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Cloud Computing and ERP: An Academic Literature Review (2010 - 2015)

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Abstract

The research history relating to Cloud ERP literature is investigated for the period of 2010 to 2015, with the aim of introducing an overview of academic research on the subject and to identify gaps in the literature in the stated period. Up to date literature in 37 research papers from various topics and sources has been discussed. Shortlisted publications are analysed and categorized into architecture, implementation, customization, mobility, benefits and disadvantages, and others. It appears that high attention has been paid by researchers to the benefits and disadvantages of Cloud ERP adoption as well as to its architecture and overarching plans for implementation. However, important issues such as integration of Cloud ERP with existing on-site legacy ERP systems and the quality of service given by respective cloud-based providers has been devoted limited attention by the authors reviewed.

Keywords: ERP, Cloud Computing, Cloud ERP, Information System.

1.0. Introduction

Cloud computing has changed software delivery models and provides a variety of new options for different enterprises of varying size Arnesen, S, (2013), GUO CHAO ALEX, P, & GALA, C, (2014), Mahara, TN, (2013). The adoption of cloud computing platforms and services by any business will have both benefits and disadvantages, meaning that careful planning and research into an appropriate Cloud enterprise resource planning (Cloud ERP) strategy will be required, and careful decisions made Arnesen, S, (2013), GUO CHAO ALEX, P, & GALA, C, (2014), Mahara, TN, (2013). According to Gartner forecasts, the service business software applications market's revenue will have grown from over $10 billion in 2011 to over $30 billion by 2016 Centaur Partners, (2015). Cloud ERP adoption is on the increase and is being adopted by many key decision makers in business. According to a 2012 Gartner report, 70% of Chief Financial Officers (CFOs) are in favour of utilizing Cloud ERP within core business functions, citing the main reasons in favour of this

approach as being related to cost reductions and mobility MIRANDA, S, (2013). The CFOs surveyed by Gartner reported that cloud computing platforms and services were useful business analytics tools. And social collaboration, facilitated through online cloud-based communication and knowledge sharing, were also important factors in their vision MIRANDA, S, (2013).

2.0. Background Research

This section discusses the various aspects of the research in detail. It enables us to grasp a good idea about the different studies that have already been conducted relating to clouding computing and ERP.

2.1. Enterprise Resource Planning

The term ‘enterprise resource planning’ describes any business process management software that enables an organization to use a system of interconnected applications to manage their business. Such software packages often automate a number of back office functions related to services, technology, and H.R. Arnesen, S, (2013), GUO CHAO ALEX, P, & GALA, C, (2014), Mahara, TN, (2013) Sahin, N.Y., (2013). Cloud ERP then relates such business process management software that is hosted online, in the cloud.

There are three well-known cloud computing models, which mainly differ in terms of physical location of the required hardware Arnesen, S, (2013). The following bullet points set out definitions for each of these models as well as briefly explaining their benefits.

2.1.1. Public Cloud ERP

Public Cloud ERP applications are hosted at the cloud provider's data center with the software itself adopting a service architecture approach. Cloud ERP is offered as application packages paid for on a subscription basis. This model is mobile and flexible, faster to implement and represents an affordable enterprise solution, particularly for smaller-scale enterprises Arnesen, S, (2013), GUO CHAO ALEX, P, & GALA, C, (2014), Mahara, TN, (2013) Sahin, PwC, (2014), N.Y., (2013).

2.1.2. Private Cloud ERP

Private Cloud ERP applications are hosted at the enterprises own data center. Private cloud services are usually adopted by larger companies with, for example, a number of offices that share the same requirements Arnesen, S, (2013).

2.1.3. Hybrid Cloud ERP

Hybrid Cloud ERP is the result of integrating legacy ERP with more Cloud ERP Sahin, PwC, (2014), N.Y., (2013). Legacy ERP is installed at the premises of the enterprise comprising the physical hardware and a computer platform, which tends to be managed in-house by members of the organization's team Sahin, PwC, (2014). This hybrid approach to software architecture tends to result out of a need to update legacy ERP that no longer satisfies the needs of the company by updating through the integration of cloud-based applications that better satisfy the enterprise's requirements Sahin, PwC, (2014), N.Y., (2013).

