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Research-in-Progress

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Abstract

Despite increasing emphasis on corporate sustainability and green IS, empirical research on the relationships between specific green IS artifacts and intended outcomes (such as various resource consumption) are relatively scant. In addition, research is silent on the firm-specific factors that could influence the benefits from such artifacts. This paper seeks to fill this research gap by examining the relationship between carbon management system (CMS) and energy consumption. The paper also explores the role of the environmental management system (EMS) and human capital development (HCD) in influencing the relationship between CMS and energy consumption. The study utilizes data from secondary sources and proprietary databases. Findings from this study empirically demonstrate the environmental value of specific green IS artifacts and the role of facilitating factors.

Keywords: carbon management system, energy consumption, green IS

Introduction

The growing concern about environmental sustainability has resulted in the increasing emphasis on the use of technology to address issues regarding climate change. Besides the increasing active role of governments globally in limiting global warming, firms are also embracing sustainability in the enterprise context or corporate sustainability. Increasing emphasis on corporate sustainability has resulted in a new role for Information systems (IS), where they are expected to facilitate resource efficiency and minimize the adverse environmental impact of firms' operations (Watson et al. 2010, Nishant et al. 2013a). Such information systems are specifically referred to as green IS or sustainable IS. Green IS is expected to contribute to environmental sustainability by bringing transparency in resource consumption such as energy consumption (energy informatics), analysis of resource utilization such as energy (energy analytics). This would help firms to devise better strategies to manage their environmental footprint (Watson et al. 2010, Melville et al. 2010). However, there is also increasing concerns about the environmental footprint of IS itself. IS is estimated to contribute to about 2% of global carbon footprint (Computerworld 2007). Consequently, there is increasing emphasis on both "greening of IT" as well as "greening through IT." (To et al. 2013).

Despite the increasing interest in the field of green IS, there is limited empirical research on the effectiveness of green IS in achieving desired environmental objectives. Studies such as Mithas et al. (2010) and Nishant et al. (2013b) investigated the relationships between green IS and different firm specific financial metrics. Few studies such as Nishant et al. (2013a) focused on the relationship between specific categories of green IS and environmental footprint. Nevertheless, green IS assets comprises several distinct artifacts such as carbon management systems (CMS), green data center, cloud computing, virtualization, smart meters, and smart grids (Corbett 2010). Firms are increasingly investing in such green IT artifacts. Hence, there is a need to empirically investigate if the adoption of specific green IT assets helps firms to achieve their intended objectives.

We address this research gap by focusing on CMS. CMS are expected to help firms manage their carbon emissions by providing visibility to the firms' energy consumption and emissions (Melville and Whisnant 2014). It is expected that transparency in energy use and emissions would help firms improve their energy efficiency and subsequently reduce their overall energy consumption. However, there is a lack of empirical studies that examine the relationship between the adoption of CMS and firm's energy performance. In addition, research is predominantly silent on the firm-specific factors that could influence whether firms leverage CMS capabilities in achieving energy efficiency and reduced energy consumption. We specifically focus on the presence of environmental management system (EMS) and human capital development (HCD) programs in firms. Firms with EMS are expected to have a comprehensive, systematic, and formalized programs to manage firms' environmental footprint. Consequently, EMS is expected to help firms benefit from CMS.

CMS would require significant training of employees and benefits from CMS would be contingent on employee involvement. HCD reflects the firms' capacity to manage and develop human capital through formalized training programs, compensation structure, professional development program, and employee engagement. Hence, a firm with HCD programs would have skilled employees that are relatively more adept at leveraging CMS.

Against this background, we examine three key research questions in this study:

RQ1: Does CMS achieve its intended objective in terms of energy consumption?

RQ2: Does the presence of EMS moderate the relationship between CMS and energy consumption?

RQ3: Does the presence of HCD moderate the relationship between CMS and energy consumption?

This study makes the following contributions. First, prior research on green IS has not empirically examine the effectiveness of specific green IS artifacts such as CMS. An empirical examination of whether CMS contributes to environmental sustainability by helping firms to achieve its intended sustainability-related objectives would help us to develop a better understanding of green IS.

Second, we examine the role of firm-specific factors such as EMS and HCD. This would help us understand that if CMS contributes to firms' environmental sustainability in isolation or require certain facilitating conditions that help firms leverage CMS.

Third, we specifically review the theoretical lens used in green IS and argues that the benefits from green IS is contingent on firm-specific factors. In doing so, we demonstrate that the potential of environmental sustainability as propounded in the theoretical lens such as natural resource-based view (NRBV) depends on several other factors.

This paper is structured as follows. First, we review the relevant literature and present our research model and hypotheses. Next, we describe our data collection and analysis method. Then, we discuss the potential findings and their implications for research and practice.

