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CLOUD ENTERPRISE SYSTEMS: A REVIEW OF LITERATURE AND ITS ADOPTION

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Abstract

In recent years, Cloud computing has revolutionized the IT industry by introducing a whole new concept and platform of enterprise systems (ES). The traditional ES seem to be too clunky, expensive and complex for most organizations to implement and use. To improve such situation Cloud ES concept was recently introduced to offer competitive advantage to organizations through flexibility, scalability and independence in IT infrastructure and capabilities. Today, this area has not been fully explored in the academia due to little available literature but it has attracted tremendous interest from the general practitioners. This study seeks to contribute to IS literature by conceptualising Cloud ES from a pragmatic understanding between practitioners and academic. It further elaborates the advantages and challenges of Cloud ES and discusses the potential of Cloud ES as an attractive option to SME in solving the problems of high investments in IT infrastructures and IT resources.

Keywords: ES, Cloud Computing, Cloud ES, SME

1 INTRODUCTION

In the wake of the recent financial and economic crises, firms have looked ways to consolidate their ICT infrastructures and services so that they can increase their return on investments (OECD, 2010). In line with the initiative, the development of new Information Systems (IS) applications have fostered most of the firms to re-design their enterprise paradigms to form highly dynamic and agile units which is known as virtual enterprises around turbulent markets (Loo et al. 2011). As the world continues to move toward a truly global economy based largely on e-commerce, a new paradigm of integrated systems that possess a flexible and web-based integrated infrastructure (Candido et al., 2009; Xu et al., 2002) has emerged and they are, “Virtual Enterprise Resource Planning (VERP)” and “Federated ERP” merged with Service Oriented Architecture (SOA). To further continue the competition, organizations set up ES solutions such as Cloud Computing (Loo et al. 2011) aiming at solving the problems of complication faced in the traditional On-Premise ES.

A decision to recommend new technology may be based on evaluating capabilities, features, and challenges of the technology (Flick, 2009; Lease, 2005). Yen et. al (2002) coined that ES can help companies reengineer their business processes and compete in the global market. Looking at the expansive literature available on both ES and Cloud Computing, few researchers have explored the integration of both systems. A significant study done by Saeed et. al. (2011) seek to overcome users’ concerns by developing a framework of Cloud ES motives and barriers.

Since there is no common definition of Cloud ES in the literature; this study synthesizes definitions and perceptions from the Academia and the Industry. Bridging the gaps between them, this study intends to contribute to the development of Cloud ES literature by providing common understanding of Cloud ES definition. Ambiguities in the understanding of what constitutes “Cloud ES” can deter the development of “Cloud ES” theories, models and measurements. Thus, it is essential to start this research with a clear conceptualisation of Cloud ES. Furthermore, a discussion on the different types of Cloud ES service models and deployment methods hoped to provide greater understanding on what is being offered in market. Subsequently, knowledge about Cloud ES advantages and challenges would enable potential cloud clients to prepare themselves before embarking into this new IT venture.

2 RESEARCH METHOD

Literature review is an essential approach to conceptualise research areas and survey and synthesise prior research (Webster and Watson, 2002), which contributes to a cumulative culture desired in any research field especially in Information System (IS) (Yang & Tate 2009). One of the ways to review emerging trend is through conducting a systematic review by searching, filtering and classifying processes (Yang & Tate 2009). Levy and Ellis (2006) posits that a systematic review involves three sequential activities of input, process and output. In addition, King and He (2005) stressed that the need to conduct a comprehensive literature search to collect as many relevant papers as possible in the investigated area and identify the trends and patterns among the papers surveyed. By doing so, the outcome of such review is often claimed to be representative of the state of art of a research domain (Yang & Tate 2009). Building on the above literature review concept, this study aims to develop a clearer conceptualisation of Cloud ES phenomenon through the following steps.