2.2. Hosted Application Server Active Software Packages (ASP)

ASP is a host, that provides sources hardware, platform and support staff Arnesen, S, (2013). ASP is a Single-Instance, Single-Tenant legacy software application which means that supports individual customers. The customer has access to dedicated servers, the flexibility of access the application tends to be regularly upgraded Arnesen, S, (2013).

On the other hand, cloud computing makes use of Multi-Tenancy architecture in which a single instance of a software application which serves multiple customers. Many cloud customers share the same resources. A disadvantage of this might be that the customers have more limited control than they would in relation to a Single-Tenant application. Cloud-based application tends also to be subject to regular upgrades Arnesen, S, (2013). Cloud computing increases the availability and accessibility of an enterprises data and computer-based systems meaning that they can be accessed at any time from anywhere Sahin, PwC, (2014), N.Y., (2013).

2.3. Cloud computing and ERP

Along with businesses' fast-growing requirements including web access and mobile sales, sourcing, recruitment and contract management, data mobility has become vital for organizations. The ability to utilize the organization's applications and data from different locations and by using different devices is a technology trend that cannot be avoided in the modern Internet era GUO CHAO ALEX, P, & GALA, C, (2014), Mahara, TN, (2013) Sahin, PwC, (2014). Furthermore, in a global market, the need for flexibility and accessibility by customers, employees, and suppliers cannot be effectively addressed by traditional legacy, on-site, ERP systems Mahara, TN, (2013) Sahin, PwC, (2014).

Apart from facilitating connectivity, Cloud ERP is recognized to have multiple cost benefits factors including savings in hardware purchase, platform set-up and maintenance and support Arnesen, S, (2013), GUO CHAO ALEX, P, & GALA, C, (2014), Mahara, TN, (2013). In addition, Cloud ERP has proven scalability and performance advantage Arnesen, S, (2013), GUO CHAO ALEX, P, & GALA, C, (2014). Moreover, system upgrades are managed and supported by cloud system providers, thus reducing risk and cost associated with handling the same in-house. ERP implementation and time costs and requirements are vastly reduced in the integration of cloud-based packages, which is particularly advantageous and attractive too small to medium-sized businesses from a budgetary point of view Arnesen, S, (2013), Mahara, TN, (2013) Sahin, N.Y., (2013). Cloud computing and associated Cloud ERP systems new technology, and therefore do not require upgrading Arnesen, S, (2013).

In contrast to the advantages cited above, protecting data privacy represents a real concern for businesses considering utilizing a Cloud ERP, as well as a considerable challenge cloud-hosting providers. The physical location of data and its ownership, SLA and the data laws and regulations in the country where data is hosted are important factors which become significant with ERP data and functions Gartner, (2014), GUO CHAO ALEX, P, & GALA, C, (2014), Mahara, TN, (2013), N.Y., (2013). For example, the European Union have strict data protection laws and regulations which prevent cloud-hosting providers from moving data out of the country it is based in N.Y., (2013).

It is likely that securing data through strong authentication and authorization will be an important factor in protecting and securing Cloud ERP data Arnesen, S, (2013), GUO CHAO ALEX, P, & GALA, C, (2014), Mahara, TN, (2013) Sahin, N.Y., (2013). However, cloud-hosting providers invest highly insecurity in order to attract business advantage leading to a high standard of security in the services they provide Arnesen, S, (2013). Integration is more complex where on-premises legacy systems and cloud-based systems are integrated into hybrid Cloud ERP solutions Gartner, (2014), GUO CHAO ALEX, P, & GALA, C, (2014). Hence, complex integrations and high volume data exchanges may put more Cloud ERP implementation at greater risk of security breaches and data loss or leaks. Governance over Cloud ERP services and cloud-hosted data varies widely between different providers, and the level of control in this regard should form a serious consideration when an organization

chooses a Cloud ERP a particular cloud-hosting provider (2013) N.Y., (2013). Providers of new cloud-based technologies are still in the process of building solutions, whether from the ground-up or by modifying existing ERP systems. Therefore, their many functions that have not yet been made available or are only being used by small enterprises Arnesen, S, (2013). Also, annual subscription costs of Cloud ERP is higher than that of traditional on-site legacy ERP maintenance Arnesen, S, (2013).

