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Xue Ning
University of Colorado Denver, xue.ning@ucdenver.edu

Jiban Khuntia
University of Colorado, Denver, jiban.khuntia@ucdenver.edu

Dobin Yim
George Washington University, dyim@gwu.edu

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Xue Ning
University of Colorado Denver
xue.ning@ucdenver.edu

Jiban Khuntia
University of Colorado Denver
jiban.khuntia@ucdenver.edu

Dobin Yim
The George Washington University
dyim@gwu.edu

Abstract

Hotels are generating a huge amount of waste. Management of these enormous amounts of waste produced by hotels is difficult. To mitigate this challenge, a systematic approach is needed, more so from the sustainable management perspective. However, implementing a sophisticated waste management system may be costly. This exploratory study focuses on how life cycle assessment system (LCAS) influences the waste management in hotels. Anchoring to organizational control theory, we argue that hotel reputation and ownership of a hotel will influence the effectiveness of LCAS. We posit that reputed, and corporate managed hotels will be able to leverage from LCAS implementation better for waste management. We also argue that the effect of reputation and ownership on waste management cost reduction will be mediated through the waste produced by hotels. Data of 1,277 hotels support our arguments. Implications and contributions are discussed.

Keywords

Life cycle assessment system, waste management, hotel, green IS, reputation, ownership

Introduction

Waste management is a considerable challenge for hotels. Most hotels produce upwards of 1 kg of waste per guest per day (Bohdanowicz 2005). Aggregating it to a total number of hotels and guests around the world, this is a significant amount. Food and beverage related waste, including packaging and food waste, aluminum cans, glass bottles, corks, and cooking oils are a significant portion of a hotel's waste. Housekeeping department generates waste such as cleaning materials and plastic packaging. Regular refurbishments in guest rooms, such as minibars, carpets, towels, and linens add to this waste. In addition to guest rooms, public areas, gardens (e.g., engine oils, pesticides, paints, and preservatives to grass and hedge trimmings) and offices (e.g., toner cartridges, paper, and cardboards) also contribute to the huge amount of waste generated from a hotel. To address this challenge, a systematic way of waste management facilitated by information systems are adopted by hotels. However, beyond technical factors, managers should consider many other factors such as sourced materials, resource availability, and human behavior when managing waste (Rahman et al. 2012). In this exploratory study, we focus on the waste management effectiveness of life cycle assessment system (LCAS), which has gained in acceptance as a powerful tool for waste management (Ekvall et al. 2007).

LCAS facilitate planning, implementation, and measurement of processes around waste management (Cherubini et al. 2009). Similar to the environment, health, and safety management system, LCAS measures potential environmental, health, and safety impact caused by production byproducts such as toxic waste. It also enables measurement of broader environmental impact from energy use such as electricity and water, recyclable materials, use of fertilizers, greenhouse gas emission, and so forth (Finnveden et al. 2009; Gössling 2015). Thus, LCAS is a comprehensive approach that uses data and information to analyze and evaluate direct and indirect environmental impact resulting from various treatment options of waste. LCAS helps to understand the "big picture" of water, energy, and materials used during productions and

operations. The broad system perspective makes LCAS a cogent system for environmental comparison of different options for waste management of a specific product, a material, or a complex waste flow (Cherubini et al. 2009; Ekvall et al. 2007). By tracking each activity along operational processes with quantitative data, managers can determine how much excess is produced and then adjust planning for future ordering of materials to prevent waste generation.

Prior research suggests that it is important to understand the information system as solutions for sustainability. For example, studies suggest that firms need management systems and tools that integrate environmental, health, and safety metrics with other process-related metrics within the company (Bowen et al. 2001; Hendricks and Singhal 2001). Firms need to adopt and align green technology and green product design frameworks (Chan et al. 2016; Singhal and Singhal 2002; Yenipazarli and Vakharia 2015). Despite the importance of green initiatives to reduce environmental impact and numerous calls for research on how information systems can contribute to environmental sustainability (Jenkin et al. 2011; Malhotra et al. 2013; Watson et al. 2010), few empirical studies provide a mechanism of green IS initiatives. Prior research on information systems has made impressive strides in explaining whether and how information systems contribute to performance at multiple levels (e.g., Dedrick et al. 2003; Melville et al. 2004; Mithas et al. 2016; Mithas et al. 2012). Still, we know very little about how green information systems with a lifecycle approach (as in the context of this study an LCAS) produces better outcomes.

