SIGNALING ECO-CERTIFICATION: IMPLICATIONS FOR SERVICE COPRODUCTION AND RESOURCE EFFICIENCY

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Abstract

Purpose – The purpose of this paper is to use an eco-friendly service concept framework to demonstrate the effect of credible eco-certification signaling.

Design/methodology/approach – The authors examine a cross-sectional data set consisting of 2,481 hotel sites across the US. The authors measure the performance of the operations component of eco-friendly service by operations-driven resource efficiency (ODF), and the performance of the marketing component by customer-driven resource efficiency (CDF). A series of multivariate regressions compare these two resource efficiency measures between credibly eco-certified hotel sites and others.

Findings – The results indicate that credible eco-certifications achieve the signaling effect. Eco-certified hotels outperform others in both ODF and CDF measures; and eco-certified hotels still achieve higher CDF after controlling for ODF.

Practical implications – The findings suggest that eco-friendly service design requires not only eco-friendly operations but also a built-in credible signaling mechanism. This mechanism engages the customers in eco-friendly service coproduction and in doing so integrates the operations and marketing components of eco-friendly service strategy through eco-certifications.

Originality/value – This study is among the first to demonstrate empirically the signaling effect of credible eco-certifications in services. It increases understanding of eco-friendly service design and delivery by exploring the role of credible eco-certifications in linking customer benefits with the service organization's strategic intent.

Keywords – Resource efficiency, Service delivery system, Services management, Eco-friendly service concept, Service coproduction, Signaling effect

Signaling Eco-Certification: Implications for Service Coproduction and Resource Efficiency

Introduction

Customers expect businesses to address environmental issues. For example, in the 2011 Cone/Echo (2011) Global Corporate Responsibility Study, 96 percent of respondents indicated that it was “very important” (69 percent) or “important” (27 percent) that businesses address environmental issues. However, addressing such expectations can be tricky because customers often are not privy to the environmental impact of goods and services or their production practices (Miles and Covin, 2000; Nelson, 1970; Shrivastava, 1995). This phenomenon is known as information asymmetry between the organization and their customers (Mason, 2006, 2012; Stigler, 1961). Many eco-certifications have emerged to address such asymmetry. An eco-certification typically includes a set of standards for voluntary, eco-friendly practices and an ecolabel or logo guaranteeing that goods and services meet these standards. Thus eco-certifications are intended not only to produce more eco-friendly goods and services but also to provide relevant information to customers.

However, there appears to be widespread customer confusion accompanying the profusion of eco-certifications. For example, customers often do not understand the meaning of an eco-certification nor what it guarantees (Berg, 2011; CMIGreen, 2010; Rheem, 2009; Terrachoice, 2009). This phenomenon begs the question: when the customer is informed of a business’s eco-friendly services through eco-certification, does such certification lead to more eco-friendly service? Credible signaling (i.e. informing customers of a business practice through use of credible certification) has been shown to lead to desired outcomes in markets as diverse as labor and used autos (Akerlof, 1970; Spence, 1973). Yet questions regarding signaling effect in

service settings remain unanswered. Central to signaling effect is the credibility of an eco-certification, which depends on the certifying entity and the audit requirement (Pullman and Sauter, 2012) This study investigates how the credibility of various eco-certifications correlates to environmental outcomes in services.

At the strategic level, the customer confusion mentioned above indicates a service design failure where the organization's strategic intent (i.e. to deliver eco-friendly service) is disconnected from customer perception. Service design research (Clark et al., 2000; Edvardsson and Olsson, 1996; Edvardsson et al., 2013; Goldstein et al., 2002), therefore, can benefit from understanding the signaling effect of eco-certification. Specifically, we are interested in understanding how credible signaling may contribute to aligning an organization's strategic intent to provide eco-friendly service with their customers' perceptions and subsequent responses during service. This alignment is critical to integrating the operations and marketing of eco-friendly service. To this end, this study examines the resource efficiency differences across eco-certifications with varying levels of credibility in a sample of 2,481 US hotel sites. Hotels are typical service settings where the service organization and its customers coproduce the service experience (Chase et al., 1984; Foster Jr et al., 2000; Sampson and Froehle, 2006).

The findings indicate that credible eco-certifications achieve the desired signaling effect: eco-certified hotels outperform others in both operations-driven resource efficiency (ODF) and customer-driven resource efficiency (CDF) measures; and eco-certified hotels still achieve higher CDF after controlling for ODF. The additional CDF gain associated with credible eco-certification highlights the benefits of integrating the operations and marketing components of the eco-friendly service concept. This study contributes to research on service design for

environmental and sustainable hospitality by providing a maiden demonstration of the effect of signaling in service settings using a large archival data set.

The remainder of the paper is organized as follows. Section 2 reviews relevant literature on service design and signaling games and proposes an eco-friendly service concept framework. Section 3 describes the empirical research design. Section 4 reports and interprets the results. Section 5 concludes by discussing the theoretical and managerial implications of the study.