While many small and medium-sized enterprises seem to be migrating core ERP functions to the cloud, a recent Gartner report found that larger enterprises were, as yet, not planning to move to fully commit to cloud-based technologies. Further, service providers are willing to move to cloud ERP due to the nature of their business, while banking and insurance are not Gartner, (2014). It seems that the most suitable ERP approach depends on the specific requirements and business needs of an organization, and its sector Arnesen, S, (2013).

The issues discussed above have been researched and analysed by many authors, and there is a great deal of literature available on the topic. For the purposes of this paper, the literature relating to Cloud ERP has been reviewed as far as time limits allow.

3.0. Data Collection

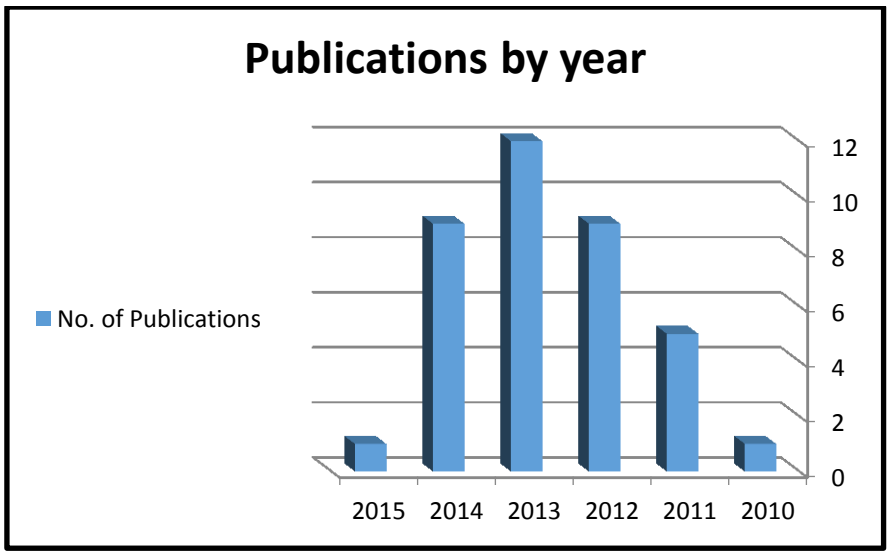

Figure 1. Publication by year

The data collection was limited to publications from 2010 with37 research papers collected and analysed. Figure 1 illustrates the incremental progress in the number of publications from 2010, with drop substantially in 2015. However, this reduction in

the number of articles collected in 2015 can be explained by the fact that the data collection was limited to the first quarter of that year.

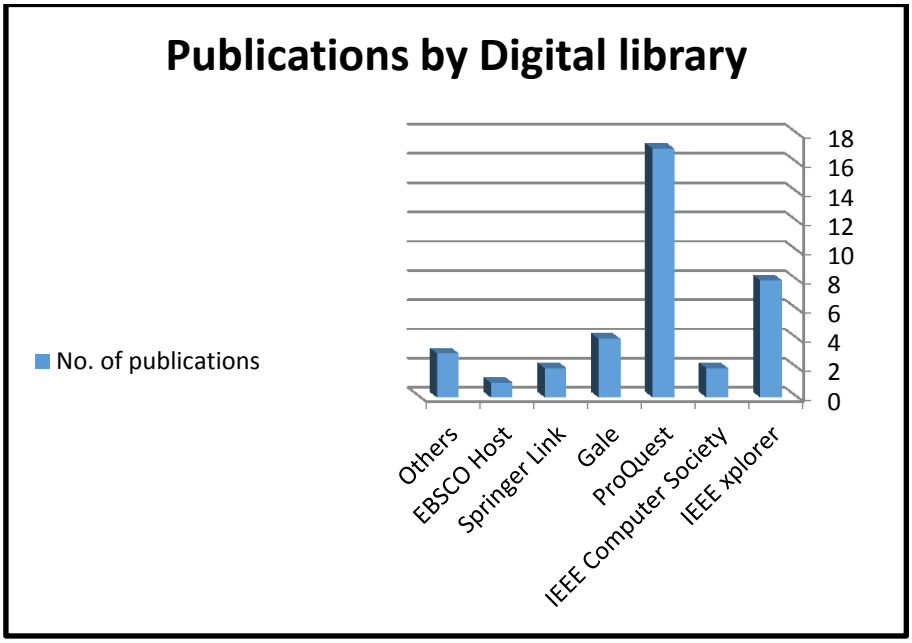

Figure 2. Publication by digital Library

Figure 2 shows the digital library where the publications downloaded. Journal articles were the main type of data collected as most of the publications relating to Cloud ERP were published in journals.

