does green really mean green? are manufacturers benefiting from adopting sustainable manufacturing practices?

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Abstract
This study aims to test the relationships between sustainability practices and business competitiveness for Caribbean manufacturers. We proposed and tested three hypothesized relationships using PLS structural equation modeling. Our results show a significant negative relationship between sustainability practices and business performance, while sustainability practices have no significant influence on competitiveness.

Keywords: sustainability, structural equation modeling, business performance

Introduction

According to Zhu and Sarkis (2006) the pressure and drive accompanying globalization have prompted enterprises to improve their environmental performance. Conceptual, anecdotal and empirical literature seems to indicate that organizations are implementing sustainability strategies which provide them with economic benefits (Stead and Stead 1992). However, despite increased empirical research looking at the link between sustainability performance and economic performance the conclusions have been mixed. The outcomes are somewhat inconclusive as a number of empirical studies have returned differing verdicts (Russo and Fouts 1997). Claver et al. (2007) attribute the disparity in results to the consequence of the type of variables used in the different studies, the methods applied to measure them and the partial or isolated treatment given to some of the variables. Wagner (2001) points to the different methodological issues and the different measures used which also makes it difficult to compare empirical studies. The literature therefore provides a mixed message to firms seeking to reap benefits of improved competitiveness and business performance as a result of adopting sustainable manufacturing practices.

So does green really mean green? This paper proposes to empirically test the relationships between the adoption of sustainable manufacturing practices, business performance and competitive advantage. The study addresses 3 primary research questions: Do organizations with higher levels of adoption of sustainable manufacturing practices have higher levels of business performance? Do organizations with higher levels of adoption of sustainable manufacturing practices have higher levels of competitive advantage? Do organizations with higher levels of competitive advantage have higher levels of business performance? This paper is based on a survey of the sustainability practices of manufacturing firms in 5 Caribbean countries and hopes to help address the lingering question: does it really pay for Caribbean manufacturing firms to be green?

Research framework

The framework underlying this research is shown in figure 1. It proposes that sustainable manufacturing practices will have a direct impact on both business performance and competitive advantage. These green practices will also indirectly impact business performance via competitive advantage.

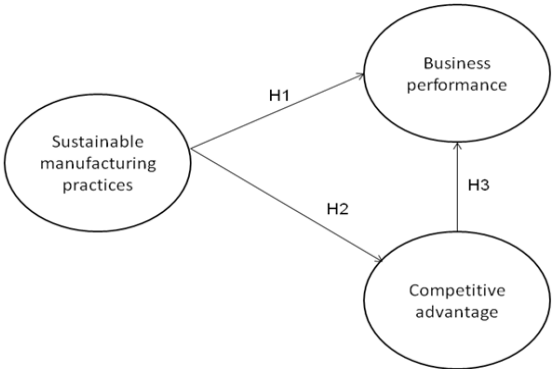


Figure 1 - Research framework

Defining the constructs

Sustainable manufacturing practices

There is no universal definition for 'sustainable manufacturing' and over the years many different terminologies have emerged. Johansson and Winroth (2010) explain that a number of concepts focusing on the concern for environmental issues in industrial operations have emerged in the literature, and many of these terms overlap and complement each other. Terms include: green manufacturing (Tan et al. 2002), environmentally responsible manufacturing (Ellram et al. 2008), environmentally benign manufacturing (Bras et al. 2006), and cleaner production (Jackson 2002).

Sustainable manufacturing is defined by the US Department of Commerce (2009) as 'the creation of manufactured products that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities and consumers and are economically sound'. Mani et al. (2010) explain that sustainable manufacturing requires a holistic and life cycle thinking which is about going beyond the traditional focus on production sites and manufacturing processes so that the environmental, economic and social impact of a product over its entire life cycle is taken into account, including the consumption and end-of-use phases. As such, for this research we focus on specific practices at each stage of the product life cycle. Using the life cycle view of manufacturing, we operationalize the multidimensional construct of sustainable manufacturing by defining 7 dimensions or sub-constructs as shown on figure 2. The 7^{th} sub-construct (not shown on the figure) is social responsibility, used in this study to represent the social dimension of the triple bottom line framework. The sub-constructs are described in table 1.