1. Theory development and hypotheses

2.1 Eco-friendly service concept: operations and marketing components

Prior research shows that market acuity, or orientation, plays a key role when service organizations consider innovations to better meet customer needs (Agarwal et al., 2003; Menor and Roth, 2008; Victorino et al., 2005). The outcome of these innovation and design efforts depends on multiple strategic factors, the most important of which is the service development strategy (Edvardsson et al., 2013). Goldstein et al. (2002) argues that the service concept is the core element of a service development strategy. Specifically, the authors propose a service concept framework in which the service concept defines the how (i.e. operational specifications for how to deliver the service to customers, also known as the operations component) and the what (i.e. which customer needs and wishes are to be satisfied, also known as the marketing component) of service design. More importantly, Goldstein et al. (2002) argues that the service concept must ensure the integration of these two components (the how and the what) so that the organization's strategic intent aligns with customer needs. Researchers have found this service concept framework useful in understanding various design issues related to service innovation and customer experience (Dixon and Verma, 2013; Stuart and Tax, 2004; Verma et al., 2001;

Victorino et al., 2005). In this study, we apply the service concept framework to the context of environmental sustainability in the hope of helping service organizations design and deliver the eco-friendly services that their customers expect. To this end, we introduce an eco-friendly service concept (Figure 1) as the core element of an eco-friendly strategy that contains: eco-friendly practices as the operations component, and customer need for and perception of eco-friendly features as the marketing component.

Extensive research has focused on the marketing component of an eco-friendly service concept. In the hospitality industry, for example, studies based on surveys and experiments have contributed to a good understanding of customer needs for eco-friendly offerings (Esparon et al., 2014; Han et al., 2011; Manaktola and Jauhari, 2007; Millar and Baloglu, 2011; Susskind and Verma, 2011). These studies have found that customers generally are aware of green initiatives and are willing to be engaged. Findings include positive customer attitude toward green hotels, stronger intention to visit them, positive word-of-mouth communication, and willingness to pay more for them than for non-green hotels. The next step in this research stream is to examine the actual environmental outcomes resulting from customer awareness and intentions.

The operations component of an eco-friendly service concept centers on the operational specifications and the service delivery system. International standards such as the ISO 14000 series and industry guidelines stipulate criteria for organizations to meet in order to make eco-friendliness claims. For example, concerted efforts in the hospitality industry have resulted in Global Sustainable Tourism Council (GSTC) Criteria. The environmental guidelines of the GSTC address resource consumption, pollution reduction, and conservation of biodiversity and landscapes. Key inputs for the eco-friendly service concept thus include basic resources used for

service production and delivery such as energy, water, and materials. Corresponding to the inputs, a key performance indicator of the eco-friendly service outcome is resource efficiency.

Integrating the marketing and operations components of an eco-friendly service concept remains a challenge, with implications for both practice and theory. In particular, the misalignment between the strategic intent and customer perception surrounding eco-certification clearly indicates a need for further research. Service is a “whole experience” that emerges from interacting parts (Goldstein et al., 2002; Maglio and Spohrer, 2008). The interactions happen while customers and service organizations coproduce the service experience (Chase and Tansik, 1983; Chase, 1978; Gupta and Vajic, 2000; Roth and Jackson, 1995; Sampson and Froehle, 2006). As a result of the interactions and coproduction efforts, eco-friendly service design must engage both the service organization and its customers in order to achieve the desired environmental outcomes, such as using resources more efficiently. For example, linen and towel reuse programs are the most common environmental initiatives to improve energy and water efficiency in hotels (AH&LA, 2008) in which housekeeping staff are trained and signs are placed to inform customers. But it is still up to customers to act on the suggestions and work with staff to achieve desired resource-efficiency gains. In order to investigate the extent of marketing and operations integration while also assessing the contributions of the service organization and customers separately, we use a two-factor resource efficiency measure that has an operations-driven factor and a customer-driven factor (CDF) (Zhang et al., 2012b). Figure 1 summarizes this discussion using an eco-friendly service concept framework. It illustrates an application of the service design planning model proposed by Goldstein et al. (2002) in the context of eco-friendly services.

Figure 1 shows how an eco-friendly service concept drives the service coproduction between the service organization and its customers and ensures the alignment between the eco-friendly strategic intent and customer responses. The dotted lines highlight the focus of our empirical model, which examines the effect of credible signaling on service coproduction and subsequent performance outcomes.

1.2 Eco-certification signaling in services

Prior studies in manufacturing settings have argued that eco-certifications such as ISO 14001 impact internal operations through a set of standard practices and then communicate the use of these practices to external stakeholders through ISO certification system (Delmas, 2001; King et al., 2005). King et al. (2005) found that ISO 14001 certification is positively associated with a functioning environmental management system and that organizations are more likely to certify with ISO 14001 as asymmetric information increases. Improved communication with external stockholders by using ISO 14001 is consistent with signaling games theory, positing that credible signals are effective in reducing the information asymmetry between sellers and buyers (Akerlof, 1970; Connelly et al., 2011). However, these studies of ISO 14001 certifications do not directly test the signaling effect of eco-certification in a game theoretical sense because they examine the signal sender (i.e. the organization) only and do not explicitly consider the signal recipient's response (i.e. the customer's response). An inherent information asymmetry exists between the service organization and end customers regarding the eco-friendliness of services because the eco-friendliness of a service often derives from switching to renewable energy sources and adopting eco-conscious materials and processes. These credence attributes are difficult to perceive by customers through observation (Nelson, 1970, 1974). However, because the signal recipient (i.e. the customer) functions as a coproducer of the service and we can proxy

their response to eco-certification by their resource consumption outcome, we have a unique opportunity to directly test eco-certification signaling effects in services.

For hospitality services, these credence environmental attributes are often associated with energy-efficient facilities and eco-friendly procedures that remain fixed from one service encounter to the next. Information asymmetry in this context is known as adverse selection, for which credible signals such as eco-certification are viable ways to help customers distinguish between eco-friendly service organizations and others (Kirmani and Rao, 2000).