An LCAS does not always result in good outcomes because of several reasons. First, these systems may not function effectively unless other resources, processes, and capabilities are in place, such as management systems, functional and technical expertise, and reliable measurement of baseline indicators (Aflaki et al. 2013; Martin 1993). In such cases, the organizational contexts and capabilities may prove to be inadequate or mismatched to produce positive effects of an LCAS. Second, firms may be investing in some of these systems according to different logics or being driven by a 'fad' effects that may not be consistent with mindful investment. Media announcements and advertisements associated with sustainability may be driving them to send positive signals through these implementations—which otherwise may not be integrated at the operational and process levels to accrue any value. Given these realizations, the effect of an LCAS on actual waste reduction and cost saving is a meaningful empirical question.

Motivated by the gap in prior research and practice insights, we pose two research questions: *What is the impact of LCAS on waste management, and how hotel's reputation and ownership influence LCAS for waste management cost reduction.* Unless it is integrated into the 'value chain' and 'life' of the hotels well enough, LCAS will remain as one of the several fads in sustainability management. Reputation and ownership act a market and bureaucratic controls, to orient a hotel's management activities—that we posit anchoring to the organizational control theory. Thus, reputed and corporate-managed hotels have incentives not only to implement the LCAS, but also to follow up with best management practices to derive better results, which then is reflected by better customer attraction, retention or stakeholder engagements. We test these effects using data of 1,277 hotels in the year 2016. We discuss implications and contributions of the findings.

Theoretical Background

Green Information Systems and Sustainability

Information systems research and sustainability issues are emerging as a forefront of academic discourse. Using IT to address sustainability challenges, and specifically to deal with waste management activities stems from the fact that various stakeholders such as customers, employees, and investors are demanding businesses to be sustainable (Jacobs et al. 2010; Khuntia et al. 2018; Klassen and McLaughlin 1996; Lee 2010; Toktay et al. 2006); and from the increasing attention of academic research that deals with sustainability considerations in different aspects of businesses, value chains, operations, and management (Atasu and Wassenhove 2012; Joshi and Li 2016; Krass et al. 2013; Lee 2004; Sroufe 2003). The overall discussion around the application of information systems for sustainability is broadly encompassed with the label of green information systems (green IS) or green information technology (green IT) research and is proposed to be a very important component of sustainable management. The context of green IS in managing waste at the operational and process level in an organization is relevant and emerging as a central piece of discourse in the recent IT/IS enabled business research, which should help in the energy consumption reduction (Khuntia et al. 2018) and carbon emissions monitoring (Melville 2010).

As much as prior research suggests green IS can be beneficial to track, monitor and manage sustainability indicators, but the effectiveness of green IS implementations may be dubious. For example, although IT can exacerbate sustainability problems due to increased energy consumption and carbon emissions with the large-scale adoption of personal computers, mobile phones, data centers, and carbon emissions from the IT devices and eventual disposal of electronic waste (Plambeck and Wang 2009; Seidel et al. 2013), IT/IS can also help to curb carbon emissions in economic sectors such as construction, power, transportation, and manufacturing (Boccaletti et al. 2008). Firms are increasingly looking for approaches to manage IT-related recycling practices (Atasu and Subramanian 2011; Ferguson et al. 2010; Subramanian et al. 2013; Subramanian and Subramanyam 2011). A plausible suggestion in this regard given by existing research is that firms need new strategies and processes to improve the sustainability (Chan et al. 2016; Singhal and Singhal 2002; Yenipazarli and Vakharia 2015), without which, appropriate leveraging from green IS implementations to sustainability outcomes may not be possible.

