An empirical examination of stakeholder pressures, green operations practices and environmental performance

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Abstract

This study explores two key attributes constituting green operations practices (i.e. internal green management and green product/process design) and examines the links of adopting green operations practices with its antecedent factors (stakeholder pressures) and consequent performance outcomes (environmental performance). Data collected from 167 manufacturing firms in the UK were analyzed using a structural equation modelling methodology. The results show that stakeholder pressures significantly affect the two attributes of implementing green operations practices. Internal green management is an enabler for implementing green product/process design, which, in turn, leads to improved environmental performance. More specifically, we find that green product/process design fully mediates the relationship between stakeholder pressures and environmental performance and the relationship between internal green management and environmental performance.

Keywords: Stakeholder pressures; Internal green management; Green product/process design; Green operations practices; Environmental performance; UK

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1. Introduction

Firms are faced with increasing environmental pressures and demands from various stakeholder groups (such as customers, suppliers, government and shareholders) that is quite challenging to manage (Berry and Rondinelli, 1998; Delmas and Toffel, 2004; Delmas and Toffel, 2008; Kassinis and Vafeas, 2006). How firms respond to stakeholder pressures has become a critical concern on implementing environmental management practices (Hofer et al., 2012; Sarkis et al., 2010). Previous studies (e.g. Sarkis et al., 2010; Darnall et al., 2010) have adopted stakeholder theory (ST) (Freeman, 1984) to examine the determinants of environmental management practices. Although previous research has highlighted the important effect of stakeholder pressures on the behaviour of firms toward the natural environmental practices (e.g. Buysse and Verbeke, 2003; Henriques and Sadorsky, 1999; Delmas and Toffel, 2008; Sarkis et al., 2010; Zhu and Sarkis, 2007; Zhu et al., 2005), there is little empirical evidence to support the notion that stakeholder pressures enhance environmental performance (Kassinis and Vafeas, 2006), especially in the context of production and operations management. Clearly, there is a need for more research that empirically explores the relationships among stakeholder pressures, green operations practices, and environmental performance.

Operations management (OM) offers an important sustainability perspective (Drake and Spinler, 2013; Kleindorfer et al., 2005). As stakeholder pressures mount, companies adopt environmental management initiatives to monitor and control the impact of their operations on the natural environment (Hofer et al., 2012). In recent years, there has been an increasing interest in examining the effects of environmental management practices in the context of production and operations management (e.g. Plambeck, 2013; Drake and Spinler, 2013; Hofer et al., 2012; Sarkis et al., 2010). According to ST, *green operations practices* can be defined as environmental management initiatives that are implemented during the manufacturing process to satisfy stakeholder pressures and, thereby, gain competitive advantages (Hofer et al., 2012). de Burgos-Jiménez et al. (2013) argue that environmental practices should be conceptualized as a multidimensional construct rather than an aggregate form. In the present study, we identify and define from the literature two important attributes of green operations practices, namely internal green management and green product/process design (Kleindorfer et al., 2005; Drake and Spinler, 2013). These attributes suggest the importance of developing strategic procedure and assessment on the effort of green operations practices that enables firms to improve environmental performance (Lai and Wong, 2012). Once environmental sustainability has become a corporate strategic focus (such as internal green management), the firms can begin to implement environmental practices (such as green product/process design) (Green et al., 2012). To the best of our knowledge, there is no empirical study that empirically investigates the relationship between the two attributes of green operations practices and clarifies which green initiatives (either internal green management or green product/process design) directly influences environmental performance. From the stakeholder perspective (Freeman, 1984), our study aims to fill this gap and refine understanding of linkages between these constructs in terms of environmental impacts.

There has been a great deal of research interest regarding whether or not environmental practices can improve firm performance (e.g. Sarkis et al., 2010; de Burgos-Jiménez et al., 2013; Montabon et al., 2007). The assumption is that improved environmental management practices will lead to improved firm performance (Dechant and Altman, 1994). However, there is a debate that firms might not always be able to create competitive advantage from implementing environmental management practices (Margolis and Walsh, 2003; Aragon-Correa and Rubio-Lopez, 2007). Environmental management practices may be ineffective or just focusing on giving an appearance of environmental responsibility to stakeholders; thus, the adoption of environmental practices does not always result in improved environmental performance (de Burgos-Jiménez et al., 2013; Henri and Journeault, 2008). King and Lenox (2001) raise the question of whether or not embracing environmental sustainability really pays and call for further empirical investigation of the effect of environmental practices on performance. Therefore, there is still a research gap to clarify the relationship between green operations practices and competitiveness (de Burgos-Jiménez et al., 2013).

To help understand the role of natural environment in production and operations process, a conceptual model of green operations practices is developed. This model explores the two key attributes of green operations practices (internal green management and green product/process design) and examines the links of adopting green operations practices with its antecedent factors (stakeholder pressures) and consequent performance outcomes (environmental performance).

Our study addresses three main research themes: 1) the relationships between stakeholder pressures and green operations practices; 2) the link between internal green management and green product/process design; and 3) the relationship between green operations practices and environmental performance. This study seeks to extend our understanding of the relationships between stakeholder pressures and different attributes of green operations practices and how they affect environmental performance. Clarifying such complex relationships can provide managerial guidelines for practicing managers to decide how to devote their environmental efforts and resources in adopting green operations practices (either investing first in internal green management or green product/process design) in order to respond to pressures from different stakeholder groups and improve environmental performance. Furthermore, by defining two important attributes of green operations practices, this study will be able to enhance our knowledge in terms of the debate about the competitive effects of the adoption of green operations practices, but is also useful for deciding on future strategies about environmental issues (de Burgos-Jiménez et al., 2013).

2. Theoretical background and research hypotheses

2.1. Stakeholder theory (ST)

Stakeholder theory (ST) (Freeman, 1984) has gained increasing popularity in the environmental sustainability literature (Sarkis et al., 2010; Sarkis et al., 2011). Stakeholders are people and groups that have an interest in the company and may be influenced by, or influence, its operations (Freeman, 1984; Slack et al., 2010). Many scholars express the view that a business is a coalition of stakeholders including customers, suppliers, employees, shareholders, the community, and government (Freeman, 1984; Donaldson and Preston, 1995; Henriques and Sadorsky, 1999; Buysse and Verbeke, 2003). In recent years, stakeholders' concerns about environmental issues have grown significantly, and companies are under growing environmental pressures from different stakeholder groups to develop strategies, policies and practices that are aligned with the organization's environmental goals (Hart, 1995; González-Benito and González-Benito, 2005; Klassen, 1993; Hofer et al., 2012). King (2007) views cooperation between firms and stakeholders as a way of finding win-win solutions and benefits. ST requires a company to take into account its relationship with specific stakeholder groups as it sets corporate direction and improves its organizational practices (Roberts, 1992). In the context of the natural environment, stakeholders can pressure firms to implement environmental management practices that lead to improved environmental performance (Darnall et al., 2010). The effect of stakeholder pressures on the adoption of environmental practices has been well studied (Sarkis et al., 2010) from the stakeholder perspective.