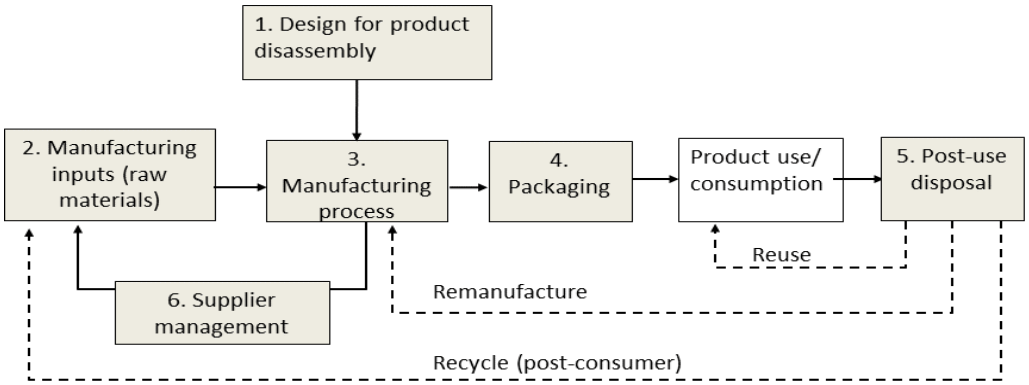


Figure 2 - Measures for the construct of sustainable manufacturing practices

Sub-construct	**Definition**
Design for product disassembly	Designing for the ability to easily disassemble products that have come to the end of their useful life. Practices include: use of materials that can be recovered easily, and designing with easily dividable materials (de Ron 1998).
Manufacturing inputs	The choice of raw materials and energy used in the manufacture of a product. Practices include: using recycled materials, biodegradable materials, environmentally-benign materials and the substitution of environmentally-questionable materials (Arup 2007).
Manufacturing process	The transformation of activities that convert raw materials to finished goods. Practices typically adopted include waste and emissions reduction, recycling and the use of renewable resources (Arup 2007).
Packaging	Practices employed for the purpose of protecting products for distribution, storage, use or sale. Practices include returnable packaging, reduced packaging and recyclable packaging (Montabon et al. 2007).
Post-use disposal	Practices that enable the recovery of materials and products post-consumer use. These include designing and planning for reuse, recycling, repair, regeneration and remanufacturing (Glavic and Lukman 2007).
Supplier management	Practices that focus on managing the relationships between the manufacturing firm and its suppliers. These include selecting providers who have adopted effective environmental practices (Sarkis 2003) and guiding suppliers to set up their own environmental programs (Rao and Holt 2005).
Social responsibility	Practices that look at corporate 'duty' and includes how a company treats its employees and its community (Collins et al. 2009).

Table 1 – Sub-constructs for sustainable manufacturing practices

Competitive advantage and business performance constructs

Li et al. (2006) define competitive advantage as the extent to which an organization is able to create a defensible position over its competitors. Firms create a competitive advantage via their competitive capabilities or priorities, which are defined by Hayes and Wheelwright (1984) as strategic preferences or dimensions along which a company chooses to compete in the targeted market. Widely accepted competitive priorities are cost, delivery, quality and flexibility

(Kathuria 2000). Based on prior literature we use 6 dimensions of competitive advantage: price, quality, delivery, flexibility, product range and customization.

Business performance takes into account the organization's responsibilities towards the shareholders and has a profit maximization objective (Rappaport 1987). It includes both indicators of market performance and financial performance (Yamin et al. 1999). A number of previous studies have used both financial and market performance measures such as ROI, return on asset (ROA), profit margins on sales and sales growth (for example, Claver et al. 2007, Hart and Ahuja 1996, Yang et al. 2011). The measures used in our study are consistent with previous studies, namely: profitability, ROA, ROI, sales growth and export growth.

Hypothesis development

Previous empirical work seems to suggest that firms with high environmental performance tend to be profitable (King and Lenox 2001). Although not all empirical studies have found a positive relationship, according to Aragón-Correa et al. (2008), the majority of the empirical studies have found a positive relationship between environmental and economic performance. As such, we hypothesize:

H1: The adoption of sustainable manufacturing practices will be positively associated with business performance.

Sustainability practices impact not only business performance, but also a firm's competitive advantage. According to Wagner and Schlategger (2003), on the whole, improved environmental performance is a potential source of competitive advantage, leading to more efficient processes, improvements in productivity and new market opportunities. Thus we hypothesize that:

H2: The adoption of sustainable manufacturing practices will be positively associated with competitive advantage.

Having a competitive advantage generally suggests that an organization can have one or more of the following capabilities when compared to its competitors: lower prices, higher quality, higher dependability, and shorter delivery time (Li et al. 2006). These capabilities will, in turn, enhance the organization's overall performance. Therefore, as the competitiveness of a firm is improved, this will be reflected in the business performance. Hence, we hypothesize that:

H3: Competitive advantage will be positively associated with business performance.

Research methods

Sample and respondent profile

A survey-based approach was adapted to test the conceptual model. We examine the sustainability practices of manufacturing firms in 5 Caribbean countries. A total of 76 firms participated in the study: Trinidad and Tobago (38% of respondents); Barbados and Jamaica (22% each); and Guyana and St. Lucia (9% each). Almost 90% of the respondents occupied senior positions in their organizations such as CEO, director, production, operations or plant manager. As such, we assume a certain level of credibility with the responses given. More than 80% of the companies participating in our study have been operating for more than 10 years and can be regarded as mature organizations. Almost 90% of the companies can be classified as SMEs (less than 250 employees). Respondents belonged to different industrial sectors including food and beverages, metals, petroleum, chemicals and minerals and rubber and plastic products. Additional demographic data can be found in Millar and Russell (2011).