A paucity of empirical studies in information systems research examine the mechanism of green IS (Khuntia et al. 2018; Nishant et al. 2017). Research is silent on suggesting what it takes to make green IT/IS more assimilated and effective. Although prior IS research has made impressive strides to suggest that managing and governing activities related to IT/IS implementations with appropriate control mechanisms could help in appropriating higher value (Choudhury and Sabherwal 2003; Henderson and Lee 1992; Kirsch 1996; Kirsch et al. 2002; Kirsch 1997), we know little about how green IS can be controlled and managed to influence sustainability effectiveness. In addition, how these effects may differ at various other contingencies remains unexplored. This exploratory study fulfills these gaps in literature by exploring the LCAS effectiveness on waste management in hotels.

Waste Management and the Challenge of Green IS Implementations

Waste management is a complex phenomenon with a range of consequences for the involved stakeholders and the society. Solid waste generation and disposal are one of the most negative impacts of hotels on the environment (Radwan et al. 2012). Mounting costs of resources and impacts of waste could affect the income, environmental performance, and public image of the hotel sector (Kumar 2005). Practices implemented most frequently include collapsing cardboard boxes, sorting waste by type of material, crushing glass, and baling paper and cardboard. The practices implemented and the type of materials recycled varied by geographic location of the property, corporate's emphasis on the importance of recycling and reduction of waste disposal costs, and the infrastructure of the organization (Pirani and Arafat 2014).

In practice, a common hierarchy of solid waste management is waste minimization (reduce, reuse and recycle), followed by incineration and landfill (Singh et al. 2015). Several waste management strategies such as landfill without biogas utilization, landfill with biogas combustion to generate electricity, and direct incineration of waste have been discussed in previous studies (Cherubini et al. 2009). Multiple factors are considered and evaluated in the waste management process, including global and local emissions, total material demands, total energy requirements and ecological footprints (Leme et al. 2014). There are many tools for assessment of environmental impact, but one of the most commonly used technique is life cycle assessment (LCA). The broad perspective of LCA makes it possible to take into account the significant environmental benefits that can be obtained through different waste management processes (Ekvall et al. 2007).

Information systems and information technologies have been applied in the waste management process. As a powerful tool for the manipulation and analysis of spatial information, geographical information systems (GIS) are widely used to provide decision support for the solid waste management, including the waste generation capacity, waste collection paths, and waste disposal modes (Ghose et al. 2006; Khan and Samadder 2014). Governments are the main users of IS/IT in handling various municipal management issues such as solid waste management through various IT/IS implementation (Hannan et al. 2015). Prior research has provided evidence that a set of system assessment tools can be used to accumulate waste related information over time, to predict waste generation, and to provide specific decision support to link waste characteristics with waste disposal process, and to evaluate and assess the waste (Pires et al. 2011).

Organizational Controls

Organizational controls describe the primary mechanisms that organization use to direct attention, motivation, and encourage organizational members to act in desired ways to meet an organization's

objectives (Eisenhardt 1985; Ouchi 1979; Ouchi 1980). Organizations use certain control mechanisms to ensure individual organizational members act in a manner that is consistent with achieving desired goals (Choudhury and Sabherwal 2003; Henderson and Lee 1992; Kirsch 1996; Kirsch et al. 2002; Kirsch 1997). Thus, control is the organization's attempt to increase the probability that organizational members will behave in ways that lead to the attainment of organizational goals (Henderson and Lee 1992).

It has been proposed that markets, bureaucracies, and clans are the three mechanisms through which an organization can be managed to move towards its goals, and thus they are the three approaches to control manifestation in organizations (Ouchi 1979). These controls can be activated through outer or decentralized and inner or centralized ways, and work against the tendencies to deviate from the appropriate path and norms in an organization. Therefore, market control is reflected as decentralized control, bureaucratic control is suggested as centralized control, and clan control is typically maintained by keeping a set of values and beliefs as mixed control (Hirschi and Gottfredson 1995).