ST has been wieldy viewed as an explanatory theory related to antecedents or contingencies for implementation of various environmental management practices (Sarkis et al., 2010; Sarkis et al., 2011). Building on ST, previous studies (e.g. González-Benito and González-Benito, 2005; Sarkis et al., 2010; Darnall et al., 2010; Buysse and Verbeke, 2003; Sharma and Henriques, 2005) have found empirical evidence of how stakeholder pressures affect firms' adoption of various environmental management practices. Thus, in this study, our theoretical framework is grounded on ST, which posits that understanding the importance of responding to stakeholder pressures can help companies develop effective environmental strategies and gain a competitive advantage (Freeman, 1984). Accordingly, we expect that stakeholder pressures may lead to adoption of different types of green operations practices, from initial matters such as internal green management to advanced issues such as green product and process design (Sharma and Henriques, 2005), which, in turn, leads to improved environmental performance. Drawing on ST, this study develops a theoretical model that explores the relationships among stakeholder pressures, internal green management, green product and process design, and environmental performance. The model is presented in Figure 1.

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2.2. Green operations practices

In the present study, we provide an overview of environmental management from an operations perspective. OM provides a vital sustainability perspective (Drake and Spinler, 2013). Environmental considerations are important to OM because customers demand products that are environmentally sustainable from design to distribution (Hofer et al., 2012). According to ST, with increased environmental regulation and consumer environmental awareness, companies are more willing to expend resources on greening operational processes (Ba et al., 2013). In recent years, there has been a remarkable increase in research related to the natural environment in OM (Plambeck, 2013; Drake and Spinler, 2013; Kleindorfer et al., 2005; Plambeck and Wang, 2009; Montabon et al., 2007; Agrawal and Ülkü, 2013; Sarkis et al., 2010; Hofer et al., 2012).

Kleindorfer et al. (2005) define green OM as "the set of skills and concepts that allow a company to structure and manage its business processes to obtain competitive returns on its capital assets without sacrificing the legitimate needs of internal and external stakeholders and with due regard for the impact of its operations on people and the environment". Gupta and Sharma (1996) further state that green OM is "the integration of environmental management principles with the decision-making process for the conversion of resources into usable products". Green OM has become an unavoidable issue for firms (Nunes and Bennett, 2010; Gupta and Sharma, 1996; Plambeck, 2013; King and Lenox, 2002). It plays an important role in contributing to solutions for the sustainability challenges that the companies currently face (Drake and Spinler, 2013). Gupta (1995) suggests that operations strategies, objectives and decisions must be reviewed continuously in the light of environmental opportunities, which in turn will strengthen operations capability that can be used to gain competitive advantages. Operations managers play a critical role in developing management systems and implementing decisions that influence environmental performance (Klassen, 1993). From the stakeholder perspective, previous researchers (e.g. Greeno, 1989; Ba et al., 2013; Lai and Wong, 2012) have suggested that world-class firms are incorporating an environmental, health, and safety perspective into their daily OM decisions in order to ensure that their operations are not only in compliance with stakeholder pressures but also are managed in an environmentally sound and responsible manner.

Green operations practices are those practices that "contribute to the enhancement of environmental performance in firms' operations" (Nunes and Bennett, 2010). According to ST, firms implement green operations practices in an effort to obtain stakeholder approval and, thus, gain competitive advantages and realize superior environmental returns (Klassen and McLaughlin, 1996; Melnyk et al., 2003; Montabon et al., 2007; Hofer et al., 2012). Over the last few years, many firms have initiated an environmental transformation of their products and processes (González-Benito and González-Benito, 2005). In order to address stakeholders' concerns, companies have adopted different environmental strategies that focus on *internal green management*, such as environmental management systems and certification (Zhu and Sarkis, 2004; Zhu et al., 2005; Zhu et al., 2008). OM function makes *product/process design* and sourcing decisions based on environmental criteria (Hofer et al., 2012). Operations is a critical functional department responsible for product design, production, and distribution (Klassen and McLaughlin, 1996). Considering the processes of the operations function, they will be practices mainly for production planning and control as well as product and process development (Nunes and Bennett, 2010; Slack et al., 2010). Many decisions that determine a firm's sustainability impact naturally intersect with established OM streams such as product and process design (Kleindorfer et al., 2005; Drake and Spinler, 2013; Sarkis et al., 2010). Green operations practices consider these operational decisions with the intent of identifying potential opportunities and threats related to improving environmental performance of the firm (Drake and Spinler, 2013).

de Burgos-Jiménez et al. (2013) argue that the notion of environmental practices is a multidimensional construct, which is too broad to be treated as an aggregate form. Accordingly, in this study, we identify and define from the literature two important attributes of green operations practices: internal green management and green product/process design (Kleindorfer et al., 2005; Drake and Spinler, 2013). These attributes of green operations practices are not all-inclusive, but attempt to capture the importance of various environmental practices adopted by a firm when facing environmental pressures from different stakeholder groups.

2.2.1. Internal green management

In this study, *internal green management* practices are defined as environmental strategies developed by a company. At the organizational level, the internal green management practices evaluate the extent to which firms are visible in environmental protection actions that are the responsibility of different stakeholders (Lai and Wong, 2012; Zhu and Sarkis, 2004). Given the increasing environmental pressure on a firm's environmental performance, firms consider adopting green operations practices as a corporate-level strategy. Internal green management is increasingly being recognized as systematic and comprehensive mechanisms for achieving superior environmental performance (Zhu and Sarkis, 2004; Zhu et al., 2008). Much of the previous research on environmental issues in business has investigated internal operations that a company adopts, such as waste management and eco-efficiency (Rao and Holt, 2005). As it is true for total quality management, environmental strategies must be conceived and supported by top management, but deployed in every functional area of an organization to be meaningful (Walton et al., 1998). It is generally believed that senior managers' support is necessary and, often, a key driver for successful adoption and implementation of most innovations, technology, programs and activities (Hamel and Prahalad, 1989). Communication between business managers and environmental professionals is also important in the successful business and environment relationship (Aspan, 2000). The internal green management dimension also includes processes such as environmental auditing of departments, environmental management systems, total quality environmental management, communication and training, and ISO 14001 certifications (Bowen et al., 2001; Klassen and Whybark, 1999; Zhu et al., 2008; Sarkis et al., 2010).

