A Multi-Perspective Framework Established on Diffusion of Innovation (DOI) Theory and Technology, Organization and Environment (TOE) Framework Toward Supply Chain Management System Based on Cloud Computing Technology for Small and Medium Enterprises

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ABSTRACT

Cloud Computing (CC) has emerged as one of the most discussed topics among enterprise information technology (IT) professionals. Small and Medium Enterprises (SMEs) with low budget and human resources are one of the major groups that tend to use CC for achieving the benefit of this technology. A multitude of factors influence the adoption of CC for SMEs. These decisive factors must be systematically evaluated prior to making the decision to adopt cloud-based solutions. Integration of supply chain activities and the technologies to accomplish it have become competitive necessities in most industries. Accordingly, the trend toward greater use of supply chain technologies is on a clear path forward. As one manager has noted: ''With almost daily technology advancement globally in every facet of the business, organizations need to synchronize by adopting and implementing new electronic commerce and supply chain technology in order to protect market share, not to mention improve market penetration''. This paper develops a model of the key factors influencing the adoption of supply chain based on cloud computing technology. The following set of variables were hypothesized to have a significant impact upon the pace of technology adoption: relative advantage, compatibility, security concerns, cost savings, technology readiness, top manager support, competitive pressure and regulatory support. The model provides a better understanding of the supply chain technology diffusion process. The purpose of this study is to identify these factors and determine the extent to which they influence the adoption of CC for SMEs. Therefore, the project describes a research model that is based on the diffusion of innovation (DOI) theory and the technology, organization and environment (TOE) framework. Data was collected by survey questionnaires from a sample of 22 SMEs that all of these SMEs as a customer's of one cloud provider. There are 77 experts in information technology department from those SMEs are selected to fill the questionnaires. The Smart PLS tool was used for data analysis. The results of the data analysis generally support the model, as well as all of the proposed hypotheses. In summary, the results of this research have shown relative advantage, compatibility, security concerns, cost savings, technology readiness, top manager support, competitive pressure and regulatory support were found to have significant influence on adoption of supply chain management based on CC for SMEs.

KEYWORDS: Innovation Adoption, Supply Chain Management, Cloud Computing, Diffusion of Innovation Theory, DOI Theory, Technology-Organization-Environment Framework, TOE Framework

1.0 INTRODUCTION

According to severe market competition and a dramatically changing business environment, firms have still prompted to adopt various state-of-the-art IT to improve their business operations [1]–[3]. During the recent years, many scholars had focused on CC as the latest development in the field of IT [1], [4]–[7]. CC is commonly described as the usage of computing resources provided as services over network [8]. Different definitions and domains have been attributed to CC [9], [10]. It provides various services for users in spite of not having relevant information over the technology structures [11]. Therefore, it actually can be called "service on the cloud" [11], [12]. In other words, CC is a kind of computing application service that is like e-mail, office software, and enterprise resource planning (ERP) and uses global resources that can be shared by the business employee or trading partners [13].

Since 1960 telecommunication enterprises suggested the theory of CC, many enterprises contributed in the strength of CC adoption in several areas from none to small enterprises and small enterprises to

larger enterprises scale but many organizations didn't have a enough information across the CC and the benefits of adoption of CC [14], [15]. Therefore, CC was rejected by organization [16]–[18]. CC adoption was not basically approaching as a technical upgrading but it was known as an essential revolution in how IT is provisioned and used [19]. The recent improvement of CC delivers an undoubted chance for organizations to outsource their information and communications technology (ICT) [20].

SMEs were had a less human recourse and financial in contrast of large sized enterprises, so small and medium enterprises couldn't development their IT supplies effectiveness [14], [17], [21]–[23]. SMEs were achieved genuine benefits, and improved business competitiveness by adoption of CC [17], [20]. The adoption of CC in SMEs is increased recently. The understanding about the CC increased more than doubled from December 2009 to March 2011, from 20 precent to 44 precent and about 45% of SMEs with fewer than 250 employees are already using at least one cloud service. Nearly 50% of SMEs will spend more than one-third of their IT budgets on cloud and managed infrastructure services in 2013 [24]. Clearly, the cloud phenomenon is not a panacea for all enterprises [15].

The purpose of this study is to understand the determinants of CC adoption in SMEs. It seeks to investigate whether the determinants of cloud adoption vary across SMEs. For this purpose, we develop a research model that synthesizes the theoretical perspectives of the DOI theory [25], and the TOE framework [26]. None of these models are flawless; and each of them has its own shortcomings [27], [28]. In this research, we proposed a research model based on DOI and TEO. We believe this model explain the adoption of the technology (in particular CC) more accurately. The conceptual framework that is being proposed in this study adapts selected elements from DOI and various from TOE. DOI proposed by Rogers [25], in one of the most commonly used theories to study the adoption of innovations; however, this theory has its own drawbacks; for instance, it does not take into account the environmental aspects of the context [29]. In order to overcome the issue with DOI, we used the second theory, which is TOE [27], [28]. Unlike DOI, which explains the innovation adoption at both individual and firm level, TOE 's focus is on firm level adoption decision. The main difference between DOI and TOE is that TOE framework considers environmental aspects as well. TOE's dependent variable is not only the adoption decision but also the likelihood of adoption, intention to adopt, or the extent of adoption of the new technology [27].

Supply chain management is recognized as an important area for information technology in- novation and investment. Supply chain management has been defined by The Global Supply Chain Forum as ''...the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders''. With implementation of supply chain management, the narrow focus of managers and the adversarial relationships between logistics providers, suppliers, and customers are replaced with strategic alliances and long-term cooperative relationships and viewing suppliers and customers as partners instead of adversaries with the objective of ''maximizing competitiveness and profitability for the company as well as the whole supply chain network including the end-customer''. Better information exchange between supply chain partners, perhaps the key advantage of an integrated supply chain, provides more up-to-date information and allows for more accurate inventory responses to changes in demand and thus more appropriate inventory levels throughout the supply chain.