In the context of this study, the organization or the controller of the hotels is the large chain owner, while the individual hotels- either managed directly by corporate or franchised independently- are the organizational members that the hotel chain would like to lead to the goal of waste and cost reduction. The decentralized control or market control mechanism in this context then refers to the factors such as price, competition, or market share, while in the centralized control such as bureaucratic control, administrative or hierarchical techniques that create standards or policies are significant manifestations (Hirschi and Gottfredson 1995; Long et al. 2004; Ouchi 1979; Ouchi 1980). Thus, customer review of a hotel is the indicator of a decentralized control or market control. The individual hotel's ownership status, i.e., managed by the hotel chain or franchised is considered as factor that maintains bureaucratic control.

The fundamental problem is with the LCAS, how the hotel chain manages to obtain cooperation among individual hotels to realize the common objectives, i.e., reduce the waste produced by the individual hotels and in turn, reduce the cost of waste management (Birkinshaw et al. 2000). As by itself, an LCAS would not reduce waste; unless a hotel has the expertise to manage the waste relevant processes. Lack of resources to re-engineer business process aligned to waste management would be a problematic aspect of leveraging from an LCAS. Second, if a hotel does not have enough expertise in waste management, the LCAS will be a defunct system. Finally, incentives may be imperative to reduce the actual waste management, in which case, the LCAS itself will not have any effect. On the contrary, if a hotel has all the above contingencies in place, an LCAS will result in reducing waste very effectively.

Reputation as a Market Control for Hotel Waste Management

Market control is considered as a decentralized control, and usually, market control is maintained through competition, pricing or market share (Hirschi and Gottfredson 1995; Ouchi 1979; Ouchi 1980). Reputation is a significant factor reflecting the market control of a business entity, especially for the online marketplace in the recent year (Collier and Hampshire 2010; Tadelis 2016). As for the hotels, online reviews and rating manifest a hotel's reputation and thus are good indicators to inform the level of the decentralized market control. For instance, online review of a hotel reflects the reputation of the hotel in the market space and leads the hotel to achieve a benchmark in that reputational mechanism (Padovan et al. 2002; Tadelis 2016). Undoubtedly, this process is not only a signaling mechanism, but also a driver for customers' preferential choice for the hotel. Thus, the reputation and subsequent signal and choices work as a feedback loop to determine the actions that a hotel should take—in the context of this study, maintaining a thread in the signal about sustainable behavior through waste management (Collier and Hampshire 2010).

Reputed hotels that adopt LCAS tend to reduce waste because hotels want to maintain reputation. Popularity reflects reputation as the outer or decentralized control factor. For popular hotels, one customer's negative review may lead the hotel into problems, through word of mouth. Two aspects are important here. First, acquiring customers is difficult and costly. Hotels would like to continue existing customers by providing incentives. Second, one grunt customer may create havoc to a hotel's reputation, as negative words spread fast. Prior studies have revealed the significant effects of word of mouth such as the online reviews on the reputation and performance of a hotel (Cantallops and Salvi 2014; Sparks and Browning 2011).

Popular hotels would try their best to maintain reputation, and to do so they will try to be efficient in waste management. Otherwise, customers' perceptions of the hotel's green 'responsibility' will be reflected as bad。

In addition, popular hotels would try to enhance the reduce, reuse and recycle processes along with the LCAS to decrease waste. The criticality of maintaining social practices will also lead them to explore certain practices and norms-based solutions to waste management. Based on these arguments, we posit that reputed hotels will be able to leverage LCAS for waste management better to reduce the waste produced, and test this effect.

Ownership as a Bureaucratic Control for Hotel Waste Management

Centralized bureaucratic control is typically maintained through administrative or hierarchical techniques such as creating standards or policies, or management controls through corporate-managed in the context of this study (Cardinal et al. 2017). Bureaucratic control involves ownership control, reflected through coordination mechanisms and budget appropriation ways in the organizational context or structure. Indeed, the formal administrative structure of an organization may be viewed as a purposefully designed mechanism for exercising bureaucratic control. The context and structure of an organization along with managerial techniques reflect on the decision making or task directed leaderships (Birkinshaw et al. 2000). Thus, broadly there are two ways of the bureaucratic control-based decision making: the centralized way through which an organization developed a directed and delegated task-activity process to the lower levels, and a decentralized way, where the discretion is permeated to the lower levels through indirect channels than hierarchical delegation.

