

A Tool to Map Applications to Information Technology Deployment Models

Uma Ferramenta para mapear Aplicações a Modelos de Implantação de Tecnologia da Informação

Han Ping Fung

Email: hanping.fung@aeu.edu.my

Asia e University. PhD (Malaysia), Kuala Lumpur, Malaysia.

Manuscript first received/*Recebido em*: 06/01/2016 Manuscript accepted/*Aprovado em*: 07/04/2016

Avaliação: Double Blind Review pelo SEER/OJS

Abstract

The moment to adopt cloud computing and IT outsourcing for application management is still prevalent. However, there is still lack of research or tool to map an application to a specific IT deployment model like public cloud, private cloud, IT outsourcing or in-house management. This research problem has encouraged the researcher to review literature, developed a Microsoft Excel mapping tool as well as tested it for 26 applications from two organizations in Singapore. This mapping tool is based on 10 criteria to evaluate each application's characteristics before mapping them to the appropriate IT deployment model. These 10 criteria include: 1) Regulatory Compliance, 2) Vendor Support, 3) Service Availability, 4) Workload Variability, 5) Security, 6) Infrastructure Compatibility, 7) Internet Suitability, 8) Architectures, 9) Financials, and 10) Affinity & Intranet Integration. This article demonstrates that the mapping tool is a valuable asset to both IT management and IT consultant in assessing applications and map them to the correct IT deployment models. The benefits of using this mapping tool include accuracy, consistency and speed in mapping the applications to the appropriate IT deployment models.

Keywords: *applications, it deployment models, criteria, mapping tool.*

Resumo

No momento em que a adoção de cloud computing e outsourcing de TI para gerenciamento de aplicações ainda é prevalente. No entanto, ainda há falta de pesquisa ou ferramenta para mapear uma aplicação para um modelo de implantação de TI específico, como nuvem pública, nuvem privada, outsourcing de TI ou a gestão in-house. Este problema de pesquisa tem incentivado esta pesquisa e com a revisão de literatura, desenvolveu-se uma ferramenta

de mapeamento Microsoft Excel, bem como foi testado por 26 aplicações de duas organizações em Singapura. Esta ferramenta de mapeamento é baseado em 10 critérios para avaliar as características de cada aplicativo, antes de mapeá-los para o modelo de implantação de TI apropriada. Estes 10 critérios incluem: 1) Conformidade Regulamentar, 2) Apoio Vendedor, 3) Disponibilidade de serviço, 4) Workload Variability, 5) Segurança, 6) Infra-estrutura de compatibilidade, 7) Adequação Internet, 8) Arquitetura, 9) Finanças e 10) Afinidade e Integração da Intranet. Este artigo demonstra que a ferramenta de mapeamento é um ativo valioso tanto para a gestão de TI e consultoria de TI em aplicações de avaliação e mapeá-los para os modelos de implantação de TI corretos. Os benefícios do uso desta ferramenta de mapeamento incluem precisão, consistência e velocidade no mapeamento das aplicações para os modelos de implantação de TI adequadas.

Palavras-chave: aplicações, modelos de implantação, critérios de mapeamento de ferramentas.

Introduction

After Information Technology (IT) management is convinced on the benefits of cloud computing, they face the dilemma of which application should be moved to the cloud and which should not. For some service providers or integrators, it is also challenging for them to determine correctly and quickly which customer applications should migrate to public cloud, private cloud, outsourcing (including hosting) or continued to retain as an in-housed application. This is because each customer's application is unique in its own context especially for those custom developed applications. Moreover, from literature reviewed there are different attributes pertaining to which application should migrate to which cloud deployment models i.e. public cloud, private cloud et al. (National Institute of Standards and Technology [NIST], 2011a; Cloud Security Alliance [CSA], 2011; Cloud Standards Customer Council, 2013; Catinean & Candea, 2013; Ghanam, Ferreira & Maurer, 2012). On the other hand, some IT management prefer to outsource their applications management to external service providers (Dibbern, Goles, Hirschheim & Jayatilaka, 2004). As a consequence, there

is a need to perform both literature review as well as empirical testing to understand the valid attributes of applications that can map to the right IT deployment model. Once the attributes were ended, they should be automated using a software tool to ensure the mapping is accurate, consistent and fast. The correct mapping is crucial as the wrongly mapped applications might not generate the benefits that the customer is expecting from cloud adoption. This mistake might also of a great impact for cloud service provider or integrator's credibility in cloud consulting area. This research and development is based on literature reviewed as there is no tool available that can map applications correctly to a specific IT deployment model. The researcher has discovered is that there are some guidelines on what applications that should be virtualized (NIST, 2011a; CSA, 2011). The objective of this article is to describe the research that has been conducted, the software tool that has been developed as well as explain how the tool has been tested correctly in helping two organizations to move their applications to the right deployment models whether they are cloud-based, outsourcing-based or retain as an in-housed application services.