2.2.2. Green product/process design

Green product/process design refers to create processes and products that have minimal impact on the environment (Sarkis et al., 2010). Essential to developing sustainable products and processes is sustainable design (Kleindorfer et al., 2005; Sroufe, 2003; Plambeck and Wang, 2009; Agrawal and Ülkü, 2013). Product design and process technology typically determine the types of pollutants emitted, solid and hazardous wastes generated, resources harvested and energy consumed (Post, 1991; Sarkis, 1995; Angell and Klassen, 1999). Product/process design is often complicated by the uncertainty inherent in the evolution of environmental trends and regulations (Kleindorfer et al., 2005). Lozada and Mintu-Wimsatt (1995) state that design activities generally present opportunities for firms to find solutions to environmental issues. Introducing environmental innovations in product and process design can influence the product's cost and demand, as well as the environmental impact in different stages of its life cycle such as manufacturing and use stages (Raz et al., 2013). Green product/process design is a critical tool for firms to produce green products which enable them to minimize or completely remove emissions and wastes (Tibor and Feldman, 1996; Agrawal and Ülkü, 2013). Firms are now improving their operations practices to adopt green design and production that avoid environmentally hazardous components and make it economically possible to save components that have high reuse value (Kleindorfer et al., 2005). Nunes and Bennett (2010) also suggest that the design of the cars is considered a key activity for addressing environmental concerns through its ability to affecting the whole life of the product. Previous studies have found positive relationship between green product/process design and environmental performance (e.g. Zhu and Sarkis, 2004; Green et al., 2012).

2.3. Hypotheses development

2.3.1. Stakeholder pressures and green operations practices

It has been widely accepted that firms face pressures from various stakeholders (e.g. customers, suppliers and competitor) on implementing environmental management practices (Henriques and Sadorsky, 1999; Delmas and Toffel, 2008; Sarkis et al., 2010). According to ST, stakeholder pressures could motivate firms to take more consideration of environmental issues and may encourage them to incorporate environmental practices into their management strategies (Sarkis et al., 2010; Sarkis et al., 2011). Supply chain stakeholders, especially customers and suppliers, may affect a firm's decision to adopt environmental practices (Sarkis et al., 2010). Product stewardship requires integrating stakeholder perspectives into product design and development processes (Hart, 1995). Firms face pressures from customers who wish to ensure that their purchases sufficiently meet environmental quality standards, which will enable firms to reduce environmental liabilities associated with final product development (Handfield et al., 2002; Sarkis et al., 2010).

Stakeholder pressures have the capacity to influence an organization's responsiveness to the adoption of green operations initiatives (Zhu and Sarkis, 2007; Henriques and Sadorsky, 1996). Previous empirical studies (e.g. Delmas, 2001; Delmas and Toffel, 2008; Henriques and Sadorsky, 1999; Sarkis et al., 2010; Sharma and Henriques, 2005) have investigated the relationship between stakeholder pressures and environmental management practices. Darnall et al. (2010) find that greater perceived pressures from stakeholders are associated with an increased likelihood that firms adopt proactive environmental practices. Sarkis et al. (2010) also find that stakeholder pressures have a significant effect on various environmental practices, which is mediated by environmental training. Delmas and Toffel (2008) also identify that firms that are more receptive to institutional pressure from market constituents (such as customer, supplier and competitor) are more likely to adopt the environmental management standard ISO 14001. Sharma and Henriques (2005) find that firms will undertake eco-design sustainability practices when subjected to usage strategies from its economic and social/ecological stakeholders. Based on the principles of ST and the results of empirical studies, it can be argued that firms aim to adopt various green operations practices (such as internal green management and green product/process design) to respond to the growing environmental pressures from different stakeholder groups. Thus, we propose the following hypothesis.

H1: Stakeholder pressures have a significant positive impact on a) internal green management and b) green product/process design.

2.3.2. Stakeholder pressures and environmental performance

According to ST, the better a firm manages its relationship with various stakeholders, the better will be its performance outcomes (Donaldson and Preston, 1995; Freeman, 1984). Gupta (1995) suggest that the perceived environmental consciousness of a company involves balancing key stakeholders' expectations with environmental performance. Firms that aim to react to stakeholder pressures by implementing various green operations practice can promote good environmental performance and reduce negative environmental impact (Hoffman, 2000; Berrone and Gomez-Mejia, 2009). Zhu and Sarkis (2007) conclude that the existence of environmental pressures (such as market and regulatory pressures) will influence companies to have better environmental performance, especially when these pressures cause implementation of environmental management practices such as eco-design. Greater environmental pressures from different stakeholder group force firms to adopt more environmental practices, which in turn leads to improvements in their environmental performance (Darnall et al., 2010). Firms may resist adopting environmental practices if they are not aware of any mode of pressures from stakeholder groups, which may result in poor environmental performance (Zhu and Sarkis, 2007). Although researchers (e.g. Darnall et al., 2010; Sarkis et al., 2010) have offered theoretical agreements, there is little empirical evidence that stakeholder pressures enhance environmental performance. Researchers have yet to reach a definitive conclusion as to the effect of stakeholder pressures on firm environmental performance (Kassinis and Vafeas, 2006). Drawing upon resource dependence theory, Kassinis and Vafeas's (2006) work builds a richer understanding of the relationship between stakeholder pressures and environmental performance. They find that higher stakeholder pressures are related to lower toxic releases and that varying stakeholder characteristics and the dependencies associated with them are related to varying levels of environmental performance. Based on the theoretical arguments and empirical evidence, we posit the following hypothesis.

H2: Stakeholder pressures have a significant positive impact on environmental performance.