The corporate-managed hotels would have a direct hierarchical structure and ownership control, while the franchised hotels would have more indirect control through different mechanisms. Given the number of different subsidiaries, a hotel chain would need to have strong communications and decision makers to concentrate decision making at central offices (Harrauer and Schnedlitz 2016). Since delays would reduce local responsiveness and flexibility, while hotels need to allow local discretion yet maintain overall coordination and control, which can be accomplished with indirect controls, such as contractual stipulations or guidelines to operate. One may attempt to control behavior indirectly by relying on procedures and records as methods for limiting discretion and for monitoring activities. Within limits imposed by such indirect controls, decisions can be delegated to lower levels in the hierarchy, and to employees in specialized roles, some of whom are concerned with operating the indirect control system itself (Smith and Bititci 2017).

Thus, turning the attention to the internal centralized control through the ownership management, we focus on the difference in approach to using LCAS across a corporate-managed and a franchised hotel. The corporate-managed hotels have a higher dependency on the headquarter of the corporate, relevant to resource allocations, overseeing of activities, and adherence to specific management approach (Birkinshaw et al. 2000; Songini and Gnan 2015). Whereas, a franchise hotel may be quite independent to take decisions regarding the property, while adhering to the overall norms and guidelines set up by the hotel chain.

Corporate managed hotels have to align and follow the practices started and put in place by the headquarters. Denial to follow these approaches may lead the hotel's headquarters to limit budget, resource or benefit allocations to the hotel (Songini and Gnan 2015). Astringent oversight not only percolates to efficient implementation, follow up and management of LCAS, but also aligns other resources and capabilities to make the system to get success. In addition, frequently, with a systems implementation, a corporate generally implements a set of performance measures to monitor and report marketable indicators (Pereira-Moliner et al. 2015).

Therefore, we argue that corporate managed hotels are under the centralized bureaucratic control of ownership management to follow the headquarters' orders. This internal control mechanism reflects in resource allocations, supplies ordering, operational support, marketing and visibility support provided to the hotel. Not being able to follow the headquarters will lead to decreased support while lacking complementary approaches in resources and capabilities will lead to low profit sharing. Because of these reasons, corporate managed hotels will put their best to appropriate and leverage from an LCAS. So, we posit and test that corporate managed hotels will be able to leverage LCAS for waste management better to reduce the waste produced in comparison to the franchised hotels.

Mediation Effect of Waste Produced by Hotel

The waste generated by a hotel reflects as an interim outcome of the LCAS implementation effectiveness. As hotels accrue values of reduction of the waste, through the evolving process of LCAS and the controls that can motivate and lead to the better functional integration of the LCAS. Indeed, LCAS implementation is learning and progressing activity. With time a hotel will progress through different stages of this learning, integrating with operational processes, functional specializations and decision-making characteristics, as well as a collective team-based management and integration process. The progression enables staff, customers, and managers to acquire both individual and collective capabilities, skills and expertise in managing waste. For example, the customers will follow the staff in segregating waste. The progression helps to develop capabilities to convert LCAS and aligned complementary resources to waste reduction, and further hone skills of staff that are crucial for orienting all the waste management activities for cost reduction. More control aligned LCAS implementation will result in higher waste reduction, but not all the efforts could result in lowering the cost of waste management if the firm does not have additional functions, processes and understanding through waste management related functional specialization and expertise. Nevertheless, when considerable organizational learning and expertise is developed, the waste reduction accomplishments will leverage the resources and capabilities even more effectively to reduce cost. Thus, we argue that the influence of LCAS and control mechanisms alignment of a hotel on total waste management cost reduction is mediated by the total waste produced by a hotel.