Firstly, literature search of Cloud ES from top Information System journals, periodical databases and conference proceedings and found only a handful of papers that have directly researched the above issue. This is supported by Saeed et. al (2011). Hence, in selecting relevant articles, we started our search with the keywords “Cloud ES”, “Cloud Computing”, “Software as a Service (SaaS)” as these were the commonly used keywords that represent Cloud ES. Thus, a total of 45 articles consisting of white papers and electronic articles have been examined, in order to synthesize the literature and grasp an understanding of the Cloud ES phenomenon.

3 LITERATURE REVIEW

The existing IT ecosystems has undergone structural changes, where IT infrastructures and resources are being increasingly provided as standardised and virtualised cloud services via the Internet (Karabek, Kleinert & Pohl 2011). The emergence of a phenomenon known as cloud computing represents a fundamental change in the way IT services are invented, developed, deployed, scaled, updated, maintained and paid for (Marston et al. 2010). Therefore, this study builds up the literature review on related domains such as Current ES deployment, Conceptualisation of Cloud ES, Advantages and Challenges of Cloud ES Adoption, and Cloud ES and SMEs.

3.1 Current ES Deployment

The scholarly review depicts traditional ES as an internal integrated information system that took shape on the manufacturing roots to seek external advantage (Blackstone and Cox, 2005), which could not support the e-business challenge and intensive data requirements. Hence, a newly enterprise systems, ERP II was introduced to enable the inter-enterprise collaboration through value chain participation, which requires companies to combine ES with other new types of intelligent business tools to reinforce both upstream and downstream chains (Loo et al. 2011) so as to extend the traditional ES capabilities (Moller, 2005). Other than that, Tarantilis et. al., (2008) coined that a new generation of Web-based enterprise information systems emerged, where the system structure is entirely modular, pluggable and separable.

Karabek et. al (2011) further noted that IT resources are being increasingly provided as standardised and virtualised Cloud Services via the Internet and thus reshaped the existing ecosystems of the IT industry. Along the same line, Cloud Computing has revolutionized the way IT services are invented, developed, deployed, scaled, updated, maintained and paid for (Marston et al. 2010). The existence of Cloud Computing technologies is apparent to the current ES deployment methods as being depicted in the table below (Aberdeen Group Report (2011)).

| ES deployment methods | Description |
|--|---|
| Traditional license on-premise | The software is use on a particular computer which is located in-house and licensed on term basis or perpetual basis. |
| SaaS or on-demand | The software is not licensed or owned by the end user, instead provided as a service of which user paid subscription fees and the service can be accessed from a normal internet connection upon use. This type of deployment method is often referred to as Public Cloud and through SaaS user avoids large upfront capital investment. |
| Hosted or managed services | Licensed applications are hosted by third party. This deployment method may be in separate instance on a separate piece of hardware (dedicated to an organization), or in a separate virtual instance (dedicated to an organization) where the application is housed on hardware shared by multiple companies. Sometimes this deployment method involves a Private Cloud, where the instance of ES is hosted by a third party and then delivered to the end user on a subscription basis. |
| Pre-configured on a hardware appliance | Licensed software is pre-configured and pre –installed on the hardware. Pre-configuration may be industry-specific and include best practices templates for workflows and definitions. |

Table1: ERP deployment methods (source: Aberdeen Group 2011 ERP Survey)

From the above table, it is interesting to note that choosing the right deployment methods would enable organisation to fully benefit from their IT investment. Aberdeen Group (2009) coined that most ES selections are predominantly driven by a combination of functionality, ease of use, cost, speed of implementation, the ability to tailor or configure the solutions to individual needs and the integration capabilities of the solutions into existing systems. As such, understanding of what constitutes Cloud ES is an important issue that is further investigated in the following section.