ERP systems of various disciplines, including business and information systems, were researched. The data collection was conducted to cover all aspects of Cloud ERP, which worked to narrow the research by shortening the number of results listed.

4.0. Classification Framework

After data collection, intensive note-taking was undertaken during the reading of all the cited publication. There were 6 main topics as introduced in Figure 3.

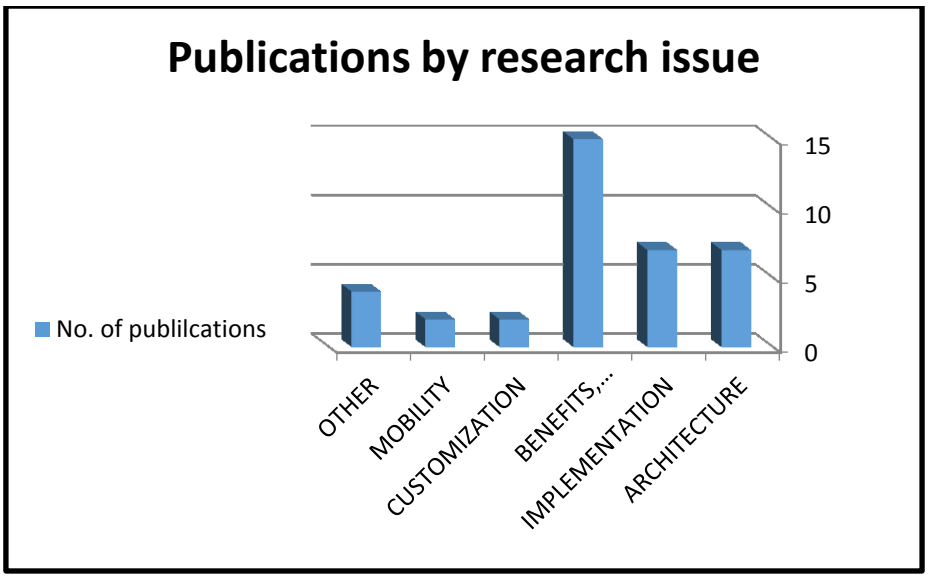

Figure 3. Main Topics

As shown in Figure 3, the collected publications on the subject of Cloud ERP fell into one of the following categories: cloud architecture, cloud ERP implementation, benefits and challenges, customization, mobility, and others. Importantly, the benefits and challenges were given the highest priority of the issues researched, followed by implementation and then architecture. The subjects of mobility and customization were not afforded a high priority in the research.

Figure 4 demonstrates the publication topics in detail. Important topics such as Cloud ERP blueprinting, quality of services and risk analysis were afforded average priority in the available research. The majority of researches discussed the general idea of adopting cloud computing for ERP together with providing reviews of the relative benefits and disadvantages of the same. Surprisingly, integration has largely not been addressed in the research papers collected.

