Eco-Design in Products and Services of SMEs: Motivation and Results

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This research study examines the direct influence of customer preference and the potential moderating influence of laws and green purchasing on eco-design of products/services in small and medium-sized enterprises (SMEs). Also studied is the relationship between these variables and environmental and economic performance in SMEs. The analysis uses theoretical underpinning of stakeholder and neo-institutional theories, and survey data collected from a sample of SMEs. Regression path analysis is applied, bootstrapped with .95 CI (Bias Corrected and Accelerated) and 2,000 samples on all regressions. Significant relationships were found between customer preference and eco-design, moderated by impact of laws, and between eco-design and environmental and economic performance. Green purchasing was found to have no moderating effect on adoption of eco-design. Managerial implications are indicated and discussed.

Keywords: eco-design, sustainability, SMEs, customer preference, firm performance, stakeholder requirements

INTRODUCTION

The design of products and services impacts the environment in two principal ways: (1) the type and source of materials and services and processes required for their production, and (2) effects of their use and ultimate disposal. Historically, these impacts and their effects on environmental sustainability have not always been of major concern to company managements. However, in recent years, due to increased concern for environmental damage from these impacts and for supplies of raw materials that have negative relationships with the environment, environmental sustainability has become an important management consideration. The design of products and services to minimize negative environmental impact is termed "eco-design."

Governments have responded to environmental concerns by implementing laws and regulations designed to minimize negative environmental impacts of products and services. Another motivation, (and perhaps a more important one for company managements), is increasing concern of customers for the environmental impact of products and services they buy. A strong indication of this is a Nielsen study that found between 2014 and 2018, consumer sales of sustainable products grew at a compound average growth rate four times larger than conventional products (Nielsen, 2018). Although that study focused on consumer sales, there can be no doubt that the trend has been pushed up the supply chain to impact next-tier suppliers.

Two of the principle external stakeholders of any public business are government and customers. The increasing interest of such stakeholders in companies' adopting sustainable management practices has led to them becoming more common in industry in general and also in SMEs. In order to compete and meet the expectations of such stakeholders, it is necessary for SMEs to implement sustainable management practices to a degree at least as significant as that of their competitors, both peers and larger companies. Internal stakeholders, including employees and management, have the expectation that a firm will continue to be competitive and survive in the marketplace. To meet this expectation also requires attention to and adoption of sustainable management practices. Research has found that in apparent response to this environment, SMEs are increasingly adopting sustainable practices such as eco-design and green purchasing. It has also been found that embedding sustainability into SME firms' operational practices and implementing sustainable innovations results in financial benefits, enhances a company's image and reputation, and improves overall performance (Shashi, et al., 2018; Schaltegger and Burritt, 2018; Wu, 2017; Hussain, Rigoni, and Orgi, 2018; Schmidt, Foerstl, and Schaltenbrand., 2017; Ramanathan, 2018; Roxas, Ashill, and Chadee, 2017; Golicic and Smith, 2013; Lee and Pati, 2012).

However, relatively little focused research has been conducted to study the inter- relationships of eco-design, green purchasing, customer preferences, impact of laws, and firm performance. This study aims to assess these inter-relationships using data from small and medium-sized enterprises (SMEs) mainly engaged in business-to-business (B2B) relationships with suppliers and customers.

LITERATURE REVIEW

Sustainability in SMEs

Small and medium sized enterprises (SMEs) are defined by number of employees, annual revenue, and other related criteria (Baird, Lyles, and Oris, 1994; D'Ambrose and Muldowney, 1988). SMEs differ from large businesses in several ways. Many of the differences are beneficial. For example, SMEs have greater flexibility, which enables them to adjust more quickly to environmental changes; they have less formal management structures and flatter organizational hierarchy; and they are able to leverage newer technology and higher quality to increase market share (Adams, Khoja, and Kauffman, 2012; Levy and Powell, 2000).But there are significant barriers to successfully implementing sustainability practices is SMEs, these include: lack of both organizational slack and in-house expertise, long-term partnership obligations, and the reality that some SME owners and/or managers see no direct connection from sustainable management practices to improving organizational performance or value and therefore do not have a positive attitude about it (Khoja, et al., 2019; Klewitz and Hansen, 2014).