Eco-certifications differ in their certifying entity and audit requirements (Pullman and Sauter, 2012). First-party or self-certifications are claims made either by service organizations themselves or through industry groups and do not involve outside verification. In this case, "eco-friendly" has no substantive meaning because it is not regulated or verified. By contrast, second-party certifications are granted by a purchasing entity that emphasizes "user's perspective" interest in the product or service. Some second-party certifications require audits. Third-party certifications are granted by an independent party that has no vested interest in the outcome and conducts an audit to determine whether standards are met. Survey evidence has shown that customers look for third-party verification when they face a myriad of eco-certifications (CMIGreen, 2010). It stands to reason that, from the customer's point of view, self-certification or second-party certification without external verification offers little assurance of the credence environmental attributes of the services.

This study distinguishes between two groups of hotels to reflect the customer's perspective. First, we assign the "eco-certified" designation to service organizations that are certified by third parties that have no vested interest in the business outcomes or by second-party purchasing or trade organizations. Eco-certified service organizations must also guarantee audits

of their claims. The second group of service organizations includes those that are un-certified, self-certified, or second-party certified without external verification. In short, eco-certified service organizations provide credible signaling, while those in the other group do not.

If there is no signal or signals fail to credibly convey information to customers, Akerlof (1970) predicted that a “market of lemons” (e.g. a market filled with low-quality, used cars only) would result because uninformed buyers would make low offers that were only profitable for low-quality cars. The “bad drives out good” scenario could also play out in services: if customers perceived that all service organizations were disinterested in the environment and made decisions based on criteria other than eco-friendliness, service organizations would have no incentive to offer eco-friendly services.

Bond (1982) directly tested the “market of lemons” prediction in an empirical study of used pickup trucks by comparing the probability that owners would do maintenance on two types of trucks – those purchased used vs those purchased new. The purchase choice is the market response to credible signals such as a warranty. The test found no difference in the probabilities of aftersales maintenance between trucks acquired new and those acquired used, controlling for the model year and life mileage of the truck. This finding shows a signaling effect that prevented the “market of lemons” from happening (Bond, 1982). That is, customers were informed by the signal and able to tell good cars from bad ones. In the marketplace, good cars and bad cars co-exist but sell for differential prices.

Using Bond’s logic in the context of eco-certification signaling, we compare the resource efficiency measures – operations driven as well as customer driven – between eco-certified service organizations and others. If eco-certifications effectively signal the underlying eco-friendly technologies and procedures, then customers are informed and able to tell the two

groups apart. Given the current context of increasing customer demand for eco-friendly services, this information should influence customer choice and subsequently the environmental outcome of service coproduction (depicted as the credible signaling step in Figure 1). Therefore, we expect to observe the following resource efficiency patterns: the eco-certified service organizations demonstrate higher resource efficiency in their operations than others; and the customers of eco-certified service organizations also demonstrate higher resource efficiency. We thus propose the following two related hypotheses:

> ***H1***. Eco-certified service organizations achieve higher resource efficiency driven by operations than service organizations in the "others" group.
>
> ***H2***. Eco-certified service organizations achieve higher resource efficiency driven by customers than service organizations in the "others" group.

Evidence supporting *H1* means that the practices codified in eco-certification guidelines do help service organizations reduce the environmental impact of their operations. It also confirms the credibility of the eco-certification signal adopted by the eco-certified service organizations.

Evidence supporting *H2* means that the certification system of eco-certification communicates effectively to customers regarding the service organization's eco-friendly practices. Informed customers respond to the signal by either choosing eco-certified service organizations over others and/or behaving in a more environmentally responsible manner. In either case, the service organization's strategic intent (i.e. deliver more eco-friendly service) aligns with customer needs and perception (i.e. experience more eco-friendly service), showing successful integration of the operations and marketing components of an eco-friendly service concept.

Service organizations apprehensive about potential backlash from eco-certifications (Bonini and Oppenheim, 2008) may choose to implement green practices without being officially certified. For example, researchers found that wine producers have implemented eco-certification practices without labeling them as such for fear that consumers would perceive their wines as inferior (Delmas and Grant, 2014). In services, however, there is empirical evidence that customers generally respond positively to environmental initiatives (Han et al., 2011; Susskind and Verma, 2011) and that eco-certification is the most influential green attribute (Millar and Baloglu, 2011). We therefore posit that eco-certification signaling helps service organizations attract more eco-conscious customers in the following hypothesis:

> ***H3.*** Controlling for ODF, eco-certified service organizations achieve higher CDF than service organizations in the "others" group.

Evidence supporting *H3* means that the signaling mechanism provides additional resource efficiency gain by informing customers of the credence environmental attributes of services and by influencing customers' purchase choices and consumption behavior during their stays.

2. Research method

3.1 Sample

We test these hypotheses using a sample of 2,481 hotel sites across 48 US states and Washington DC, which includes 336 eco-certified hotel sites (13.54 percent) and 2,145 hotel sites in the other group (86.46 percent). Our sample is representative of all market segments, property types, geographic locations, major hotel chains, and independent hotels.