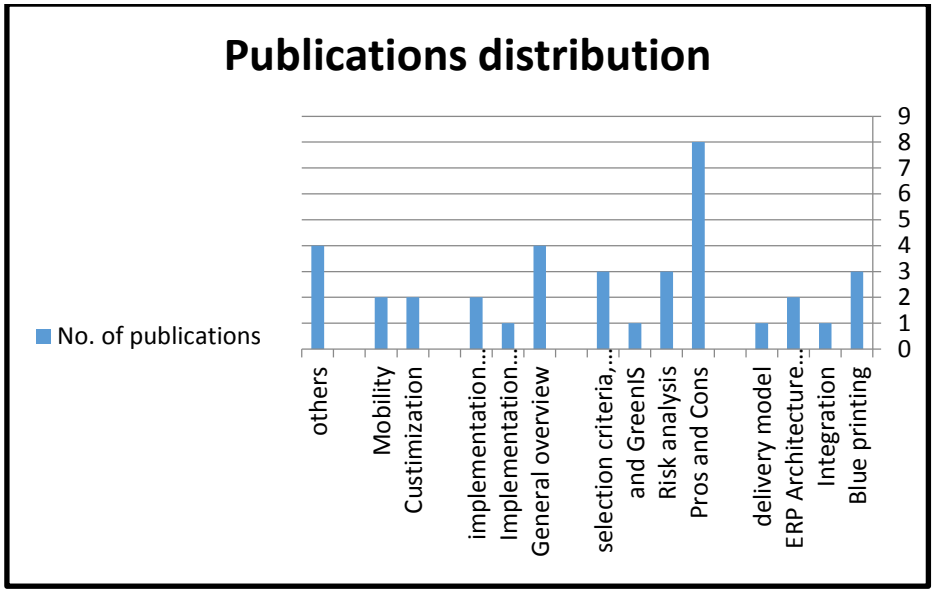

Figure 4. Publications distribution.

5.0. Findings

Three issues relating to Cloud ERP architecture has been researched considerably: (1) ERP architecture's historical development; (2) the manner in which ERP extends functionally to both customers and suppliers; (3) considerations relating to cloud-based computing, service-oriented architecture and business intelligence Vasilev, J. (2013), Jian Zhang; Ran Wang, (2013); and finally (4) cloud blueprinting, Cloud ERP models and Cloud ERP's potentiality Papazoglou, M. P., & Heuvel, W. v. d. (2011), Suciu, G. et al. (2011). Further, proposals relating to an intensive cloud integration web model designed specifically for business information systems including ERP is widely discussed Okezie, C. C., Chidiebele, U. C., & Kennedy, O. C, (2012).

The use of the hybrid cloud model is discussed in relation to situations where ERP's dealing with sensitive information are distributed across a private cloud, such as in the finance sector, or a public cloud, such as in the marketing and sales sector Johansson, Björn, et al. (2014).

Less importantly, distributing cloud resources in public PC's and offices as an alternative to storage in large data centres has been researched as an approach which may benefit ERP and resolve some obstacles to evaluating cloud-hosting service providers Suciu, G.; Cernat, C.; Todoran, G., (2012). For example, building large data centres is expensive. Availability of service is essential for Cloud ERPs, where vendors have different choices of infrastructure including storage, network and virtual

machines. A high availability Cloud ERP architecture is proposed Bao Rong et al., (2014).

Cloud computing as a new technology presents some concerns for business decision makers – they have to weigh up the relative benefits and disadvantages of adopting cloud computing technologies. These concerns have been highly addressed in the literature reviewed Awad, H. A. H, (2014), Alali, F. A., & Yeh, C, (2012), Weng, F., & Hung, M, (2014), Elragal, A., & El Kommos, M, (2012), Clohessy, T., Acton, T., & Coughlan, C, (2013), Mezghani, Karim, (2015), Gill, Ron, (2015), Appandairajan, P.; Khan, N.Z.A.; Madiajagan, M., (2012). In addition, a great many risk analyses on ERP systems, such as those used in finance and accounting and auditing which deal with sensitive data, have been undertaken Alali, F. A., & Yeh, C, (2012). Risks including information security threats such as session hijacking, virtual machine escaping and insecure cryptography have been identified and researched Sahin, N.Y., (2013), Dixit, Ashish K, (2012).

Product and provider selection criteria and the quality of service, including support, provided by the cloud-hosting and Cloud ERP providers are significantly important considerations for business decision makers which seem to have been downplayed and given a low priority in the in the literature Mahara, TN, (2013), James, Jong Park and Hwa-Young Jeong, (2013) Schrödl, H.; Simkin, P., (2014).

Cloud ERP approach has a number of important benefits including the fast speed at which they can be implemented; however, customization of the ERP system is restricted. ERP providers can offer Single Tenant software applications where only one customer using the software instance or Multiple Tenancy applications where many customers share one software instance. The benefits and impact these respective tenancies have on the ability to customize, the level of customization and limitations have been researched Chin-Sheng Chena, Wen-Yau Liangb, Hui-Yu Hsub, (2015), Mijac, M., Picek, R., & Stapic, Z, (2013).