2.0 LITERATURE REVIEW

2.1 Cloud Computing and Supply Chain Management

CC was defined by the national institute of standards and technology (NIST) as a model for enabling convenient, on- demand network access to a shared pool of configurable computing resources (e.g., network, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [11], [13], [30], [31]. This cloud model promotes availability and is composed of five essential characteristics: On Demand Self-Service, Broad Network Access, Resource Pooling, Rapid Elasticity, and Measured Service [11], [32]–[35]. Additionally, this cloud model has three service models: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) [36], [37]. Moreover, it has four deployment models: Private, Public, Community, Hybrid [11], [12], [38], [39].

Supply chain management is recognized as an important area for information technology in- novation and investment. Supply chain management has been defined by The Global Supply Chain Forum as ‘‘...the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders’’. With implementation of supply chain management, the narrow focus of managers and the adversarial relationships between logistics providers, suppliers, and customers are replaced with strategic alliances and long-term cooperative relationships and viewing suppliers and customers as partners instead of adversaries with the objective of ‘‘maximizing competitiveness and profitability for the company as well as the whole supply chain network including the end-customer’’. Better information exchange between supply chain partners, perhaps the key advantage of an integrated supply chain, provides more up-to-date information and allows for more accurate inventory responses to changes in demand and thus more appropriate inventory levels throughout the supply chain [1-17]. The global environment at the beginning of the 21st Century has undergone a series of radical changes that exert great pressure on organisations, including fierce global competition, shorter product lifecycles, increasing customer expectation, fluctuating inventory and changing costs. Organizations have to demonstrate the greater capability to handle these challenges in order to stay competitive and continually survive in the market. To this end, they have to be responsive enough to satisfy customised and ever-changing demand from the market. Therefore, establishing a supply chain with great responsiveness has become a core strategy to gain a competitive advantage for most of the organisations. The paper fills a gap in academic research by proposing a reference approach for cloud-based SCM and shows how it can be utilised to improve SCR. The introduction of cloud provides potential benefits through several promising IT capabilities, converting them into services that can be consumed by widely dispersed organisations, in an on-demand and cost-effective manner. Thus, organisations do not have to purchase licenses of these IT resources, deploy them on their own servers and hire dedicated staff or team to maintain them [22-36]. Cloud enables the traditional point-to- point integration mode to evolve to hub-and-spoke mode, which significantly reduces the number of integration interfaces. Thus, it facilitates rapid deployment and promotes real-time information integration and sharing. The on-demand scalability enables C-SCM to accommodate suddenly increased or decreased data volumes and trading partners. With the utilisation of a C-SCM, a supply chain-wide knowledge learning, decision making, reaction, and optimisation can be achieved. The advantages of proposed C-SCM over conventional SCM approaches are a multitude. Real-time end-to-end supply chain visibility is the most promising one, which provides a basis for demand sensibility and various other capabilities. Collaboration between organisations can be improved by C-SCM. Flexibility in infrastructure level, application level, process level, partner relationship level and cost structure level are all improved. Various exceptions, disruption risks as well as business trends can be captured in real time. The knowledge learning capability can achieve a real-time reaction. C-SCM can be beneficial for several business processes, especially for those processes that widely dispersed or require intensive partners' collaboration, such as logistics management, purchase management, collaborative planning forecast, and replenishment, etc.

2.2 Small and Medium enterprises

SMEs are a well- known abbreviation in most parts of the world and are generally accepted. Small, mediums as well as micro organizations that exist today are referred to as SMEs [40], [41]. There are three criteria that have to be evaluated to determine which organization can be counted as an SME. When evaluating whether an organization is an SME or not, the staff head-count, balance sheet and the annual turnover of the organization is taken into account [23], [27], [42].

2.3 Cloud Computing Solution for SMEs

The size and structure of SMEs gives them some advantages including fast communication between employees and their managers and their ability to rapidly implement and execute decision [43]. But in most cases these companies face many disadvantages [13]. Most of the challenges that SMEs face are due to their lack of access to enough resources [44]. These resources include but not limited to financial and human resources [23]. This limitation makes SMEs weaker than large companies in terms of financing, planning, control, training and also information technologies. Keeping cost under control is one the biggest challenges that SMEs faces. It is not feasible for SMEs to spend a significant amount of money on their IT [27]. In addition to their high cost, IT projects usually involve a high risk of failure too [23]. About 20 percent of IT projects are canceled before completion and less than a third are finished on time and within budget with expected functionality [45]. Overall SMEs have low tolerance in bearing costs and risks that are involved in IT investment. Different studies have been