3.2 Conceptualisation of Cloud ES

Information technologies and systems typically mature and undergo commoditization as new stream of technologies emerges (Hofmann 2008). The concept of cloud computing is said to be relatively new and an emerging paradigm (Bayrak & Conley 2011; Buyya et al. 2009b; Chen 2011). Kim et al. (2009) on the other hand, argued that cloud computing is not an entirely new concept, noting that it is similar to network computing and grid computing concept of the 1990s. Following this, a number of researchers (Bayrak & Conley 2011; Munteanu & Fotache 2010) conjectured that the existence of cloud computing is due to the convergence of earlier technologies such as virtualization, cluster computing, grid computing, broadband marketing and large scale data centers centralized at a low cost locations. As such most researchers (Foster et al. 2008; Sotomayor et al. 2009) comparatively discussed cloud technology in association with grid technology and virtualization technology.

3.2.1 *Cloud ERP Definition: Academia Perspective*

Till today, there is no precise definition of Cloud ES. However, ERP III definition has been widely used by researchers to describe Cloud ES (Saeed, Juell-Skielse & Uppström 2011; Wan & Clegg 2010). Currently, ERP III is defined as a flexible, yet powerful information system incorporated with web-based SOA and Cloud Computing, which enables virtual enterprises to offer increasing degrees of flexibility, agility and dynamic amorphousness (Wan & Clegg 2010). However, such definition was later challenged by Rafiq (2011), noting that Cloud ES is different from the ES which was launched years ago. The significant difference between Cloud ES from On-Premise ES is users accessing services through the cloud from Cloud ES provider only for the components relevant to their business, and it could be bought on a pay-and-go basis, without the need to purchase whole ES (Amir M. Sharif 2010). In fact, it is the shortest possible route to a new ES and it is a cost-effective way of allowing multiple users to gaining access to the same resource without having to upgrade a server or spend a fortune on new equipment (Rafiq 2011). This concept is further supported by Lenart (2011).

Ultimately, with the flexibility and capability of Cloud Computing, it enabled ES to be delivered via the Internet and accessible to wide variety of users at a much lower costs. With organisations having to reduce most of their IT budgets during economic turmoil, Cloud ES concept is certainly an option that attracts the attention of Academia and Industry. However, the scant research done in this area has limited the development of theoretical definition on Cloud ES.. Most researchers (Buyya et al. 2009a; Mell & Grance 2011; Vaquero et al. 2008; Wu, M 2011) also noted that there is no unified definition that is commonly acceptable in the Cloud Computing research.

National Institute of Standards and Technology (NIST) 2009 definition of Cloud Computing which describes the different types of services in a layer model (infrastructure, platform, software) seems to have gained common acceptance in the literature (Mell and Grance 2009; Iyer and Henderson 2010; Babcock 2010; Vaquero et al. 2009; Buyya et al. 2009). Even though there is no widely accepted definition of Cloud Computing, some common characters, such as on-demand, virtualization, agility and pay-as-you-go are included in the definitions (Wu, M 2011). Wyld (2009) argued that Cloud Computing platforms are based on utility model that enhances the reliability, scalability, performance and need based configurability and all these capabilities are provided at relatively low costs as compared to the dedicated infrastructures.

3.2.2 *Cloud ERP Definition: Industry Perspective*

Cloud ES holds a different meaning to the practitioners. The current Cloud ES definition is mainly vendor-driven (Schubert & Adisa 2011). The actors in the Industry such as IT analysts, users, and Cloud vendors are in a disagreement on what constitute Cloud ES. Despite the benefits that many Cloud ES vendors are hyping, some IT industry analysts (Beaubouef 2011) believed that Cloud ES have been lacking in providing a fully integrated system as compared to On-Premise ES. Cloud vendors sometimes failed to distinguish between Cloud ES and hosted ES (Web-based ES). Furthermore, many ES vendors simply shift their old systems to the cloud and claimed it to be Cloud ES.