The sample resulted from merging two data sets that were collected around the same time in early 2012. The first data set is derived from Year 2011 operating statements at individual

hotel properties. The Appendix details the survey and data management mechanisms by our data partner PKF Hospitality Research (PKF-HR). The second data source is the Travelocity.com Green Hotel Directory. Travelocity's Green Hotel Directory awards eco-friendly designation (demonstrated using an ecoleaf symbol on the hotel description page at Travelocity.com) to hotels certified by second and third parties whose standards closely align with the GSTC and who can guarantee an audit (Travelocity, 2011).We use archival data, which are appropriate for our investigation because they offer comprehensive information on the actual outcomes from consuming fundamental resource inputs (i.e. electricity, water, and materials), operating performance measures (e.g. revenue per available room and occupancy rate), eco-certification signaling, and hotel site characteristics including star ratings, number of rooms, and property type.

North and South Dakota are the only two states that do not have hotels represented in the combined data set. A small number of hotels in these two states participate in the Trends® in The Hotel Industry survey by PKF-HR and none of them was awarded ecofriendly designation at the time of data collection.

3.2 Eco-friendly strategy outcome variables

Resource consumption is a primary concern in environmental sustainability (Meadows et al., 1972). Moreover, increasing cost efficiency is a chief competitive weapon in operations strategy (Jacobs and Chase, 2012, p. 30). Thus a key issue in designing and delivering eco-friendly services revolves around understanding the common factors that drive the cost efficiency of fundamental resource inputs. Fundamental resource inputs in hotel operations mainly consist of utilities and materials. We apply the environmental performance benchmarking method developed in Zhang et al. (2012b) to capture the performance outcome of the operations

and marketing components in the eco-friendly service strategy. Specifically, we apply exploratory factor analysis to five resource expense items: electricity cost, water and sewer cost, supplies used by the rooms department, supplies used by the food and beverage (F&B) department, and supplies used by the maintenance and engineering department. For resource efficiency benchmarking purposes, all five expense items are normalized by the revenue per available room. We refer the reader to Zhang et al. (2012b) for a more detailed discussion of this benchmarking method.

Table I reports the EFA factor loadings of the two factors extracted. The loadings are used as weights for calculating the factor scores, which measure the level of resource efficiency for every unit of revenue generated. The customer-driven factor score (CDF) of a hotel site is a normalized cost efficiency measure of resource consumption driven by customer decisions as indicated by the higher loadings associated with supplies consumed in the rooms and F&B departments in Table I. The operations-driven factor score (ODF) measures the resource consumption efficiency of the service organization as indicated by the higher loadings associated with utilities and maintenance expenses. All five resource inputs consumed in service coproduction contribute to the two factor scores. Negative scores indicate higher resource efficiency than the sample average, while positive scores indicate the opposite. CDF and ODF measure the environmental outcomes of the service coproduction system as driven by the eco-friendly service concept. Specifically, CDF (the resource efficiency driven by customers) measures the marketing component, while ODF (the resource efficiency driven by operations) measures the operations component of the eco-friendly service concept.

3.3 Model specifications

In order to test the proposed hypotheses, we use a series of regression models that compare the resource efficiency measures between eco-certified and other hotels. The regression model specification for *H1* is:

$$Model\ 1: ODF = \alpha + \beta_1 * ecoleaf + y * Z + \varepsilon$$

where the ecoleaf indicator represents the eco-certification designation of each hotel site and *Z* is a set of control variables explained in the next Section 3.4. Ecoleaf equals 1 for eco-certified hotels, 0 for others. We expect β_1 to be negative. Empirical evidence that shows higher resource efficiency (i.e. lower factor score) driven by operations for eco-certified hotels will lend support to *H1*.

Next, we turn to the marketing component by comparing the CDF between the eco-certified and other hotels in Model 2:

$$Model\ 2: CDF = \alpha + \beta_1 * ecoleaf + y * Z + \varepsilon$$

If a good understanding of customer needs has motivated the pursuit of eco-certification, then eco-certified hotels are likely to meet customer needs and enjoy higher resource efficiency driven by their customers. The increase in resource efficiency can arise from attracting more eco-friendly customers or from the newly implemented practices that enable customers to consume more efficiently. Evidence that shows higher resource efficiency driven by customers (i.e. lower factor scores) for eco-certified hotels will lend support to *H2* and demonstrate the signaling effect of eco-certification. Therefore, we expect β_1 to be negative.

Finally, we test the impact of integrating the operations and marketing components through eco-certifications signaling (H3) in Model 3:

$$Model\ 3: CDF = \alpha + \beta_1 * ecoleaf + \beta_2 * ODF + y * Z + \varepsilon$$

We expect β_1 to remain negative. The additional CDF gain for eco-certified hotels, after controlling for ODF, demonstrates the importance of integrating the operations and marketing components of eco-friendly service and lends further support to the signaling effect of eco-certification. We expect β_2 to be positive because both the service organizations and the customers rely on the same facilities and procedures in service coproduction.

3.4 Control variables

In hotel operations, resource efficiency can be influenced by several contextual variables, including annual average occupancy rate, hotel size, the star rating, and property type. To rule out alternative explanations for the observed variation in resource efficiency, we include the following variables (Z's) in the models:

- Occupancy: the occupancy rate is the percentage of all rooms that are occupied or rented at a given time, with values between 0 and 1. We measure the Year 2011 average occupancy rate for each hotel site. Occupancy can impact resource efficiency by increasing the customer base for sharing fixed costs. For instance, fixed costs such as maintenance contract fees become a smaller portion per dollar of revenue generated as occupancy rate increases. Also, even variable expenses can have fixed components (Walls and Lane, 2011). For example, guest supplies are traditionally considered variable expenses, but a minimum quantity of supplies must be purchased to operate the hotel regardless of the occupancy rate. So we expect a positive relationship between resource efficiency and occupancy rate.
- LogRooms: we measure the size of a hotel site by the number of guest rooms and use logarithmic transformation to correct the positive skew in the data. Size may impact resource efficiency due to overhead associated with larger operations. For example,

larger hotels have more rooms that require heating and cooling to keep temperature regulated whether the rooms are occupied or not. ODF could suffer as a result. With a higher volume of customers, larger hotels also face higher complexity in customer and operations management. The net effect of hotel size on CDF is not clear because there are potential savings from ordering large quantities of supplies (Walls and Lane, 2011).

