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An investigation of the challenges and issues influencing the adoption of cloud computing in Australian regional municipal governments

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ABSTRACT

New developments in information technology (IT) provide opportunities for a better quality of life through benefits such as increased comfort and convenience. Compared to dedicated infrastructures such as cluster and grid computing, cloud computing can better cater to users' needs by increasing effectiveness, efficiency and functionality at a potentially lower cost. This research aims to provide insights into the challenges and issues faced by implementers and users of cloud computing by comparing the extant literature about this issue with current insights provided by IT managers. A systematic literature review and in-depth interviews with IT managers in local government councils were conducted for this research. The research indicated that the factors in the extant literature were supported; additional challenges and issues emerged which are related to effective network, data storage location, availability of different service providers, policy makers, a limited understanding of the cloud and business transformation. The findings of this research are expected to assist managers to evaluate possible adoption and increase their awareness about challenges and issues that influence the cloud adoption when planning to adopt it.

1. Introduction

Cloud computing, a recent development in information and communication technology (ICT), has superseded some older technologies such as virtualisation, utility computing, elasticity, distributed computing, and grid computing (Wang et al., 2011). It offers simplicity and potential for scalability, reliability and high performance service delivery at a relatively low cost (Ali et al., 2015a; Mell and Grance, 2009; NIST, 2009). Cloud computing is changing the way industries and enterprises do their businesses in that dynamically scalable and virtualised resources are provided as a service over the Internet; it offers new opportunities for enterprises (Xu, 2012).

Growth in the adoption of cloud computing is expected (Opitz et al., 2012); predictions for growth range from $46.3 billion reported in 2008 to $148.8 billion and $150 billion by 2014 and $222.5 billion market by 2015 (Opitz et al., 2012). Cloud computing spending is predicted to grow from $16 billion in 2008 to around $55 billion in 2014 (Gens, 2010; Leavitt, 2009). The expectations of the business with cloud computing are high and it is important for organisations to consider the potential benefits for their operations (Opitz et al., 2012). There is an expectation that 7.1 percent of total ICT spending in Australia in 2015 will be directly cloud related, up from 2.8 percent in 2011; this will be a net increase in value of around $4.3 billion (IT Industry Innovation Council, 2011).

Research about cloud computing in the public sector in general is limited (Janssen and John, 2011). There is research

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on the challenges and issues of cloud computing in relation to security, privacy, trust issues (Ali and Soar, 2014; Buyya et al., 2011; Ghanam et al., 2012; Kim, 2009; Takabi et al., 2010), and policies (Ali et al., 2015a, 2015b; Jaeger et al., 2008; Tweneboah-Koduah, 2012). There is a lack of exploratory studies that provide an in-depth and holistic investigation of all the actual challenges and issues in a relation to cloud computing adoption (Low et al., 2011; Misra and Mondal, 2011). That is, we could not find any studies that listed all challenges and issues and explained why and how they are influencing the adoption of cloud computing.

Despite its potential benefits, the adoption rate of cloud computing in regional municipal government sectors in Australia has been lower compared to urban areas (IT Industry Innovation Council, 2011). The paucity of empirical studies about challenges and issues to cloud computing adoption in Australian regional municipal governments has hindered understanding and thus strategy development to improve its adoption (IT Industry Innovation Council, 2011). This situation has prompted regional municipal governments to request further research related to challenges and issues that influence the adoption of cloud computing with the purpose to guide their cloud adoption and implementation decisions (Department of Innovation Industry Science and Research, 2011). The current gap in the literature has led us to the following research problem: What are the actual challenges and issues that influence the adoption of cloud computing in Australian regional municipal governments.

This research identifies and provides an overview of the challenges and issues affecting the adoption of cloud computing in Australian regional municipal governments. The paper provides an overview of cloud computing, a report on a systematic literature review and a report on interviews with IT managers in Australian local government councils about their opinions on the challenges and issues that influence the adoption of cloud computing. Then, we conclude this paper with contributions, research limitations, future research, and conclusions.

2. The basic concept of cloud computing

Cloud computing has been a paradigm shift in the IT domain (Kantarcioglu et al., 2011). It is the result of significant innovations in virtualisation, utility computing, distributed computing, grid computing, storage, content outsourcing, security, Web 2.0, and networking (Catteddu and Hogben, 2009). The most widely used definition of the cloud computing model is introduced by the U.S. National Institute of Standards and Technology (NIST, 2009) as:

> *"A model for enabling ubiquitous, convenient, on-demand network access to a shared pool of services (for example, networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction".*

The NIST definition recognises the availability of cloud computing and describes its five essential characteristics: on-demand self-service; broad network access; resource pooling; rapid elasticity; and measured service (NIST, 2009).

Cloud services can be categorised on the basis of the following three service/delivery models: Software as a Service; Platform as a Service; and Infrastructure as a Service (Ali et al., 2014; Buyya et al., 2011; Cloud Security Alliance, 2009; Mell and Grance, 2009). Software as a Service (SaaS) enables consumers to use the service provider's applications running on a cloud infrastructure. Consumers can access the applications using various client devices through a client interface such as a Web browser. Consumers have access to limited user-specific application configuration settings and cannot manage or control the underlying cloud infrastructure such as its network, servers, operating systems or storage (Clemons and Chen, 2011; Cloud Security Alliance, 2010; Mell and Grance, 2009; Velte et al., 2010; Wang et al., 2008).

The Platform as a Service (PaaS) model of cloud computing is somewhat similar to the SaaS model. This model enables the consumer to deploy consumer-created or -acquired applications onto the cloud infrastructure with the help of programming languages and tools the provider supports. Just like the SaaS model, the consumer does not manage or control the underlying cloud infrastructure, but can control the deployed applications and possibly the application-hosting environment configurations (Cloud Security Alliance, 2010; Dillon et al., 2010; Velte et al., 2010).

The third platform, Infrastructure as a Service (IaaS), provides the consumers with processing, storage, network and other fundamental computing resources (Bhardwaj et al., 2010). The consumer can deploy and run arbitrary software, including operating systems and applications. Like the other two models, the consumer cannot manage or control the underlying cloud infrastructure but has control of the operating systems, storage and deployed applications and possibly has limited control over select networking components, such as host firewalls (Bhardwaj et al., 2010; Cloud Security Alliance, 2010; Mell and Grance, 2009; Sohan and Zeng, 2010).

There are believed to be four cloud deployment models: public; private; community; and hybrid (Ali et al., 2014; Catteddu and Hogben, 2009; Cloud Security Alliance, 2009; Dustin-Amrhein et al., 2010; Mell and Grance, 2009). Public cloud enables the cloud infrastructure to be made available to the general public. The infrastructure is owned by an organisation that provides cloud services (Dustin-Amrhein et al., 2010). In the private cloud model, the cloud infrastructure is deployed solely for a single organisation. The organisation may itself manage the infrastructure or outsource it to a third party, and the cloud infrastructure may exist in the organisation's premises or be based off-premise (Armbrust and Fox, 2009; Dustin-Amrhein et al., 2010). Community cloud deploys the cloud infrastructure to several organisations at the same time and supports a specific community that shares similar concerns. The cloud infrastructure may be managed by the organisations or by a third party and may exist in the organisations' premise or be based off-premise (Dustin-Amrhein et al., 2010). In the hybrid cloud model the cloud infrastructure is composed of two or more clouds (private, community or public) that remain unique entities but are bound together by standardised or proprietary technology that enables data and application portability (Cloud Security Alliance, 2009).

Despite the potential advantages provided by cloud computing, there are still several challenges and issues for its