud services exhibit five essential characteristics that demonstrate their relation to, and differences from, traditional computing approaches [2]:

1. On-demand self-service. A consumer can unilaterally provision computing capabilities such as server time and network storage as needed automatically, without requiring human interaction with a service provider.
2. Broad network access. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs) as well as other traditional or cloud-based software services.
3. Resource pooling. The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a degree of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources, but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter
4. Rapid elasticity. Capabilities can be rapidly and elastically provisioned — in some cases automatically — to quickly scale out; and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.
5. Measured service. Cloud systems automatically control and optimize resource usage by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, or active user accounts). Resource usage can be monitored, controlled, and reported — providing transparency for both the provider and consumer of the service.

The cloud service delivery models provide three layers of cloud computing services [3] [5] [6] [25] [26]:

1. Infrastructure as a Service (IaaS). It provides the customer with the necessary computing resources (e.g. processing, storage, networks, and other basic computing resources) and allows the customer to install and run different software such as operating systems and software applications.
2. Platform as a Service (PaaS). It provides the customer with the ability to install onto the cloud infrastructure applications produced using programming languages and tools supported by the provider.
3. Software as a Service (SaaS). It provides the customer with the capability to use the provider's applications which can be accessed from various remote devices, through a thin client interface, such as a web browser. The customer does not manage the cloud infrastructure or individual application configurations.

Regardless of the service model utilized (SaaS, PaaS, or IaaS), there are four deployment models identified for cloud computing services [5] [25] [26]:

1. Private cloud. This cloud is either owned or exclusively used by a single organization. It may be managed by the organization or a third party, and may exist on premise or off premise. It offers the highest degree of security.

2. Public cloud. This cloud is owned and operated by the cloud computing provider. The provider manage and sell the cloud services to customers.
3. Community cloud. This cloud is shared by several organizations and supports a specific community that has communal concerns (e.g., security requirements, policy, compliance considerations, etc..). It may be managed by the organizations or a third party, and may exist on premise or off premise.
4. Hybrid cloud. This cloud is a combination of public and private clouds. It requires determining the best split between the public and private cloud components, but are bound together by standardized or proprietary technology, that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).

RESEARCH VARIABLES AND HYPOTHESES

A search of the literature revealed that the TOE framework has been used in the field of information and communication technology innovation adoptions [1] [7] [10] [11] [17] [20]. The TOE has three contexts involving technological, organizational, and environmental characteristics. The specific factors within each of the three contextual factors vary across different studies. However, the TOE framework has received consistent empirical support [10] [21]. The TOE framework provides an appropriate theoretical foundation for this study to examine the factors associated with the adoption of cloud computing.

Technological Context

The technological context refers to internal and external technologies applicable to the firm. The main focus of technological context is on how technology characteristics influence the adoption decision [19]. Tornatzky and Klein [22] conducted a meta-analysis study and found that relative advantage, complexity, and compatibility were highly associated with innovation behavior. Relative advantage is defined as the degree to which a technological factor is perceived as providing greater benefit for the firm [19]. The expected benefits of embedded cloud computing services include the following: speed of business communications, efficient coordination among firms, better customer communications, and access to market information mobilization [12]. From a previous research, the relative advantage had a significant effect on the adoption of cloud computing [12]. Complexity is defined as “the degree to which an innovation is perceived as relatively difficult to understand and use” [19, p.257]. Firms may not have confidence in a cloud computing system because it is relatively new to them. It may take adopters a long time to understand and implement. Thus, complexity of an innovation may act as a barrier to the implementation of new technology, like cloud computing [12]. Compatibility refers to the degree to which innovation fits with the potential adopter’s existing values, previous practices and current needs [12]. Compatibility was found to be a key factor in influencing cloud computing adoption [23]. Hence, it is worthwhile to examine this factor in this study. Thus, the following hypotheses are proposed:

H_1: The Cloud Computing adopters will have higher perception of relative advantage than will the non-adopters.
H_2: The Cloud Computing adopters will have lower perception of complexity than will the non-adopters.
H_3: The Cloud Computing adopters will have higher perception of compatibility than will the non-adopters.

Organizational Context

This context may have a high impact on cloud computing adoption. Factors in the organizational context include top management support, organizational readiness, and company size. Top management support is the most critical factor for creating a supportive climate and for providing adequate resources for the adoption of new technologies. Top management plays an important role because cloud computing implementation may involve integration of resources and reengineering of business processes. Moreover, a previous research has found the top management support is one of the major determinants of cloud computing adoption [12] [16]. Organization readiness is defined as “the availability of the needed organizational resources for adoption” [7, p.467]. The readiness of organizations refers to technological infrastructure, financial and IT human resources that influence the adoption of new technology. Technological infrastructure refers to installed network technologies and enterprise systems, which provide a platform on which the cloud computing applications can be implemented. IT human resources provide the knowledge and skills to implement cloud-computing-related IT applications [12] [16]. Thus, the following hypotheses are proposed:

H_4: The Cloud Computing adopters will have higher perception of top management support than will the non-adopters.
H_5: The Cloud Computing adopters will have higher perception of organizational readiness than will the non-adopters.

