

The Adoption of Sustainable Manufacturing Practices in the Caribbean

Harvey H. Millar¹ and Suzana N. Russell^{2*}

¹*Sobey School of Business, Saint Mary's University, Halifax, NS, Canada B3M 3M3*

²*Centre for Production Systems, The University of Trinidad and Tobago, O'Meara Campus, 78-94 O'Meara Industrial Park, Arima, Trinidad, West Indies*

ABSTRACT

The Caribbean region is awakening to the reality that environmental sustainability is fast becoming a major business performance dimension that is shaping the competitive landscape for manufacturers. This research attempts to gain a picture of the current level of emphasis on environmental sustainability among manufacturers in five Caribbean countries. This paper reports on the level of awareness of the concept of sustainable manufacturing, the sustainability practices Caribbean manufacturers are currently engaged in, and the barriers preventing the adoption of sustainability practices. The findings from our survey show that the majority of Caribbean manufacturers have little knowledge of the concept of sustainable manufacturing and the adoption of sustainability practices is low. In light of these findings, the paper discusses potential roles for Caribbean governments, manufacturing associations, and educational institutions in addressing the need for greater emphasis on sustainable manufacturing in the region. Copyright © 2011 John Wiley & Sons, Ltd and ERP Environment.

Received 08 June 2010; revised 07 December 2010; accepted 16 December 2010

Keywords: sustainable development; survey; Caribbean; SMEs; manufacturing

Introduction

IT IS NOW WIDELY ACCEPTED THAT MANUFACTURING ENTITIES HAVE A VITAL ROLE TO PLAY IN THE QUEST FOR SUSTAINABILITY. Manufacturing industries consume significant amounts of resources and generate waste. Mortensen (2007) points out that manufacturing contributes 22% of European global warming potential (climate change), 14% of acidification and 21% of tropospheric ozone. On a global scale, the worldwide energy consumption of manufacturing industries grew by 61% (from 1974 to 2004) and accounts for nearly a third of today's global energy usage and is responsible for 36% of global carbon dioxide (CO₂) emissions (IEA, 2007). In addition to the environmental importance of manufacturing firms, Shahbazzpour and Seidel (2006) point out that sustainability has been emerging as a new means to achieve differentiation for many companies in today's competitive marketplace. Not surprisingly, the use of the term 'sustainable manufacturing' has become commonplace among manufacturers. However, it means different things to different people, and it is apparent from the literature that there is a broad range of concepts and strategies for sustainable manufacturing. Even though there are clear

*Correspondence to: Suzana N. Russell, Centre for Production Systems, The University of Trinidad and Tobago, O'Meara Campus, 78-94 O'Meara Industrial Park, Arima, Trinidad, West Indies. E-mail: suzana.russell@utt.edu.tt

economic and business incentives for the development of sustainable operations (Seidel *et al.*, 2006), one questions whether manufacturing firms are actually adopting sustainable manufacturing practices.

Several studies have looked at the uptake or adoption of sustainability practices. For example, Collins *et al.* (2007) examined the uptake of sustainability practices by businesses in New Zealand; and Arup (2007) conducted a study into UK manufacturers' perceptions of sustainable manufacturing. There are a few studies on small–medium enterprises (SMEs) and their environmental practices (Lawrence *et al.*, 2006), but to our knowledge there has been little work, if any, looking at the extent to which sustainable manufacturing practices have been adopted by Caribbean manufacturers. This paper, which represents an initial study, therefore aims to help fill this void.

The main aim of this paper is to assess the current sustainable manufacturing practices of Caribbean manufacturers. The paper attempts to answer the following questions: Are Caribbean manufacturers aware of the meaning and concept of sustainable manufacturing? To what extent are Caribbean manufacturers engaging in sustainable manufacturing practices? What sustainable manufacturing practices are they currently engaged in? What are the barriers preventing the adoption of sustainable manufacturing practices? What would drive or motivate companies to adopt sustainability practices?

In order to answer these questions, the following primary objectives were set for our research:

- To determine the extent to which Caribbean firms are aware of the concept of sustainable manufacturing.
- To identify the current practices of sustainable manufacturing in the Caribbean.
- To determine which factors influence the barriers to and adoption of sustainable manufacturing practices.

The rest of the paper is organised as follows. The next section reviews the literature on sustainable manufacturing, looking at the various definitions and terminologies and how it is actually measured. Then, the methodology and the sources of the data are introduced. The results of the survey and data analysis are then presented and the final two sections reflect on the research and discuss the implications for future research.

Literature Review

What is Sustainable Manufacturing?

Similar to the term 'sustainable development', there is no universal definition for 'sustainable manufacturing' and over the years many different terminologies have emerged. It is apparent from the literature that many of the elements of these concepts overlap and complement each other. Some of the different terminologies include 'environmentally responsible manufacturing' (ERM) (Ellram *et al.*, 2008; Curkovic, 2003), 'environmentally benign manufacturing' (EBM) (Bras *et al.*, 2006; Gutowski *et al.*, 2005), 'environmentally conscious design and manufacturing' (Zhang *et al.*, 1997), 'green manufacturing' (Tan *et al.*, 2002), 'cleaner production' (Jackson, 2002) and 'industrial sustainability' (Jansson *et al.*, 2000). So how is sustainable manufacturing defined?

Sustainable manufacturing is defined by the US Department of Commerce (2009) as 'the creation of manufactured products that minimise negative environmental impacts, conserve energy and natural resources, are safe for employees, communities and consumers and are economically sound'. Traditionally, a narrow definition of manufacturing is typically used to describe the physical transformation of materials or the process of converting input materials into products.¹ In many instances, manufacturing is used interchangeably with production, although some researchers make a distinction. For example, according to Livesey (2006), production and manufacturing are not the same. He explains that production is but one of the activities of a manufacturing company, while manufacturing is the collection of activities that are required to develop, produce and deliver goods and services. For the purpose of this research we suggest that sustainable production and sustainable manufacturing can be used interchangeably.

¹For example, manufacturing is defined in Merriam-Webster Online as 'to make from raw materials by hand or by machinery' (accessed online at: <http://www.merriam-webster.com/>).

The term 'sustainable production' emerged at the United Nations Conference on Environment and Development in 1992 (Veleva and Ellenbecker, 2001). According to Falkman (1996), sustainable production emphasises a life-cycle perspective in the manufacture, use, recycling and disposal of goods and services, instead of the traditional focus on discrete activities, as well as encourages continuous improvement in efficiency of the use of energy and resources. The Lowell Center for Sustainable Production defines sustainable production as 'the creation of goods and services using processes and systems that are non-polluting; conserving of energy and natural resources; economically viable; safe and healthful for employees, communities and consumers; and socially and creatively rewarding for all working people' (Veleva and Ellenbecker, 2001). In dealing with a complex issue such as sustainability, a life-cycle approach that considers all the phases of a product should be used. Gutowski *et al.* (2001) refer to this as a 'systems view' of manufacturing (Figure 1), which would track the consequences of manufacturing and design decisions and take us through raw material production, manufacturing, use and end-of-life phases. This is therefore a far broader view of manufacturing than the one that simply looks at the consumption, wastes and pollutants occurring at the factory. De Ron (1998) explains that in order to arrive at sustainable production for the complete product chain, each activity (shown in boxes in Figure 1) should be sustainable.