conducted to investigate how to improve SMEs' operational efficiencies; and help them grow larger [22], [23], [28], [29], [43]. For example, researcher proposed some changes in public policies that increase an SME's incentive to innovate [46]. Another strategy, which has been proven to enhance SMEs' ability to compete against larger companies, is the use of appropriate ICT [27]. Although adopting new technologies help SMEs gain competitive advantage, it usually involves high cost. These costs are fixed costs (such as hardware, software, storage, licensing etc.), operating costs (such as cost of operation, maintenance, systems upgrade, etc.) and training costs [47]. Moreover in many cases IT projects involve cost overruns [48], [49]. CC, as a new computing paradigm, offers many advantages to companies, especially smaller ones. Flexibility, scalability, and reduced cost are just some of many advantages that CC offer to SMEs. CC enhances companies' competitive advantage [50]. It also enables SMEs to access sophisticated technologies without spending significant amount money. These advantages help SMEs grow larger and become more efficient, productive and innovative, by allowing SMEs to focus on their core business [27]. This is applicable to both start-ups and already existing companies. It should also be noted that cloud providers are specialized in providing IT services; therefore, the service provided by these companies is better than the service that is delivered by IT department of SMEs. Relying on massive, centralized data centers, results in achieving economies of scale. Cloud's security measures are implemented on large scale, which makes it much cheaper. This is another result of levering economies of scale [51]. As with big organizations, this technology for SMEs is not as easy to embrace. SMEs benefit more from having it out of house as they have more technology outsourced. SMEs, by implementing this technology, create healthy competition as well as provide extension to new markets with new opportunities arising [27]. Big organizations usually benefit more from having in-house solutions and do not embrace technology from outside as much; hence, they do not qualify in the SME criteria. As compared to big organizations, SMEs also have a restriction in manpower, hence it is tougher to have staff to maintain and care for the technology [52]. Some of the assured advantages from CC can be extremely tempting for SMEs, which, while still remaining competitive in an ever challenging business environment, need to capitalize on the return on their investment [15], [27], [43]. Contrary to the past where only large enterprises could deliver, if SMEs have connections to scalable technologies, they could possibly provide products and services and hence destroy the competitive field [53]. The advantages of cloud-based technologies, from the standpoint of an SME, are: low start-up costs, low cost for intermittent use, simplicity of management, scalability, tool and location independence and quick innovation, according to Google [54]. Hence, by taking advantage of its prospect for incremental improvement in aiding businesses to obtain the advantages of CC, it averts disturbances in the transformation of business processes [11], [13], [27], [43]. SMEs stand to gain from pay-per-use, quality performance computing situations allowing them to inspire innovation and increase their competitiveness [55]. From a customer 's viewpoint, the CC service delivery model offers capital expenditure decrease, enhanced IT dexterity, quicker return on investment, elimination of barriers to entry and a more vigorous and hardy infrastructure, leading to greater business posterity. In the present digital business context, CC technology and services produce favourable opportunities for SMEs to cooperate with one another and create new competitive benefits [56]. By integrating cloud infrastructure as part of their IT strategy, the appeal of CC is based on its capacity to highlight SME entrepreneurs to direct cost savings, enhanced output and better receptiveness to the business. CC can act as a key provider for tomorrow's innovation, adding value and augmenting growth, wealth and employment in the world economy, hence creating healthy and viable societies [20]. Cloud delivered innumerable advantages. The two foremost advantages for SMEs are cost saving on technology infrastructure and quicker software upgrades without much outlay. The other advantages for SMEs are lesser investment in hardware, more effective use of computing systems in current data centres, simpler scale-up of the applications and services [17].

2.4 Adoption Model

During the last five decades, scholars have tried to determine the factors that influence the diffusion process of different technologies. Many different theories and models have been proposed to study the process of adopting new technologies. The nine major theories of this field are theory of reasoned action (TRA) [57], the technology acceptance model (TAM) [58], [59], the motivation model (MM) [60], the theory of planned behaviour (TPB) [61], the combined TAM and TPB (c-TAM-TPB) [62], the model of PC utilization (MPCU) [63], diffusion of innovations (DOI) [64], technology environment organization framework (TOE) [26] and social cognitive theory (SCT) [65]. Among these theories, DOI is one of the most commonly used theories that try to explain and predict the adoption of innovations. DOI is a theory developed by Rogers [64], which is originated from Sociology field. Majority of these theories explain and predict the adoption decision, based on factors that are related to

the technology itself (such the characteristics of the technology, or users' perception about the technology). However, technology-related constructs are not the only factors that influence the adoption of technologies. There are other factors (such as environmental and organizational factors) that influence the decision to adopt an innovation. These factors, specifically environmental factors, are not taken into account in DOI [27]–[29]. TOE is another theoretical framework that overcomes this drawback. This framework not only uses technological aspects of the diffusion process, but also non-technological aspects such as environmental and organizational factors [66]. According to Hsu [67], TOE improves DOI's ability to explain the intra-firm innovation diffusion.

2.5 Diffusion of Innovation (DOI) Theory

DOI is predominantly based on characteristics of the technology and the users' perceptions of the innovation. An organization, on the other hand, is a more complex entity than are individuals. Here, Rogers [64], suggests that innovation is a communication process using the various channels within the social system. Three factors influence the adoption of innovation in organizations. They are individual characteristics (leadership attitude toward change), internal characteristics of the organizational structure (centralization, complexity, interconnectedness, number of employee and organizational slack), and external characteristics (system openness) of the organization. There are various definitions for innovations. Most commonly, innovation is considered as any new idea, process, product, technology etc. As new individuals perceive that, Rogers [68] , argue that each innovation has different attributes, which influence its diffusion in the society. Relative advantage, compatibility, complexity, trial ability, and Observe ability are the five key attributes of each innovation. Relative advantage is defined as "the degree to which an innovation is perceived as being better than the idea it supersedes" [25]. Often times, relative advantage has a positive influence on diffusion of innovation. Compatibility is "the degree to which an innovation is perceived as consistent with the existing values, past experience, and needs of potential adopters" [25]. Compatibility of an innovation also positively influences the speed of adoption in a society. An innovation, which is compatible with the norms and values of individuals or with norms of a social system, spreads faster than an innovation, which is not compatible. Complexity is "the degree to which an innovation is perceived as relatively difficult to understand and use" [25]. Usually complexity has a negative effect on diffusion. This means that a more complex innovation has less chance to be successfully diffused in the society. Trial ability is defined as "the degree to which an innovation may be experimented on a limited basis". Last but not least, is observe ability, which is "the degree to which the results of an innovation are visible to others" [25]. According to Tornatzky and Fleischer [26], among all these five characteristics, relative advantage, compatibility and complexity are factors that most significantly influence the adoption rate of different innovations.