IT Deployment Model

Cloud computing is one of the IT deployment models that facilitate on-demand network access to share pool of computing resources like applications, servers, storage, network et al. that can be rapidly provisioned and de-provisioned with minimal management effort (NIST, 2011a). According to NIST (2011a), five essential characteristics of cloud computing include: 1) broad network access, 2) rapid elasticity, 3) measured service, 4) on-demand self-service, and 5) resource pooling. Cloud deployment models consist of 1) public cloud, 2) private cloud, 3) community cloud, and 4) hybrid cloud. Public cloud is built and made available to general public from individual consumers to large enterprises which is owned by cloud service providers that are selling public cloud services. On the other hand, private cloud is built solely dedicated for an organization which will manage by the organization itself or through third party vendor. Community cloud is shared by few organizations to support a specific community purpose or to meet certain policy requirements whereby it will be manage by the organizations themselves or through third party vendor. Lastly, hybrid cloud consists of different types of cloud like public, private and community clouds which are connected together to facilitate applications and data portability e.g. during the events of

cloud bursting or load balancing.

IT outsourcing is another type of IT deployment model refers to an arrangement between a customer and an outsourcing service provider whereby the customer is subcontracting-out some or all IT services for multiple years to the provider. In return for a periodical fee, the provider will provide IT management services which include traditional application management and hosting services (Dibbern et al., 2004). Besides all the IT deployment models that have been shared above, an organization can choose to maintain and manage all its applications in-house without moving to cloud nor outsource to a service provider. The IT deployment models to be considered in this research include: 1) public cloud, 2) private cloud, 3) traditional IT outsourcing, and 4) in-house management. Reason being at high level, community cloud is a kind of private cloud that shared by few organizations. Moreover, hybrid cloud is generally the mixed combination of public and private clouds as mentioned above.

Criteria to Map Applications to IT Deployment Model

Different researchers have proposed different criteria to migrate applications to clouds. The common criteria from literature include:

- organizational readiness to adopt cloud, financials, architectures, security, integration considerations (Cloud Standards Customer Council, 2013).
- security, performance, architectures (Catinean & Candea, 2013).
- security, infrastructure, data management, interoperability (Ghanam et al., 2012).

The researcher tried to consolidate the above criteria and included some new criteria from the feedbacks of several cloud computing practitioners. The researcher also considered other factors influencing IT deployment models other than cloud which include IT outsourcing and in-house management. In the end, the researcher had developed 10 criteria to map applications to IT deployment models. These 10 criteria are based on literature reviewed as well as empirically tested with 2 organizations to predict their applications that had mapped correctly and migrated successfully to the correct deployment models. Following depict the 10 criteria used in this research.

Table 1: Criteria Information

No.	Criteria Name	Operational Definition	Examples of Question Asked	Why this Criteria is Important?
1.	Regulatory Compliance	Capability of the application to meet conformity and transparency requirements to avoid potential cost of legal threats (CSA, 2011; Buyya, Broberg & Goscinski, 2011; Cianfaro, 2014).	<ul style="list-style-type: none"> • Does the application subjects to regulatory requirements such as Federal Information Security Management Act (FISMA), Health Insurance Portability and Accountability Act (HIPAA) et al.? • Is there any government regulation such as data must reside within a geographic region? 	If regulatory compliance is important then public cloud or outsourcing deployment model might not be suitable.
2.	Vendor Support	Vendor's readiness to support cloud-based applications (CSA, 2011; Buyya et al., 2011).	<ul style="list-style-type: none"> • Does the application supported by vendor in virtual environment? • Does the application run on vendor certified operating system image? 	If vendor is ready to support cloud-based applications then public or private cloud deployment model is feasible.
3.	Service Availability	Availability of the application service (CSA, 2011; Buyya et al., 2011; Nagaty, 2014).	<ul style="list-style-type: none"> • Does the application service requires high availability? • When the application service failed, can it be restarted without human intervention? 	If service availability is important then public cloud or outsourcing deployment model is suitable.
4.	Workload Variability	Application usage pattern based on user's demand (CSA, 2011; Buyya et al., 2011).	<ul style="list-style-type: none"> • Does the application workload requires unpredictable demand peaks and troughs? • Does the application workload has spiky or cyclic usage profile? 	If workload variability is important then public or private cloud deployment model is suitable.