Nowadays, sustainable manufacturing has evolved beyond the life-cycle view. OECD (2009) traces the evolution of sustainable manufacturing initiatives from traditional pollution control through cleaner production initiatives, to a life-cycle view, to the establishment of closed-loop production. However, the US Department of Commerce (2009) believes the adoption of more sustainable manufacturing practices is hampered by the ability of companies, particularly smaller firms, to both measure their own environmental performance and then use the data obtained to make decisions on methods of improvement. The situation is further exacerbated by the plethora of metrics or indicators used to measure sustainable manufacturing. Even though the many indicators are diverse in nature, OECD (2009) advises that an appropriate combination of existing indicator sets could help give companies a more comprehensive picture of economic, environmental and social effects across the value chain and product life-cycle.

Sustainability and SMEs

It is estimated that SMEs account for between 70 and 85% of Caribbean enterprises (Chida, 2000). This suggests that the Caribbean region predominantly comprises SMEs. One of the difficulties in getting accurate data is the absence of a universal definition of a SME and different countries or regions adopt different definitions or classifications. Among the more than 15 countries comprising the Caribbean region, the classification for SMEs varies from country to country. For example, Barbados defines a small enterprise as one with no more than 25 employees, while in Guyana and Trinidad, there are no formal (legal) definitions with regard to what size of enterprises qualifies for categorisation as a small business (Chida, 2000). The European Commission defines SMEs as enterprises having fewer than 250 employees (CEC, 1996). Although exact figures are not available, the Caribbean region predominantly comprises companies employing fewer than 250 employees.

Because SMEs are thought to contribute as much as 70% of all industrial pollution (Hillary, 1999), they are important from an environmental point of view. So although SMEs have relatively minor importance individually,

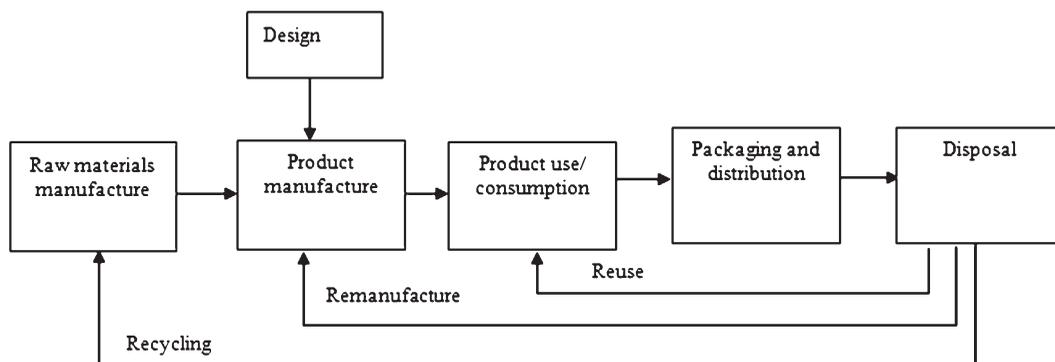


Figure 1. Life-cycle view of manufacturing. Adapted from Gutowski *et al.* (2001)

collectively their impact may be great (Lawrence *et al.*, 2006). According to Revell and Rutherford (2003), as much as 60% of CO₂ emissions from UK businesses result from the activities of SMEs. However, SMEs often perceive their own environmental impact as negligible in comparison with large operators (Connell and Flynn, 1999). Moreover, according to Ammenberg and Hjelm (2003), when discussing strategies and measures to improve or mitigate against environmental impact, large firms are often the focus, that is, companies that individually contribute to environmental pollution to the greatest extent. As such, SMEs are lagging behind in developing environmentally friendly behaviour (Masurel, 2007). In addition, small businesses often lack the characteristics that would otherwise enable them to engage effectively with the 'sustainable development' agenda (Revell and Rutherford, 2003).

Several drivers for engaging in sustainability practices are cited in the literature. Besides legally enforced behaviour, the motivation to invest voluntarily can be considered under two headings: (1) free choice and (2) pressure from the external environment (Masurel, 2007). In general SMEs are motivated to invest in environmental measures more by external than by internal reasons (Masurel, 2007). According to Bianchi and Noci (1998), because SMEs tend to comply with external pressures they generally adopt a reactive strategy. Different external factors play a role in the push towards the adoption of sustainable manufacturing practices. For example, a study of 304 UK manufacturers reveals that the major external drivers for the adoption of sustainable manufacturing practices are customer pressure, legislation and regulation (Arup, 2007). This is in striking contrast to a study of 811 businesses in New Zealand that seems to indicate that SMEs face no external pressure whatsoever to adopt sustainability practices (Lawrence *et al.*, 2006).

SMEs pose special challenges for stakeholders interested in promoting sustainability practices, as they are perceived as having greater barriers to implementing these practices (Collins *et al.*, 2007). Lawrence *et al.* (2006) identify from various studies three key barriers to the adoption by SMEs of environmental practices: (1) the perception that they have little or no environmental impact compared with larger corporations; (2) a lack of environmentally focused capabilities; and (3) concern over the cost of these measures.

Even though there is a growing body of research exploring the relationship between business and the environment, according to Tilley (1999), small firms are still a comparatively under-researched field in academia. This paper therefore uses the case of Caribbean manufacturers to examine the extent to which sustainable manufacturing practices are being adopted. In addition, the paper examines the drivers and barriers for adoption of sustainable manufacturing practices.

Methodology

This study examines the manufacturing practices in five Caribbean countries: Trinidad and Tobago, Jamaica, Guyana, St Lucia and Barbados. Two approaches were used to obtain the data. First a web-based survey was administered with the assistance of the respective manufacturing associations in the five countries. Each manufacturing association was asked to invite its members to participate in the online survey. A limited number of responses were received using this approach. In order to increase the data set, a visit was made to each of the countries. Each manufacturing association was asked to organise a seminar on sustainable manufacturing and invite members to attend. The manufacturing companies were informed beforehand that they would be invited to complete the questionnaire. The presentations took place between February and March 2009. A total of 76 unique companies ultimately participated in the study.

The Survey Instrument

The written questionnaire used in this study was based on a survey instrument used in a pilot study on manufacturing and sustainability in Atlantic Canada (Millar, 2005). The final questionnaire contained 32 primarily multiple-choice questions and was divided into five main sections: (1) demographics; (2) awareness of sustainable manufacturing; (3) sustainable manufacturing practices; (4) adoption of new practices; and (5) barriers to engagement (see online Supporting Information). For this study, we aimed for a comprehensive set of

sustainability measures that we believe covered the economic, environmental and social practices of Caribbean firms. The questionnaire was kept simple, with more than 80% of the questions being multiple-choice, dichotomous (yes/no) and ordered-rank responses such as somewhat aware, very aware and not at all aware. A few open-ended questions were posed so that respondents could provide further insight into their responses. Based on our observations of the manufacturers who completed the survey at the workshop, it took approximately 15–20 minutes to complete. In general, there was a high response rate for most closed-ended questions except for income. Many respondents were either unwilling to divulge that information, even though they were assured of confidentiality, or were unable to provide an accurate figure. There was a lower response rate for some of the open-ended questions where explanations or definitions were requested.