Literature Review and Hypotheses Development

Green IS and CMS

Studies on green IS have often focused on issues such as adoption, market response to green IS and relationship of green IS with firm performance (Loeser et al. 2017). Prior research with regard to green IS/IT has categorized green IS into four categories, namely information to support decision-making, direct IT assets and infrastructure, collaboration, and sustainable products and services (Corbett 2010, Nishant 2013a). CMS is categorized as information to support decision-making as it provides visibility to firms' carbon footprint. CMS is defined as an enterprise information system that captures various types of environmental data such as energy use and provides insights to firms on their environmental footprint through processing and analysis of such data (Corbett 2013, Melville and Whisnant 2014). CMS are of several types varying from simple spreadsheet based solutions to the dedicated platform provided by environmental software companies such as SAP and Enablon (Catulli and Fryer 2012). Adoption of CMS by firms could help them in regulatory compliance, leveraging carbon trading schemes, as well as building reputations among various stakeholders (Corbett 2013). Lately, few studies such as Rush and Melville (2012, 2014) have examined the shareholders' response to announcements of CMS adoption. Studies such as Corbett (2013) and Melville and Whisnant (2014) utilized qualitative approaches to understand how CMS helps firms manage their environmental footprint.

Studies focused on green IS have often invoked NRBV to argue for the positive payoffs from green IS (Loeser et al. 2017). NRBV argues that firms develop unique resources when they embrace environmental sustainability (Hart and Dowell 2011). Studies specifically focused on CMS have approached it from a persuasive systems perspective (Corbett 2013). Such studies have argued that access to information available through CMS could change employees' attitude towards sustainability.

Hypotheses Development

CMS are readily available in the market, and several vendors provide them as well as help interested firms to adopt them. Consequently, CMS alone could not result in any competitive advantage that could arise from a unique resource. Therefore, potential environmental benefits due to CMS cannot be approached from the NRBV perspective. Although employees are an essential constituent of firms, firms also needs processes, policies, and technology. Hence, we cannot view potential benefits from CMS from a merely persuasive systems perspective. As a persuasive systems perspective is more suited to the individual as a unit of analysis, in this study, we approach CMS from the dynamic capability perspective.

Dynamic capabilities refer to firms' ability to respond to any change in the dynamic business environment (Teece et al. 1997, Teo et al. 2016). Although CMS itself is not a unique resource, firms' capabilities that could develop due to the adoption of CMS would be exclusive to each firm. This view is consistent with past research that emphasizes capabilities as the real source of competitive advantage (Wade and Hulland 2004). CMS could provide current information on the firms' energy consumption and therefore could help firms to make necessary changes in their processes relatively quickly compared to firms that do not have CMS.

A typical comprehensive CMS include various data components that capture data on energy consumed in different facilities, estimates of emissions from purchased goods and services, energy consumed by fleets, on-site generation facilities, and other miscellaneous activities (Melville and Whisnant 2014).

Energy consumed in a firm is contingent on production and service generation activities. The level of production and service generation is in turn dependent on various external factors such as demand as well as internal factors such as existing inventory level or stock level of the different inputs. Firms with CMS have visibility to energy consumed by various operational processes and are better able to

leverage information from existing enterprise resource solutions to optimize energy use to reduce overall energy consumption. Firms with CMS can ascertain which processes are more energy intensive and facilitate operational strategies such as anti-idling strategies to minimize energy consumption. Energy consumed, and emissions from purchased goods and services, fleets, on-site generation facilities are also conditional on energy portfolio at the source of such goods and services and technological state of fleets. Firms with CMS have visibility to energy consumed by purchased goods and services, fleets, and on-site generation facilities and are better able to leverage analytical insights derived from analysis of energy data to select options with better energy efficiency. Consequently, energy consumption is likely to decline. In sum, CMS enables firms to understand their energy consumption and therefore enables them to implement initiatives to reduce their energy consumption. Hence, we hypothesize:

H1: CMS is negatively associated with energy consumption.

While CMS provides visibility to energy consumption, whether firms are able to leverage the data and insights on energy consumption also depend on the presence of complementary systems such as EMS. EMS comprises policies, procedures, and organizational structure for improving the environmental performance of firms. As EMS facilitates better monitoring of firms' processes (Boiral 2007), firms with EMS are likely to be more adept at leveraging insights and information obtained from CMS, and hence are better able to leverage on existing policies, procedures, and organizational structure to initiate actions that reduce energy consumption.

Firms without EMS can utilize insights and information from CMS to design initiatives to reduce energy consumption. However, such firms are likely to lack the complementary processes and procedures that enhances the effectiveness of sustainability initiatives. Therefore, they would not derive optimal benefits from such initiatives. In firms without EMS, there is a lack of strong monitoring system that helps ensure that initiatives are implemented in a proper and timely manner. Following the above arguments, we hypothesize:

H2: The presence of EMS moderates the relationship between CMS and energy consumption such that firms with EMS experience stronger negative relationship.