Recent studies (as referred to in the Introduction) have shown the significance of SMEs' sustainable business practices and their proliferation in the value chain. Other examples of this include a study in which Ayuso, Roca, and Colome (2013) examined the extent to which SMEs receive social and environmental requirements from customers and the extent to which they pass on such requirements to their own suppliers. The results of their structured telephone interviews of SMEs in the region of Catalonia (Spain) showed that customer typology is an important factor in determining corporate social responsibility (CSR) requirements imposed to SMEs: large buying firms exert more pressure than small and medium companies and public authorities. By contrast supplier typology seems to have no influence on SMEs that pose CSR requirements. The main implication of their study is that SMEs can be effective transmitters despite their comparatively low level of resources and bargaining power.In a similar vein, Acosta, Acquier, and Delbard (2014) using neo-institutional theory and building on an in-depth case study of a middle-sized supplier of a multinational

company in Latin America, explored how a firm integrates the requirements of a supplier development scheme and to what extent these demands are diffused to next-tier suppliers. The imbalance in power relationships between actors seems to play a central influence on institutional responses to sustainable supply chain management (SSCM) programs. Overall, higher level of adoption can be observed when demands bring a clear market benefit. Their study also revealed that one key dimension of adoption also lies in the cultural and cognitive distances between SSCM programs and local practices, and the difficulty managers face with adoption of international practices.

Another interconnected and evolving theme of research in sustainable development in SMEs, is sustainability-oriented innovation through product, process, and organizational innovations (Wu, 2017). The study by Wu (2017) found that socially responsible supplier development (SRSD), which entails investment, collaboration, and engagement of buying firms in sustainable supplier development activities, impacts sustainable innovations and sustainable innovation capabilities that in turn positively affect sustainable performance. Klewitz and Hansen (2014) conducted a review of research into sustainability-oriented innovation in SMEs over a 20-year period and found sustainable innovations in products, processes, and organization. Among other findings their research found the attitude of SMEs, with regard to sustainable management practices, ranged from resistant to sustainability-rooted.

A recent paper by Shashi, et al. (2018), studied the relationship between different constructs of the supply chain such as sustainable orientation, internal integration, external integration, sustainable procurement and design, and environmental and cost performances in SMEs. The findings of that paper revealed that sustainability issues are of primary interest to SMEs and that sustainable business processes and practices can be improved for operational and strategic purposes.

Eco-Design

Eco-design has been defined as: "The integration of environmental aspects into the product development process, by balancing ecological and economic requirements. Eco-design considers environmental aspects at all stages of the product development process, striving for products which make the lowest possible environmental impact throughout the product life cycle" (European Environment Agency 2023). Also, complementary to eco-design, "As a method of eco-design, life cycle assessment (LCA) is a systematic tool that enables the assessment of the environmental impacts of a product or service throughout its entire life cycle, i.e., raw material production, manufacture, distribution, use, and disposal including all intervening transportation steps necessary or caused by the product's existence" (Wang & Bessede, 2015). A review of 106 review articles on eco-design addressed terminology, evolution, barriers and success factors, methods and tools, and synergies. The study recommended more research on eco-design in SMEs in particular (Shafer and Lower, 2021).

Customer Influence in the Adoption of Sustainable Management Practices

The influence of customers on the adoption of sustainable management practices has been recognized by a number of researchers in recent years. Research examples include: the positive impact of customer emphasis on supplier firms' implementation of environmental management (Lee, Jo, and Leong, 2019); positive influence of customers on the adoption of environmental management practices and sustainability as a factor in supplier selection (Pekovic, Rolland, and Gatignon, 2016; Reuter, Goebel, and Foerstl, 2012); influence of multiple stakeholders, including customers, being the driving force behind sustainable practices including sustainable supply chain management (Paulraj, Chen, and Blome, 2017); and supply chain tiers that are closer to the end customer are more likely to follow sustainable practices (Ghadge, et al., 2019); Schmidt, Foerstl, and Schaltenbrand, 2017). Other research found that customer pressure positively affects sustainable supply management (Gualandris and Kalchschmidt, 2014), and that there is a positive relationship between environmental activities and customer satisfaction (Shin, et al., 2017). Furthermore, Laari, et al. (2016) showed that customer requirements are positively related to internal green supply chain practices and manufacturers transfer such customer requirements upstream due to customer pressure. Research intended to assess sustainability practices in SMEs has also identified the potentially

significant influence of customers on implementation of sustainable practices (Khoja, et al., 2019). Appendix 1. provides a summary of the research studies.

RESEARCH GAP AND STUDY OBJECTIVES

While there has been research on sustainable management practices in SMEs and customer influence on them, there have been continuing calls for more SME-oriented research (e.g. Shafer and Lower, 2021), and there has been relatively little research on the inter-relationship in SMEs of eco-design, green purchasing, customer preferences, impact of laws, and firm performance. Therefore, to address this gap, this research has the following objectives:

1) Address the indicated need for additional research on current sustainable management practices in SMEs and assess what motivates SMEs to implement such practices.
2) Analyze relationships among key sustainable management practices, stakeholder preferences, and performance impacts in SMEs.
3) Assess whether sustainable management practices in SMEs such as eco-design have economic and environmental benefits.