We acknowledge that there may be some level of selection bias (Groebner *et al.*, 2008, p.13) as those manufacturers with an interest in sustainability will more than likely be the ones to have attended the seminar. As such, their responses may be more favourable since they may have already had some knowledge of sustainable manufacturing, which could have been the motivating factor behind attendance at the seminar. In order to minimise response bias, manufacturers who attended the workshop were asked to complete the questionnaire prior to the start of the presentation. In addition, we did not provide specific definitions, as one of the objectives of the study was to determine the respondents' understanding of sustainable manufacturing.

Results

The results of the survey are presented in four sections: (1) demographics of the companies; (2) awareness of sustainable manufacturing; (3) current sustainable manufacturing practices; and (4) drivers and barriers to the uptake of sustainability practices.

Demographics of the Companies in the Study

A total of 76 manufacturing firms from five Caribbean countries participated in the study: Trinidad and Tobago (38% of respondents); Barbados and Jamaica (22% each); and Guyana and St Lucia (9% each). For the purpose of this study we have used the following three classifications: small enterprises (fewer than 50 employees); medium enterprises (50 to under 250 employees); and large enterprises (250 and more employees). Based on our classifications 87% of the firms are SMEs and 13% are considered large.

Almost 81% of the companies in our study have been operating for more than 10 years. Hence, the majority of the participating manufacturing firms can be regarded as mature organisations. Almost 90% of the respondents occupied senior positions in their organisations, such as CEO, director, production, operations or plant manager. One can assume a certain level of credibility with the results.

Figure 2 shows the annual turnover for the companies in this study. Approximately 64% of the companies have sales of less than US\$5 million. The majority (80%) of the respondents earn less than 40% of their sales from exports. Seventy per cent (70%) of the companies are privately owned limited-liability Caribbean companies.

The industry sectors covered can be grouped into eight categories as shown in Table 1. Other products manufactured by firms in the study include artificial teeth, adhesive glue, natural soaps and skin-care products.

Awareness of Sustainable Manufacturing Concepts, Tools and Approaches

Manufacturers were asked to indicate their level of awareness of related manufacturing approaches such as green manufacturing, clean manufacturing and sustainable manufacturing. For all these approaches fewer than 50% of the respondents claimed strong awareness. Clean manufacturing had the largest number of respondents (43%) claiming strong awareness. Approximately 80% of the manufacturers are either strongly aware or somewhat aware of all approaches, which is an indication that many Caribbean manufacturers are aware of sustainability issues. Awareness of clean manufacturing and green manufacturing are both positively correlated with sustainable manufacturing. This correlation is significant at the 1% level, which implies that manufacturers who are aware of

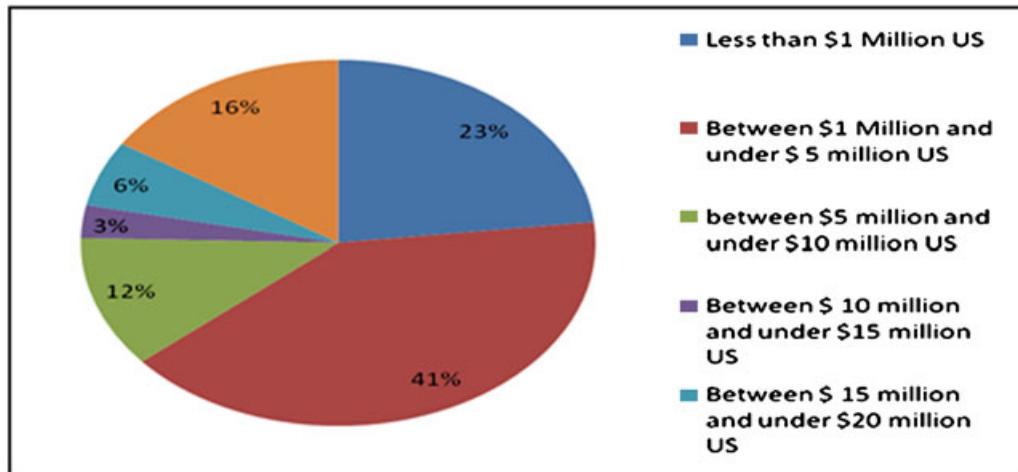


Figure 2. Annual sales for companies in the study

| Industry sector | No. of companies in sample | % of sample |
|--|----------------------------|-------------|
| Food, beverages and tobacco | 15 | 19.7 |
| Metals, metal products | 10 | 13.2 |
| Petroleum, chemicals and minerals | 14 | 18.4 |
| Textiles, apparel and leather | 8 | 10.5 |
| Wood, wooden products, furniture, paper | 8 | 10.5 |
| Rubber and plastic products | 5 | 6.6 |
| Stone, clay, glass and concrete products | 10 | 13.2 |
| Machinery, equipment and instruments | 6 | 7.9 |
| TOTAL | 76 | 100% |

Table 1. Industry sectors of firms in the study

clean and green manufacturing are also aware of sustainable manufacturing. This is not surprising as the terms are used interchangeably in policy documents and literature.

When we asked the participants what 'sustainable manufacturing' means we received a wide range of responses. Many manufacturers spoke of the environmental aspect, and definitions included 'manufacturing that has the least possible impact on the environment' and 'ensuring continuity over generations'. Others mentioned 'keeping non-renewable resources to a minimum and using them as efficiently as possible' and 'using renewable and recycled inputs wherever practical'. Many respondents viewed sustainable manufacturing entirely from a business perspective and spoke of 'business viability' and 'survival' as well as 'minimisation of imports'. The wide-ranging responses suggest that Caribbean manufacturers are still not entirely clear what sustainable manufacturing actually means. Interestingly, many of the companies claiming strong awareness of sustainable manufacturing (from the previous question) did not provide a definition.

Manufacturers were also asked to indicate their level of familiarity with the concept of 'triple bottom line' for the management of manufacturing organisations. Of the 70 respondents, approximately half claim some level of awareness – 17% claim strong awareness while 33% are not aware of the concept at all. Figure 3 shows the triple bottom line performance results emphasised in the business plans of the companies surveyed. Most of the companies (61%) emphasise economic measures. This is an interesting result, as we would expect that a higher percentage of companies would use some financial measure to monitor performance. One possible reason for this low figure may relate to the relatively high percentage of respondents who were not sure (18%). The least emphasis

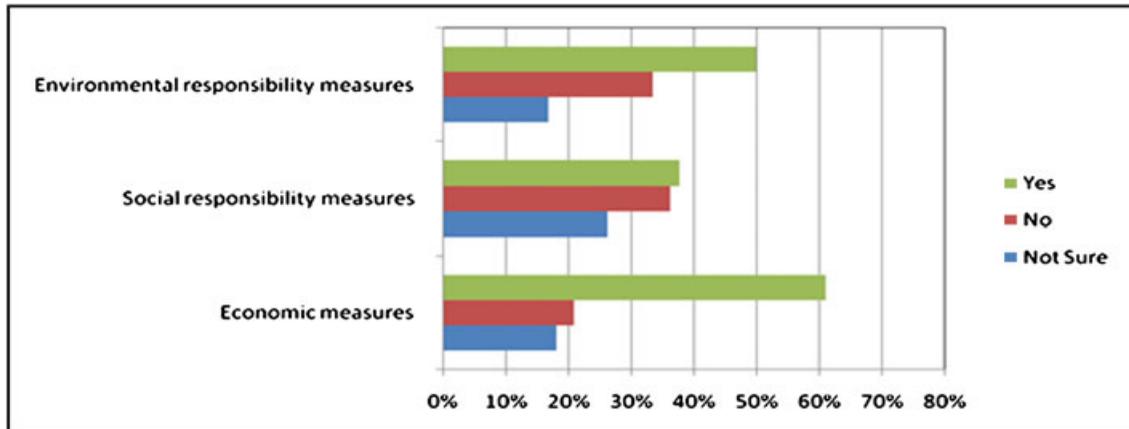


Figure 3. Performance results included in strategic or business plans of companies

is placed on social responsibility measures, even though it is noted that this measure had the highest percentage of respondents who were unsure. Those who are unsure will probably give a more negative/conservative response.