2.3.3. Internal green management and green product/process design

As noted earlier, this study explores the two important attributes of green operations practices, namely internal green management and green product/process design. The first attribute is to embrace the strategy organizationally, i.e. adopting internal green management, such as top management commitment and support, set aural targets for recycling or waste reduction, a clear environmental mission statement and environmental management system. The second attribute is to adopt green product and process design, such as material recycling, remanufacturing, eliminating waste, and integrating environmental considerations when designing new products and processes. Once a firm adopts environmental initiatives as a strategic imperative and the imperative receives the commitment and support from top management team, the firm can proceed with the implementation of green product/process design (Green et al., 2012). Subsequently, internal green management may influence green product/process design. The incorporation of the imperative into the overall corporate strategy is a necessary precursor to successful implementation of the green operations practices (Murray, 2000). Klassen and McLaughlin (1993) suggest that environmental excellence starts during the initial product and process design that can be strengthened by internal green management. Therefore, we argue that companies with a high level of internal green management are more likely to strengthen their operations and production processes to implement environmental management initiatives. Without internal green management, it is difficult for companies to adopt green product/process design. Considering the above arguments, it can be suggested that internal green management is an antecedent to green product and process design. State formally:

H3: Internal green management is positively associated with green product/process design.

2.3.4. Green operations practices and environmental performance

Researchers claim that firms are improving their environmental performance by adopting various environmental management practices (Theyel, 2000). The assumption is that better environmental management practices will lead to better performance (Dechant and Altman, 1994). Previous researchers (e.g. Clarke, 1994; Hart, 1995; Porter and van der Linde, 1995) have suggested that the adoption of environmental management practices lead to improvements in environmental performance. By considering environmental objectives in production planning and operations processes, the firms can improve environmental performance during every stage of operations (Williams et al., 1993). Firms use improved environmental performance to lower their costs by reducing waste in their production processes (Shrivastava, 1996). Using a deterministic approach, Stuart et al. (1999) develop a mixed integer programming tool that examines the effect of product and process design options on manufacturing environmental performance. Eco-design is an important tool to improve firm environmental performance by addressing product functionality while simultaneously minimizing life-cycle environmental impacts (Zhu and Sarkis, 2004). There is growing empirical evidence that adoption of various environmental management practices leads to improved environmental performance (Klassen and McLaughlin, 1996; Zhu and Sarkis, 2004; Theyel, 2000; Green et al., 2012). Zhu and Sarkis (2004) find that internal environmental management has a significant effect on environmental performance. They also find that eco-design has a direct and positive effect on environmental performance. Green product/process design will lead to cost reduction such as decrease of cost for energy consumption and fees for waste treatment and discharge. Klassen and McLaughlin (1996) conclude that environmental management (such as product and operations technologies and environmental management systems) is one important determinant of environmental performance. Theyel (2000) finds that environmental management practices (such as total quality management for pollution prevention and employee pollution prevention training program) are significantly and positively related to improved environmental performance (reduction of chemical waste). Green et al. (2012) find that eco-design is significantly and positively related to environmental performance. In addition, there is consensus within the environmental management literature that internal green management is central to improving environmental performance (Carter et al., 1998; Melnyk et al., 2002; Zhu and Sarkis, 2004). Therefore, it can be argued that firms that adopt green operations practices (such as internal green management and green product/process design) can improve environmental performance. Using the above arguments, the following hypothesis is proposed.

H4: a) Internal green management and b) green product/process design are positively related to environmental performance.

3. Research method

3.1. Data collection

The data were gathered during September 2009–March 2010. Before executing the survey, several academics from the field of operations management reviewed the initial measurement scales and provided feedback. We then conducted a pilot-test with several manufacturing managers to ensure that the questions were clear, meaningful, relevant and easy to interpret (O'Leary-Kelly and Vokurka, 1998). Minor changes to the scales were made accordingly.

A random sample of 3000 manufacturing firms was drawn from a population of 15102 firms provided by the Financial Analysis Made Easy (FAME) database (based on SIC 10-32 codes in the UK). We first sent the questionnaire to 2000 manufacturers in September 2009. Follow-up calls were made to encourage completion and return of the questionnaires and to clarify any questions or concerns that potentially had arisen. In spite of reminders, we managed to get only 125 completed questionnaires. In order to improve sample size, we contacted another 1000 firms in February 2010 resulting in 50 more responses. After deleting unsatisfactory responses with significant missing data, the final sample size was 167 for use in subsequent analyses. The effective response rate was 5.6%, which is comparable to other survey-based environmental management studies (e.g. Green et al., 2012; Chiou et al., 2011; Kassinis and Soteriou, 2003). Although higher response rates are desirable, researchers (e.g. Harmon et al., 2002; Melnyk et al., 2003) have noted that low response rates are typical in large-scale survey research. The single most serious limitation to data collection via direct mail is the relatively low response rates, which are often only about 5-10% (Alreck and Settle, 1995; Melnyk et al., 2003). Thus, our number of responses can be regarded as satisfactory in this type of survey-based studies. Our respondents typically hold relevant positions such as CEO, general manager, safety, health and environmental manager, quality manager, operations and production manager, and environmental systems manager. Most of the respondents (77.2%) were corporate managers with more than five years of work experience in the same company, it is reasonable to expect that the respondents could be knowledgeable about their respective firms so as to ensure the quality of the collected data. In addition to collecting data on the main theoretical constructs, we also collected demographic data on the firms including industry type, sales, firm age, and number of employees. A profile of the respondent manufacturers is reported in Table 1.

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We assessed non-response bias using the extrapolation method suggested by Armstrong and Overton (1977). One way of checking non-response bias is to compare the responses of late respondents with those of early respondents. We performed *t*-tests to verify whether there were substantial differences between the two sets of samples. We found no statistically significant difference for all questions in the questionnaire. Thus, we confirmed that non-response bias was not an issue with our study. To further test for non-response bias, we then compared data on several important organizational characteristics (turnover, cost of sales, total assets, number of employees, profit, and return on total assets in 2008) of our respondent companies with corresponding data on all manufacturing firms in the UK in order to confirm that data collected from our survey (the 167 companies) represented the population of manufacturers in the UK. The data were obtained from the FAME database. We found no statistically significant differences, confirming that non-response bias is not a serious problem with our survey.