Cloud maturity and mobile computing and their benefits for ERP have been researched. Cloud ERP and supply chain management tend to have been discussed by authors and researchers with a history of SCM devices and its development with mobile devices Elena Geanina ULARU et al., (2013), Clemens, B., Cata, T., & Hackbarth, G. (2012).

Implementation of Cloud ERP is different in nature in comparison with on-site legacy ERP implementation, and this subject has been well-covered in the research Arnesen,

S, (2013), GUO CHAO ALEX, P, & GALA, C, (2014), Purohit, G. N., Jaiswal, M. P., & Pandey, S, (2012), Nick, S., (2013), Chen, Yizeng; Li, Xingui; Chen, Fangning, (2011). It is noted from the literature that Cloud ERP implementation is planned to be undertaken by way of a SAP approach ASAP and Oracle AIM Okezie, C. C., Chidiebele, U. C., & Kennedy, O. C, (2012), Yaghubi, S., Modiri, N., & Rafighi, M. (2014). The added value and return on investment for small and medium enterprises SME's has been addressed and comparison between cloud-based approaches versus on-site, legacy ESP systems has been discussed MIRANDA, S, (2013), Saini, I.; Khanna, A.; Peddoju, S.K., (2014). However, topics such as institutional theory and convergence have been rarely researched Teracino, Elizabeth A, (2015).

6.0. Recommendations

There are many subjects require organizations highest attention in addition to the topics covered in this paper, which are trending, essential, represent common mistake or affecting the competitiveness. It is highly recommended to review the following points before moving to Cloud ERP.

Comparing Cloud ERP that are designed for cloud to web-based ERP that have been shifted to cloud is a common mistake, as the cloud designed solutions gives the highest value of cloud technology. Selecting full stack Cloud ERP architecture which include delivering the cloud provider servers' to the customer site, and hybrid cloud connectivity and orchestration would empower organizations growth and development.

Connected everything is trending in the era of Internet of Things, where connectivity scale from systems within organization to connect with other organizations, systems, people and devices'. Connectivity affect the digital transformation options and possibilities.

Intelligent ERP is emerging and becoming highly essential to organizations' future, and to enable smart organization. Applying cognitive properties such as artificial intelligence, machine learning, advance analytics and deep learning would extract value from data and change the decision making approach. Further, ERP personalization, customer experience and localization shall be evaluated carefully while selecting cloud ERP provider.

Recently, leaders ERP technology and Cloud providers have team up to improve their cooperation, co-engineering, integration, which changes the ERP and cloud markets,

open new possibilities and go beyond traditional approaches. Acquisitions and merges also represent ceither risks or opportunities to ERP and cloud technologies and require organizations to consider them while selecting cloud ERP.

Cloud vendor evaluation is significant to the selection criteria, this factor does not focus on technology but on the cloud providing vendor. The provider financial stability, strategic plan, agility towards rapidly changing technology, functionality and regulations shall be studied carefully. The geographical distribution of the cloud providers is well-planned and selecting provider with best presences are highly considered success factor on performance, disaster recovery, local regulations, time zone and currency.

7.0. Findings and Conclusion

Latency reduction, availability and the quality of cloud services are important research areas that have not been adequately addressed by the present research. Fog Computing, which is another new technology related to cloud computing, is another area in which further focused research is highly recommended in order to contribute to the fulfilment of requirements for efficient information systems, ERP in particular, design and development.

Further, important legal issues relating to the provision of cloud-based technologies including service level agreement, security and privacy should be explored. Technical aspects such as sustainability and vendor technology roadmaps form vital research issues which were not adequately addressed. Finally, vendor agility in term of contracts, integration, customization, and cost should be researched to provide further ideas and foundations for the advancement of the new technology.

8.0. Future Work

With the passage of time cloud computing has become a very hot topic for researchers, and it has applications in several domains. Studies depict that researchers have already started deploying cloud computing in ERP implementations of higher education. As a future endeavour I would like to explore the drawbacks or shortcomings of ERP implementation in the stated domain. I would also like to present the guidelines on how to use cloud computing in ERP implementation particularly for educational institutes that provide higher education. Further, I will study some empirical studies to evaluate the early adopter’s experiences.

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