Firms were further asked to identify some specific indicators used within their companies to track or measure aspects of the economic, environmental and social factors. This question had a low response rate: 57% of the respondents did not identify any economic measure; 74% did not identify social measures; and 70% did not identify environmental measures. This is interesting, because even though respondents indicated that their company has a strategic or business plan that emphasises triple bottom line measures, most were unable to identify specific measures included in these reports. Some specific economic indicators identified by respondents include increase in sales, profitability, return on investment (ROI), return on equity (ROE) and current ratio. Social indicators include donations to the community, employee satisfaction surveys, human resource index and sponsorship or assistance to the public. Environmental measures reported on include waste level and emissions, environmental footprint, air quality and noise pollution and CO₂ emissions.

Current Sustainable Manufacturing Practices

Sustainable manufacturing practices adopted by manufacturers usually focus on manufacturing input materials, manufacturing processes, packaging and waste disposal, among others. Practices can also extend to the supply chain as well as social responsibility actions. This section summarises the sustainable manufacturing practices currently being adopted by participants in our study.

Figure 4 shows the results with respect to input materials for production. The most common sustainable manufacturing practices currently being adopted are the use of recycled materials and the use of materials producing little or no hazardous waste. More than half of the firms surveyed (55%) are using water-based paint and 50% are using biodegradable materials. The results shown in Figure 4 seem to indicate that Caribbean manufacturers have adopted a number of practices related to their input materials that promote sustainable manufacturing.

Regarding the manufacturing processes, firms appear to be actively engaged in practices that promote sustainability, as shown in Figure 5. Eighty-three per cent (83%) of the firms have implemented processes to minimise waste and 78% have sought to minimise the negative impact of their production processes on the work environment. While 58% of the participants have made plans for the use of their by-products, 38% of those surveyed have not made any such plans. As such, there are opportunities to be explored. It is interesting to note that energy efficiency was not a top priority for Caribbean manufacturers in the design and operation of their manufacturing processes.

Product packaging is a major contributor to environmental waste. Figure 6 shows that only about half of the manufacturers minimise the use of shrink wrap, use reusable packaging materials or minimise materials and weight. Thirty-two per cent (32%) of the respondents do not currently use reusable packaging materials, and this presents an opportunity for environmental improvement as well as cost savings.

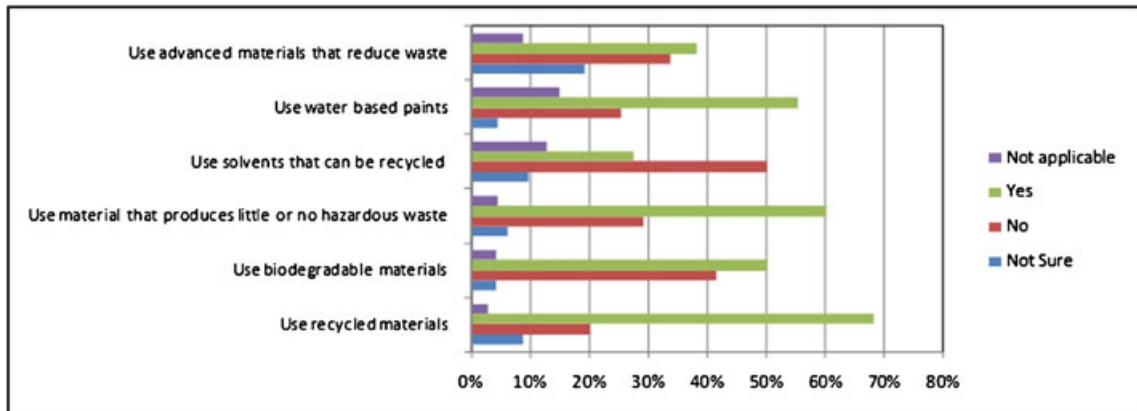


Figure 4. Sustainability practices with respect to input materials

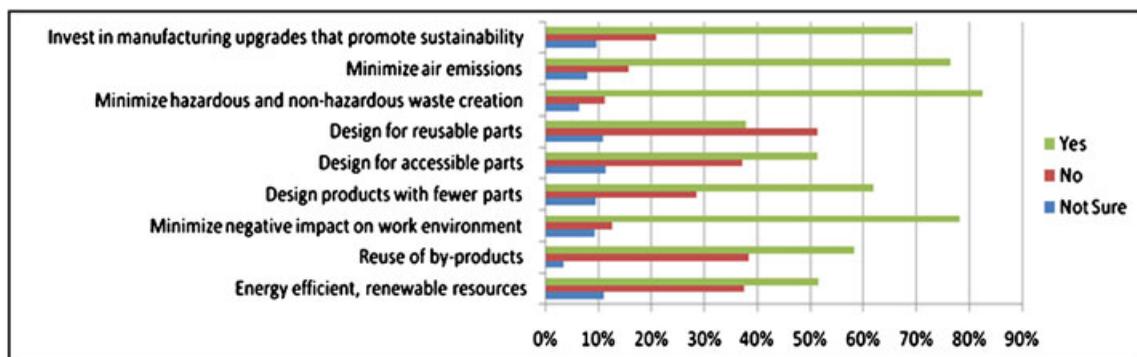


Figure 5. Sustainability in manufacturing processes

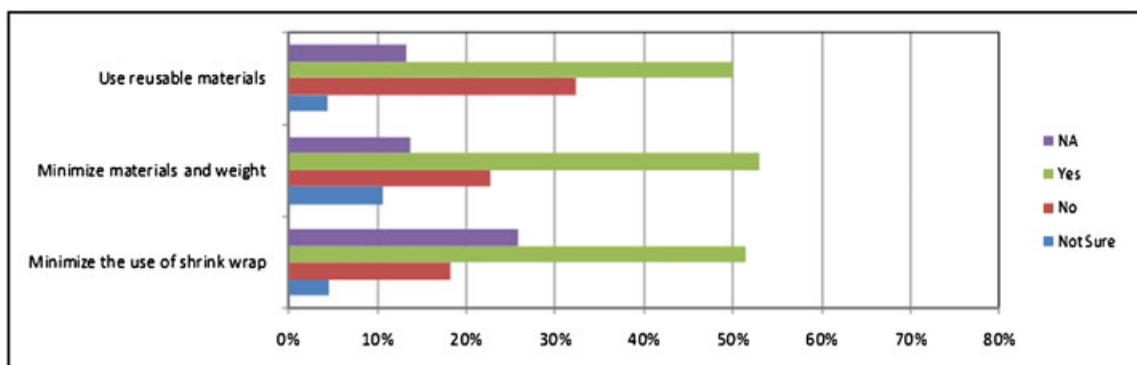


Figure 6. Sustainable practices in packaging

The ability to easily disassemble products that have come to the end of their useful life is important for recycling. As seen in Figure 7, a little more than half of the respondents (52%) use minimal welds and incorporate the use of screws, clinches and snaps in their products to allow for easy disassembly. In addition, 53% claim to design their products with accessible parts. Easily accessible parts can facilitate relatively easy disassembly by the end-consumer. The level of response here is related to the number of respondents producing products that require welding or the use of screws, or require disassembly at their end of life.