Method and Results

The data for this study comes from a large multinational hotel chain. The hotel chain has several brands under its flagship and has locations across the world. The dataset comprises of waste data of 1,277 properties for a single year in 2016. As part of the enterprise-wide program to adopt LCAS since 2009, the dataset reports waste management progress of the properties that are corporate managed and independently owned. The dataset contains property characteristics such availability of rooms for guest, services offered such as laundry, banquet, as well as calculated measures such as greenhouse gas (GHG) produced (i.e., CO_2), cost of waste disposal, and so forth. The descriptions of variables are shown in Table 1.

Variables	Description
COST	Total cost of waste disposal measured in dollars (log-transformed).
WASTE	Total waste that a property produces reported, measured in tons (log-transformed).
REVIEWS	Volume of reviews for a property. Total number of reviews was divided by 100.
LCAS	Whether a property adopted *lifecycle assessment software platform or system* to measure and report various waste. The waste reporting items include recycled materials (i.e., glass, plastic, metal, etc.), carbon emission generated from electrical and gas use, food waste, etc. A positive value (e.g., 1) indicates a property has adopted LCAS.
MANAGED	Whether a property is managed a corporate office. A property may be owned by corporate or franchised to an independent owner. A property owner may choose to allow corporate office to manage all of its operations. A positive value (e.g., 1) indicates a property is managed by corporate office.
MONITOR	Whether a property measures food waste. A positive value (e.g. 1) indicates a hotel measures food waste.
INTL	Whether a property is located outside of U.S.
CO2	Total carbon emission measured in pounds (log-transformed).
LAUNDRY	Total waste produced from laundry services, measured in pounds (log-transformed).
BANQUET	Total waste produced from banquet services, measured in pounds (log-transformed).
AVAIL	Total number of nights a hotel's rooms were available for stay (log-transformed).
OCC	Occupancy rate, a ratio of rooms rented to hotel guests and availability for a stay.
MONTHS	Number of months a property has completed waste measurement
RATING	Average rating of a hotel on a scale from 1 to 5

Table 1: Descriptions of Variables

Our key variable of interest is whether a property has adopted LCAS to measure waste. Not all the properties have LCAS in place. Thus, properties with LCAS are treatment group, which allows us to compare the effect of LCAS on waste generation. We consider several variables to control for variance of waste generated across hotel properties. First, number of guests occupying rooms needs to be controlled. We use room availability

and occupancy rate to control for the guests' effect on waste generation. In addition, we further control for guest services such as laundry and banquet services to account for different types of services that guests use. Third, energy demand such as variation in temperature is controlled through CO2 emission, measured in lbs. In addition to data provided by the hotel chain, we collected online reviews data as a proxy variable to gauge popularity in a particular hotel. We also collect average rating of the hotel to control the hotel status. The datasets are merged to conduct our empirical analyses.

	Variables	Mean	SD	MIN	MAX	1	2	3	4	5	6	7	8	9	10	11	12	13
1	COST	15.34	1.04	8.88	19.13	1												
2	WASTE	4.18	1.59	0.01	12.17	0.44	1											
3	LCAS	0.14	0.35	0.00	1.00	0.19	0.15	1										
4	REVIEWS	9.56	12.14	0.02	123.20	0.36	0.26	0.09	1									
5	MANAGED	0.20	0.40	0.00	1.00	0.36	0.28	0.19	0.28	1								
6	MONITOR	0.27	0.45	0.00	1.00	0.18	0.12	0.67	0.11	0.18	1							
7	INTL	0.12	0.33	0.00	1.00	0.21	0.10	0.32	0.09	0.38	0.27	1						
8	CO2	15.35	1.04	8.78	19.13	1.00	0.44	0.19	0.36	0.36	0.18	0.21	1					
9	LAUNDRY	2.00	4.42	0.00	17.73	0.38	0.23	0.18	0.21	0.35	0.14	0.37	0.38	1				
10	BANQUET	1.06	2.61	0.00	12.04	0.32	0.22	0.13	0.14	0.25	0.10	0.24	0.32	0.59	1			
11	AVAIL	10.93	0.73	0.00	13.47	0.58	0.40	0.20	0.36	0.25	0.19	0.09	0.58	0.34	0.28	1		
12	OCC	75.23	10.90	0.00	97.70	0.01	0.11	-0.05	0.17	-0.07	-0.03	-0.24	0.01	-0.05	-0.07	0.26	1	
13	MONTHS	2.00	4.19	0.00	12.00	0.13	0.05	0.17	0.06	0.16	0.16	0.36	0.13	0.27	0.17	0.10	-0.09	1
14	RATING	4.55	0.54	2.00	5.00	-0.08	-0.07	-0.02	0.12	-0.04	-0.01	0.09	-0.03	-0.03	-0.07	-0.03	-0.01	0.05