- StarRating: this is a categorical variable with seven levels of star ratings going from two to five stars in half-star increments. Star ratings reflect the amenities and service levels at each site and corresponding resource requirements across market segments. As a hotel's star rating increases, higher prices lead to higher revenue. Even though the cost of amenities and functions provided by the hotel property also increase, it is likely to constitute a smaller portion of revenue. So, we expect a positive relationship between star ratings and resource efficiency.
- PropertyType: there are seven hotel property types (enumerated in Figure 3 in Section 4, Results). Different amenities and services offered by various property types also have a large impact on resource consumption. The implementation of eco-certifications often involves careful documentation and monitoring of current processes, which helps uncover wasteful activities hidden in complex operations. We expect that hotel sites with a wide range of offerings, such as convention centers and resorts, will have more opportunities for efficiency improvement through eco-certification.

Controlling for these contextual variables permits more meaningful comparisons among heterogeneous sites in the hotel industry. Table II lists the descriptive statistics (top) and correlations among the key variables (bottom).

3. Results

We used a series of OLS regressions to analyze systematic variations in resource efficiency measures associated with the credibility of eco-certifications. As part of the diagnostic check, we ran various STATA regression commands (regress with robust option, rreg, and qreg) with the same model specifications. The coefficients and significance levels are materially the same as the OLS regression output, suggesting that outliers do not pose threats to the coefficient estimates and interpretation. In addition, we conducted a series of tests (not reported for brevity) to confirm that issues such as influential points and heteroscedasticity are under control. Following Jann (2012), we report OLS regression results in Table III. The regression analysis results show support for *H1*, *H2* and *H3*.

The negative coefficient estimate for ecoleaf (-0.180) in the Model 1 column indicates that the eco-certified hotels are more resource efficient in their operations than others. This provides empirical evidence for *H1* and confirms the credibility of the eco-certification signal.

The negative coefficient estimate for ecoleaf (-0.290) in the Model 2 column indicates that the CDF of the eco-certified hotels is higher than that of others, providing support for H2. Together with the evidence for *H1*, the direct test of eco-certification signal effect is supported by our sample.

Model 3 again compares the CDF between the two types of hotels but holding the ODF constant. The negative coefficient estimate of ecoleaf (-0.267) means that hotels achieve additional CDF gain when they signal through credible eco-certifications. This result shows the importance of integration between the operations and marketing components of the service concept and provides additional support for the green signaling effect of eco-certifications.

The coefficient estimates for occupancy rate are consistent with our expectations outlined in Section 3. The negative coefficients across all three models indicate resource efficiency gain due to increased utilization. This phenomenon holds true for both ODF and CDF. Hotel size does not appear to have any effect on ODF. However, larger hotel size is associated with lower CDF, as suggested by the positive coefficient estimates in Models 2 and 3. Although outside the scope of this study, it would be interesting to investigate whether larger hotels experience higher complexity or higher resource consumption by their customers, leading to efficiency decreases.

To make the table size manageable, Table III suppresses the regression estimates for two categorical control variables – star rating and property type. These two control variables are statistically significant predictors of resource efficiency measures, and their relationship with the dependent variables is as expected. We explain the implications of these coefficient estimates in Figure 2 (star rating) and Figure 3 (property type).

In Figure 2, the table at the bottom shows the predicted means of CDF factor scores using Model 3 results for hotel subgroups based on their star rating and holding ODF, occupancy rate, logrooms, end property type at their sample means. The figure graphically presents the same information. Comparing the graph on the left (eco-certified hotels) with the one on the right (other hotels) for each star rating level, we observe that at every star rating level eco-certified hotels lead the others in CDF (i.e. lower factor scores in the graph on the left). This suggests that the effect of credible eco-certification is associated with more efficient resource consumption by customers across all market segments.

In Figure 3, the table at the bottom shows the predicted means of CDF factor scores using Model 3 results for hotel subgroups based on their property type and holding ODF, occupancy rate, logrooms, and property type at their sample means. The figure above plots this information.

Again, we observe that, for each property type, eco-certified hotels lead the others in CDF (i.e. lower factor scores in the graph on the left). The functions and amenities provided by different property types satisfy a diverse set of customer needs. For example, conference centers derive at least 60 percent of their occupancy from hosting business travelers attending conferences, while resort hotels attract leisure travelers with special recreational facilities. Therefore, the pattern in the graph indicates that the signaling effect of eco-certification exists for customers with diverse travel purposes (e.g. business vs leisure).