No.	Criteria Name	Operational Definition	Examples of Question Asked	Why this Criteria is Important?
5.	Security	Capability to protect the application when it is operating in cloud or non-cloud environment (CSA, 2011; Buyya et al., 2011; NIST, 2011b; Dutta, Peng & Choudhary, 2013; Ahmed & Hossain, 2014; Sasko, Gusev & Kostoska, 2012).	<ul style="list-style-type: none"> • Does the application uses encrypted data or encrypted communication? • Is there any requirement to prevent intruder from accessing the application? 	If security is an important concern then in-house management or private cloud deployment model is suitable.
6.	Infrastructure Compatibility	Capability of the application to run on traditional infrastructure (CSA, 2011; Buyya et al., 2011).	<ul style="list-style-type: none"> • Is there any hardware or clustering technology dependencies for the application? • Does the application licensing restricts the application from running on virtual environment? 	If infrastructure compatibility is important then in-house management or outsourcing deployment model is suitable.
7.	Internet Suitability	Internet dependency and requirement of the application (Buyya et al., 2011).	<ul style="list-style-type: none"> • Does the application requires high Internet network bandwidth availability, reliability or low data latency? • Is there any proprietary Internet protocols dependency? 	If Internet Suitability is important then in-house management or private cloud deployment model is suitable.
8.	Architectures	Capability of application components and sub-components that can operate in cloud environment (CSA, 2011; Choudhary, 2012; Hajjat, Sun, Sung, Maltz, Rao, Sripanidkulchai & Tawarmalani, 2010).	<ul style="list-style-type: none"> • Can the application leverages on parallel processing or multi-threading for scale up and scale out? • Is there any 3-tier application architecture or modern software development technologies being 	If the application architecture is align with cloud reference architecture then public or private cloud deployment model is suitable.

No.	Criteria Name	Operational Definition	Examples of Question Asked	Why this Criteria is Important?
			adopted?	
9.	Financials	Economic savings for the application deployment and ongoing operations (Buyya et al., 2011; Walterbusch, Martens & Teuteberg, 2013; Nanath & Pillai, 2013).	<ul style="list-style-type: none"> • What are the Capital Expenditure (Capex) vs Operational Expenditure (Opex) to date for the application? • What is the migration cost consideration? 	If financial savings in long run are important then public or private cloud deployment model is suitable.
10.	Affinity & Intranet Integration	Capability of the application to interconnect effectively with other applications within the Intranet (Buyya et al., 2011).	<ul style="list-style-type: none"> • What is the affinity among applications e.g. frequent low latency communications? • What is the application's dependency on other application(s) within Intranet? 	If Affinity & Intranet Integration is important then in-house management or private cloud deployment model is suitable.

The Mapping Tool

Based on the 4 IT deployment models and 10 mapping criteria as mentioned in the previous sections, an **application to IT deployment model mapping** (ATITDMM) tool is developed using Microsoft Excel spreadsheet. Total 32 questions were developed based on the above 10 mapping criteria. Answers provided for the 32 questions will be used to determine which IT deployment model an organization should adopt. Each question can be answered as either low, moderate, high or very high score. "Low" score refers to an answer that is very little relevance for a given requirement, no good fit or does not pose any risk. On the contrary, "Very High" score refers to an answer which is a critical consideration and if it is not consider properly can pose a very high risk to the organization. When all the questions have been filled up for a specific application, it will draw a radar diagram. Following Figure 1 shows the base radar diagram without the application scoring.