In the following sections, theoretical underpinnings and hypotheses are explicated, after which the research methodology for this study is discussed. Analysis results are presented followed by discussion of the results, managerial and theoretical implications, study limitations, and future research.

THEORETICAL UNDERPINNING AND HYPOTHESES DEVELOPMENT

Theoretical Underpinning

There is no universally accepted definition of sustainability. But a literal definition is the "ability to continue a defined behavior indefinitely" (thwink.org, 2020; Goodland, 1995). Hussain, Rigoni, and Orgi (2018) reviewed 31 relatively recent papers to ascertain the relationship between sustainability performance and financial performance. One aspect of their research was to determine an appropriate theoretical basis for hypothesis development. They found contradictory empirical findings and some of the theories used are based on contending assumptions. In the 31 papers reviewed, there were seven different theoretical bases and 11 of the papers employed no specific theory. The most-used theory was "no theory" and the second most used theory was stakeholder theory. Stakeholder theory holds that firms should include interests of various stakeholders and not only the firm owners' pursuit of profit (Freeman, 1984). Because pursuit of sustainability performance may not always be aimed only at improving profits but also at meeting the requirements of other stakeholders such as governments, stakeholder theory appears to be the most applicable to studying adoption of sustainable management practices by SMEs and the relationship between sustainability and firm performance.

To examine how external pressures influence a firm to adopt organizational practices, Paulraj, et al., (2017) took a theoretical perspective, and Acosta, et al., (2014) a supplier perspective. These can be related to neo-institutional theory which adopts an extended perspective, such that coercive pressures may result from wider social pressures for conformity within the institutional environment (DiMaggio and Powell, 1983; Scott, 2013). Institutions that can be defined as enduring, constitutive elements of social life, providing stability and meaning to it, are sustained by three pillars, namely cognitive (shared understandings shaping behavior), normative (expectations in specific social settings) and regulative (formal and legal rules).

The model in this study is developed using these underpinnings: stakeholder theory indicates that stakeholders in general have expectations that a firm will operate in a manner that assures its continuation and that meets particular expectations of each stakeholder; social pressures as explicated in neo-institutional theory require attention to wider social pressures in adoption of management practices, including cognitive, normative, and regulative aspects.

Customer Preference and Eco-Design Hypotheses

By adopting environmental practices, SMEs meet the needs of more stakeholders (Freeman, 1984; Hussain, et al., 2018; Paulraj, et al., 2017), which in turn legitimizes how their actions are perceived by others. Environmental regulations and closeness to the end customers have been found to support sustainable procurement performance (Ghadge, et al. 2019). Based on stakeholder and neo-institutional theories, normative and mimetic drivers such as increasing requirements from buyers and customers for environmental expectations as well as growing industry pressure through competition, influence SMEs to adopt sustainable strategies and practices.

Additionally, the external motivator, 'impact of laws' and correspondingly, the internal supply chain practice of 'green purchasing' emphasize legal constraints and boundaries and reduction of waste. Also, material substitution through management practices such as environmental sourcing of raw materials, and minimization of hazardous waste materials, attest to and strengthen the relationship between customer preference, eco-design, and sustainable management practices (Dubey, et al., 2013).

Thus:

Hypothesis 1: *Customer preference positively impacts eco-design in SMEs.*

Hypothesis 1a: *The relationship between customer preference and eco-design is further enhanced by impact of laws in SMEs.*

Hypothesis 1b: *The relationship between customer preference and eco-design is further enhanced by green purchasing in SMEs.*

Eco-Design and Environmental and Economic Performance Hypotheses

Numerous researchers have found positive relationships between eco-design and other sustainable supply chain management practices and firm performance. Examples of these impacts include: green product development and supply chain management practices positively impact environmental performance (Ardakani and Soltanmohammadi, 2019); green supply chain practices are significantly and positively related to market performance (Schmidt, et al. 2017); environmentally sustainable performance positively impacts financial performance (Ramanathan, 2018); environmental sustainability orientation is positively related to firm performance (Roxas, et al. 2017); overall environmental supply chain practices are associated with positive firm performance (Golicic and Smith, 2013; Gualandris and Kalchschmidt, 2014); and firm environmental sustainability performance and composite environmental-social sustainability performance is positively associated with firm economic performance (Lee and Pati, 2012). Thus, the potential benefits of eco-design and other sustainable supply chain management strategies and practices include: efficiencies, overall cost reduction, meeting specific legal and customer requirements, and enhancing organizational reputation.

