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Identifying critical factors for corporate implementing virtualization technology

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ABSTRACT

Virtualization technology has attracted great attention with its advantages of multiple platform operation and resultant cost and power reduction. This study investigated the key factors for corporations to implement virtualization information environment from the viewpoint of IT staffs. Through purposeful sampling, 400 effective questionnaires were collected from IT personnel currently working in the virtualization-related fields. From key factor analysis, seven influential factors were identified for corporations to implement virtualization. These seven factors include: (1) system quality, (2) information quality, (3) simplified management and maintenance, (4) integration of resources, (5) cost reduction, (6) ease of deployment, test and development, and (7) organizational consensus. Based on the obtained findings, suggestions for corporations and to IT system integrators were provided to the implementation of virtualization information environment. The scales developed in this study provide useful measures to study common factors of the implementation of virtualization information technology.

1. Introduction

Cloud computing issue has become one of the greatest concerns to the IT field in the 21st century. The features of cloud computing technology may include super-large scale, dynamic scalability, and on-demand deployment in which virtualization plays a central role and the industry realizes its importance and begins to implement it (Li & Yang, 2010). Virtualization has such advantage as having a single server to carry multiple operating systems. It not only saves the quantity of purchased servers, reduces the management and the maintenance costs, but also reduces the consumption of electricity and cooling power. The global market of virtualization technology is now on the rise. According to the forecast by Global Industry Analysts, Inc., the global virtualization software market is projected to reach US$11.98 billions by 2015 (Global Industry Analysts, Inc. [GIA], 2010).

The success of a new technology requires the careful coordination from various aspects. For virtualization technology, most prior studies focused on aspects in the information engineering domain such as principles, architecture, performance tuning, and backup mechanism of virtualization. However, in the process of adopting virtualization technology, the opinions from engineers who are in charge of managing and maintaining the system must be taken into serious consideration to ensure a successful implementation. So far, limited studies have been found regarding the analysis of the key factors influencing corporations' implementing virtualization technology from the viewpoints of IT staff. As a result, for those corporations in the evaluation process of whether or not to introduce virtualization technology, this subject is certainly worth of discussion.

The rest of this paper is organized as follows. After the introductory section, Section 2 reviews literatures regarding virtualization and its key factors for implementation. The next section discusses the research methodology including questionnaire design and sampling. Section 4 focuses on statistical analysis of research data. A conclusion is given in Section 5 which also addresses the implications, contributions and future research directions in this subject field.

2. Literature review

2.1. Virtualization

The concept of virtualization was originated in the 1960s when mainframes were highly expensive. IBM divided a UNIX mainframe into multiple logic units in order to enable users to fully utilize a mainframe's calculation resources.

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In 1974, Popek and Goldberg proposed a set of requirements to examine whether the architecture of a computer system can be efficiently virtualized. They defined a virtual machine as "an efficient, isolated duplicate of a real machine (Popek & Goldberg, 1974)." These requirements, called "The Popek and Goldberg virtualization requirements," provide a convenient way to search for a computer architecture that supports virtualization, and lay down the guiding principles to design a system with architecture suitable for virtualization. They considered a virtual machine monitor (VMM) must present the following three properties: (1) Efficiency: Statistically dominant instructions from VMM are executed by the hardware directly, without any software intervention from VMM; (2) Resource Control: VMM must have the full control of all virtual resources; (3) Equivalence: Any program running under the VMM should exhibit behaviors identical to those exhibited when running on a equivalent real machine.

With the advancement of cloud computing technology, virtualization has attracted a great attention in the past decade. New definitions have been given to virtualization to clarify its scope and related functions. The study of Fichera (2002) pointed out that virtualization divides the mainframe into the individual logic units and input/output units among them and has the full control of the functions of these units. Further, Singh's study (2004) defines virtualization as a technology that provides multiple operating environments in a computer through assembling or dividing resources such as CPU, memory or hard drive. VMware (2006a) considers virtualization as the separation of resources or demands from the hardware setting and Waters (2007) describes virtualization as the provision of an abstract layer between the computer hardware and software running on the hardware to allow users to execute multiple operating systems on a single machine. Moreover, Tulloch (2009) regards the virtualization as a method to deploy operating resources and utilize these resources through different information layers such as hardware, software, data, network, and memory. The study of Shavit and Migliore (2009) defines a virtual machine as a program or an operating system that establish an independent guest environment within the host, which allows multiple guest environments to be executed and dynamically allocates resources among them.