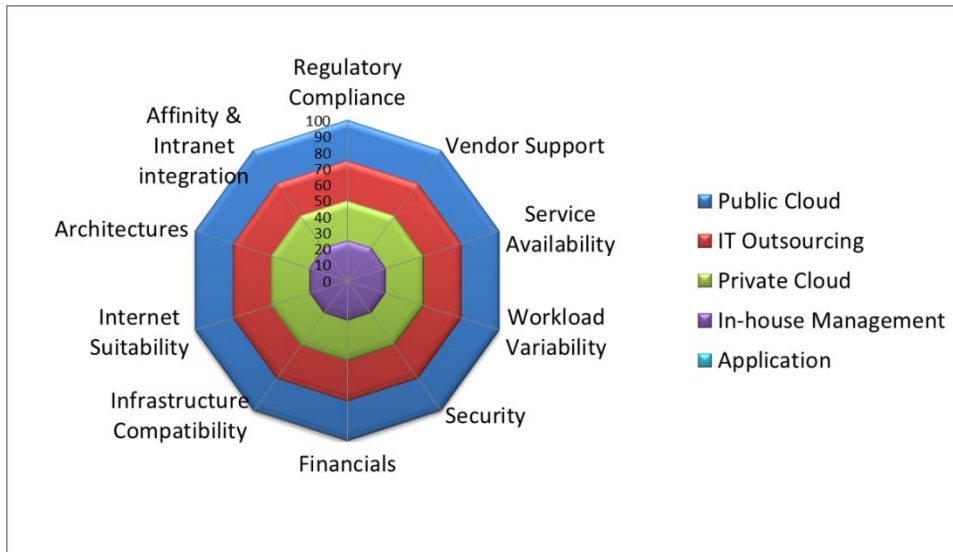


Figure 1: Mapping Tool's Base Radar Diagram

The base radar diagram is based on the 10 criteria as described in the previous section. The area covering the 10 criteria indicates a particular IT deployment model i.e. public cloud (the largest area), IT outsourcing, private cloud and in-house management (the smallest area in the center). Following shows the radar diagram with an application's scorings on top of the base radar diagram.

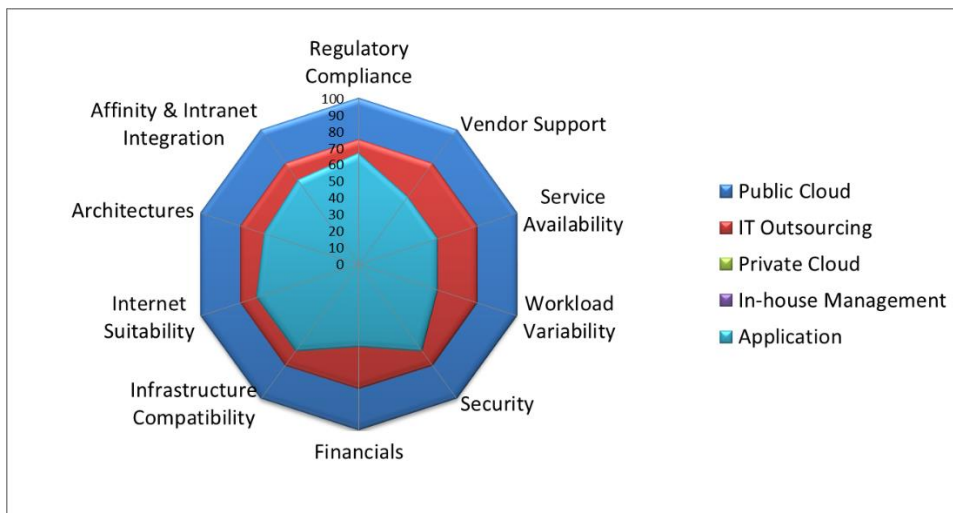


Figure 2: Mapping Tool's Radar Diagram with an application scoring

The area covered by the application that match a particular IT deployment model's area in the base radar diagram indicating it is the best IT deployment model that should be

adopted. For an example, the above Figure 2 shows private cloud can be adopted since the application covered all the private cloud area in the base radar diagram. Moreover, this mapping tool also will base on the radar diagram area covered by the application to compute & recommend the specific IT deployment model that should be adopted. In the above example, private cloud will be generated in the Microsoft Excel mapping tool.

Case Studies' Findings

The above application to IT deployment model mapping tool has been tested in two organizations in Singapore. Each organization has their own IT department to manage all their applications. Following depicts the information pertaining to those applications.