Thus:

Hypothesis 2a: *Eco-design positively impacts environmental performance in SMEs.*

Hypothesis 2b: *Eco-design positively impacts economic performance in SMEs.*

RESEARCH METHODS

Survey Instrument

The survey questionnaire included 30 question statements across 7 subsections: B- green purchasing; C and K- customer preference; D- eco-design; F- environmental performance; G- economic performance; I- impact of laws on sustainable business practices. Respondents were asked to indicate the extent to which they agreed or disagreed with the statement in each question using Likert-like scales of 1 (completely agree) to 5 (completely disagree). Some items are reverse coded. Survey question statements are shown in

Appendix 2. The validated scale used in the survey instrument was originally developed by Zhu, Sarkis and Lai (2008) and later adapted by Khoja, et al., (2019).

Data Collection

Data was collected by graduate students personally visiting in person or contacting by email representatives of SMEs in the metropolitan area of Houston, Texas, USA. The sample included companies in diverse product and service industries. Each respondent was provided a copy of the survey question statements and a form for recording their responses. For this study, an SME is defined as having fewer than 500 employees, annual sales of less than $20 million and being an autonomous entity (Baird, Lyles, and Oris, 1994; D'Ambrose and Muldowney, 1988). The target recipients of the survey were business owners or high-level managers (executives) in the business. The authors closely monitored all data collection activities and followed up with respondents to ensure accuracy. 72 surveys were collected. Two of the 72 companies had an employee count far greater than the others (over 10,000 employees) and were removed from the data set; of the remaining 70 companies, 21 had failed to answer all items on the survey questions and so were left out of the analysis. The remaining 49 companies had their answers computed into means for each of the subsections of the questionnaire. Sections B & G- 'cooperation with customers' and 'impact of customer requirements on sustainable business practices' were combined to create the construct of 'customer preference'. The individual subsections were weighted through a principal components analysis to ensure the construct adequately factored in the weight of each survey subsection.

Methodology

Because of the relatively small sample size, bootstrapping was used to resample the data set to create an increased number of simulated samples for analysis. The path model used multiple linear regressions, using a bias-corrected accelerated confidence interval (CI = .95) and with 2,000 bootstrapped samples. The bootstrapped coefficients all showed a confidence interval that did not intersect with 0, and in cases where the significance value differed between the normal regression model and the bootstrapped coefficient, the bootstrapped value was used. The model uses the beta coefficients where applicable and shows significance at the .05 level (*) and the .01 level (**). Error values are shown using $^{2}\sqrt{(1-R^2)}$. Industry, Enterprise Age, and Size (employee count) were controlled in the analysis for all regressions.

RESULTS

Table 1. shows the descriptive statistics and correlation matrix resulting from analysis of the data. The variables and constructs are found to be highly correlated indicating when there is a change in one of the variables there is likely also a change in other variables. Figure 1. depicts the resulting path model and shows graphically the relationships between the variables and associated statistics. The results of the analysis found that customer preference is significantly related to eco-design, hence supporting hypothesis 1 (β=0.472, p<0.01). The impact of laws on the relationship between customer preference and eco-design is also significant, further strengthening the relationship, and supporting hypothesis 1a (β=0.488, p< 0.05). However, the interaction of green purchasing does not significantly enhance the direct relationship (β=0.281, n.s). Thus, hypothesis 1b is not supported. Both hypotheses 2a and 2b are supported as eco-design positively impacts both environmental and economic performance, respectively (β=0.480, p<0.01; β=0.459, p<0.01). Figure 1. shows the hypothesized model and the results of the analysis.