Environmental Context

The environmental context describes the industrial settings in which an organization conducts its business. These include level of competition, trading partners, and rules and regulations. Competitive pressure refers to the level of pressure felt by the firm from competitors within the industry. Additionally, many firms rely on trading partners for their IT design and implementation tasks [1] [12] [16]. Organizations need to adopt new technologies and try to have a competitive advantage over their competitors. In addition, organizations should adopt the same or compatible technologies with their partners in order to have compatibilities that ease data sharing and interchangeability. Competitive and trading partner pressures have been found as significant determinants of cloud computing adoption [12]. Thus, the following hypotheses are proposed:

H_6: The Cloud Computing adopters will have higher perception of competitive pressure than will the non-adopters.
H_7: The Cloud Computing adopters will have higher perception of partner pressure than will the non-adopters.

METHODOLOGY

Survey Development

To test the above hypotheses, a survey instrument was developed based on an extensive review of the literature. The measurement items of the research variables were adapted from previous research studies. Items adapted from [21] were used to operationalize relative advantage and partner pressure. Complexity was measured by three items adapted from [12] [24]. Three items drawn from [4] were used to measure compatibility. Three items adapted from [21] [24] were used to operationalize top management support. Items adapted from [4] were used to measure organizational readiness and competitive pressure. To assure the face validity of the survey instrument, it was reviewed and validated by a group of IT professionals who are well aware of cloud computing technologies. Based on their feedback, the survey has been reviewed and modified according to the IT professionals' comments and feedback. As a result, some of the items have been rephrased to make them easier to understand by the respondents. The survey consists of two parts. The first part of the survey captured the demographic details of the respondents. The second part captured the respondent's perception of relative advantage, complexity, compatibility, top management support, organizational readiness, competitive pressure, and partner pressure. They were asked to give their level of agreement or disagreement on the items of the study variables using the following scale: 1= strongly disagree, 2= disagree, 3= somewhat disagree, 4=neutral, 5= somewhat agree, 6= agree, and 7= strongly agree. The adoption was operationalized as a dichotomous variable, whether a firm was an adopter or non-adopter of cloud computing (0: non-adopter; 1: adopter). A summary of the measurement items and their sources is provided in the appendix.

Data Collection

The target respondents are IT managers, IT consultants and IT professionals who work at Saudi firms and have some knowledge about cloud computing technology. The survey was designed as a webpage hosted by kwiksurveys.com, an online survey service provider. Then, the link to the survey embedded in a short note explained the purpose of the research and assured the confidentiality of the responses was sent, through E-mails, LinkedIn and Facebook, to 560 IT professionals in Saudi Arabia. The number of returned responses were 146 responses. After omitting incomplete responses, 106 responses were used for further analyses. The effective response rate was around 19%.

RESULTS

Sample Characteristics

The total number of usable responses to the survey was 106 responses. Most of the respondents were IT professionals, IT consultant, or IT managers. Respondents whose companies had not adopted cloud computing were classified as non-adopters, whereas respondents whose companies had adopted cloud computing were classified as adopters. Out of those, 40 (37.7%) indicated that their firms have adopted cloud computing while the remaining 66 (62.3%) have not yet adopted cloud computing. The majority of these firms were in the market for more than 30 years. Seventy-nine percent of these organizations employed more than 2,000 employees. Table 1 summarizes the demographic characteristics of the respondents in adopting and non-adopting organizations.

Table 1. Demographic Characteristics of adopters and non-adopters of cloud computing

		All		**Adopters**		**Non-adopters**	
		N	**%**	**N_1**	**%**	**N_2**	**%**
Organization Age	Less than 10 years	13	12.3	5	12.5	8	12.1
	10-30 years	17	16.0	9	22.5	8	12.1
	Over 30 years	76	71.7	26	65.0	50	75.8
Number of Employees	Less than 1,000	15	14.2	7	17.5	8	12.1
	1,000 to 2,000	12	11.3	4	10.0	8	12.1
	More than 2,000	79	74.5	29	72.5	50	75.8
Number of IT Staff	Less than 10	5	4.7	2	5.0	3	4.5
	10 to 50	5	4.7	2	5.0	3	4.5
	51 to 100	7	6.6	3	7.5	4	6.1
	101 to 200	12	11.3	4	10.0	8	12.1
	More than 200	77	72.6	29	72.0	48	72.7
Organization Annual Revenue (SAR)*	Less than 10 million	8	7.5	4	10.0	4	6.1
	10 to 100 million	6	5.7	1	2.5	5	7.6
	101 to 500 million	14	13.2	5	12.5	9	13.6
	500 million to 1 billion	6	5.7	4	10.0	2	3.0