4. Conclusion

5.1 Theoretical and managerial implications

The primary purpose of this study is to empirically test the signaling effect of eco-certification in services. Although theoretical arguments exist for eco-certification's role in reducing information asymmetry between the service organization and its customers, empirical validation of whether and how the signaling process takes effect has been lacking. We leverage the service concept framework and the potential for coproduction in service operations and quantify the operations and marketing components of eco-friendly service from a resource-efficiency perspective. The evidence from our empirical analysis suggests that service organizations with credible eco-certifications do maintain more eco-friendly operations and that their customers consume resources in a more eco-friendly fashion. These findings affirm the existence of credible eco-certification's signaling effect.

Further, this signaling effect lends empirical support to the proposition that the integration of the operation and marketing components is critical to successful service design (Goldstein et al., 2002; Verma et al., 2001; Victorino et al., 2005). This paper is among the first

within the service research field to report on this integration issue through a signaling game perspective. We argue that the service organization and its customers coproduce intangible service experience by consuming tangible resources. Therefore, variations in the resource efficiency measures driven by these two parties allow investigations into alignment between the eco-friendly strategic intent and customer perception.

The main managerial implication of our study is that the pursuit of credible eco-certification can increase resource efficiency, which is an important contributor to operating performance (Zhang et al., 2012a). Figures 2 and 3 clearly demonstrate that hotel sites across all market segments and of all property types can benefit from implementing credible eco-certification. The emphasis is on the credibility of eco-certification, which has a few important implications. First, taking the shortcut of self-certification may seem harmless in the short run, but the absence of verified information can confuse customers and diminish the effectiveness of the signal. Furthermore, the service organization does not accrue operational benefits from the standard practices required and audited by an impartial certifying body. Second, the existence of inherent information asymmetry in eco-friendly services means that the provision of credible eco-certification complements authentic eco-friendly operations. As environmental awareness in society continues to increase, actively informing customers about internal practices is critical for reaching the ever-growing number of environmentally conscious customers. Finally, managers need to be thoughtful about selecting proper information channels for signaling. For example, customers now search extensively before making a purchase decision (e.g. 9.5 search sessions prior to booking (ThinkWithGoogle, 2012). Making easy-to-understand, third-party verified labels available at booking time improves credibility at the relevant point of purchase.

5.2 Limitations and future research

We recognize several limitations in this study and offer thoughts on potential ways to address them in future research. First, the sample is limited to one industry in one country. The resource efficiency measures are, therefore, context specific. The CMIGreen survey identifying different levels of credibility across eco-certifications was conducted among US travelers only. Replicating our approach in other service industries and countries is therefore necessary to increase the generalizability of our findings. Second, archival data used in this study addressed only the aggregate level signaling effect by focusing on expenses. In addition to understanding the eco-certification effects from a "whole experience" perspective, there is significant value in identifying the specific drivers of these effects at individual hotel sites and at the customer level. Our data lack the precision required for identifying these drivers. Third, there are other factors that may interfere with the eco-certification signaling effect in practice. For example, the number of customers who receive the signal is likely to be influenced by the service organization's green marketing efforts.

These limitations suggest a few directions for further research. First, there are important questions regarding the revenue implications of eco-certifications. Prior research has found evidence of a price premium for eco-certified goods (Delmas and Grant, 2014). Future research can explore whether (and when) similar price premiums occur in service settings, especially when these hotel sites are attempting to improve revenue. Such research may also extend findings on resource expenditures (Zhang et al., 2012a) into the realm of eco-certification and revenue management.

In addition, research could investigate the eco-certification signaling effect on customers at a more individual level. For example, did the resource efficiency gain arise from attracting

new, green customers or from enabling existing customers to become more environmentally responsible? Experimental designs such as choice modeling (McFadden, 1974; Verma and Plaschka, 2003) are excellent methods for studying these drivers because they are capable of teasing out confounding factors.

In summary, this study blends insights from theories of signaling games, service coproduction, and service concept design. We show that credible eco-certifications can inform customers, differentiate eco-friendly service organizations from others, and influence customer behavior. From a practicing managers' perspective, our findings mean that by focusing on resource efficiency drivers, credible certification, and eco-friendly service coproduction, service design can not only tighten intended integration between operations and marketing, but also have a positive impact on the environment.

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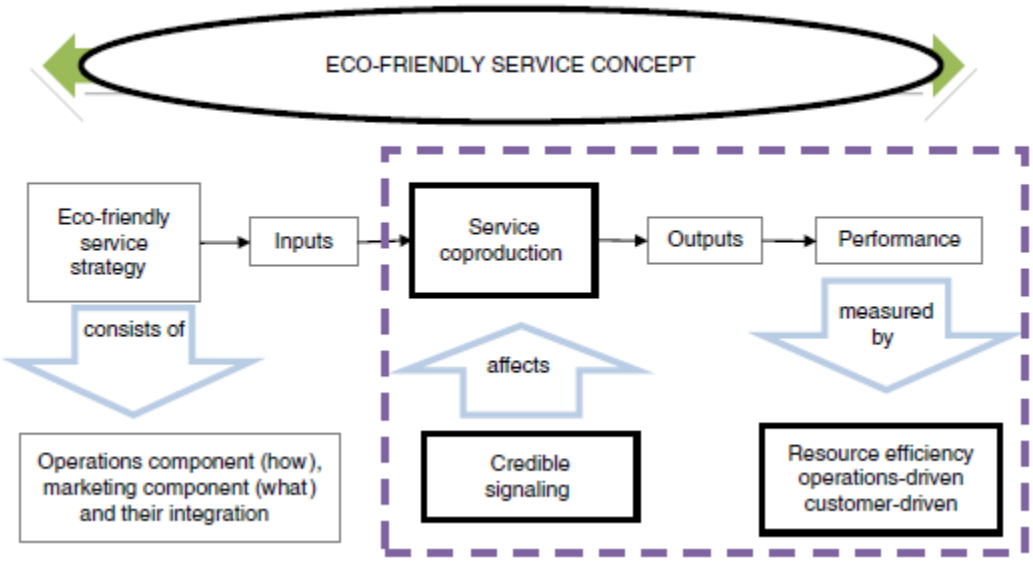
Appendix

