An Empirical Analysis of Antecedents to the Assimilation of Sensor Information Systems in Data Centers

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ABSTRACT

This paper is concerned with studying the antecedents to and the assimilation of sensor information systems (SIS) in Data Centers. Using the Technology Organization and Environment Framework as a guide and drawing from the Natural resource based view and Diffusion of Innovation theories and five case studies, the paper builds a theoretical framework to investigate the factors that explain the assimilation (diversity and intensity) of SIS. The framework is tested based on data collected from a survey of 107 Data Centers. The findings show that the compatibility of SIS, knowledge of Data Centre managers, green data centre orientation and pressure from peers in the industry affect the assimilation of SIS to manage the facility, power and cooling and computing functions of Data Centers. Further the type of Data Centre, whether it is corporate or co-located or managed has a significant influence on both the level of the SIS assimilation as well as the antecedent factors that influence assimilation.

Keywords: Data Centers Management Systems, Energy Informatics, Green Information Systems (Green IS), Information System Assimilation (IS Assimilation), Intelligent Systems, Monitoring & Automation, Sensor Information Systems

1. INTRODUCTION

Data Centre inefficiency is becoming a non-negligible risk to business performance because of the rise of energy costs, availability of energy, business continuity and the environmental responsibility of IT departments (Velte et al., 2008; Melville, 2010). Data Centers can leverage the power of information systems (IS) to improve not only their operational and cost performance but also their environmental footprint (Alaraifi et al., 2011b). For example,
Schulz (2009) proposes that IS solves various Data Centre problems such as resource inefficiency and infrastructure utilisation. Krauter et al. (2002) and Siddiqui and Fahringer (2010) show that the use of IS improves resource on-demand provisioning, infrastructure monitoring and security and quality of service. This paper is particularly concerned with one type of IS, called Sensor Information Systems (SIS).

Sensors refer to devices that detect physical variation of the surroundings environment and the objects within that environment such as temperature, pressure, airflow, toxic, load and other substance (Fraden, 2010). The use of sensor devices to monitor temperature, smoke, heat and security is now considered an old practice in Data Centers. Nevertheless, it is only recently that these sensors have been integrated into IS to automate Data Centre management functions, inform decision making in Data Centre management and transform Data Centers to improve their environmental and economical sustainability (Alaraifi et al., 2011b). SIS therefore refer to any IS that utilize sensor(s) data which are directly or indirectly connected to one or more sensors or sensor network in order to automate, inform and/or transform a given task or process or appliance (Alaraifi et al., 2010).

A number of vendors and laboratory experiments have introduced SIS and SIS enabled best practices for Data Centers. For example, Sharma et al. (2005) design and evaluate dynamic thermal management approaches to improve the monitoring and controlling of a Data Centre’s temperature and humidity. Larkin (2007) highlights the opportunities underlying the commercially based system ‘SensiNet’ Wireless Sensor Network for monitoring temperature, humidity, and airflow in Data Centers. Furthermore, both vendor and experimental research shows that SIS can be used to increase the efficiency of Data Centre airflow management (Liu et al., 2008), power management (Marwah et al., 2009) and computing resources load and demand management (Padala et al., 2007). Despite these potentials of SIS, the extent to which Data Centres in Australia and elsewhere have assimilated SIS and the factors that influence SIS assimilation has not been researched.

Therefore, this paper addresses the research questions of (1) What are the antecedent factors that can explain the differences in the assimilation of SIS and (2) how these antecedents shape the extent of SIS assimilation in the Data Centers. The rest of the paper is organized as follows. First, we present a theoretical background of SIS assimilation and the research framework and hypotheses. This is followed by the research method. Afterwards, the results of the survey are discussed and hypotheses tested. The paper concludes with some observations based on the data analysis.

2. THEORETICAL BACKGROUND

The theoretical background of the paper is based on The Diffusion of Innovation (DOI) (Roger, 1983), Technology, Organization, Environment Framework (TOE) (Tornatzky & Fleischer, 1990) and Natural Resource Based View (Hart, 1995) theories.

2.1. The Diffusion of Innovation (DOI)

The DOI posits that both perceived attributes of technology and firms’ characteristics influence the adoption and use of technology innovation (Roger, 1983). The DOI therefore identifies two groups of factors, technological and organizational, that encourages, and/or discourages the assimilation of innovation. The technological factors refer to relative advantages, compatibility, complexity, trialability, and observability. The organizational factors refer to firms’ centralization, complexity, size, slack, formalization, and interconnectedness. DOI is widely used by many researchers within the IS discipline to address the adoption of innovation. Although the DOI appears to be robust, it has received criticism due to its limitation to explain complex technologies (Kouki et al., 2010). Therefore, the TOE framework emerged...
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