Saeed et. al., (2011) perceived that cloud users are basically interested in the value creation of Cloud ES in terms of increased efficiency and reduced IT investments. Interestingly, amongst Cloud vendors and IT analyst there seems to be contradictory opinions. Plex.com (2009) for instance, defines Cloud ES as a hosted service delivered over the Internet. This notion is refuted by some industry analysts saying that a hosted deployment is different from a cloud deployment (djohnson 2011). These differing views amongst Cloud ES vendors and Industry analysts on understanding Cloud ES have trigger the need for further study on the definition of Cloud ES.

In summary, the Academia perceived Cloud ES as massively scalable IT-related capabilities provided 'as a service' using Internet technologies to multiple external users. The industry on the other hand is defining Cloud ES based on vendor's offerings which may or may not be suitable to all types of organisations. Regardless of whether ES is provided On-Premise, Web-based or Cloud-based, there should be a clear distinction on each of this definition. For that reason till today, Industry and Academia still holds a different view in what constitute Cloud ES. As such, to bridge the gap, by consolidating and introducing a pragmatic understanding of Cloud ES between practitioners and academic, the authors define Cloud ES as scalable and flexible integrated ES use through the Internet with the concept of pay per use. To further understand Cloud ES scalability and flexibility, this study will be looking into the Cloud ES service model typology.

3.2.3 Cloud ES Service Model Typology

This study consolidated three key studies ([Rittinghouse & Ransome 2010](#); [Sharma, Sood & Kaur 2011](#); [Velev & Zlateva 2011](#)) of Cloud ES service models typology into the following table 2.

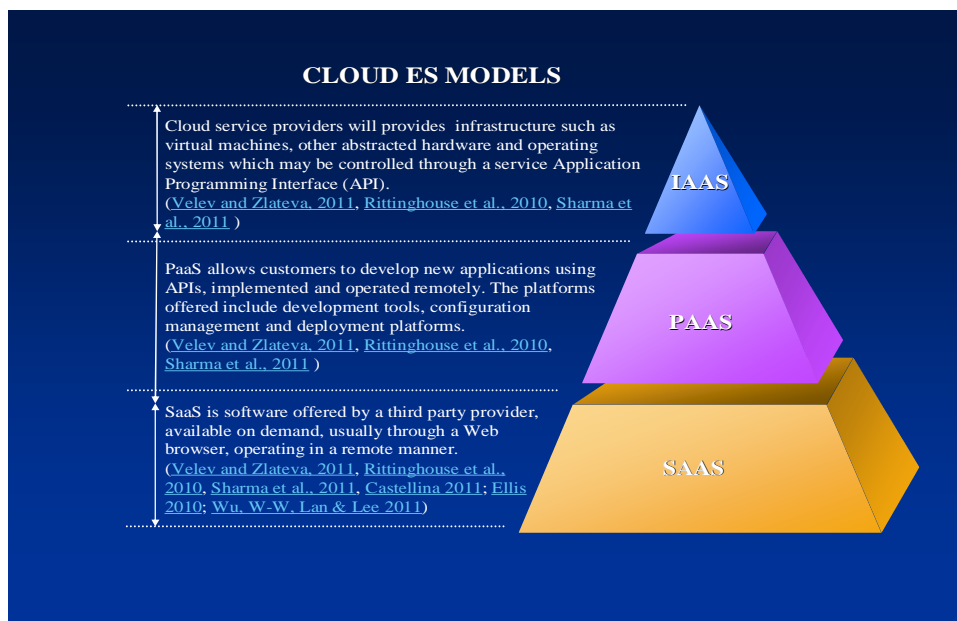


Table 2: Type of Cloud ES service models

As to date, studies done by researchers (Castellina 2011; Ellis 2010; Wu, W-W, Lan & Lee 2011) mainly focussed on the above service models especially the SaaS models. Since the adoption of Cloud ES is still at a premature stage, it becomes increasingly important to understand the nature of each type of these models in order for organisations to fully benefit from them.

In the Infrastructure as a Service (IaaS) model, the cloud service provider are offering virtualized hardware to clients (djohnson 2010). This model enable user to maximize the flexibility to switch providers and user would only pay rent upon the use of infrastructures (Schubert & Adisa 2011). IaaS model creates a specific operating system combined with user own applications.