Good disposal practices represent an important facet of environmental sustainability. Disposal by manufacturers can be in various forms such as take-back policies, selling returned products to a third party for reuse or recycling and new venture into start-up recycling business. Forty per cent (40%) of the companies plan for the disposal of their products via take-back policies and third parties (Figure 8). Only 41% of the companies have plans for consumers to return products. This suggests that there is a need for Caribbean manufacturers to enhance planning for disposal. These findings present an opportunity for Caribbean manufacturers to be proactive in the absence of environmental policies such as extended producer responsibility (EPR), which requires producers in many parts of the world to take responsibility for the post-consumer stage of a product's life cycle (OECD, 2001).

Sustainable production takes into consideration the performance of the entire supply chain, from raw material to end-of-life disposal. We acknowledge the breadth of this subject and as such we were only interested in a high-level consideration of sustainable practices related to the management of supply chains. The results are shown in Figure 9. Only 32% of the respondents claim to source materials/products from environmentally friendly suppliers, while only 22% encourage suppliers to use recycled materials. This is probably consistent with the idea that many SMEs believe that because of their size and purchasing power, particularly if purchasing from large foreign suppliers, they are unable to influence these large, more powerful suppliers. Eighteen per cent (18%) of the respondents have forged partnerships with suppliers to promote sustainable manufacturing. Therefore, there may be potential opportunities for SMEs to gain competitive advantage through long-term partnerships with suppliers.

In addition to economic and environmental sustainability, social sustainability has emerged as the third ingredient of a successful sustainable business strategy (Foot and Ross, 2004). Social responsibility focuses on incorporating practices and policies that are cognizant of social impacts into the daily operations of businesses. Firms were asked to indicate whether or not they have adopted several social practices. Figure 10 highlights the results of these practices among the respondents. The majority of the firms (97%) claim to promote the health, wellbeing and safety of workers. Eighty-four per cent (84%) are committed to diversity in hiring and promoting