Table 2: Two Organizations' Application Information

No.	Description	Organization A	Organization B
1	Number of in-house applications assessed using the Application to IT Deployment Model Mapping Tool (ATITDMM Tool)	17	9
2	Number of Applications Recommended for Public Cloud Deployment	2	0
3	Number of Applications actually Migrated to Public Cloud	2 (migrated after three months)	0 (not applicable)
4	Number of Applications Recommended for IT Outsourcing Deployment	3	0
5	Number of Applications actually being Outsourced	3 (outsourced after three to five months)	0 (not applicable)
6	Number of Applications Recommended for Private Cloud Deployment	8	5
7	Number of Applications actually Migrated to Private Cloud	8 (migrated after five months)	5 (migrated after four months)
8	Number of Applications Recommended for In-house Management Deployment	4	4

9	Number of Applications continue remain In-house Managed	4 (status quo)	4 (status quo)
---	---	----------------	----------------

From the Table 2 above, 17 applications from organization A have been assessed in which two applications were recommended and migrated to public cloud. Public cloud is suitable as these two applications were email and customer relationship management related. Three applications were outsourced to different application management service providers and hosted at their data centers. Eight applications were moved to organization A's private cloud after five months migration. Lastly, four applications were retained as in-house managed applications mainly due to two reasons. Firstly, some applications were newly acquired or implemented as Capex and managed by internal IT team. Later, management had decided to put them as status quo as there is no Return of Investment (ROI) if they are moved to cloud or outsource again. Secondly, some applications are critical to the overall function of the organization in which management had decided not to move to cloud or outsource. The main reason for all the 13 applications being moved to cloud or outsourced is because there are some dependencies among the applications in which management wanted to consider an overall plan and moved them as a whole.

For organization B, there were only 9 applications being assessed in which there was no application was recommended for public cloud and outsourcing. Only five applications were assessed and moved to private cloud after four months of project implementation. There were also four applications which had been decided by management to retain as in-housed managed applications. The reasons to keep them as in-house or status quo were similar to the reasons of organization A.

After various applications have been migrated or moved to different IT deployment models, the two organizations are capable to enjoy the benefits of cloud and outsourcing in which those migrated applications are running stable, reliable yet their total costs of ownership have been reduced. After the actual cloud migration and outsourcing were completed, there was a separate interview with the respective two organizations' IT management. According to them they were satisfied with the projects being implemented and would consider more in-housed applications moving to cloud especially for those applications that their Capex had been depreciated.

Discussion

By using the **application to IT deployment model mapping tool** (ATITDMM), it can help IT management to assess their applications and map them to the right IT deployment model. This is possible because the 10 criteria can differentiate and map an application based on its unique characteristics to either public cloud, private cloud, IT outsourcing or in-house management deployment model. This 10 criteria is not only based on literature review but also had been tested empirically with 26 applications from 2 organizations in Singapore. Once the IT management knows which IT deployment model they should opt for, this will help them to focus their resources to plan and implement the infrastructure, negotiate the contract with supplier(s) and migrate those applications to the particular IT deployment model.

The benefits of using this mapping tool (ATITDMM) include:

1. Help IT management to assess their applications logically and objectively so that they can map to a particular IT deployment model correctly. This mapping tool will eliminate the human error in assessing their applications manually or based on gut feel.
2. Enable the IT management to save cost in terms of assessment and actual implementation or migration. This is possible as IT management can channel the right resources to do the right things rather than to do the things right later which will incur more costs.
3. Enable the IT management to save time from idea inception to actual implementation or migration of the applications to the right IT deployment model.
4. Provide comprehensive 10 criteria to evaluate which IT deployment model that IT management should choose from for their existing or new applications.
5. This mapping tool is practical and reliable as it has gone through empirical assessment with 26 applications.

However, there are some limitations of this mapping tool which include:

1. At the moment this mapping tool does not consider other cloud deployment models
Revista de Administração de Roraima-UFRR, Boa Vista, Vol. 6 n. 1, p.114-127, jan - jun. 2016.

like community cloud, hybrid cloud in which IT management or IT consultant needs to perform the assessment manually from case to case basis.

2. After determining which IT deployment model the IT management or IT consultant should opt for, this tool does not provide further detailed steps or project plans to implement and migrate the applications to the particular IT deployment model.
3. At the moment this mapping tool is not designed to assess an application and determine which cloud service model it should move to e.g. Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS) et al.

Future improvement for this tool includes further research to address the above limitations. Moreover, future improvement includes acting on feedbacks solicited from various IT management and IT consultants that have been using this tool for a while.