In Platform as a Service (PaaS) model, cloud service provider offers both cloud platform and infrastructure. Cloud service provider are normally involved in web-based development and generally do not involve in operating system selection or use (djohnson 2010; Schubert & Adisa 2011). This

model is argued to be unsuitable (Schubert & Adisa 2011) because platform services normally provide resources in a pre-defined software environment which is inappropriate for the provision of a Cloud ES.

In Software as a Service (SaaS) model, the cloud service provider offers services over the Internet (Rittinghouse & Ransome 2010; Sharma, P, Sood & Kaur 2011; Velez & Zlateva 2011). SaaS is commonly referred to as an application that is hosted in a multitenant environment (Ellis 2010). Merging with the SaaS model, ES vendor offer a new service which is commonly known as ES as a Service (EaaS). Amongst the three models, SaaS ES or EaaS is becoming increasingly effective and popular in the market offering profound consequences in improving IT performance and lead to many benefits for users (Ellis 2010; Layo 2011). Through a survey done by Aberdeen Group (2011), it was found that this model is leading the trends of future deployments by most companies, mostly small enterprises (SMEs).

3.3 Advantages and Challenges of Cloud ES Adoption

Cloud ES adoption is a complex concept, and researchers measure the degree of adoption or use from various viewpoints to capture it. Cloud computing literature often gives an insight in the dimensions to characterise cloud computing adoption. In the studies reviewed, cloud computing is often associated with supporting business activities through the use of the Internet. Typically, cloud computing adoption is measured by listing which business activities that cloud technologies supported (activity), complemented by looking at which cloud service models and deployment models are used (applications) and the business value being created (value creation). Evidently, it is important for potential cloud clients to understand the advantages and challenges of Cloud ES adoption before making the decision to adopt cloud technologies. Hence, the following sections describe the advantages and challenges of Cloud ES.

3.3.1 Advantages of Cloud ES

Amongst the industry sectors there remains a differing view of moving ES away from On-Premise deployments (Kern 2011). A survey done by Aberdeen Group (2011) supported this and found that On-Premise still dominate deployment method for ES amongst all company sizes. There is always concern on data stored in the cloud and although Cloud ES shifts the IT burden to vendors but when adopting Cloud ES, user is required to dismantle their current technologies which leave the enterprise with little or no alternative arrangements in the event that the cloud service provider fails to deliver the service has contributed to the domination of On-Premise ES.

The greatest advantage that a Cloud ES has as compared to On-Premise ES is that it offers low initial costs (Epicor ; Saeed, Juell-Skielse & Uppström 2011; Saini et al. 2011), promotes greater emphasis on standardisation (Beaubouef 2011), provide flexibility for business innovation (Saeed, Juell-Skielse & Uppström 2011) and allows organisation to focus on their strategic activities while leaving the non-strategic activity to the cloud vendor (Epicor ; Saeed, Juell-Skielse & Uppström 2011). In Cloud ES, cloud vendor managed, maintain and deployed IT infrastructure development, hence reduced the IT complexity that users faced when implementing an ES. No further IT investment is required in terms of infrastructure, software and support resources upgrading (Beaubouef 2011). Cloud ES is also regarded as utility computing as fee will be charged based on usage. In terms of environmental issues, Cloud ES model proved to be favourable as the entire IT ecosystem footprint is removed (Beaubouef 2011).

In summary, the important values of the Cloud ES are reduction of hardware and license costs, lower total cost of ownership, lower up front costs, reduces the cost and effort of upgrades, ease of implementation, best fit solution regardless of delivery model, focussing internal resources elsewhere and limited IT resources, scalability and manageability (Castellina 2011; Lenart 2011). Nevertheless, Cloud ES does not eliminate the need for IT department staff, because users still require access to the Internet and application configuration. Cloud ES allows IT managers to concentrate on core business functions. Nonetheless, as with any other IT deployment that has dominated the industry, potential

Cloud ES adopters must be wary on the challenges faced when their IT infrastructure and capabilities is migrated to the cloud environment.