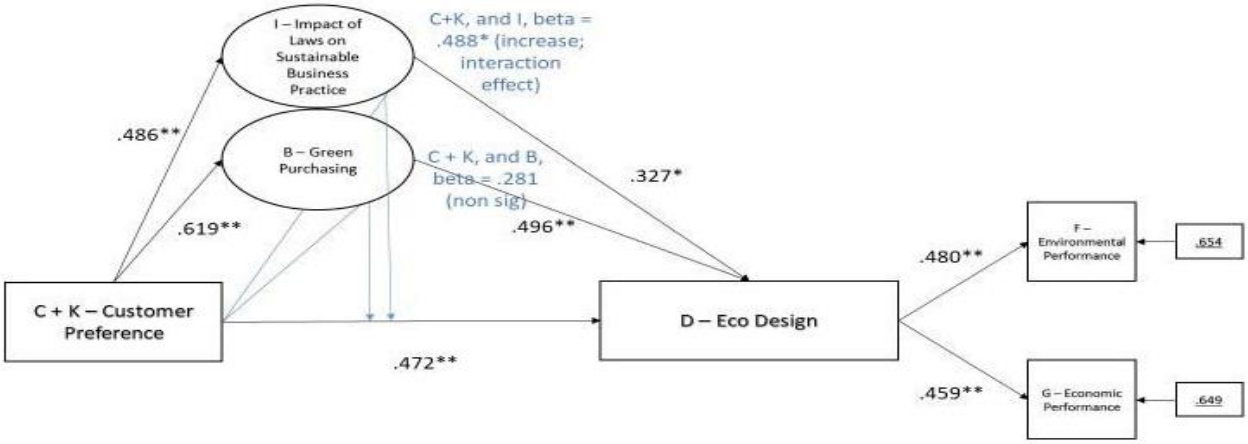
The indications of the analysis are that customer influence is a significant positive factor in SMEs' employment of eco-design in their products and services. Also indicated is the additional positive impact of laws and regulations on the application of eco-design by SMEs in their products and services. Finally, application of eco-design can lead to improvements in environmental and economic performance by SMEs.

TABLE 1
DESCRIPTIVE STATISTICS AND CORRELATIONMATRIX

	Mean	Standard Deviation	B. Green Purchasing	D. Eco-Design	F. Environmental Performance	G. Economic Performance	I. Impact of Laws	C. + K. Customer Preference
B. Green Purchasing	2.404	1.179	1	0.602**	0.649**	0.658**	0.355*	0.688**
D. Eco Design	3.177	1.268	0.602**	1	0.610**	0.625**	0.402**	0.593**
F. Environmental Performance	2.910	1.283	0.649**	0.610**	1	0.825**	0.556**	0.620**
G. Economic Performance	2.816	1.287	0.58**	0.625**	0.825**	1	0.470**	0.559**
I. Impact of Laws	3.666	0.909	0.355*	0.402**	0.556**	0.470**	1	0.500**
C. + K. Customer Preference	3.122	1.066	0.688**	0.593**	0.620**	0.559**	0.500**	1

N= 49
**Correlation is significant at the 0.01 (2-tailed)
*Correlation is significant at the 0.05 (2-tailed)

FIGURE 1
THE HYPOTHESIZED MODEL



DISCUSSION

The results of this study support the contention that customer requirements and cooperation influence the eco-design of products and services within SMEs. This result is in line with past studies that show by adopting environmental practices, business firms meet the needs of stakeholders (Freeman, 1984; Hussein, et al., 2018; Paulraj, et al., 2017). Eco-design in turn positively impacts environmental and economic performance. These results also support past research that have found positive relationships between sustainable supply chain management practices (including eco-design) and firm performance (Ardakani and Soltanmohammadi, 2019; Gualandris and Kalchschmidt, 2014; Ramanathan, 2018). Impact of laws further strengthens the relationship between customer preference and eco-design, endorsing the regulatory requirements that enforce sustainable practices for eco-design (Khoja, et al. 2019). However, green purchasing does not impact eco-design, though in prior research customer orientation has been shown to have positive influence on the extent of sustainability prevalence in supplier selection (Reuter, et al. 2012).It may be that even though green purchasing may not serve as a significant meditating factor between customer preference and sustainable practices such as eco- design, the high correlation between the two variables may be an indication that smaller businesses, such as SMEs, may have to procure sustainable material and build partnerships with other companies in order to develop eco-designed products and services. Hence, the need for green purchasing may be subsumed within eco-design.

This study thus adds to the existing research in sustainable management practices in SMEs and indicates that such practices are motivated by customer preferences and the impact of laws, thus meeting Objective 1) of the study. The results of the study also analyze the relationships among particular management practices, stakeholder preferences, and performance impacts in SMEs, thus meeting Objective 2) of the study. In addition, the results of the study indicate that sustainable management practices including eco-design, when applied by SMEs, contribute economic and environmental benefits, thus meeting Objective 3) of the study.

MANAGEMENT IMPLICATIONS

This study shows it is important for managements of SMEs to be aware of their stakeholders' (customers in particular) requirements and to develop environmentally sustainable practices that support those requirements. Improvement of sustainable management practices require knowledge of the current status of such practices in their organizations and the development of practices that are most advantageous to their business and meet the needs of its stakeholders. The results of this study also indicate that

management should pay particular attention to how their products and services are designed to assure that eco-design principles are applied to meet legal, regulatory, and customer requirements. Though not significant in this study, green purchasing would seem to be an obvious component of eco-design and, as discussed above, it may already be significantly present in the practices of SMEs through their sources of supply. In addition to developing green sources or creating in-house expertise, SMEs should actively engage with their suppliers to assure use of green supply sources upstream in their supply chains.