Table 2: Summary Statistics and Correlation Coefficients (N: 1,277)

Table 2 shows summary statistics and pairwise correlations of key variables used in our study. We observe that the distribution of waste produced, and costs incurred to handle waste is positively skewed, reflecting variation in waste management behavior across properties. Thus, we log-transform with zero inflation for this variable to reduce skewness in our analysis. Likewise, we log-transform cost with zero inflation for our analyses. Due to the large occurrence of zero values in our dependent variables – i.e., total waste generated (tons) and costs incurred to handle waste ($) – we use Tobit estimation approach to test our hypotheses. Tobit model has a unique feature that controls for censored outcomes in the data distribution at both tails. The model allows latent or unobserved factor that generates censored outcomes. Thus, we model both left (i.e., censoring values below y_L) and right censored outcomes (i.e., censoring values above y_H), which can be specified as:

$$y_i = \begin{cases} y_i^* & if\ y_L < y_i^* < y_H \\ y_L & if\ y_i^* \leq y_L \\ y_H & if\ y_i^* \geq y_H \end{cases}$$

Where, the latent or unobservable dependent variable y_i^* linearly depends on x_i using a parameter vector of β. The observable variable y_i is defined to be equal to the latent variable whenever the latent variable is above zero and zero otherwise. There is a normally distributed error term u_i that captures the random influences on this relationship. Thus, y_i^* can be specified as:

$$y_i^* = \beta x_i + u_i, u_i \sim N(0, \sigma^2)$$

Our empirical model specifies waste management and cost incurred upon waste disposal as key dependent variables. We also test mediation model, where total waste generated mediates cost of waste disposal. Formal specification of our general model is as follows:

Waste Model: $WASTE_i = \beta_0 + \beta_1 LCAS_i + \beta_2 REVIEWS_i + \beta_3 MANAGED_i + \beta_4 REVIEWS_i \times LCAS_i + \beta_5 MANAGED_i \times LCAS_i + \beta_c Controls_i + \varepsilon_I,$ (1)

Cost Model: $COST_i = \beta_0 + \beta_1 LCAS_i + \beta_2 REVIEWS_i + \beta_3 MANAGED_i + \beta_4 REVIEWS_i \times LCAS_i + \beta_5 MANAGED_i \times LCAS_i$

$+ \beta_6 WASTE_i + \beta_c Controls_i + \varepsilon_I,$ (2)

Where *Controls* are control variables. We use the Tobit model with instrument variable, a hotel's operations efficiency score, to control for self-selection associated with LCAS adoption, to estimate the β coefficients of the key parameters and employ robust standard errors to test our arguments. Last, ε are disturbances associated with each observation.

Results

Table 3 shows our main results. We find that the interaction REVIEWS x LCAS is negatively associated with the WASTE (see Column 1, Table 3, *β =-0.068, p<0.1*). Similarly, the interaction MANAGED x LCA is negatively associated with the WASTE (see Column 1, Table 3, *β =-3.215, p<0.01*).

	(1)	(2)
	WASTE	**COST**
REVIEWS x LCAS	**-0.068* (0.03)**	0.050 (0.03)
MANAGED x LCAS	**-3.215*** (1.57)**	0.777 (1.24)
LCAS	5.547* (2.85)	-2.797 (2.27)
REVIEWS	0.023** (0.01)	0.003 (0.01)
MANAGED	0.481** (0.19)	-0.053 (0.14)
WASTE		**0.212*** (0.03)**
Chi-sq.	320.10***	529.28***
Wald-test of exogeneity	4.70**	2.08

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Models include all controls; N=1277.