2.6 Technology-Organization-Environment (TOE) Framework

Tornatzky and Fleischer [26], proposed the TOE framework to explain the process of innovation in the context of an enterprise. It considers three features of an enterprise that influences the adoption of innovation - technology, organization and environment context. The technology context refers to the internal and external technology relevant to the organization, and the relevant technologies that are available for possible adoption. The organization context refers to the descriptive characteristics of the firm (i.e., organizational structure, firm size, managerial structure, degree of centralization), resources (human resources and slack resources), and process of communication (formal and informal) among employees. The environment context comprises the market elements, competitors, and the regulatory environment [26]. Technological aspect of the TOE framework refers to both availability and characteristics of the technologies. Any internal and external technology that is relevant to the firm is part of the technological aspect. According to TOE, technologies that are currently in use by the firm and technologies, which are in the market but not in use by the firm, influence the adoption decision. Technologies that are currently in use by the firm influence the adoption decision, because they define the scope and limit of the technological change that the firm can accept. On the other hand, the technologies that are in the market but not in use by the firm influence the adoption decision, because they indicate how firms can evolve by adopting new technologies. According to Tornatzky and Fleischer [26], Technologies that are outside the firm's boundaries create incremental, synthetic or discontinuous changes. Technologies that offer incremental changes only add new features to the existing technologies. This type of technologies has the lowest amounts of risks. Innovations, which produce synthetic changes, are those, which combine already existing technologies in a novel way. These innovations are moderately risky. Discontinuous changes are those, which are radically different

than the existing technologies [69]. Organizational context of TOE framework describes the characteristics and resources of the organization such as its size, structure and communication processes. Organizational characteristics affect the adoption and implementation decisions in many ways. Organizational Structure is a factor that influences the adoption process. Researchers believe that decentralized organizations are best suited for innovation stage; while centralized organizations are best suited for implementation stage of innovation process. Communication process within the organization is another organizational factor that influences the adoption process. Top management behavior is also another influential factor, which can promote or inhibit the adoption of an innovation. There are different opinions about the role of slack resources in the organizations. Although the existence of slack is desirable for companies, it does not necessarily support the adoption process. The role of size in adopting innovations is not yet understood; and there is no defined relationship between size and adoption rate. Environmental aspect of this framework refers to structure of the industry, technological support infrastructure, and government's regulations. Some researchers believe that in the rapidly growing industries the adoption is higher, while in mature or declining industries, innovation practices are not clear. Another environmental factor that influences the adoption process is the availability of skilled labor. The impact of government on innovation process is not clear. Government regulation can either support or inhibit the adoption of innovation [69].

2.7 Pervious Innovation Adoption Studies based on DOI and TOE

There are many factors identified by the past studies, which will affect adoption of new technology in organization. Table 1 shows the results of past researches. The all factors can effect on adoption of new technology in two groups. One group is related to the DOI theory of and another one is related to the TOE framework.

Table 1: *Factors that used in Pervious Adoption Study based on DOI Theory and TOE Framework*

Construct	DOI Factors				TOE Factors				Author
	Relative Advantage	Compatibility	Security Concerns	Cost Saving	Technology Readiness	Top Manager Support	Competitive Pressure	Regulatory Support	
Cloud Computing Adoption	*	*			*	*	*	*	[53]
	*				*	*	*	*	[24]
	*	*			*	*	*	*	[66]
IT Adoption for SMEs			*	*	*		*	*	[70]
	*	*	*	*	*	*	*		[71]
	*	*				*		*	[52]
	*	*		*		*	*		[72]
			*		*		*	*	[73]
			*	*	*	*			[74]
	*	*	*			*	*	*	[75]
	*	*	*	*		*	*		[76]
	*	*				*	*		[77]
	*	*		*		*	*	*	[78]
Other Adoption used DOI Theory and TOE Frameworks	*	*	*		*	*	*	*	[79]
			*	*	*		*	*	[80]
			*		*		*		[81]
		*			*		*		[82]
			*	*	*			*	[83]
			*	*	*		*	*	[84]
			*				*	*	[85]
	*	*			*				[86]
				*	*			*	[87]
	*	*		*	*				[88]
		*		*		*		*	[89]
	*	*	*	*	*		*		[90]
Total	**14**	**15**	**13**	**13**	**17**	**13**	**18**	**15**	

3.0 RESEARCH MODEL & HYPOTHESIS DEVELOPMENT

The primary purpose of this paper is to develop and present a model of the determinants for supply chain technology adoption. However, we would also like to provide a blueprint on how the model could be tested. Accordingly, a survey instrument was developed with input from the Revere Group, a consulting firm specializing in supply chain management. The survey consisted of a series of five-point Likert scaled questions typically anchored with ‘‘Not at all’’ and ‘‘To a great extent’’ as well as several open-ended questions. Unless questions were reverse coded, higher values indicate a greater level of the construct under investigation. The first step was to develop a list of supply chain technologies to be included in the survey. The list includes a variety of technologies ranging from mature and widely used technologies such as bar coding technology to relatively new software applications such as supply chain planning systems and supply chain event management systems. The one theme that runs through all of these technologies, however, is that all are primarily concerned with managing and controlling supply chain related data and activities and information exchange within and between organizations. The survey included several potential questions regarding each independent and dependent variable of the model. Thus, the survey allows a measure to be constructed for each construct represented in the hypotheses. A survey question on number of employees could be used to measure organizational size, organizational structure could be measured by assessing the degree of decentralized decision-making. ROA growth over the previous three years could be used to assess organizational performance. The degree of supply chain strategy incorporation into overall business strategy could be used to measure supply chain strategy integration.

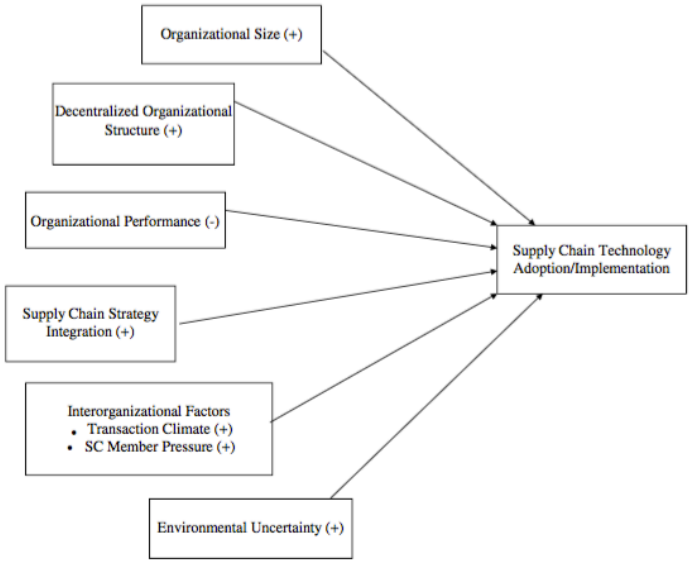

Fig. 1. Antecedents of supply chain technology adoption.