Because we obtained data from a single respondent per firm using the self-reported questionnaire, the potential for common method bias was assessed using several steps. First, Harmon's one-factor test using exploratory factor analysis (EFA) was conducted (Podsakoff et al., 2003). The results of EFA indicate two distinct factors with eigenvalues above 1.0 and explaining 54.779% of total variance. The first factor explained 42.315% of the variance, which is not majority of the total variance. The finding suggests that the common method bias does not appear to be a problem. Second, confirmatory factor analysis (CFA) was applied to Harman's single-factor model (Flynn et al., 2010; Podsakoff et al., 2003). The model fit indices of χ^2/df (345.684/119) = 2.905, CFI = 0.827, IFI = 0.831, TLI = 0.777, and RMSEA = 0.107 were unacceptable and were significantly worse than those of the measurement model. This suggests that a single factor model is not acceptable, thus common method bias is unlikely. Third, a latent factor representing a common method was added to the measurement model, which is the strongest test of common method bias (MacKenzie et al., 1993; Podsakoff et al., 2003; Zhao et al., 2011). The resulting fits were not significantly different from those of the measurement model (RMSEA = 0.057 vs. 0.040 for the model with the common method factor; CF1 = 0.953 vs. 0.980; IF1 = 0.955 vs. 0.981; TLI = 0.937 vs. 0.969). Also, the item loadings for their factors are still significant in spite of the inclusion of a common latent factor. As such, we conclude that common method variance bias is not an issue in this study.

3.2. Measures

All the measurement items for our theoretical constructs were adapted from the literature. The stakeholder pressures scale was mainly adapted from Delmas and Toffel (2008), which focused on environmental pressures from key stakeholders such as customers, suppliers, competitors, and employees. The measures for internal green management were adapted from Montabon et al. (2007), which emphasized green operations practices conducted within a company from a corporate strategic perspective, such as annual targets for energy conservation, recycling and waste reductions, environmental mission statement, environmental management system, a separate environmental department/team, training programmes for employees, and ISO 14000 certification. The green product/process design scale was also adapted from Montabon et al. (2007), which included sustainable operations process design implemented by the companies to produce green products, such as material recycling, remanufacturing, eliminating waste, and integrating environmental considerations when designing new products. The measures for environmental performance in this study are also in line with previous studies (e.g. Delmas and Toffel, 2008; Darnall et al., 2010; Montabon et al., 2007). A five-point Likert scale (1 = "strongly disagree"; 5 = "strongly agree") was used for all five constructs. The measurement items are presented in Table 2.

We used two control variables in our model, namely, firm size and firm age. Firm size was measured by number of employees. Firm age was evaluated by the number of years of respondent firm has been involved in the manufacturing business. Firm size and age were controlled in the current analyses because larger and older manufacturers may have greater resources for adopting green operations practices to resist stakeholder pressures (Bowen, 2002; Darnall et al., 2010).

4. Data analysis and results

Following a two-step approach (measurement and structural model) recommended by Anderson and Gerbing (1988), structural equation modelling (SEM) was used to evaluate the hypothesized model.

4.1. Measurement model

The unidimensionality of the key constructs was assessed using CFA (Gerbing and Anderson, 1988). Based on the CFA results summarized in Table 2, we conclude that the model (χ^2/df = 1.543; RMSEA = 0.057; CF1 = 0.953; IFI = 0.955; TLI = 0.937) is acceptable and unidimensionality is confirmed (Byrne, 2009; Hair et al., 2006; Hu and Bentler, 1999).

Cronbach's alpha coefficient and composite reliability (CR) were used to examine the reliabilities among the items within each factor. As shown in Table 2, the Cronbach's alpha and CR of all the constructs exceed or marginally below the widely recognized rule of thumb of 0.70. The alpha values ranged from 0.667 to 0.913. The alpha values for green product/process design and environmental performance were marginally below 0.70, but above the lower limit of 0.60, which can be considered marginally acceptable (Hair et al., 2006). Researchers (e.g. Flynn et al., 1990; Nunnally, 1978) have noted that alpha levels above 0.70 are desirable, but 0.60 and above are acceptable for newly developed scales. Gupta and Somers (1996) further argue that since alpha is a function of the number of items in the composite, it tends to be conservative. Thus, we conclude that our measurement scales have acceptable levels of reliability.

We evaluated the convergent validity of each measurement scale by conducting CFA using the maximum likelihood approach (O'Leary-Kelly and Vokurka, 1998). As shown in Table 2, all indicators in their respective constructs have statistically significant ($p < 0.001$) factor loadings greater than 0.50, which suggests convergent validity of the theoretical constructs (Anderson and Gerbing, 1988). The results of CFA also reveal that the standardized coefficients for all items greatly exceed twice their standard errors, and that the standardized coefficients for all variables are large and significant (all the t-values are larger than 2) (Hair et al., 2006). Therefore, all items are significantly related to their underlying theoretical constructs. While the average variance extracted (AVE) values for some constructs are marginally less than the cut-off point of 0.50 suggested by Fornell and Larcker (1981), we satisfied the more detailed criteria set by several other studies as indicated above. For example, though two measurement items of green product/process design have relatively low factor loadings, which lead to a relatively low AVE, we still keep these items because they are very important for the concept of green product/process design (Montabon et al., 2007). Some empirical studies have used AVE values below 0.50 to establish convergent validity (e.g. Zhao et al., 2011; Flynn et al., 2010; Sarkis et al., 2010). Overall, our constructs express sufficient convergent validity.

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We examined discriminant validity using Chi-square difference test (Bagozzi et al., 1991). Significant χ^2 differences between all pairs of constructs suggest discriminant validity (Bagozzi et al., 1991; O'Leary-Kelly and Vokurka, 1998). A constrained CFA model for every possible pair of latent constructs was examined (the correlations between the paired constructs were constrained to 1.0). We then compared the constrained model with the original unconstrained model allowing the correlations among constructs to be freely estimated (Bagozzi et al., 1991). The results indicate that all χ^2 differences between the fixed and unconstrained model are significant at the 0.001 level, providing evidence of discriminant validity between each measurement scale (Bagozzi et al., 1991). In addition, Table 3 reports the means, standard deviations, and correlations of the theoretical constructs.

------------------------------ Insert Table 3 about here ------------------------------

4.2. Structural model

The results of structural model using AMOS 20 are reported in Table 4 and Figure 2. The overall fit indices of the structural model are good (χ^2/df = 1.580; RMSEA = 0.059; CFI = 0.938; IFI = 0.940; TLI = 0.917) (Byrne, 2009; Hair et al., 2006; Hu and Bentler, 1999). Although we controlled for each firm's age (β = -0.025, p = 0.674) and size (β = 0.100, p = 0.102), neither of the two factors has an apparent impact on environmental performance. Table 4 reveals significant positive paths from stakeholder pressures to both internal green management and green product/process design, which lends support for H1a and H1b. However, the structural model indicates that neither stakeholder pressures nor internal green management has a significant effect on environmental performance. Hence, H2 and H4a are rejected. The path analytic model shows that internal green management has a significant positive effect on green product and process design, which lends support for H3. Green product/process design is positively and significantly associated with environmental performance, which provides support for H4b.