Table 3: Key Estimation Results

We find WASTE is significant in the COST model (see Column 2, Table 3, *β =0.212, p<0.01*). Because the independent variables are also significant in WASTE models, this indicates that the effect of the independent variables on COST is mediated through the WASTE variable. To check the mediation effects, we conducted Sobel's mediation tests, which show that the mediation effects are significant at p<0.01 levels. The Sobel tests indicate a partial mediation of less than 50% mediation effect through WASTE.

Discussion

Research Implications and Contributions

The study provides three principal contributions to green IT/IS area of research. First, this study is among the first studies to provide evidence on the contingencies associated with LCAS effectiveness. Our findings suggest that green IS is effective when aligned to internal and external control mechanisms and need to establish additional processes. This suggests hotel to take a holistic approach to green IS investment and implementations, instead of evaluating more from the 'political and social fad or not' perspectives. We do establish when and how LCAS are effective to waste and cost reduction-a positive and key indicator for firms. Future research can investigate other performance implications of similar green IS implementations, such as customer satisfaction, stock market reaction and inform how much strategic importance to attach to a specific green IS solving a less-discussed and key issue, such as waste management.

Second, this study contributes by examining how the overall effectiveness of green IS implementation is mediated through its direct effect on waste reduction. Existing research has called to explore sustainability and economic performance of green IS implementations with a more nuanced lens (Linton et al. 2007), which the current study fulfills. Future research can study other mechanisms for the effect of LCAS implementation, such as profits, hotel occupancy, reduction in capital costs and thereby saving interest costs, responsible disposal and recycling, and reduction in operating efficiencies in areas other than waste management.

Third, our study findings go beyond examining the linkage between green IS implementation and effectiveness with a view from internal and external value chain and control perspectives—as suggested by extant research (Kleindorfer et al. 2005). Along with operational imperatives, operational orientation is a critical factor to leverage from the green IS. The contrast in the findings with respect to direct impacts of the green IS vs. control mitigated effects, suggests the importance of the two-pronged strategy of inward-looking and external-facing green IS implementation strategies. Both need to work in tandem to create value—that future research can explore and assert, possibly taking an IT duality perspective discussed in information systems research (Mithas and Rust 2016).

Limitations and Future Research Suggestions

Our study has limitations which can be starting points for future research. First, while we controlled for important variables that are likely to be correlated with the focal variables and dependent variables, other omitted factors may affect the relationships in the model. Because of these data limitations and the use of a cross-sectional design, our results are associational in nature, and do not establish causality. Second, the data for this study were collected for hotels in the United States. This may be a concern for generalizing the study to other countries, specifically in those where either sustainability is not a concern, or the ones where the sustainability approach is at an advanced stage of policy and practice. In either case, future scope of research is wide open to explore in these lines.

The study opens several other opportunities for future research. The study informs to the life cycle assessment approach to sustainability impacts (Hendrickson et al. 2006). However, the operationalization of the aspects that may be involved in this approach such as product designers, service providers, government agents, and individuals to make choices for the longer term and with consideration was not done (Hendrickson et al. 2006). Life cycle assessment approaches avoid shifting problems from one life cycle stage to another, from one geographic area to another and from one environmental medium (for example, air quality) to another (for example, water or land). Possibly, future studies may explore beyond only LCAS implementations to the complete LCAS approach, and the long-term viability impacts of such approach.

In conclusion, this study provides one of the first empirical tests to assess how LCAS and control mechanisms can create effective value in terms of waste reduction and cost reduction of waste management. The study argues that LCAS needs alignment to process and practices to accrue favorable outcomes in terms of waste and cost reduction. We found that tighter bureaucratic control through corporate management linkage and external control through review-popularity reflections do influence the LCAS effectiveness. Furthermore, we found that waste reduction outcome through enabling LCAS implementation is a critical mediator for waste management cost saving. Taken together, the findings contribute to research on green IS for sustainability and inform to the life cycle assessment-based systems' effectiveness within the plethora of green IS research area.

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