SMEs should also monitor their internal and external stakeholders closely to be aware of changing expectations and requirements. Availing their agility and preparedness to change, it may serve in the SMEs' interest and help them attain or maintain competitive advantage, thus building brand reputation. In general, SME managers need to be aware that environmentally sustainable practices lead to improved firm performance, both operationally and environmentally.

LIMITATIONS

This study has a few limitations. First, this study is limited to SMEs in one large metro region. Thus, the results are based on one broad geographic area. Second, the sample size is relatively small (as only completed surveys were include in the analysis) and may not be representative of a larger population of SMEs, although this was simulated by applying the bootstrapping technique in the analysis of the data. Lastly, to keep the study specifically targeted on eco-design, the scope of this study is limited to analysis of particular relationship variables.

FUTURE RESEARCH

Future research is suggested by the limitations of the study. First, this study should be extended across several other geographic regions to collect and analyze a larger sample size thus improving the study's robustness. In addition, other methodologies, such as multiple case studies including the social dimension on sustainability, should be used to triangulate the research findings. Lastly, future studies in sustainable supply chain management should focus on theoretical development in the field (Touboulic and Walker, 2015) and ascertain other confirmatory models using variables that were not included in this study.

CONCLUSIONS

The results of this study found significant positive relationships between customer preferences and eco-design and that eco-design has a significant positive relationship with environmental and economic performance. Results also showed that the impact of laws strongly moderates the relationship between customer preferences and eco-design.

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APPENDIX 1: SUMMARY OF RESEARCH STUDIES

Authors & Year of Publication	Type of Study (empirical, case study, qualitative)/ Theory	Unit of Analysis	Variables studied	Results
Paulraj, Chen and Blome (2017)	Empirical Study Stakeholder, RBV, & institutional theories.259 German firms	Firm	Independent variables: Instrumental, Relational, Moral Motives Dependent variables: SSCM Practices: -Sustainable product design, -Sustainable process design, Supply-side sustainability collaboration, -Demand-side sustainability collaboration, -Environmental and financial performance	Significant relationships between relational motives and SSCM practices support utilitarianism and stakeholder theory, and suggest that multiple stakeholders, including customers and competitors, can be driving forces behind sustainability practices such as SSCM. Many firms have strong moral motivations based on deontological ethics and/or virtue ethics and are not primarily driven by self-serving or ethical egoism intent onto practice SSCM. Sustainable product design, process design, supply-side sustainable collaboration, and demand-side sustainability collaboration play a central role in enhancing a firm's environmental and financial performance.
Lee, Jo, and Jeong (2019)	Empirical Survey data LISREL analysis Theories:- Dynamic capability	300 Korean SMEs	-Customer emphasis on Environmental management (EM) -Firm recognition of EM -Firm capabilities for EM -Firm implementation of EM -Firm performance	~~Hypotheses~~: -H1: Customer emphasis of EM is positively related to Recognition of EM -H2: Recognition of EM is positively related to Capabilities for EM -H3: Recognition of EM is positively related to Implementation of EM -H4: Capabilities for EM is positively related to Implementation of EM-H5: Implementation of EM is positively related to Firm performance -H6: Firm performance is positively related to Implementation of EM ~~Results~~: H1, H2, H4, H5, supported H3, H6 not supported

Nguyen, Onofrei, Truong, and Lockrey (2020)	Empirical Survey data 2stage Cluster analysis Theories: -Dynamic capability -Nudging- Diffusion of innovations	Mfg. plant 629 firms in 9 countries (85% were SMEs)	-Customer green orientation -Plant process innovation -Environmental performance -Firm performance -Costs	Identified 3 clusters of subject plants 1. "Process active" -High process innovation -Low customer green orientation 2. "Green proactive" -High process innovation -High customer green orientation 3. "Green minimalist" -Low process innovation -Low customer green orientation Hypotheses: -H1: A mfr. pursuing Green Minimalist configuration with customers will obtain lowest benefits in both environmental and business performance than other mfrs. -H2: A mfr. pursuing Process Active and Customer Green Active configurations with its customers will obtain lesser environmental and business performance than those pursuing Green Proactive configuration. -H3: A mfr. pursuing Green Proactive configuration with its customers will obtain greater benefits in environmental, efficiency, and financial performance than other mfrs. Pursuing Process Active and Customer Green Active configurations.