3.3.2 *Challenges in Cloud ES*

Cloud ES posed similar challenges to Cloud Computing. Researchers have commonly agreed that security, flexibility, customization, ownership of data, integrity of the provider and ability to move to other cloud service provider represents the concerns that is highly anticipated by potential cloud ERP adopters (Castellina 2011; Lenart 2011). In addition, the need to integrate cloud services into existing IT environments has many organisations doubtful on the actual advantage that Cloud ES may posed. Large organisations for instance may find it unnecessary to abandon their in-house ES to switch to Cloud ES as there will be trade-offs associated with this switch (Saeed, Juell-Skielse & Uppström 2011). Karabek et. al (2011) coined that enterprises require substantial guarantees for data protection before they are willing to move into the cloud. Although Cloud ES offers a huge reduction in costs, potentials clients is questioning the possibility of managing all network security from a single point, real-time protection without any impact on the system, and thus hindering the adoption of Cloud ES. Essentially, cloud vendors needs to develop a strategy of security services and protocols in order to meet the needs and assuage the fears of clients, before the deployment of Cloud ES (Kritsonis 2011) .

Also, as cloud offerings proliferate, there will be ongoing challenges with interoperability, portability, and migration (Hofmann & Woods 2010; Kim 2009). Interoperability between different cloud vendors is a challenge that is magnified in the cloud. In the cloud, enterprises loses control of their infrastructure and platforms as they are locked in to the cloud provider (Lenart 2011). Some challenges seems to hinder the adoption of Cloud ES especially among large enterprises such as the integration with in-house IT and the difficulty of customisation (Schubert & Adisa 2011). It is also important to note the importance of internet bandwidth to support Cloud ES adoption. If the internet bandwidth is low or is technically departed, Cloud ES users will faced difficulty. Therefore, it is prudent to potential users to consider all possibilities when designing an implementation, selecting a cloud provider and negotiating the service level agreement (Smith 2011).

Other than that, in terms of organizational change, Cloud ES may fail to give customer greater sense of ownership as they neither own the infrastructure nor run the applications. Beaubouef (2011) supported this and further sanctioned that a rapid deployment of functionality does not necessarily means a rapid user acceptance and effective use of technology. Hence, despite the opportunity that Cloud ES provide, customers need to balance their enthusiasm for Cloud ES with realistic expectations.

3.4 Cloud ES Adoption and SMEs

As an emerging market, Cloud ES has experienced continued change in its legitimacy, reflected by the views held by various industry actors regarding the long-term viability of the market (Su 2011). Companies early adoption of Cloud ES was slow and cautious (Stone & Vance 2010). This is proved by an ERP survey done by Aberdeen Group in 2011 (Castellina) which depicted a low adoption rate of Cloud ES of about 9% especially the SaaS model, and is mostly dominated by SMEs (17%) as compared to only 2% adoption from large enterprises. Currently, industries such as financial services and healthcare are more likely to adopt Cloud ES model as compared to manufacturing companies (Castellina 2011). Despite its' low adoption rate (Lenart 2011; Saeed, Juell-Skielse & Uppström 2011) but the interest for Cloud ES especially the SaaS model is gaining ground and has grown steadily amongst enterprises of smaller sizes. Forrsights Software Survey (Kisker's 2011) support the trend of the growing Cloud ES adoption mainly by a two-tier ES strategy that is either replacing their On-Premise ES with Cloud ES via SaaS model or complemented their On-Premise ES with SaaS.