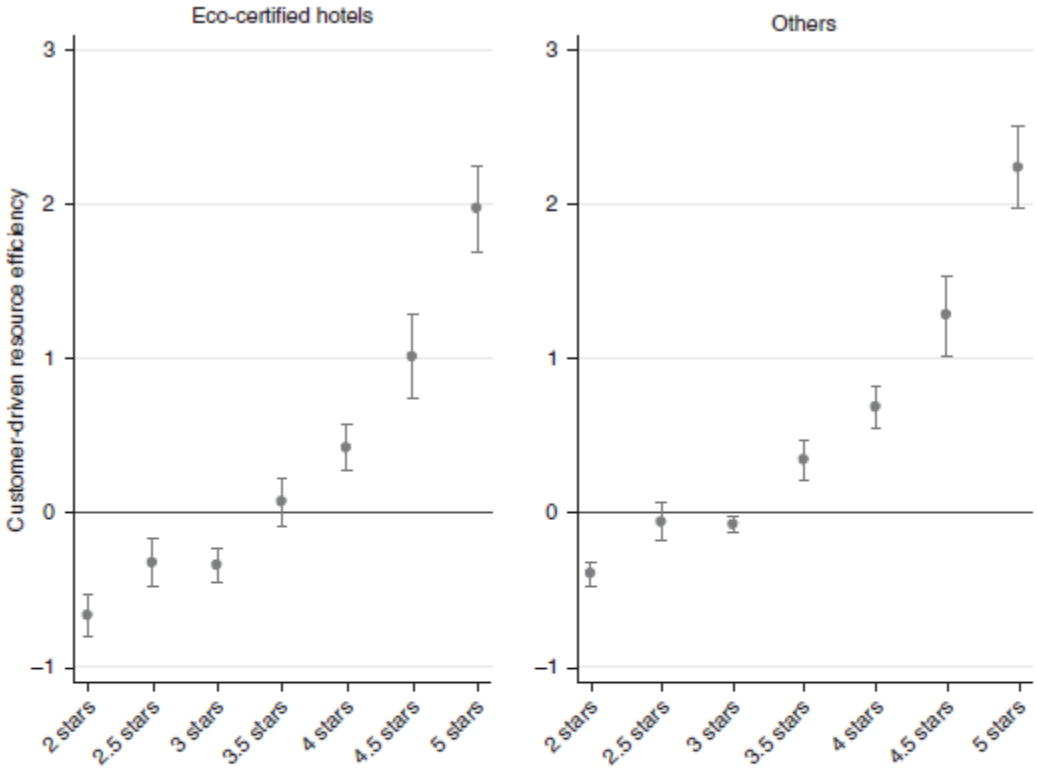
PKF Hospitality Research (PKF-HR) has collected annual operating statements from thousands of hotel sites across the USA since 1936, reporting more than 200 revenue and expense items in their proprietary Trends® in The Hotel Industry database. Participation in the survey is voluntary, which is done using survey forms or simply by sending copies of December profit and loss statements. To ensure comparability, PKF-HR enters all the data it receives in accordance with the classification system prescribed by the most current edition of the Uniform System of Accounts for the Lodging Industry (USALI).

Figure 1. Eco-friendly service design planning and allied performance measures



Notes: This figure is modeled after Figure 2 in Goldstein et al. (2002). Our model focusses on the dotted area, where the credible signaling affects service coproduction, the outcome of which is observed through the resource efficiency measures. The blue arrows show the relationship between the conceptual constructs and the operationalized variables

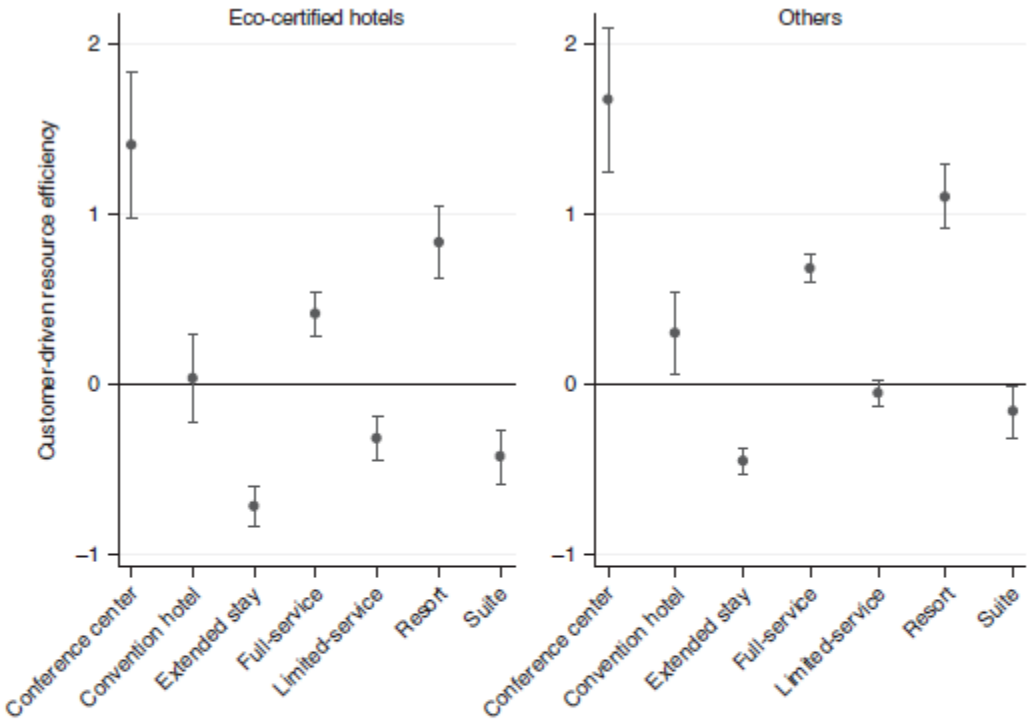
Figure 2. Predicted average customer-driven factor scores and 95 per cent confidence interval across star rating subgroups