Measures

Three latent constructs were used to test the three hypothesized relationships: sustainable manufacturing practices (SMP), business performance (BP) and competitive advantage (CA). BP and CA were perceptual measures of financial performance and competitiveness, respectively, whereby respondents rated his/her organization relative to their competitors. The BP and CA constructs were measured using 5 and 6 items, respectively. The construct of SMP was operationalized using the 7 dimensions shown in figure 2 for a total of 36 specific practices. CA and BP were evaluated on a Likert's five-point scale, while SMP used a binary scale: 0 if the respondent did not adopt the particular practice and 1 if practice was adopted. The total number of sustainable manufacturing practices adopted ranged from 0 to 33, with a mean of 16.34 and standard deviation of 7.54.

Data analysis and results

The conceptual model shown was tested using the partial least squares (PLS) structural equation modeling technique (Wold 1985). PLS was used primarily because of its suitability to analyze data from small sample size (Koh et al. 2007). First we test the measurement model to establish validity and reliability and then we test the structural relationships. SmartPLS 2.0 (Ringle et al. 2005) was used for our data analysis.

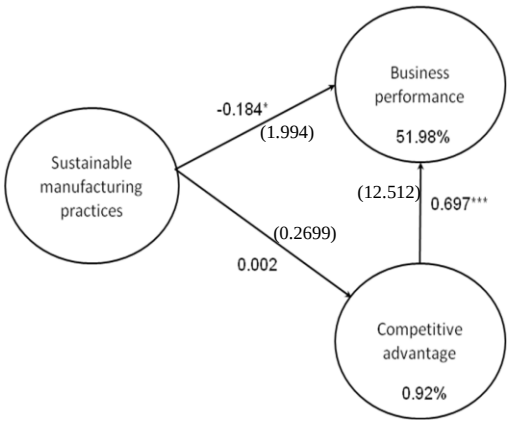
Measurement model

The adequacy of the measurement model was addressed by evaluating validity and reliability. The average variance extracted (AVE) and composite reliability (CR) results from SmartPLS are adequate indicators of the convergent validity of measurements (Bagozzi and Yi 1988). The AVE and CR results for our constructs are 0.819 & 0.969 (BP); 0.733 & 0.950 (CA); and 0.512 & 0.821 (SMP), respectively. These results have values higher than the 0.5 for AVE and 0.7 for CR suggested as acceptable convergent validity by Chin (1998).

Cronbach's Alpha was used to assess the reliability of the three constructs. The reliability values were all greater than 0.7 which is generally acceptable for a construct (Nunnally 1978) – .963 for BP, .939 for CA and .756 for SMP.

Structural model

Given that the measurement model showed sufficient validity and reliability measures, the hypothesized relationships were then tested. Figure 3 shows the structural model results and the bootstrapped t-values (shown in bracket). The results show that the adoption of sustainable manufacturing practices is statistically significantly associated with business performance ($p < 0.05$). The sign on the coefficient shows that this relationship is negatively correlated, and therefore hypothesis 1 is not supported. Hypothesis 2 is also not supported as the results show that the adoption of sustainable manufacturing practices has no significant influence on competitive advantage ($p > 0.1$). The relationship between competitive advantage and business performance is strongly statistically significant ($p < 0.001$) and positive providing support for hypothesis 3, suggesting that high levels of competitive advantage will lead to improved business performance.



*: t > |1.96|, p <0.05; **: t > |2.58|, p <0.01; ***: t> |3.29|, p <0.001
Figure 3 - PLS results for hypothesized model.

Discussion and conclusion

This research sought to empirically test the relationships between the adoption of sustainable manufacturing practices, business performance and competitive advantage for Caribbean manufacturing firms. Our results establish that the adoption of sustainable manufacturing practices may not lead to better business performance and improved competitiveness. It appears that these firms are not using sustainable manufacturing to gain competitive advantage. Hart and Ahuja (1996) point to a time lag between the adoption of green practices and the realization of bottom line benefits as they found that environmentally conscious business practices took up to 2 years to improve profitability measures of return on sales (ROS), return on assets (ROA) and return on equity (ROE). In a previous study using the same data we showed that the manufacturing firms in this study were in fact in their infancy with regards the adoption of sustainability practices. Therefore it is probably still too early for the firms in our study to have started to reap the benefits in terms of financial and market performance. This may have accounted for the negative relationship between sustainable manufacturing practices and business performance.

So the debate continues. Does green really mean green? Can the adoption of sustainability practices really improve organizational performance and competitiveness or is it just an investment burden leading to increased costs? Finding similar results, Cordeiro and Sarkis (1997) cautioned that although the results are *prima facie* discouraging for companies seeking to be environmentally proactive, the results do not necessarily indicate that environmentally-proactive firms lose money over the long-term. The nature of investments required and financial returns that can be expected may differ from strategy to strategy, industry to industry, and firm to firm and therefore managers should pursue sustainability strategy implementation with some vigor, but base their choices of particular strategies on sound analysis of their respective situations (Stead and Stead 1992).

Limitations and future direction

The link between sustainable manufacturing practices, business performance and competitiveness cannot be established with certainty based on a single study and some care should be taken in interpreting the results. Our study was limited to 76 companies and as such

the results cannot be generalized. In addition, the data was collected from a single respondent in each company and we recognize there may be possible response bias. Future research may focus on a single sector study as this could help inform whether there are specific green practices that are sector-specific that are more likely to drive business performance and competitive advantage.

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