Conclusion

Every application is unique in which its unique characteristics are suitable for certain IT deployment models like public cloud, private cloud, IT outsourcing or in-house management. Through literature review and empirical testing of 26 applications from two organizations in Singapore, 10 criteria are deemed important to evaluate an application belongs to which IT deployment model. These criteria include: 1) Regulatory Compliance, 2) Vendor Support, 3) Service Availability, 4) Workload Variability, 5) Security, 6) Infrastructure Compatibility, 7) Internet Suitability, 8) Architectures, 9) Financials, and 10) Affinity & Intranet Integration. A software tool called ATITDMM based on Microsoft Excel spreadsheet has been developed to map applications based on the 10 criteria to the appropriate IT deployment models. Total 32 questions from the 10 criteria have been developed to solicit answers for computation before determining the best IT deployment model. The mapping of the applications to the IT deployment models have been validated by the actual migration of those applications to the appropriate IT deployment models. The benefits of using this mapping tool include accuracy, consistency and speed in assessing an application belongs to which IT deployment model. Hope this mapping tool ATITDMM will be beneficial to both IT management and IT consultants. In conclusion, this mapping tool has contributed a small step into deeper understanding on the research of the applications assessment and IT deployment models.

References

- Ahmed, M., & Hossain, M. A. (2014). Cloud Computing and Security Issues in the Cloud. *International Journal of Network Security & Its Applications*, 6(1), 25-36.
- Buyya, R., Broberg, J., & Goscinski, A. (2011). *Cloud Computing – Principles and Paradigms*. John Wiley & Sons, Inc., Publication.
- Catinean, I., & Candea, D. (2013). Characteristics of the Cloud Computing Model as a Disruptive Innovation. *Review of International Comparative Management*, 14(5), 783-803.
- Choudhary, R. (2012). A Survey on Cloud Computing Architecture. *International Journal of Computer Technology & Applications*, 3(4), 1400-1405.
- Cianfarò, M. (2014). *Legal Challenges to Cloud Computing: Does Physical Location Matter?* Unpublished Master Thesis, Utica College.
- Cloud Standards Customer Council (2013). *Migrating Applications to Public Cloud Services: Roadmap for Success*. Cloud Standards Customer Council, 1-28.
- CSA (2011). *Security Guidance for Critical Areas of Focus in Cloud Computing v3*. Cloud Security Alliance.
- Dibbern, J., Goles, T., Hirschheim, R., & Jayatilaka, B. (2004). Information Systems Outsourcing: A Survey and Analysis of the Literature. *The DATA BASE for Advances in Information Systems*, 35(4), 6-102.
- Dutta, A., Peng, G. C. A., & Choudhary, A. (2013). Risks in Enterprise Cloud Computing: The Perspective of IT Experts. *The Journal of Computer Information Systems*, Summer 2013, 39-48.
- Ghanam, Y., Ferreira, J., & Maurer, F. (2012). Emerging Issues & Challenges in Cloud Computing – A Hybrid Approach. *Journal of Software Engineering and Applications*, 2012, 5, 923-937.
- Hajjat, M., Sun, X., Sung, Y. W. E., Maltz, D., Rao, S., Sripanidkulchai, K., & Tawarmalani, M. (2010). Cloudward Bound: Planning for Beneficial Migration of Enterprise Applications to the Cloud. *SIGCOMM'10*, ACM, 243-254.
- Nagaty, K. A. (2014). Cloud Tree: A Hierarchical Organization as a Platform for Cloud Computing. *International Journal of Computer and Electrical Engineering*, 6(1), February 2014.
- Nanath, K., & Pillai, R. (2013). A Model for Cost-Benefit Analysis of Cloud Computing. *International Information Management Association, Inc.*, 22(1), 95-119.
- NIST (2011a). *The NIST Definition of Cloud Computing*. Special Publication 800-145, National Institute of Standards and Technology, August 2011.
- NIST (2011b). *Guidelines on Security and Privacy in Public Cloud Computing*. NIST Special Publication 800-144, National Institute of Standards and Technology, December 2011.
- Sasko, R., Gusev, M., & Kostoska, M. (2012). Cloud Computing Security in Business
Revista de Administração de Roraima-UFRR, Boa Vista, Vol. 6 n. 1, p.114-127, jan - jun. 2016.

Information Systems. *International Journal of Network Security & Its Applications*, 4(2), 75-93.

Walterbusch, M., Martens, B., & Teuteberg, F. (2013). Evaluating Cloud Computing Services from a Total Cost of Ownership Perspective. *Management Review*, 36(6), 613-638.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.