Averaging responses across a number of related questions could derive two of the independent variables (transaction climate and supply chain member pressure). The ‘‘transaction climate’’ variable could be calculated as a composite value by averaging the extent of trust and commitment between the respondentÕs firm and its suppliers, customers, carriers, and third party logistics providers. The ‘‘supply chain member pressure’’ variable could be computed by averaging the degree to which customers, suppliers, carriers, and third party logistics providers had encouraged the respondentÕs firm to adopt supply chain technology. To assess the degree to which firms have adopted supply chain technology, a technology adoption score can be computed for each firm by averaging the responses across 13 functional technologies and two integrative technologies. The 13 technologies were: Product Data Man- agement, Customer Relationship Management, Automated Quality Control Systems, Computer Aided Design Systems, Warehouse Management Systems, Manufacturing Execution Systems, Transportation Management Systems, Radio Frequency Systems, Geo-coded Tracking Systems, Bar Coding Technology, Electronic Commerce Technologies, Supply Chain Event Management, and Demand Forecasting Management. The two integrative technologies were Enterprise

Resource Planning (ERP) and Supply Chain Planning Systems (SCP). The future direction of this study is to conduct an experimental approach that measures the potential quantitative achievements (e.g., lead-time and operation cost reduction) that can be achieved by adopting the proposed approach. Future research could also study how organisations implement cloud-based approaches in order to have minimum impact on their business, and how service providers can improve cloud level interoperability in order to establish linked communities in the cloud

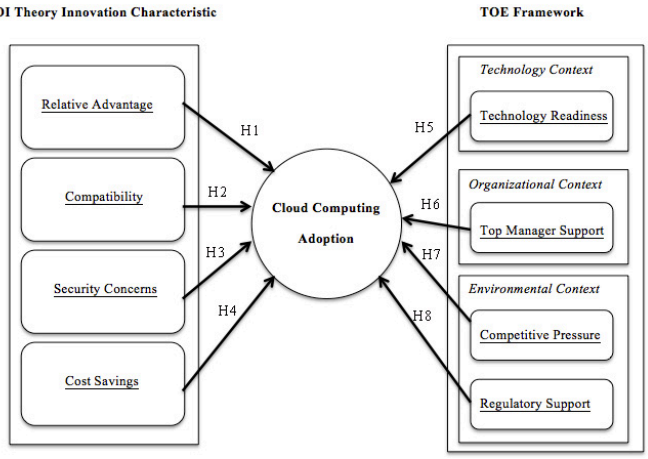

Figure 2. *Research Model for adoption of CC in SMEs*

Based on the literature review, Figure 1 shows Supply Chain Management implementation and a model that links the DOI innovation characteristics to the TOE context is shown in Figure 2. Hypotheses [H1 – H4] correspond to the DOI innovation characteristics that influence the adoption of cloud computing. Hypotheses [H5 – H8] are related to the technology, organizational and environmental contexts that may constrain or facilitate the adoption of CC.

1. Relative Advantage: is defined as "the degree to which an innovation is perceived as being better than the idea it supersedes" [52], [75]–[79], [86], [88], [90], [91]. Innovations that have a clear, unambiguous advantage in creating strategic effectiveness (for e.g., increase sales) and operational effectiveness (for e.g., reduce operational costs) has a higher impetus for adoption [92]. If the benefits of the technology (in this case, CC) supersede existing practices and processes [75]. The merits will positively influence its adoption. Many studies which investigated the diffusion process of innovations have found relative advantage to be a significant determinant; therefore, it is crucial to study this concept in the context of CC [74]–[78]. I would like to know whether being advantageous make any difference in making decision to adopt CC. An advantageous technology is the one that enables companies to perform their tasks quicker, easier and more efficiently [91]. Moreover, it improves the quality, productivity and performance of the company. Because of the above-mentioned reasons, relative advantage has a positive influence on adoption of CC.
H1: *Relative advantage will positively influence Supply Chain Management based on cloud-computing adoption for SMEs*

2. Compatibility: Rogers [68], defines compatibility as "the degree to which the innovation fits with the potential adopter's existing values, previous practices, and current needs". Compatibility is an important determinant of innovation adoption [78], [86], [88], [89]. For example, if the purpose of adopting CC is to take advantage of the scalability benefits for applications with lower security concern, then offloading the capability to the cloud infrastructure makes economic sense [91]. Effortless business enablement and compatibility are therefore factors that will determine whether CC will be adopted by an organization. To be more specific, a technology that is difficult to understand, and use is considered to be complex. Furthermore, a technology is considered to be complex if it takes too much time and effort to be learnt; or if the user should spend too much time to perform its normal duties [53]. Therefore, we hypothesize that in the context of CC the level of complexity of the system has a positive influence on adoption of CC.
H2: *Compatibility will positively influence Supply Chain Management based on cloud-computing adoption for SMEs*

3. Security Concerns: A security breach is an incident in which a company or a government agency loses information, personal records or other sensitive data [93]. With the merging of storage and computing in a shared multi-user environment, CC heightens concerns of security [94], [95]. Identity management still remains a challenge in the cloud environment. The lack of a mature security and identity management standard implies that SMEs will be reluctant to adopt a solution that lacks unified identity provisioning and credential management [79], [85]. Moving to the cloud adds new layers of complexity for securing data and will thus influence the firms' decision to adopt the innovation. Cloud providers claim that they are able to protect companies' data more securely than the companies themselves. Security is defined as the security of the service, data centers and media. This construct also takes into account, the privacy and confidentiality of the companies' data [37], [96]. We believe higher levels of security and privacy have a positive influence on the adoption of CC; thus, in the context of CC, the following hypothesis has been developed

H3: *Security and privacy concerns positively influence Supply Chain Management based on cloud-computing adoption for SMEs*

4. Cost Saving: CC creates an opportunity to increase IT innovation and lower capital expenditure [97]. By adopting CC, a firm can reduce the time devoted to system maintenance and routine upgrades [98]. As an enabler, CC offers cost effective ways to transform businesses by re-inventing the way in which goods and services are sold and consumed [47]. As it has already been mentioned, cloud providers claim that their service significantly decreases the SMEs total IS cost. Total cost includes fixed costs such as initial investment, variable costs such as systems maintenance and upgrade, and training costs. Therefore, we believe, low cost of obtaining the service increases the likelihood of adoption of CC; therefore, in the context of CC the following hypothesis is developed.