With the rapid development in the area of cloud computing, researches and /or studies have been directed into various application areas of virtualization in the past few years, as summarized in Table 1. In the aspect of architecture design, for example, Smith and Nair (2005) explained and compared different types of virtual machines for different hardware/software interfaces; Uhlig et al. (2005) explored the virtual machine platform based on Intel's virtualization technology. In terms of implementation and performance, the study of Seetharaman and Murthy (2006) provided a comparison of effectiveness and resource utilization efficiency among different types of virtualization software. In addition, Menasce and Bennani (2006), Sotomayor, Keahey, and Foster (2006), and Jung et al. (2009) proposed mechanisms for efficient resource management and the study of Chen's and Xin's (2005) and Oguchi's and Yamamoto's (2008) investigated issues of planning and implementing virtualization in enterprises. For the aspect concerning the benefits of virtualization, some researchers pointed out the fact of the improved server efficiency through the utilization of virtualization (Sehgal & Ganguli, 2006; Tsai, 2007), while some others mentioned the cost-reduction benefits of using virtualization (C. T. Chen, 2007; Rasmussen, 2009; Symantec, 2009; Weltzin & Delgado, 2009). In terms of operating issues, Arce (2007), Prueksaaroon, Varavithya, and Vannarat (2009), Yang, Zhao, Zhao, and Yang (2009), and Silva, Alonso, and Torres (2009) addressed the realization of system recovery through virtualization; Thein, Chi, and Park (2008) and Prueksaaroon et al. (2009) discussed the implementation of cluster for virtual server. About the issue of information security, Perez, van Doorn, and Sailer (2008) examined the information security strength of emerging hardware and software virtualization technologies and the study of Hoesing (2009) established a mechanism for corporation risk recognition and safety control.

2.2. Key factors to implementing virtualization

The purpose of this study is to explore the key success factors to implementing virtual information environment in corporations, from the viewpoint of IT staffs. The concept of key success factors (KSFs) actually originated from the "limited factor" proposed by Commons (1934). Initially KSF was applied in economics theory; and later, Barnard (1948) transformed KSF to "strategic factor" and applied it in the management decision theory.

There have been many research literatures focusing on key factors analysis in various industries and businesses. However, most of these previous literatures focused on the key factors through the strategic management view, and only few of them were related to the management of information system (MIS). For example, Desanctis and Gourtney (1983) suggested six KSFs to the implementation of information systems and they are: (1) Top management involvement, (2) desire for the system from the intended users, (3) an immediate problem to address, (4) an established MIS group, (5) involvement of users in the design process, and (6) support for users to the system implementation. Laughlin (1999) proposed 10 KSFs based on his experiences in assisting corporations to implement ERP system: and these factors include (1) Clearly Defined Vision, (2) Change Management Effort, (3) Aggressive Schedule and Timelines, (4) Strong Sponsorship, (5) Target Communications, (6) Focused Issue Resolution, (7) Limited Scope, (8) Early Success, (9) Appropriate Project Staffing, and (10) Solid Project Management. Wixom and Watson (2001) investigated the success factors to data warehouse and identified three facets of warehousing implementation success: (1) Organizational Implementation Success, (2) Project Implementation Success, and (3) Technical Implementation Success.

There were also limited studies on the key factors to the implementation of virtualization. VMware in the white paper "The

Table 1
Summary of prior studies on different application areas of virtualization. *Source*: organized by this study.

Application phase	Researchers
Architecture design	Smith and Nair (2005), Uhlig et al. (2005), Vaughan-Nichols (2006)
Implementation and performance	Kallahalla et al. (2004), Khanna, Beaty, Kar, and Kochut (2006), Seetharaman and Murthy (2006), Menasce and Bennani (2006), Sotomayor et al. (2006), Zhang, Li, and Guan (2008), Oguchi and Yamamoto (2008), Jung et al. (2009), Friedman (2006), Chen and Xin (2005)
Benefits	Sehgal and Ganguli (2006), Tsai (2007), C. T. Chen (2007), Jin (2008a, 2008b), Symantec (2009), Rasmussen (2009), Weltzin and Delgado (2009), Hu (2009), Mevag (2007), Ribiere (2008)
Operating virtualization systems	Arce (2007), Singh, Korupolu, and Mohapatra (2008), Thein et al. (2008), Prueksaaroon et al. (2009), Yang et al. (2009), Silva et al. (2009), Matthews et al. (2005)
Information security	Perez et al. (2008), Hoesing (2009)