------------------------------ Insert Table 4 about here ------------------------------

Following Baron and Kenny (1986), to identify the mediation effects of green product/process design, we estimated two additional models: stakeholder pressures → environmental performance and internal green management → environmental performance. The models and results indicate that stakeholder pressures have a significant impact on environmental performance (β = 0.346, $p < 0.001$) and that internal green management is significantly and positively related to environmental performance (β = 0.877, $p < 0.001$). However, these impacts became insignificant (see Figure 2) when the mediator (green product/process design) was added in the theoretical model. Furthermore, to directly examine the significance of the mediating effects of green product/process design, we conducted the Sobel test (Sobel, 1982) using the interactive tool provided by Preacher and Leonardelli (2003). As an additional test for mediation, Mackinnon et al. (2002) suggest that the Sobel test is superior in terms of power and intuitive appeal. The Sobel test lends additional support for the mediated relationships hypothesized through a change in significance of the indirect effect. The results of the Sobel test provide support for the fully mediating effects of green product/process design on the relationship between stakeholder pressures and environmental performance (t = 1.962, $p < 0.05$) and the relationship between internal green management and environmental performance (t = 2.243, $p < 0.05$).

------------------------------ Insert Figure 2 about here ------------------------------

5. Discussions and implications

5.1. Discussions

There are several notable findings in this study. Drawing upon ST, we develop a conceptual model that examines the relationships among stakeholder pressures, internal green management, green product/process design, and environmental performance. Overall, our analysis reveals that stakeholder pressures significantly influence green operations practices, and that green product/process design is significantly and positively related to environmental performance. More specifically, we find that green product/process design fully mediates the stakeholder pressures–environmental performance relationship and the internal green management–environmental performance relationship. The significant positive link between the two important attributes of green operations practices (internal green management and green product/process design) suggests the importance of a staged implementation of the practices (Green et al., 2012).

Our results show that environmental pressures from different stakeholder group (such as customers, suppliers and competitors) have a significant positive effect on the adoption of green operations practices. Stakeholder pressures are important antecedent factors influencing the implementation of green operations practices. This finding is consistent with the principles of ST, which explain firms' implementation of green operations practices as a response to different stakeholders' requirements, expectations and preferences (Freeman, 1984; Donaldson and Preston, 1995; Buysse and Verbeke, 2003). According to ST, managers' perception of stakeholder pressures will drive the firms to adopt internal green management and green product/process design. Our results reinforce previous studies (e.g. Delmas, 2001; Delmas and Toffel, 2008; Henriques and Sadorsky, 1999; Sarkis et al., 2010; Sharma and Henriques, 2005) that highlight the important role of stakeholder pressures in implementing green operations practices. Our analysis also reveals that stakeholder pressures significantly affect environmental performance, but the effect is *indirect* and fully mediated by green product/process design.

Our results also indicate that green product/process design is positively and significantly associated with environmental performance. A positive influence (i.e. benefits) of internal green management on environmental performance is realized *indirectly*, and is mediated through green product/process design. This finding is consistent with previous empirical studies (Zhu and Sarkis, 2004; Theyel, 2000; Green et al., 2012) that conclude that the adoption of environmental management practices leads to improvements in environmental performance. Unlike those previous studies, our research identifies the mediation effect of green product/process design. The finding of significant relationships between green operations practices on environmental performance is very promising. These are important results that provide support for the important values of green product/process design practices for assisting manufacturers with the ability to respond to stakeholder pressures and improving environmental performance.

Another important contribution of our research is the confirmation of the mediating role of green product/process design. Our findings indicate that green product/process design fully mediates the relationship between stakeholder pressures and environmental performance among UK manufacturers. The environmental pressures and demands from different stakeholder groups is an important driver for firm to adopt green operations practices in order to improve environmental performance. However, the effect of stakeholder pressures on environmental performance is *indirect*, through green product/process design. Furthermore, our analysis also reveals that green product/process design fully mediates the relationship between internal green management and environmental performance. It is green product/process design that has a significant direct effect on improved environmental performance. The findings of mediating effect of green operations practices provide important empirical evidences for the notion that green product/process design is an important tool for firms to react to stakeholder pressures in order to improve environmental performance. To respond to the environmental pressures from various stakeholders, the firms seek to improve environmental performance must take more consideration of environmental issues and incorporate green product/process design into their production and operations processes (Kassinis and Vafeas, 2006; Sarkis et al., 2010; Delmas and Toffel, 2008; Hofer et al., 2012). However, internal green management should not be ignored, because it is an enabler for implementing green product/process design.

More specifically, our structural model reveals that internal green management significantly affects green product and process design. This finding provides strong empirical evidence for the proposition of a staged implementation of the green operatories practices (Green et al., 2012). The present study develops and empirically validates the green operations practices construct characterized with two important attributes, namely internal green management and green product/process design. Internal green management is an antecedent of green product and process design, which indicates that companies need to progress from good internal green management initiatives to effective management of green product and process design. Internal green management should first be adopted as a strategic imperative at the firm level. A firm (e.g. top management commitment and support) may incorporate green operations as a key part of the organizational mission statement, which would enable the firm to develop green processes and produce eco friendly products in order to achieve effective response to various stakeholder pressures. The findings reinforce the work of Green et al. (2012) that conclude that the adoption of environmental sustainability as strategy through the implementation of internal environmental management significantly influences the environmental practices such as eco-design.