H4*: Cost savings will positively influence Supply Chain Management based on cloud-computing adoption for SMEs*

5. Technology Readiness: The technology context refers to the technological characteristics available in the organization for the adoption of technology [24], [53], [91]. It involves the structural aspects and the specialized human resources. Together they enhance the technology readiness of an organization. The structural aspects refer to the platform or the technological infrastructure (e.g., installed network technologies and enterprise systems) within the firm that the CC services can complement or compensate for (e.g., implementing a collaborative document sharing solution using cloud-based storage). The specialized human resources are those in the organization with the knowledge and skill to implement the CC services (e.g., employees with computer skills, IT specialists) [99]. Therefore, SMEs with a higher degree of technology readiness are better positioned for the adoption of CC.

H5: *Technology Readiness will positively influence Supply Chain Management based on cloud-computing adoption for SMEs*

6. Top management support plays an important role in cloud computing adoption as it involves the allocation of resources, integration of services and re-engineering of processes[24], [43]. Top management that recognizes the benefits of cloud computing will likely allocate the necessary resources for its adoption and influences the organizational members to implement the change [53], [91]. Where they fail to conceive the benefits of CC to the business, the management will be opposed to its adoption.

H6*: Top management support will positively influence Supply Chain Management based on cloud-computing adoption for SMEs*

7. Competitive pressure: has long been recognized in the innovation diffusion literature as an important driver for technology diffusion. It refers to the pressure felt by the firm from competitors within the industry [66], [83]. Adopting new technology is often a strategic necessity to compete in the market place. By adopting CC, firms can benefit from greater operation efficiency, better market visibility, and more accurate access to real-time data [100]. They have been proposed that an essential determining factor in IT adoption is due to the experience of stiff competition. Firms experience pressure and become gradually aware of and imitate their competitors' embrace of new technologies because the high-tech industry has the characteristics of swift changes [83].

H7*: Competitive pressure will positively influence Supply Chain Management based on cloud-computing adoption for SMEs*

8. Regulatory support: refers to the support given by the government authority in order to encourage IT innovation by firms [78], [79]. The impact of existing laws and regulations can be critical in the adoption of new technologies. Prevailing government regulations can encourage or discourage businesses to adopt CC [17]. For example, the European Union have specific mandates to protect organizational data. Moving to a cloud-based solution can be a costly venture for smaller firms that lack the resources to maintain compliance.

H8*: Regulatory support will positively influence Supply Chain Management based cloud-computing adoption for SMEs*

4.0 Material and Method

This was a survey research and a questionnaire was developed after extended literature review. The population of interest was chosen from employees of SMEs in Malaysia. In this research, suitability of the indicator to the construct and the constructs reliability and validity, were tested by an analysis of 22 SMEs case studies information as a customers of Optin Company which offers cloud service to their customers. The respondents were selected from these 22 SMEs for the measurement model. The respondents were selected from information technology department such as head of information system, chief of information technology office and chief of executive information technology department, directors and senior information technology. Later, the responded questionnaires were gathered with the conventional order. After reviewing the data carefully, the odd answers were pulled out and the highest points for each item was identified based on the answers. After checking the responses of all 88 respondents, 11 responses were removed because the 7 items with missed data and 4 items from other department. The data were transferred to Microsoft Excel software and after that SmartPLS software was used to analyze them [101]. We used Partial Least Square (PLS) for data analysis. Indeed, even a casual glance at the IT literature suggests that Structural Equation Modeling (SEM) has become necessary in validating instruments and testing linkage between constructs [102]–[104]. The PLS procedure, as one of the SEM techniques, has been gaining interest and use among researchers in recent years because of its ability to model latent constructs under conditions of non-normality and small to medium sample sizes. It allows the researchers to both specify the relationships among the conceptual factors of interest and the measures underlying each construct. The logical analysis was running by using smart partial least squares, which adopted the SEM technique [105]–[107]. Furthermore, the hypothesizes were evaluated.

5.0 RESULT

5.1 Demographic Statistics

In this section data were sort according to the gender, age, level of education and job tenure. Each section completely explains the group, frequency and percentage. Statistics indicates the percentage of the answers by both men and women. Almost 31% of all participants were female, whereas 69% were male. The responses were analyzed in the four different ranges of the years. Respondents were categorized, according to their ages, into four ranges including less than 30, between 31 and 40, between 41 and 50 years and older than 50 years. The statistics show that 32% of respondents were younger than 30 years old, 47% were between 31 and 40 years old, 16% of the respondents were between 41 and 50 and 5% were older than 50 years. The 77 survey responses were analyzed by reference to the three different types includes diploma, undergraduate, and postgraduate. Respondents were categorized by their degree. The statistics show that 27% of respondents were postgraduate, 69% of respondents were undergraduate and only 4% had Diploma degree. The respondents were divided into three groups. The first group has been worked in their company less than 5 years (43%). The second group has an experience in working in their company in a range of 5 to 10 years (30%) and the third group has been working in their company for more than 10 years (27%).

5.2 Evaluation of the Proposed Model

The structural equation modeling approach was used to validate our research model. To perform the analysis partial least squares (PLS) was employed. The PLS technique can be very helpful to obtain measures about the internal reliability and validity of the research model [102], [104], [108]. These measures can show the level of relationship's strength between the defined constructs in the model [103], [109]. These three concepts are as the requirements the model proposed that should be acquired [106], [110].