		All		Adopters		Non-adopters	
		N	**%**	**N_1**	**%**	**N_2**	**%**
	More than 1 billion	72	67.9	26	65.0	46	69.7
Occupation	IT Manager	17	16.0	9	22.5	8	12.1
	IT Consultant	20	18.9	13	32.5	7	10.6
	IT Professional	66	62.3	16	40.0	50	75.8
	Other	3	2.8	2	5.0	1	1.5
Organization Sector	Business services	5	4.7	1	2.5	4	6.0
	Logistics & Manufacturing	5	4.7	1	2.5	4	6.0
	Oil & Gas	62	58.5	17	42.5	45	68.2
	IT	21	19.8	16	40.0	5	7.6
	Other	13	12.3	5	12.5	8	12.1

* Saudi Arabian Riyals (SAR) 3.75 = 1USD

Instrument Validity and Reliability

Face validity was ensured by consulting a group of IT professionals who reviewed and validated the survey items and pilot testing of the survey instrument with another group of IT professionals before carrying out the main study and distributing the survey. This ensured correcting any ambiguities in survey items. Cronbach's Alpha was used to assess the reliabilities of the research variables. As shown in Table 2, Cronbach's alphas were ranging from 0.734 to 0.898 for all variables that exceeded the threshold value of 0.7 [15]. Hence, the scales for all research variables were deemed to exhibit adequate reliability.

Table 2. Overall Mean, Standard Deviation, and Cronbach's Alpha Reliability

Dimension	No. of Items	Mean	Standard Deviation	Alpha
Relative Advantage	6	5.545	0.922	0.854
Complexity	3	4.163	1.293	0.734
Compatibility	3	4.654	1.449	0.898
Top Management Support	3	4.918	1.347	0.878
Organizational Readiness	2	5.344	1.279	0.817
Competitive Pressure	2	4.368	1.368	0.709
Business Partner Pressure	2	3.929	1.583	0.880

Hypotheses Testing

The hypotheses were tested by applying the independent-samples T tests. As presented in Table 3, the hypotheses related to relative advantage (H_1), compatibility (H_3), top management support (H_4), organizational readiness (H_5), competitive pressure (H_6) and partner pressures (H_7) were supported at 5% significance level. Complexity (H_2) was not supported. Table 3 shows the results of the comparisons between adopters and non-adopters in relation to the three contexts of cloud computing adoption: (1) technology context (i.e. relative advantage, complexity, and compatibility), (2) organizational context (i.e. top management support and organizational readiness) and (3) environmental context (i.e. competitive and partner pressures).

Table 3: Comparison between adopters and non-adopters of cloud computing

Hypothesis	Variable	Adopters Mean (SD)	Non-adopters Mean (SD)	t	p
	Technological Factors				
H_1	Relative Advantage	5.779 (1.044)	5.404 (0.815)	2.062	0.042
H_2	Complexity	4.225 (1.376)	4.126 (1.250)	0.379	0.705
H_3	Compatibility	5.583 (1.101)	4.091 (1.345)	5.914	0.000
	Organizational Factors				
H_4	Top Management Support	5.992 (0.822)	4.268 (1.177)	8.859	0.000
H_5	Organizational Readiness	5.800 (0.911)	5.068 (1.392)	3.269	0.001
	Environmental Factors				
H_6	Competitive Pressure	4.887 (1.195)	4.053 (1.379)	3.172	0.002
H_7	Business Partner Pressure	4.575 (1.361)	3.538 (1.589)	3.433	0.001

DISCUSSION AND IMPLICATIONS

The objective of this study was to extend the understanding of cloud computing adoption by identifying the factors that affect the cloud computing adoption, and comparing the perceptions of cloud computing adopters and non-adopters in relation to the technological context, organizational context and environmental context.

Technological Context

IT professional adopters perceived the relative advantage and compatibility more than the non-adopters did. This is not surprising result because adopting firms have reaped the benefits of and appreciated the experience with cloud computing. On the top of the relative advantages of cloud computing, as compared to in-house computing, are the cost reduction, operation efficiency, fast application process, better customer services, better relationships with business partners and improvement of the firm competitive advantage. In addition, adopters perceived cloud computing more compatible than the non-adopter did, in terms of organization culture, values and work practices. However, there is no significant perception differences towards complexity. In fact, they have neutral perceptions. This implies that both adopters and non-adopters believe that complexity is not a barrier of adopting cloud computing. That is, they neither perceive cloud computing taking long time to understand and implement nor requiring complex skills from employees to deploy and use.