5.2. Theoretical implications

This study makes important contributions to the existing environmental management practices literature. Drawing upon ST, we provide an overview of environmental management from an operations perspective. First, to our knowledge, this study offers the first theoretical arguments describing the relationships among stakeholder pressures, green operations practices and environmental performance by considering the mediating effect of green product/process design. Our theoretical model is valuable for extending our understanding of environmental and operational practices. Our results provide empirical evidence supporting the notion that managerial perceptions of stakeholder pressures motivate firms to take more consideration of green operations practices issues in their production and operations process in order to improve environmental performance (Freeman, 1984; Donaldson and Preston, 1995; Sarkis et al., 2010;

Buysse and Verbeke, 2003). Second, although many previous studies (e.g. Delmas and Toffel, 2008; Sarkis et al., 2010; Sharma and Henriques, 2005; Kassinis and Vafeas, 2006; Sarkis et al., 2010; Zhu and Sarkis, 2004) have examined the important role of environmental pressures in adopting environmental practices and improving environmental performance, few of them has examined the mediating effects of green operations practices. Our study reveals that green product/process design fully mediates the stakeholder pressures– environmental performance relationship and the internal green management–environmental performance relationship. Third, our study addresses a demonstrable gap in the existing literature that few empirical studies have explored the potential links between the main attributes of implementing green operations practices. By defining two important dimensions of green operations practices, our results indicate a significant positive relationship between internal green management and green product/process design, which offers strong support for the proposition that the green operations practices should be implemented in strategic procedures (Green et al., 2012).

5.3. Managerial implications

Our findings provide a number of managerial implications that could prove to be valuable insights for manufacturers. First, the findings of the important effect of stakeholder pressures on the adoption of green operations practices provide strategic direction to manufacturers. The increasing political, social, and economic pressures regarding environmental issues over the last few decades in the UK manufacturing industry has motivated firms to take these issues into greater consideration in their production and operations processes (Sarkis et al., 2010). According to ST, manufacturer should adopt green operations practices such as internal green management and green product/process design in order to achieve effective response to various stakeholder pressures and improve environmental performance. Second, it is important for managers to decide how to devote their environmental efforts and resources in implementing green operations practices, either investing first in internal green management or green product/process design, in order to improve environmental performance. Our results suggest that the environmental practices of green product/process design fully mediate the relationship between stakeholder pressures and environmental performance and the relationship between internal green management and environmental performance. The growing environmental demands and pressures from various stakeholder groups require manufacturers to devote their environmental resources in adopting green product/process design, which will enable them to obtain greater environmental performance. Third, our results suggest that green operations practices should be implemented in the two main attributes of green operations practices, namely internal green management and green product/process design. We believe that this finding provides a number of valuable insights into how firms adopt the two attributes of green operations practices to obtain competitive advantages and improve environmental performance. Managers, however, should not expect internal green management to directly influence performance. To effectively respond to the increasing environmental pressures and demands, "green" manufacturers should place greater emphasis on the adoption of green product/process design. However, internal green management should not be ignored because it is an antecedent of green product/process design.

6. Conclusions

In conclusion, our analysis shows that stakeholder pressures significantly affect green operations practices, and that green product/process design leads to improved environmental performance. Our results also indicate that there are two main attributes of implementing green operations practices, namely internal green management and green product/process design. Internal green management is significantly and positively associated with green product and process design. More specifically, we find that green product/process design fully mediates the relationship between stakeholder pressures and environmental performance and the relationship between internal green management and environmental performance. The findings of this study also provide practical insights that will help managers implement green operations practices to effectively respond to stakeholder pressures and improve environmental performance.

Notwithstanding its contributions, this study has a number of limitations that warrant consideration in future research. First, the present study just focuses on stakeholder pressures mainly from customer, suppliers and competitors. However, according to ST, businesses face increasing pressure from various stakeholders to go green, such as governments, community groups, environmental organizations, and the media (Freeman, 1984; Henriques and Sadorsky, 1999; Buysse and Verbeke, 2003). Future study may identify more relevant stakeholder pressures and examine their important effects on the implementation of green operations practices. Additionally, future research may also test the moderating effects of stakeholder pressures on the relationship between green operations practices and firm performance (Zhu and Sarkis, 2007; Lai and Wong, 2012). Second, our study just focuses on two important green operations practices (internal green management and green product/process design). Nunes and Bennett (2010) suggest that green operations practices include green building, eco-design or design for environment, green supply chain, greener manufacturing, and reverse logistics. Thus, future study may identify more relevant operations practices and investigate their effects on environmental performance. Third, this present study just examines the effects of green operations practices on environmental performance. Future efforts should investigate the important impacts of green operations practices on economic, social and operational performance (Klassen and McLaughlin, 1996; Green et al., 2012) and may further explore the relationships among the different performance measures. Finally, although our sample size and response rate is similar to other previous survey-based studies on environmental management, such size may limit the generalizability of study results (Lai and Wong, 2012). Future research may collect data from other countries with larger sample size to validate the specific attributes constituting green operations practices and also confirm the results obtained in this study.

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Table 1: Demographic characteristics of respondents

Industry	Fabricated metal products	Automotive	Electronics and electrical	Pharmaceutical and medical	Others
	37	17	26	11	76
Annual UK sales (in million Pounds)	< 1 M	1-2 M	2-5 M	5-10 M	> 10 M
	–	–	6	31	129
Number of employees	< 50	50-250	251-500	501-1000	> 1000
	6	94	22	19	24
Firm age	< 2	2-5	5-10	10-25	> 25
	–	3	8	33	122

Table 2: Construct reliability and validity analysis

Variables	**Factor loadings**	***t*-values**
1. Stakeholder pressures (α = 0.782; CR = 0.784; AVE = 0.476) (adapted from Delmas and Toffel, 2008)		
Customers put pressure on management of my company in adopting environmentally friendly practices	0.714	–
Supply chain partners (e.g. supplier) put pressure on management of my company in adopting environmentally friendly practices	0.662	7.030
Actions by competitors have put pressure on management of my company in adopting environmental friendly practices	0.705	7.352
Marketing department of my company puts pressure on management in adopting environmental friendly practices	0.676	7.140
2. Internal green management (α = 0.913; CR = 0.921; AVE = 0.662) (adapted from Montabon et al., 2007)		
My company sets annual targets for energy conservation, recycling or waste reductions	0.803	–
My company has a clear environmental mission statement to guide environmental decision making	0.809	11.785
My company has a clear environmental management (information) system to collect data on environmental impacts	0.903	13.769
My company has an environmental manager and/or a separate environmental department/team with well defined responsibilities	0.767	10.973
My company regularly provides training programmes to our employees to improve their awareness in protecting the environment	0.854	12.740
My company has achieved important environment related certifications (e.g. ISO 14000)	0.733	10.370
3. Green product/process design (α = 0.667; CR = 0.675; AVE = 0.343) (adapted from Montabon et al., 2007)		
My company is involved in significant levels of material recycling	0.522	–
My company is involved in significant levels of practices that minimise waste	0.583	5.499
My company integrates environmental considerations (including the life-cycle assessment and environmental risk analysis) while designing new products or developing new processes (e.g. substitution of hazardous substances)	0.605	5.619
My company considers opportunities for reuse/recycling/ recovery of material when designing products/processes	0.628	5.728
4. Environmental performance (α = 0.672; CR = 0.687; AVE = 0.427) (adapted from Montabon et al., 2007)		
My company has regularly achieved targets imposed on energy conservation, recycling or waste reductions	0.773	–
Due to its environment friendly practices, my company has saved significant amount of money in the past	0.595	7.557
On an average, overall environmental performance of my company has improved in the past five years	0.575	7.266
Model fit statistics: χ^2/df (174.304/113) = 1.543; RMSEA = 0.057; CF1 = 0.953; IFI = 0.955; TLI = 0.937		