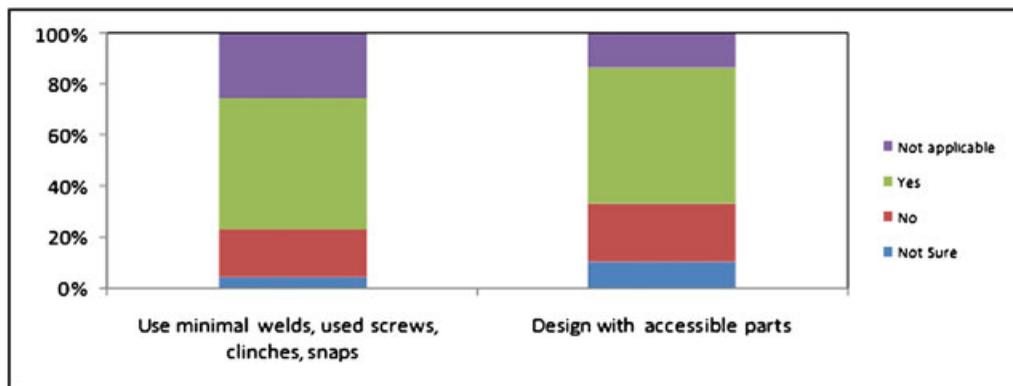


Figure 7. Sustainable practices in product disassembly

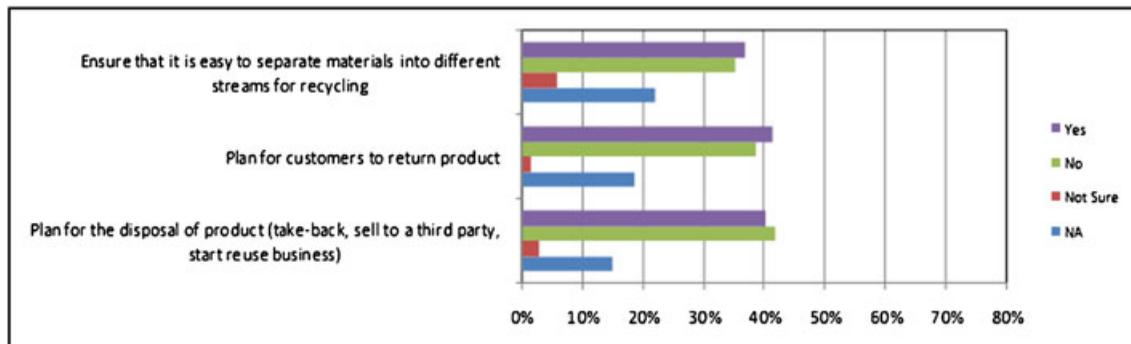


Figure 8. Sustainable practices related to product disposal

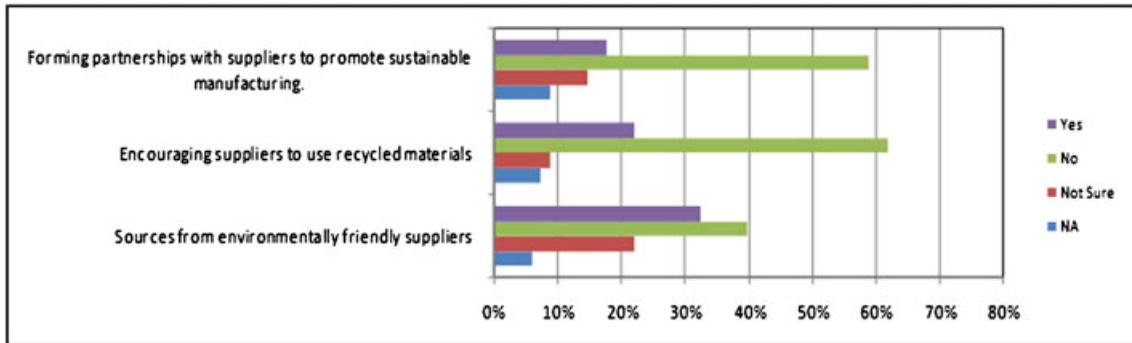


Figure 9. Sustainable supply chain management

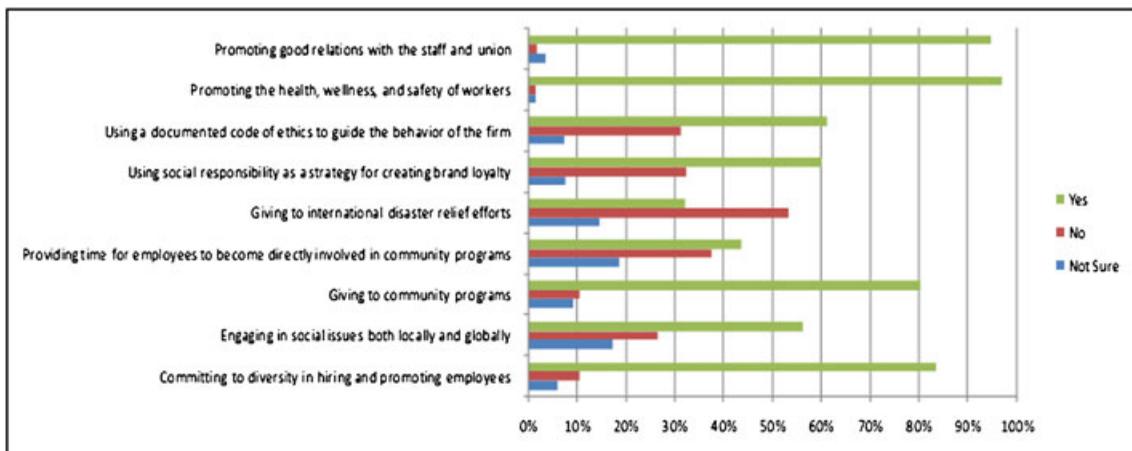


Figure 10. Social responsibility practices

employees and 80% donate to community programmes. Less than half of the firms (32%) give to international disaster relief efforts, while more than half (60%) use social responsibility as a strategy for creating brand loyalty.

Drivers and Barriers to the Uptake of Sustainable Manufacturing Practices

The principal reasons for companies not investing in sustainability are discussed in this section. Motivators or drivers as well as barriers to the adoption of sustainable manufacturing practices in the Caribbean are also discussed.

Principal Reasons for Not Investing in Sustainable Manufacturing

Companies that have not invested in sustainability were asked the principal reasons for not doing so. The results are shown in Figure 11. It is noted that only 63% of the companies answered this question, so it is unclear if the companies that did not respond were not investing in sustainable manufacturing or the respondents were simply unsure. Twenty-seven per cent (27%) cite a lack of awareness of sustainability practices as the main reason for not investing, while 21% cite a lack of opportunity to practice sustainability. Only 6% cite cost as a reason for not investing. This is an interesting result, as the majority of companies in the study are SMEs and according to Lawrence *et al.* (2006), the literature indicates that SMEs tend to cite cost as one of the primary reasons for not adopting sustainability practices. In a study of 811 New Zealand businesses, 51% cite cost as the top barrier to adopting sustainability initiatives (Collins *et al.*, 2009). The anomaly in this study may be plausibly explained by the fact that a significant percentage of the respondents are unaware of sustainable practices. As such, they would not

be in a position to discern cost as a barrier to implementation, since they would not be aware of the cost of the technologies. The results also indicate that although Caribbean manufacturers are not legally obliged to employ sustainable practices, only 4% of the companies surveyed cited this as a primary reason for not investing.

Motivators for Adopting New Sustainability Practices

We wanted to determine what would drive manufacturers to adopt new sustainability practices. The focus here was on internal drivers or objectives. Based on the responses, most firms are willing to implement specific practices if such practices will positively impact key performance criteria (shown in Table 2). Interestingly, for the companies in this study, the opportunity to reduce cost is not the main business objective that will motivate the adoption of sustainable practices, as is the case for UK manufacturers in which cost reduction was identified as the main business objective driving them to change the way they operate (Arup, 2007).

In terms of drivers, the potential for improved quality, efficiency and reduced waste are key performance criteria that will drive these companies to adopt more sustainable practices. This is consistent with previous studies in which Caribbean manufacturers cite quality as the top strategic manufacturing priority, ahead of cost and delivery speed (Millar and Russell, 2009). As such, sustainable practices that will have a positive impact on quality will be highly valued. The fact that manufacturers see the creation of new markets and increased market share as well as the ability to differentiate themselves from their competitors as drivers is encouraging, as this implies that manufacturers may willingly adopt sustainable practices, motivated by the potential long-term competitiveness of

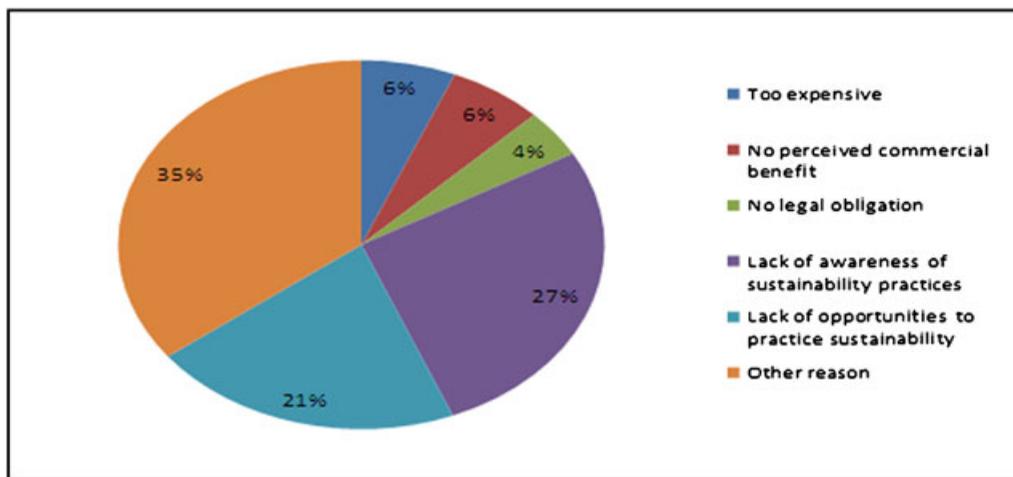


Figure 11. Primary reasons for not investing in sustainability

| Drivers | % of sample |
|--|-------------|
| Improve quality | 88 |
| Reduce waste | 88 |
| Improve efficiency | 87 |
| Increase market share | 82 |
| Creation of new markets | 82 |
| Differentiation (from competitors) | 80 |
| Lower costs | 80 |
| Delivery speed | 76 |
| Help to meet social responsibility goals | 75 |
| Enable innovation | 75 |
| Improve flexibility | 74 |

Table 2. Main drivers for adopting sustainability practices

their firms rather than being forced to do so by legislation or mandatory compliance. The least important drivers for adopting sustainable practices are the potential for improved flexibility, the ability to innovate and the desire to meet social responsibility goals. Again, these results are not surprising, as flexibility and innovation are not key performance criteria for Caribbean manufacturers (Millar and Russell, 2009).

Barriers to Adopting New Sustainability Practices

The study highlights a number of potential barriers or constraints affecting the willingness of companies to engage in sustainability practices. Overwhelmingly, cost is cited as the main potential barrier to adopting new sustainability practices. It may be interesting to note that when manufacturers were asked the principal reasons for not investing, only 6% cited cost. The response here is understandable in that the previous response required awareness of the cost of specific technologies. In this case, cost of investment is a generic concern. Companies will invest as long as there are positive returns and the cost of investment is not too high. Manufacturers express concern that new sustainability practices will require funds to implement changes and cite the 'cost of re-engineering', 'insufficient justification of costs and benefits' and 'possibly no return on investments' as associated cost factors that are potential barriers to adoption.

Lack of awareness, knowledge and education are also major barriers to the uptake of sustainability practices. Some manufacturers explain that they 'lack the understanding as to what sustainable manufacturing entails'. Others cite 'not enough public information', 'training and exposure' and 'lack of the required techniques and technology' as other potential barriers.