Reuter, Goebel, and Foerstl (2012)	Empirical model Structural using PLS	71 German industrial firms from various industries	-Shareholder orientation -Public orientation -Customer orientation -Formalization of ethical culture -Sustainability prevalence in supplier selection -Cost prevalence in supplier selection	Hypotheses -H1a: Shareholder orientation is negatively related to the extent of sustainability prevalence in supplier selection -H1b: Shareholder orientation is positively related to the extent of cost prevalence in supplier selection -H2a: Public orientation is positively related to the extent of sustainability prevalence in supplier selection -H2b: Public orientation is negatively related to the extent of cost prevalence in supplier selection -H3a: Customer orientation is positively related to the extent of sustainability prevalence in supplier selection -H3b: Customer orientation is negatively related to the extent of cost prevalence in supplier selection -H4a,b,c: A higher level of (a) shareholder orientation is negatively related to the formalization of ethical culture, whereas higher levels of (b) publi8c orientation and (c) customer orientation are positively related to the formalization of ethical culture -H5a,b: A higher level of formalization of ethical culture is (a) positively related to the extent of sustainability prevalence in supplier selection and (b) negatively related to the extent of cost prevalence in supplier selection -H6: There exists a negative relationship between sustainable and cost prevalence in supplier selection

Gualandris and Kalchschmidt (2014)	Empirical model Structural using PLS	77 Italian firms	-Sustainable Supply management -Customer pressure -Innovativeness	Hypotheses -H1: Sustainable process management positively affects sustainable supply management -H2a: Customer pressure positively affects sustainable process management -H2b: Customer pressure positively affects sustainable supply management -H3a: Innovativeness positively affects sustainable process management -H3b: Innovativeness positively affects sustainable supply management -H3c: Innovativeness negatively moderates the positive effect customer pressure has on sustainable process management Results H1, H3c supported H2b, H3b not supported when Sustainable process management is included in the model, but are supported without Sustainable process management
Pekovic, Rolland, and Gatignon (2016)	Empirical Linear Logit model		Dependent -Adoption of environmental management practices Independent -Customer information processing -Firm's values and norms -Firm's capacity to be responsive Moderators -Munificence/ Market growth -Competitive intensity -Market uncertainty	Hypotheses: -H1: Customer orientation positively influences the likelihood that a firm will adopt environmental management practices -H2: Customer orientation, as information processing (cognitive customer orientation), under high levels of munificence/market growth,positively influences the likelihood that a firm will adopt environmental management practices -H3: Customer orientation, as information processing (cognitive customer orientation), in highly competitive markets, positively influences the likelihood that a firm will adopt environmental management practices -H4: Customer orientation, as information processing (cognitive customer orientation), in an uncertain industry context, positively influences the likelihood that a firm will adopt environmental management practices

Wang, Wang, Zhang, and Zhao (2018)	Empirical Structural using PLS model	246 firms in multi countries	Environmental performance: -Customer driver -Cost driver -External green practice -Internal green practice -Firm size	H6a: The impact of cost driver on internal green practices will be stronger for large firm than for small firm H6b: The impact of cost driver on external green practices will be stronger for large firm than for small firm
Walker, DiSisto, and McBain (2008)	Case study	7 Firms	Dependent -Green supply chain management initiatives Independent -Internal drivers -External drivers	Results: Internal drivers -Organizational factors -Values -Value champions -Cost reduction External drivers -Regulation -Customers -Competition -Society Barriers -Costs -Lack of legitimacy internally -Regulation -Poor supplier commitment -Industry specifics

Shin,Thai, Grewal, and Kim (2017)	Empirical Structural equation modelling	214 logistics firms in S. Korea	Independent Impact of corporate sustainable management activities (CSMA) divided into: -Economic activities -Social activities -Environmental activities Dependent variables: -Customer satisfaction -Word of mouth intention -Repurchase intention	Hypotheses: H1a: Positive relationship between Economic activities and Customer satisfaction H1b: Positive relationship between Social activities and Customer satisfaction H1c: Positive relationship between Environmental activities and Customer satisfaction H2: Customer satisfaction has a positive relationship with Word-of-mouth intention H3: Customer satisfaction has a positive relationship with Repurchase intention H4: Word of mouth intention has a positive relationship with Repurchase intention
Sigala (2014)	Conceptual	Firm	Customer involvement and results of that in sustainable supply chain management Independent variables –Factors motivating customer involvement: Customer factors -Environmental factors -Firm factors -Management strategies for customer involvement: -How to ID customers to be involved- How to motivate customer involvement -Reduce customer cost of involvement –Degree of customer involvement - No. of business stages where customers are involved - Goals of	Research supports the position that customers can contribute to sustainable supply chain management at all business stages: -Service -Design -Procurement -Production -Marketing -Feedback