Cloud ES is a revolutionary change ideal for innovative organizations, especially for new start-up that could not afford expensive IT systems (Beaubouef 2011). The significant difference between Cloud ES from previous technology platforms that have tried to commoditize computing is users accessing services through the cloud from cloud computing provider only for the components relevant to their business, and it could be bought on a pay-and-go basis, without the need to purchase whole ERP,

finance or CRM suites (Amir M. Sharif 2010). As compared to their larger counterpart, small and medium enterprises (SME) normally operate in limited IT budgets. In light of that, Cloud ES appears as an attractive option to SME in solving the problems of high investments in IT infrastructures and IT resources. This is proved by a number of researchers (Beaubouef 2011; Sharif 2010; Sharma, M et al. 2010; Sultan 2011), whom posit that cloud computing relieved SME from high IT resources investments.

However, the benefits that Cloud ES brings have yet to convince large enterprises in joining the Cloud Computing bandwagon. Over the last decades, most large companies have made vast investments in their ES. Given that large organisations have already invested multibillion dollars into their On-Premise ES, the likelihood or practicality of adopting Cloud ES is considerably low. This investments combined with how critical these systems are to large organisations have resulted resistance of Cloud ES adoption among large organisations. The fact that SMEs business environment has more flexible processes as opposed to their larger counterpart is contributing to the high adoption rate of Cloud ES amongst SMEs. Cloud vendors have evidently promoted the suitability of Cloud ES for SMEs due to the lack of IT capabilities and resources that SME posed. Saini et. al (2011) believed that Cloud ES is more suitable to SMEs in order to help SMEs concentrate on its core business and reduce their IT burden.

Cloud ES provides SME a chance to advanced business software to join the competition of its marketplace. Furthermore, recent research by Karabek et. al (2011) lends support to the notion that Cloud ERP is well suited for SMEs. Sultan (2010b) purported that cloud computing is likely to prove commercially viable for many SMEs due to its flexibility and pay-as-you-go cost structure, particularly in the current climate of economic difficulties. In this vein, Karabek et al. (2011) noted that cloud computing, empower SMEs to move large parts of their business IT from their premises into the cloud, offering them efficient, flexible and scalable processing power. Besides that, cloud based services reduce On-Premise ES costs in terms of software up gradation and licensing costs (Aggarwal and Barnes, 2010). The software level of cloud computing will benefit small companies because it can lower the barriers to the use of ES systems in general. SMEs can have access to full-fledged ES systems without the need of running their own IT department or to hire an expensive IT consultant (Sharif 2010).

Nonetheless, Lenart (2011) perceived ES delivered through SaaS is "ES lite" which only suitable for SMEs but Castellina (2011) coined that SMEs benefits the most out of Cloud ES due to their lower start-up costs. Karabek et. al (2011) on the other hand sees Cloud ES as a concept that empower SMEs to move large parts of their business IT from their premises "into the cloud", offering them efficient, flexible and scalable processing power and functionality on a "per use" cost basis. Based on the above, it is conjectured that the use of Cloud ES has a positive consequences both financially and operationally to SMEs. Hence, Cloud ES offers an attractive option to SME to solve the problems of high investments required in terms of infrastructure and the complexity of business process embedded in the traditional On-Premise ES.

4 CONCLUSION

Technically Cloud ES is simple to deploy, and it represents the latest, greatest, and most influential IT change in years (Mozammel-Bin-Motalab & Shohag 2011). In summary, this paper consolidates and introduces a pragmatic understanding of Cloud ES definition between practitioners and academic. Furthermore, with the literature review presented above, this paper also contributed into the understanding of Cloud ES service model typology, advantages and challenges of Cloud ES adoption. A clear objective on the features and capabilities of Cloud ES could facilitate potential cloud adopters into making the decision on whether to adopt cloud technologies into their existing IT systems. Besides, Cloud ES concept is currently more acceptable by SMEs since cloud technologies empower SMEs to operate more efficient and flexible, and with scalable processing power at lower cost.

Since this is a research in progress, the next phase is to investigate the extent of different types of Cloud ES deployment methods use in organisations' and the factors influencing the use of Cloud ES including the benefits and challenges faced by Cloud ES adopters and On-Premise adopters.

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