Manufacturers are also concerned that input raw materials that promote sustainability may not be readily available at competitive prices. Moreover, there is additional concern that the raw materials that are available may not have the requisite performance characteristics or meet quality specifications. Some manufacturers believe that the cost of such raw materials may also be prohibitive, having a further negative impact on the competitiveness of Caribbean manufacturers.

Staff knowledge and capabilities are also highlighted as potential barriers. Respondents see a lack of skilled personnel and the reluctance of staff, especially those who have been with the company for a long time, as well as the capability of existing staff as barriers. As such, respondents point to the need for education, training and cultural realignment of staff.

Role of Government

When manufacturers were asked about actions their respective governments could take to advance the practices of sustainable manufacturing the respondents had a number of suggestions. Some of the responses are summarised here.

- Promote the adoption of sustainable manufacturing initiatives by the use of monetary and fiscal incentives such as tax breaks and concessions.
- Encourage recycling by assisting manufacturers to identify alternative uses for their waste.
- Subsidise the cost of auditors and consultants to assist manufacturers in identifying sustainability practices.
- Encourage recycling programmes by means of legislation.
- Provide funding/grants for manufacturing firms willing to adopt sustainable manufacturing practices and/or technologies.
- Implement tariff structure to discourage inflow of products that are not recyclable.
- Consider the establishment of low-interest loans for manufacturers to make the transition to sustainable manufacturing practices.
- Explore existing pollution laws and fine or prosecute major polluters who contravene the laws.
- Create a campaign to increase awareness of sustainable manufacturing.
- Provide and/or facilitate training and education for interested manufacturers.

The results of the survey suggest several roles for Caribbean governments, namely: (1) as a major funder – financially supporting manufacturers who are willing to adopt sustainability practices; (2) as an auditor – providing assessments of current practices and accrediting manufacturers as 'sustainable manufacturers'; (3) as a facilitator – providing free training and seminars on sustainable manufacturing; and (4) as a regulator/enforcer – pursuing and punishing major polluting companies.

Discussion

This research, which is an initial study of the sustainability practices of Caribbean manufacturers, fills a gap in the literature, as Lawrence *et al.* (2006) point out that the practices of SMEs are not reported and are little discussed in the literature. Moreover, limited research is available on the sustainability practices of Caribbean manufacturers. Based on the dominance of SMEs in the Caribbean, it was interesting to examine whether or not the practices and challenges of these firms are similar to those in other countries.

It is apparent from the survey results presented that even in the absence of strict regulatory pressure, adoption of sustainable manufacturing practices is taking place among some local manufacturers. This is true for all five countries in the study. While there is some familiarity, many Caribbean manufacturers still lack understanding of the meaning of sustainable manufacturing, despite the majority claiming some level of awareness. If manufacturers do not know the meaning of the term, then it is likely they will have a difficult time implementing the practices. In relation to the triple bottom line measures, economic and environmental performance measures are more emphasised than social measures. This is not surprising, since according to Foot and Ross (2004), of the three components social sustainability is the least familiar and therefore the most poorly defined and least consistently adopted by business. The majority of the sustainable manufacturing activities currently adopted involve recycling initiatives, reducing waste and by-product reuse.

While the majority of respondents are aware of the tools and concepts of sustainable manufacturing, many are not actually implementing these practices for various reasons. Some companies cite the lack of any real business case, perceived increased costs, possibly no return on investment, lack of awareness and knowledge and the difficulty in changing the culture of their staff as barriers preventing them from adopting new practices. One internal strategy that companies can employ to increase the awareness of sustainability issues is to designate a 'sustainability champion', someone with responsibility for implementing sustainability initiatives. Such a person should be in a position to influence their company's approach to sustainable manufacturing. For companies that are actively engaged in the uptake of sustainability practices, they see the opportunity to positively impact the quality of their products, the creation of new markets and differentiation as motivating factors for doing so.

There is little pressure from governments in the Caribbean for manufacturers to undertake sustainable practices and the manufacturers believe there is a greater role for governments to encourage the uptake of sustainability. Many companies believe governments can provide financial incentives in the form of tax breaks, green schemes etc. that could motivate manufacturers to change.

We believe therefore that governments can engage the manufacturing sector as a stakeholder group to explore public policy options. In particular, governments can give consideration to the following:

- Changes in business tax policy that incentivises investments in sustainable technologies.
- Changes in tariff structure to encourage the use of 'green' suppliers for raw materials.
- Funding of special initiatives to raise awareness of sustainability among manufacturers.
- Funding for business transformation to sustainable practices. In this case the government can pay for consultancies up to a specified amount for businesses wanting to transform their operations.
- Introduction of legislation which encourages companies to explore newer technology that supports sustainability.

Universities and colleges in the region can play a significant role. These schools can begin to integrate sustainability across the curriculum. Management curricula on strategy can incorporate triple bottom line philosophy into competitive strategy.

Finally, the regional manufacturing associations, in addition to providing skills development opportunities for members, can act as major advocates and partners, pushing educational institutions as well as governments to take decisive action towards the advancement of sustainable practices among manufacturers.

Conclusion

This study provides some insight into the level of awareness and uptake of sustainability practices among Caribbean manufacturers. The paper is based on a survey of 76 manufacturing firms in five Caribbean countries.

Caribbean manufacturers, on average, contribute 10% of their country's GDP, but are having a tough time battling it out with global competitors (Ahmed, 2001). These companies are under ever-increasing pressure to remain competitive, while maximising profits. In order to convince manufacturers to adopt more sustainable approaches, a sound business case for sustainability must be made to help them understand the link between sustainability and competitive advantage. This study highlights the need to educate Caribbean manufacturers on the benefits of sustainable manufacturing, such as cost reductions in waste, material and energy. Cost reduction is still a great motivator that can drive manufacturers to change.

The study also highlights the need for more awareness and training so that local manufacturers can unlock the potential to competitiveness by focusing on sustainability practices. Simpson *et al.* (2004) point out that if a competitive advantage could be found by adopting environmentally sound practices, then SMEs are more likely to improve their environmental performance simply because it makes good business sense to do so. Sustainability is fast becoming an imperative, not an option, and local manufacturers need to capitalise on early adoption in the absence of legislation and regulatory pressure. According to Arup (2007), legislation that will impose the true cost of carbon is inevitable. When this happens, Caribbean manufacturers who fail to act will be caught off guard and will find it far more costly, in the long run, to implement sustainability practices. Moreover, penalties or levies would cause further erosion of their competitiveness.

The study reveals that Caribbean manufacturers are interested in learning more about sustainable manufacturing practices. This is encouraging because as more consumers begin to push the sustainable development agenda, companies embracing sustainability will gain a competitive advantage and market share. Finally, the study points to the role that government agencies and manufacturing networks can play in facilitating sustainable manufacturing. The results of this study can be used by these bodies to begin to formulate strategic responses to the sustainable manufacturing challenge.

While this paper attempts to fill the gap in knowledge of the behaviour of Caribbean manufacturing firms, which are largely SMEs, it also raises some additional questions. Since it was not a comparative study, no attempt was made to compare the behaviour of SMEs and large firms. Further research is required to understand whether or not there are differences in the awareness and adoption of sustainability practices among firms of different sizes.

Supporting Information

Supporting information may be found in the online version of this article.

Acknowledgments

The following manufacturing associations were instrumental in helping us to gain access to their members: The Jamaica Manufacturers' Association (JMA), The Barbados Manufacturers' Association (BMA), The Trinidad and Tobago Manufacturers' Association (TTMA), The Saint Lucia Manufacturers' Association (SLMA) and The Guyana Manufacturers' Association (GMA).