			customer involvement -Methods of customer involvement -Strategies for managing customer involvement Dependent: -Outcomes of customer involvement: Customer benefits -Firm benefits -Society benefits	
Ghadge, Kidd, Bhattacharjee, and Tiwari (2018)	Empirical (secondary data)	Firm	Independent variables: -SC network -East or west (world) location of company -Closeness to end customer Dependent variable: -Sustainability performance in procurement Moderator:-Stakeholders	Identified criteria that tend to support sustainable procurement performance: -Environmental regulations -Green purchasing practices -Sustainable product quality Found that supply chain tiers that are closer to the end customer are more likely to follow sustainability practices.
Schmidt, Foerstl, and Schaltenbrand (2017)	Empirical survey of 284 European companies in various industries	Firm	Independent variables: (green supply chain practices) -Green design -Green internal management -Green logistics -Green purchasing -Green manufacturing Dependent variables: -Market pe rformance-Financial performance Moderating variable: -Position of firm in supply chain	Green supply chain practices are significantly and positively related to market performance. Green supply chain practices and significantly and positively related to financial performance. Position of firm in its supply chain moderates both market and financial performance. The farther down that a firm is in the supply chain, the higher the level of green supply chain practices.

Klewitz and Hansen (2014)	Review of 84 research articles 1992-2012	Article	Strategic sustainability behavior types: -Resistant -Reactive -Anticipatory -Innovation-based -Sustainability-rooted	Resultant innovation types: -Process -Organizational -Product
Schafer and Lower (2021)	Review of 106 review articles	Article	-Ecodesign concepts -Evolution of Ecodesign -Barriers and success factors in Ecodesign -Ecodesign methods and tools	608 statements in the reviewed articles were related to the identified variables to present a summary of the current state of ecodesign

APPENDIX 2: SURVEY QUESTION STATEMENTS

Statement items for subsections B through G are from Zhu, et al, (2008)
Statement items for subsections I and K are based on the sustainability adaptations in Khoja, et al., (2014, 2019) of the Hayes and Wheelwright four-stage model of manufacturing operations (Hayes and Wheelwright, 1984).

Respondents were asked to indicate the extent to which they agreed or disagreed with each statement using Likert-like scales of 1 (completely agree) to 5 (completely disagree).

B. Green Purchasing

8. Eco-labeling of products and/or services
9. Cooperation with suppliers for environmental objectives
10. Environmental audit for supplier's internal management
11. Supplier's ISO 14000 certification
12. Second-tier supplier environmentally friendly practice evaluation

C. Cooperation with Customers

13. Cooperation with customers for eco-design
14. Cooperation with customers for cleaner production of products and/or services
15. Cooperation with customers for green packaging

D. Eco Design

16. Design of products and/or services for reduced consumption of material energy
17. Design of products and/or services for re-use, recycle, recovery of material, component parts
18. Design of products and/or services to avoid or reduce use of hazardous products and/or their manufacturing process.

F. Environmental Performance

22. Reduction of air emission
23. Reduction of waste water
24. Reduction of solid wastes
25. Decrease of consumption for hazardous/harmful/toxic materials
26. Improvement of the enterprise's environmental situation
27. Decrease of cost for energy consumption
28. Decrease of fee for waste treatment
29. Decrease of fee for waste discharge
30. Decrease of fines for environmental accidents

G. Economic Performance over the past 2 to 3 Years

31. Decrease of cost for materials and/or services purchases

I. Impact of laws on sustainable business practices

37. Use of sustainable business practices *anywhere in our company* is a result of legal requirements to do so
38. Use of sustainable business practices *in our supply chain management operations* is a result of legal requirements to do so

39. Our company is fully aware of legal requirements for use of sustainable business practices *in all areas of our company operations*

40. Our company is fully aware of legal requirements for use of sustainable business practices *in our supply chain management operations*

41. We are *in full compliance with all legal requirements* for use of sustainable business practices *in all areas of our company operations*

42. We are *in full compliance with all legal requirements* for use of sustainable business *practices in our supply chain management operations*

43. We are *in the process of achieving compliance with all legal requirements* for use of sustainable business practices *in all areas of our company operations*

K. Impact of customer requirements on sustainable business practices

50. Use of sustainable business practices *anywhere in our company* is a result of requirements of major customers to do so

51. Use of sustainable business practices *in our supply chain management operations* is a result of major customers' requirements to do so.