CMS are complex enterprise systems as they capture data from different processes, functions, and units in a firm (Melville and Whisnant 2014). The success of CMS depends on the decisions that managers make regarding firms' processes (Melville and Whisnant 2014). Managerial decision-making ability, in turn, depends on knowledge and capabilities of employees. Firms with HCD programs would have employees that are trained and skilled to understand the insights provided by CMS. Consequently, they would design better initiatives to reduce energy consumption. Such firms are also better able to retain skilled employees due to their vigorous and continuous emphasis on employee involvement and better compensation structure. Hence, firms are likely to be able to execute initiatives targeted at energy consumption in a better manner.

In contrast, firms without HCD tend to lack strong human capital. They have relatively less trained and skilled employees and may be unable to retain skilled employees. Hence, they are likely to lack employees with the strong know-how necessary to understand insights from CMS. Consequently, they are unable to design and effectively execute initiatives targeted at reducing energy consumption. Hence, we hypothesize:

H3: The presence of HCD moderates the relationship between CMS and energy consumption such that firms with HCD experience stronger negative relationship.

We present our research model in Figure 1.

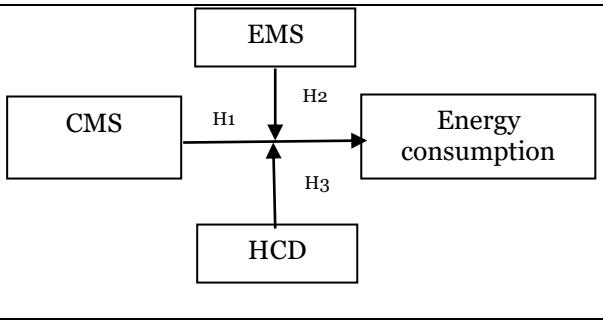

Figure 1. Research Model

Method

Data Collection

Our sample comprises firms that have been publishing annual sustainability report and announcing sustainability initiatives since 2009. We select 2009 as the initial cut-off year for our sample as green IS became a part of public discourse in 2008 (Chen et al. 2008). We use several secondary data sources such as annual sustainability reports and firms announcements archived on sustainability-related websites. We examine them to ascertain if the firm adopted CMS and the year of adoption. We obtain data on the presence of EMS and HCD in a firm from the KLD database. We use Bloomberg and firms' sustainability report to compile information on firms' energy consumption. We use two distinct measures of energy consumption, namely, energy intensity and aggregate energy consumption. Energy intensity is operationalized as energy consumed per unit of sales, whereas aggregate energy consumption is the total energy consumed by firms.

Analysis Approach

We analyze secondary data sources to ascertain firms that implemented CMS and firms that do not. We use percentage change in energy intensity and aggregate energy consumption two-year post the implementation of CMS as our dependent variable. We also control for factors such as organizational size, industry, and time. We use robust regression to test our model. We follow it with in-depth qualitative analysis of unstructured data available on firm's environmental sustainability to further understand how firms' leverage CMS.

Expected Implications for Research and Practice

The findings from this study will empirically demonstrate if the CMS is effective in reducing energy consumption. Our empirical analysis will also highlight if the relationship between CMS and two distinct measure of energy consumption are similar or different. If the findings support a significant negative relationship between CMS and energy intensity but do not support the negative relationship between CMS and aggregate energy consumption, it would highlight the limitations of information and insights on energy consumption in a firm in curbing the overall energy consumption. It would also highlight that reduction in energy intensity, which reflect improvement in energy efficiency does not ensure a reduction in aggregate energy consumption. This would also emphasize the need to approach firms' energy consumption from the sustainable consumption perspective. It would also underscore the need for governments and lawmakers to provide additional incentives to firms to reduce energy consumption.

If our findings suggest that firms achieve a reduction in energy intensity as well as aggregate energy consumption, it would indicate that CMS helps the firm to optimize their energy consumption. This would also indicate to managers that CMS helps firms to reduce the overall cost of revenue.

The support for our hypothesized moderating relationships would indicate the salience of EMS and HCD in realizing benefits from CMS. It would indicate to managers that mere adoption of a green IS artifact is not sufficient to achieve better environmental performance. Theoretically, our findings would highlight the need to approach green IS from a more nuanced perspective such as socio-materiality perspective that integrates technology with other actors.

Conclusion

In conclusion, there is limited empirical research on the effectiveness of specific green IS artifacts such as CMS. This study intends to fill this research gap by investigating the relationship between CMS and energy intensity/aggregate energy consumption. In addition, this study also explores the role of firm-specific factors such as the presence of EMS and HCD in realizing benefits from CMS. In sum, this study contributes to the present debate on the effectiveness of green IS. Future research could focus on other green IS artifacts to develop a more nuanced understanding of the role of green IS in achieving superior environmental performance.

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