Organizational Context

Organizational context involves the top management support and the organizational readiness. Unlike non-adopting firms, top management of adopting firms is very supportive of and interested in cloud computing initiatives. The non-adopting firms have shown lower perception towards top management support. This confirms that the important role of top management support in creating a supportive climate and providing adequate resources for successful adoption of cloud computing. This finding is consistent with [12] who found that top management support was significant discriminators between cloud computing adopters and non-adopters.

The organizational readiness entails the technology infrastructure, IT skills and financial resources. Adopters perceived technological and financial resources more important than non-adopters did. One possible explanation might be the non-adopters perceived that the required resources are as important for cloud computing as for in-house computing. Another explanation might be that the cloud computing is new to Saudi organizations. Hence, the non-adopters have found it difficult to assess the importance of technical and financial resources required for cloud computing implementation. They might not perceive that cloud computing differs from in-house computing in terms of resources requirements.

Environmental Context

In a complex business environmental, there is a paramount external pressure on business firms to leverage new ways to outperform rivals. The pressure emanates from the competition within the industry and from the trading business partners, especially those implementing hybrid cloud. A firm may feel pressure from its trading partners if they request or recommend it to adopt cloud computing. Another source of pressure is from the industry. Firms may feel the need to adopt cloud computing, in order to be remain competitive, when they see most of their peer firms adopting cloud computing.

CONCLUSIONS, LIMITATIONS & FUTURE DIRECTIONS

This paper examined the IT professionals' perceptions of cloud computing adoption in Saudi Arabia. This study represents an attempt to examine perceptions of cloud computing adoption using technology-organization-environment framework. Overall, the results showed that adopters have much higher perceptions of cloud computing than the non-adopters. This might be attributed to the fact that increasing familiarity with the cloud computing technology would lead to a greater degree of adoption. Another explanation is that non-adopters did not perceive a need to adopt the cloud computing. The results suggest that the study variables (i.e. relative advantage, compatibility, top management support, organizational readiness, competitive pressure, and partner pressure) play important roles in differentiating between adopters and non-adopters of cloud computing.

This research has some limitations. First, the cloud computing is a relatively new concept and has different service models. Each model may have different perceptions. Future studies need to focus more on specific service or delivery models like SaaS, PaaS, or IaaS. Second, this study is conducted in a single country, which implies that the results reflect only the situation in Saudi Arabia. Therefore, the results cannot be generalized to other countries. Different countries have different aspects such as cultures, competition, business partners, and government policies. Similar research work may be conducted in other countries and the results are compared. Third, the results provide overall perceptions of cloud computing, regardless of the industry. Future research should target and focus on different sectors and industries.

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APPENDIX

Measurement items of the research variables

Relative advantage
CC reduces costs (Teo, Lin, & Lai, 2009)
CC improves operations efficiency (Teo, Lin, & Lai, 2009)
CC enables faster application process (Teo, Lin, & Lai, 2009)
CC improves customer service (Teo, Lin, & Lai, 2009)
CC improves relationship with business partners (Teo, Lin, & Lai, 2009)
CC improves competitive advantage (Teo, Lin, & Lai, 2009)
Complexity
CC takes long time to understand and implement (Low, Chen, & Wu, 2011)
CC lacks confidence from the employees because it is relatively new (Low, Chen, & Wu, 2011)
CC requires complex skills from employees (Yu-hui, 2008)
Compatibility
CC adoption is compatible with the organization culture (Grandon & Pearson, 2004)
CC adoption is compatible with the organization values (Grandon & Pearson, 2004)
CC adoption is compatible with the organization preferred work practice (Grandon & Pearson, 2004)
Top Management Support
Top Management is interested in CC adoption (Teo, Lin, & Lai, 2009)
Top Management supports the CC adoption (Teo, Lin, & Lai, 2009)
Top Management is aware of the benefits of CC (Yu-hui, 2008)
Organizational Readiness
Organizational financial resources is important to adopt CC (Grandon & Pearson, 2004)
Organizational technological resources is important to adopt CC (Grandon & Pearson, 2004)
Competitive Pressure
Competition is a factor in the decision to adopt CC (Grandon & Pearson, 2004)
The industry is pressuring to adopt CC (Grandon & Pearson, 2004)
Business Partner pressure
Majority of business partners have requested to use CC (Teo, Lin, & Lai, 2009)
Majority of business partners have recommended to use CC (Teo, Lin, & Lai, 2009)