- **Reliability Test**: reliability test is use for testing reliability of constructing. Main way exists for determining contract reliability like Cronbach's alpha and composite reliability [111], [112]. If content of each feature is more than 0.70 that means this construct is acceptable [113], [111], [114]. Table 2 Shows the Cronbach's α results, and in base of table 2 all results are more than 0.70. Thus, all of the variables are acceptable.

- **Composite Reliability Test**: composite reliability is used for measuring of the reliability of a specific related item to the feature, which are similar but heterogeneous [112]. The reliability of the constructs is used for testing based on Clum [113], which says if composite reliability is greater than 0.70, it means that the item has high reliability. Table 2 shows the results of composite reliability and all feature content are higher than 0.70. Hence, all figures are reliable.

- **Average Variance Extracted (AVE) Test:** average variance extracted is the variance in the indicators explained by the common factor, and average trait-related variance extracted [101], [115]. AVE varies from 0 to 1, and it represents the ratio of the total variance that is due to the latent variable. A variable extracted of greater than 0.50 indicates that the validity of both constructs and the individual variables is highly valid [75], [101], [112], [115]. Table 2 shows AVE results, which are used to measure project health and project performance. According to these results, all of the contracts are variable because their contents are greater than 0.50.

Table 2: *Reliability and Validity Statistics for the Questionnaire Items*

	Cronbach's alpha	Composite Reliability	Average Variance Extracted (AVE)
Relative advantage	0.905	0.929	0.726
Compatibility	0.923	0.949	0.827
Security Concerns	0.886	0.929	0.814
Cost Savings	0.825	0.895	0.740
Technology Readiness	0.748	0.824	0.798
Top Manager Support	0.772	0.888	0.686
Competitive Pressure	0.786	0.875	0.700
Regulatory Support	0.710	0.873	0.775
Cloud Computing Adoption	0.893	0.934	0.876

5.3 Hypotheses Test

For preceding the study, according to the evaluation and prediction of the structural model [102], [107], some data about the path coefficients (β), T-values (T), P-values (P) and squared R (R^2) are identified in details.

- **Path coefficients (β):** Path coefficients (β) show how strong and significant the associations between dependent and independent variables are [116]. It means that, a path coefficient reveals the immediate influence of a variable (considered as cause) that is supposed to result in a different variable (considered as effect) [111]. Since a Path coefficient can be identified based on the correlation, it is standardized while a path regression coefficient cannot be considered standardized. Path coefficients should between 1 and -1 [116]. Table 3 shows the results.

- **T-Value:** For conducting the hypothesis testing the path significance can be determined via t-tests values by using the bootstrapping procedure [110]. Commonly, the acceptable value for T-values larger than two (T-value >1.96) means significant level [117]. Table 3 shows the result of T-Value.

- **P-value:** The P-value can be considered as a quantitative measure of the numerical importance of testing a hypothesis [104]. Furthermore, regarding the studies conducted formerly, P-value < 0.05 implies the significance of the related hypothesis (e.g., [75], [23]). Table 3 shows the result of P-Value.

- **Squared R (R^2):** The R^2 shows the expected effect of the model of dependent variables through estimating the percentage of a construct's variance in the model [75]. In this research $R^2 = 0.919$.

Base on this result and relationship between patch coefficients, T-value and P-value that explain in this section, we conclude that each hypothesis was supported. The research model in this study was found to be able to anticipate these factors to reach a high level of adoption. Moreover, since R^2 of adoption of CC for SMEs equals 0.919, it is possible to identify the alteration of the diversity of adoption through these eight factors. That is, 91.9% of adoption might be estimated and predicted by the model.

Hypothesis	Patch Coefficients	T-Value	P-Value	Results
H1: Relative Advantage → Adoption of Cloud Computing	0.182736	5.232520	1.40 E-06	Support
H2: Compatibility → Adoption of Cloud Computing	0.180259	7.012348	7.87 E-10	Support
H3: Security Concerns → Adoption of Cloud Computing	0.146042	12.544119	2.69 E-20	Support
H4: Cost Saving → Adoption of Cloud Computing	0.048284	2.135209	3.59 E-04	Support
H5: Technology Readiness → Adoption of Cloud Computing	0.214678	17.260114	3.46 E-28	Support
H6: Top Management Support → Adoption of Cloud Computing	0.145625	11.812925	5.76 E-19	Support
H7: Competitive Pressure → Adoption of Cloud Computing	0.220330	13.467357	6.17 E-22	Support
H8: Regulatory Support → Adoption of Cloud Computing	0.169929	17.947256	3.09 E-29	Support

Table 3: *Summary of Results*

6.0 DISCUSSION

Relative advantage is a facilitator for the adoption of CC. This finding is consistent with similar studies reported in the literature [75], [118]. The survey data confirms that SMEs are aware of the benefits of CC. Perceived advantages include opportunities to increase productivity and improve quality of operations. The findings suggest that relative advantage is more important for SMEs. This suggests that SMEs are more willing to adopt CC when the opportunity to improve efficiencies of business operations and agility to scale are recognized.

Compatibility is a facilitator for cloud computing adoption. This is consistent with earlier studies that also identify compatibility as a facilitator of innovation [76]. It is similar to the finding of Alshamaila [53], who argues that compatibility is an encourage the adoption of CC by SMEs. The survey data confirms that compatibility is support the adoption of CC for SMEs.

As expected, security concerns are greater for SMEs considering CC [119]. For executives and managers of companies, concern of security in the cloud environment is of utmost importance [51]. The federal information security management act (FISMA), are examples of newly established standards and controls to cloud-based products and services. Standardization of cloud specific protocols (e.g., access control, configuration management, incident response, media protection, risk assessment and communications) will help mitigate existing security and privacy concerns among SMEs considering a cloud strategy [120].

Firms, especially those in the SMEs group, value the strategic benefits of a new innovation over the costs associated with the adoption [121]. CC offers recognizable benefits such as reduced operating

cost, lower utility expenses, minimal maintenance, and lower footprint. In related research in CC adoption, Rath [17], argue that cloud computing promises countless benefits. For SMEs the two biggest benefits are cost saving on technology infrastructure and faster software upgrades without much expense [98]. The other advantages for SMEs are lowered investment in hardware, more efficient use of computing systems in existing data centers, easier scale-up of the applications and services [50]. The survey data confirms that cost saving is one of the important factors in the adoption of CC for SMEs.