References

- Ahmed B. 2001. The impact of globalization on the Caribbean sugar and banana industries. *The Society for Caribbean Studies Conference*, 2–4 July, 2001. Nottingham, UK.
- Ammenberg J, Hjelm O. 2003. Tracing business and environmental effect of environmental management systems – a study of networking small and medium-sized enterprises using a joint environmental management system. *Business Strategy and the Environment* 12: 163–174.
- Arup. 2007. *Sustainable manufacturing: a study into UK manufacturers' perceptions*. Ove Arup and Partners Limited.
- Bianchi R, Noci G. 1998. 'Greening' SMEs' competitiveness. *Small Business Economics* 11(3): 269–281.
- Bras B, Isaacs J, Overcash, M. 2006. Environmentally benign manufacturing – a workshop report. *Journal of Cleaner Production* 14(5): 527–535.
- CEC (Commission of European Communities). 1996. *Commission recommendation of 3 April 1996 concerning the definition of small and medium-sized enterprises*. Official Journal L 107, 30/04/1996: 0004-0009 (Document 396X0280).
- Chida A. 2000. *Small enterprise development in the Caribbean*. International Labour Organisation (ILO), Caribbean Office, Port-of-Spain.

- Collins E, Lawrence S, Pavlovich K, Ryan C. 2007. Business networks and the uptake of sustainability practices: the case of New Zealand. *Journal of Cleaner Production* 15: 729–740.
- Collins E, Roper J, Lawrence S. 2009. Sustainability practices: trends in New Zealand businesses. *Business Strategy and the Environment* 18: 1–16.
- Connell L, Flynn A. 1999. The environment, innovation, and industry: a case study of South Wales. *International Journal of Technology Management* 17(5): 480–494.
- Curkovic S. 2003. Environmentally responsible manufacturing: the development and validation of a measurement model. *European Journal of Operational Research* 146(1): 130–155.
- De Ron AJ. 1998. Sustainable production: The ultimate result of a continuous improvement. *Int. Journal of Production Economics* 56–57: 99–110.
- Ellram L, Tate W, Carter CR. 2008. Applying 3DCE to environmentally responsible manufacturing practices. *Journal of Cleaner Production* 16(15): 1620–1631.
- Falkman EG. 1996. *Sustainable Production and Consumption: A Business Perspective*. Geneva: World Business Council for Sustainable Development (WBCSD).
- Foot DK, Ross S. 2004. Social sustainability. In *Teaching Business Sustainability Volume 1: From theory to practice*, Galea C (ed.). Greenleaf Publishing Limited: Sheffield; 107–125.
- Groebner DF, Shannon PW, Fry PC, Smith KD. 2008. *Business statistics: a decision-making approach*. 7th edition. Prentice Hall: New Jersey.
- Gutowski T, Murphy C, Allen D, Bauer D, Bras B, Piwonka T, Sheng P, Sutherland J, Thurston D, Wolff E. 2005. Environmentally benign manufacturing: observations from Japan, Europe and the United States. *Journal of Cleaner Production* 13(1): 1–17.
- Gutowski TG, Murphy CF, Allen DT, Bauer DJ, Bras B, Piwonka TS, Sheng PS, Sutherland JW, Thurston DL, Wolff EE. 2001. *Environmentally benign manufacturing WTEC Panel report*. International Technology Research Institute.
- Hillary R. 1999. *Evaluation of study reports on the barriers, opportunities, and drivers for small and medium sized enterprises in the adoption of environmental management system*. Department of Trade and Industry: London.
- IEA (International Energy Association). 2007. *Tracking industrial energy efficiency and CO₂ emissions*. OECD/IEA, Paris.
- Jackson T. 2002. Industrial ecology and cleaner production. In *A Handbook of Industrial Ecology*, Ayres RU, Ayres LW (eds). Edward Elgar Publishing Limited: UK; 36–43.
- Jansson PM, Gregory MJ, Barlow C, Phaal R, Farrukh CJP, Probert DR, So V. 2000. *Industrial sustainability – a review of UK and International research and capabilities*. University of Cambridge: Cambridge.
- Lawrence S, Collins E, Pavlovich K, Arunachalam M. 2006. Sustainability practices of SMEs: the case of NZ. *Business Strategy and the Environment* 15: 242–257.
- Livesey F. 2006. *Defining high value manufacturing*. Institute for Manufacturing, University of Cambridge. January 2006.
- Masurel E. 2007. Why SMEs invest in environmental measures: Sustainability evidence for small and medium-sized printing firms. *Business Strategy and the Environment* 16: 190–201.
- Millar HH. 2005. *Manufacturing and sustainability in Atlantic Canada: A pilot study*. Logix Consultants.
- Millar HH, Russell SN. 2009. A study of manufacturing strategy in the Southern Caribbean, POMS-2009, 20th Annual Conference – Global challenges and opportunities, USA, 2009.
- Mortensen LF. 2007. *Measuring environmental sustainability of manufacturing – insights from environmental accounts*. OECD Workshop on Sustainable Manufacturing Production and Competitiveness, 21–22 June, 2007. Copenhagen.
- OECD. 2001. *Extended producer responsibility: a guidance manual for governments*. <http://www.oecd.org/publications/e-book-9701041E.pdf> [10 November 2009].
- OECD. 2009. *Sustainable manufacturing and eco-innovation: Framework, practices and measurement*. Synthesis Report. OECD: Paris.
- Revell A, Rutherford R. 2003. UK environmental policy and the small firm: broadening the focus. *Business Strategy and the Environment* 12: 26–35.
- Seidel R, Shahbazzpour M, Oudshoorn M. 2006. Implementation of sustainable manufacturing practices in SMEs – case study of a New Zealand furniture manufacturing. *Proceedings of LCE*: 249–254.
- Shahbazzpour M, Seidel R. 2006. *Using sustainability for competitive advantage*. LCE 2006, 13th CIRP International Conference on Life Cycle Engineering, 31 May–2 June, 2006. Leuven, Belgium.
- Simpson M, Taylor N, Barker K. 2004. Environmental responsibility in SMEs: does it deliver competitive advantage? *Business Strategy and the Environment* 13: 156–171.
- Tan XC, Liu F, Cao J, Zhang H. 2002. A decision-making framework model of cutting fluid selection for green manufacturing and a case study. *Journal of Materials Processing Technology* 129(1–3): 467–470.
- Tilley F. 1999. The gap between the environmental attitudes and the environmental behavior of small firms. *Business Strategy and the Environment* 8: 238–248.
- United States (US) Department of Commerce. 2009. *Sustainable manufacturing initiative and public-private dialogue*. <http://www.trade.gov/competitiveness/sustainablemanufacturing/index.asp> [23 October 2009].
- Veleva V, Ellenbecker M. 2001. Indicators of sustainable production: framework and methodology. *Journal of Cleaner Production* 9: 519–549.
- Zhang HC, Kuo TC, Lu H, Huang SH. 1997. Environmentally conscious design and manufacturing: a state-of-the-art survey. *Journal of Manufacturing Systems* 16(5): 352–371.

Copyright of Business Strategy & the Environment (John Wiley & Sons, Inc) is the property of John Wiley & Sons, Inc. and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.