Star rating	Eco-certified Hotels		Others	
	Customer-driven Resource Efficiency Factor Score		Customer-driven Resource Efficiency Factor Score	
	Mean	SE	Mean	SE
Two	–0.663	0.066	–0.396	0.040
Two and a half	–0.325	0.079	–0.058	0.061
Three	–0.342	0.058	–0.075	0.028
Three and a half	0.074	0.078	0.341	0.065
Four	0.419	0.076	0.686	0.068
Four and a half	1.010	0.139	1.276	0.133
Five	1.966	0.143	2.232	0.133

Notes: The table shows the predicted means of customer-driven resource efficiency (CDF) for hotels across seven star rating levels to interpret the suppressed coefficients for star rating dummies, while holding all the other variables in Model 3 (Table III) at their means

Figure 3. Predicted average customer-driven factor scores and 95 per cent confidence interval across property type subgroups



Property Type	Eco-certified Hotels		Others	
	Customer-driven Resource Efficiency Factor Score Mean (SE)		Customer-driven Resource Efficiency Factor Score Mean (SE)	
	Mean	SE	Mean	SE
Conference Center	1.406	0.218	1.672	0.215
Convention Hotel	0.031	0.134	0.298	0.126
Extended Stay Hotel	–0.723	0.062	–0.456	0.036
Full-Service Hotel	0.411	0.065	0.678	0.041
Limited-Service Hotel	–0.322	0.065	–0.055	0.041
Resort Hotel	0.835	0.107	1.102	0.098
Suite Hotel	–0.432	0.080	–0.165	0.076

Notes: The table shows the predicted means of customer-driven resource efficiency (CDF) for hotels across seven property types to interpret the suppressed coefficients for hotel property type dummies, while holding all the other variables in Model 3 (Table III) at their means

Table I. Factor loadings from exploratory factor analysis (EFA)

Revenue normalized expenses	Customer-drive factor (CDF)	Operations-driven factor (ODF)
Electricity	−0.02	*0.68*
Water and sewer	−0.28	*0.49*
Maintenance other expense	0.20	*0.52*
Supplies used in F&B department	*0.73*	−0.10
Supplies used in rooms department	*0.67*	−0.05

Notes: *n* = 2,481. EFA promax rotated, Kaiser off

Table II. Descriptive statistics and correlations

Variable	Min	Max	Mean	Median	SD	Skewness	Kurtosis
CDF	−3.30	9.81	0.00	−0.34	1.33	1.73	7.76
ODF	−3.42	12.49	0.00	−0.21	1.30	1.50	9.78
Ecoleaf	0	1	0.14	0	0.34	2.13	5.54
LogRooms	3.26	7.96	5.08	4.87	0.61	1.34	4.94
Occupancy	0.24	1	0.70	0.72	0.11	−0.71	3.59
	CDF	ODF	Ecoleaf	LogRooms			
CDF	–						
ODF	0.11*						
Ecoleaf	−0.12*	0.22*					
LogRooms	−0.12*	0.55*	0.48*				
Occupancy	−0.41*	−0.30*	0.05*	−0.004			

Notes: n = 2,481. Significance level *$p < 0.05$

Table III. Regression analysis coefficient estimates (standard error in parentheses)

	Model 1 (*H1*) (D.V. = ODF)	Model 2 (*H2*) (D.V. = CDF)	Model 3 (*H3*) (D.V. = CDF)
Ecoleaf	−0.180**	−0.290***	−0.267***
	(0.076)	(0.058)	(0.057)
ODF	–	–	0.128***
			(0.015)
Occupancy	−5.847***	−2.693***	−1.946***
	(0.227)	(0.172)	(0.191)
LogRooms	−0.009	0.028***	0.281***
	(0.065)	(0.049)	(0.048)
Star rating dummies	Reference group: two-star hotels, results suppressed for brevity[a]		
Property type dummies	Reference group: conference center hotels, results suppressed for brevity[a]		
Constant	6.093 ($t = 13.40$)	1.958 ($t = 5.69$)	1.180 ($t = 3.36$)
Adj. R^2	0.30	0.62	0.63

Notes: *n* =2,481. [a]The coefficient estimates for the dummy variables (seven levels each) are all statistically significant. Results are available upon request. The implications of the results are explained in Figure 2 for star ratings and in Figure 3 for property type. **,***Significance level $p < 0.01$ and $p < 0.001$, respectively

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