This finding is predictable with previous studies about technology readiness [53], [81], [83]. Technology readiness is a facilitator for the adoption of CC [91]. This implies that SMEs employing specialized IT workforce and developing strategic projects to support business growth are better suited for cloud integration [53]. For successful adoption of cloud solutions, SMEs need to factor in realistic expectations of integration challenges and ramp up a team of experts whose skill sets cross the conventional IT environment and the cloud platform. The result of this research shows that, the technology readiness is one of the important factors in adoption of CC for SMEs.

Our study provides empirical support for the belief that top management is crucial to the successful adoption of CC. The results show that the levels of adoption of cloud computing are higher when there is support at the top management tier. This is consistent with conclusions from many related studies that have recognized the role of top management support in the adoption and use of innovative technologies [43], [53], [122]. According to Low [91], that explained the top manager support is one of the essential factors for adoption of CC. The result of this research shows that, the top manager support is one of the most important factors in adoption of CC for SMEs. It is similar to the finding of Alshamaila [53], who argues that top manger support is an encourage the adoption of CC by SMEs.

Competitive pressure is a facilitator for the adoption of CC. This finding is consistent with similar studies reported in this area [81], [90]. According to Chang [24], that explained the competitive pressure is one of the important factors for adoption of cloud computing. The result of this research shows that, the competitive pressure is one of the important factors in adoption of CC for SMEs.

Regulatory is a facilitator for the adoption of CC. This finding is consistent with similar studies reported in this area [81]. According Alshamaila [53], to that explained the regulatory is one of the important factors that allows SMEs to Adopt the CC in their organization. The result of this research shows that, the regulatory is one of the important factors in adoption of CC for SMEs.

7.0 CONCLUSION

CC is a new computing paradigm which is advantageous for both companies and individuals [123], [124]. CC differ from other types of computing paradigms in many ways [13]. It allows users to access and use the most sophisticated technologies without being required to pay enormous amounts of money to purchase the system; or to develop it in house [11]. The service is delivered to customers over a network; this network can be a private network or a public network such as Internet. Users can access the service on an on-demand basis; and only pay for the resources that they used [15], [27]. One of the entities which benefit the most from CC are SMEs [43], [53]. Services offered by cloud providers help SMEs perform their tasks easier, quicker, and more efficient; it also allows SMEs to improve the productivity and performance of their companies [17], [20], [29], [41], [43].

While CC has been regarded an important technology that can provide strategic and operational advantages, it has yet to see significant rates of adoption in the SME [17], [20], [41], [43], [53]. Hence, it is necessary to understand what determines CC adoption in the SMEs. In the literature we find studies that examine the adoption of innovation based on innovation characteristics and through the analysis of contextual factors, such as technology, organization, and environment. This study shows that the combination of innovating characteristics and contextual factors is more holistic and meaningful in explaining the adoption of cloud computing. Based on the TOE theoretical framework and the DOI Theory, this study is an early attempt to explore, develop and validate a research model to examine the influence of eight contextual factors on CC adoption in the SME. The main factors that were identified as playing a significant role in SME adoption of cloud services were: relative advantage, compatibility, security concerns, cost savings, technology readiness, top manager support, competitive pressure and regulatory support. Integration of supply chain activities and the technologies

to accomplish it have become competitive necessities in most industries. For example, one respondent to the pre-test survey wrote, ‘‘Our senior management have now come to realize that supply chain management will enhance our ability to be successful.’’ Another commented, ‘‘With almost daily technology advancement globally in ever facet of the business, organizations need to synchronize by adopting and implementing new electronic commerce and supply chain technology in order to protect market share, not to mention improve market penetration’’.

Thus, we developed a model on the antecedents of supply chain technology adoption. We theorize that firms with greater numbers of employees adopt more technologies perhaps to improve information management and activity coordination. Large organizations may have greater volumes of transactions, more geographically dispersed operations, more supply chain partners, and/or more information to manage and are thus would be more likely to adopt information technology systems to improve operational efficiency and very often lower cost.

Regarding decentralization, while this variable has been a point of contention in many studies as researchers have found both positive and negative relationships between decentralization and technology adoption, we follow projects who suggested that a more decentralized organizational structure leads to greater boundary scanning, greater awareness of business opportunities, and thus greater levels of technology adoption. We believe that firms that allow decision-making to be located throughout the organization may engage in more environmental scanning, which leads to a greater awareness and appreciation of potential innovations.

Previous research suggests that better performing firms have a tendency of strategic persistence and adopt fewer strategic changes than poorer performing firms. Considering information management systems have become essential components of firm strategy, it is, therefore, hypothesized that poorer performing firms would be more likely to adopt new technology.

The final organizational variable included in the model is supply chain strategy integration. As projects suggested, as firms realize the advantages gained from efficient and effective supply chain operations, managers begin to incorporate supply chain strategy into their overall corporate strategy which then leads to greater technology adoption and electronic integration. Organizations that understand the competitive benefits of efficient and effective supply chain operations incorporate supply chain strategy into organizational strategy. The elevation in importance of the supply chain in an organization then leads to the application of information technology to these operations.

In addition to organizational variables, three environmental variables are also included in the model. Those three variables are supply chain partner pressure, transaction climate with supply chain partners and environmental uncertainty. The first environmental variable examined was supply chain partner pressure. The hypothesis suggests supply chain partners successfully pressure organizations to adopt new technologies. As previously reported supply chain partners have a substantial impact on a firm decision to adopt supply chain technologies. As organizations integrate operations and technology becomes more prevalent, firms coerce members of their supply chain to adopt new technologies to satisfy the need for fast and accurate information. The pre-test written comments on the survey provide support for the notion that customers exert greater pressure than other partners in the sup- ply chain. A typical comment was, ‘‘Most customers demand this technology or they will go someplace else’’.

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