Table 3: Descriptive statistics

	Mean	S.D.	1	2	3	4
1. Stakeholder pressures	3.117	0.768	1.000			
2. Internal green management	3.704	0.925	0.303**	1.000		
3. Green product/process design	3.709	0.614	0.447**	0.677**	1.000	
4. Environmental performance	3.621	0.671	0.328**	0.716**	0.681**	1.000

** ***p*** **≤ 0.01. (2-tailed).**

Table 4: Results of hypotheses 1–4 tests using SEM

Structural paths	Standardized coefficient	t-value	Hypothesis test
Stakeholder pressures → Internal green management (H1a)	0.383***	4.026	Supported
Stakeholder pressures → Green product/process design (H1b)	0.323***	3.284	Supported
Stakeholder pressures → Environmental performance (H2)	-0.198	-1.264	Not supported
Internal green management → Green product/process design (H3)	0.711***	5.629	Supported
Internal green management → Environmental performance (H4a)	0.175	0.647	Not supported
Green product/process design → Environmental performance (H4b)	0.937*	2.448	Supported

*** ***p*** **≤ 0.001;** * ***p*** **≤ 0.05.**

Figure 1: Theoretical model

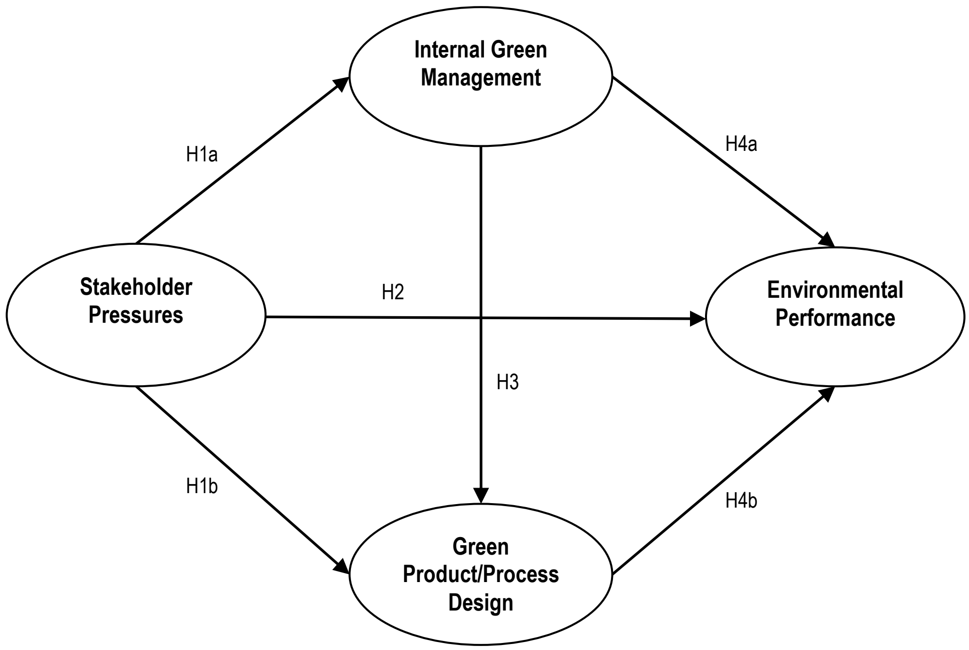
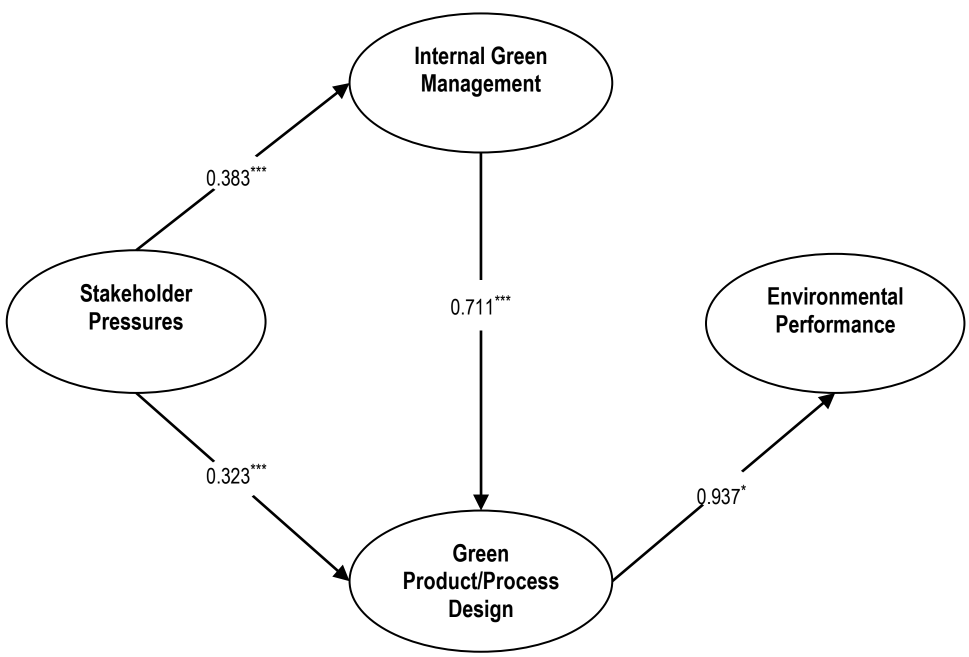


Figure 2: Statistically significant paths



*** $p \leq 0.001$; * $p \leq 0.05$

Model fit statistics: χ^2/df (225.876/143) = 1.580; RMSEA = 0.059; CFI = 0.938; IFI = 0.940; TLI = 0.917