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SMEs and Environmental Practices: A Study of the UK-based Manufacturing SMEs sector

Abstract

Purpose – Evaluating environmental practices of UK-based manufacturing SMEs stipulated by market pressures and post Great Recession business environment.

Design/methodology/approach - A mixed methods research strategy, consisting of a survey of 104 manufacturing SMEs located in the UK, complemented by 17 in-depth interviews with senior management representatives from this survey group.

Findings – The survey suggests there is relatively less impact by the Great Recession of 2008 on environmental practices by manufacturing SMEs compared with other competitive priorities that inform business strategy. The determinants of change include cost in both negative and positive senses, customer expectation, energy efficiency and effective solutions to waste management.

Research limitations/implications - The sample of surveyed participants was relatively small to draw statistical conclusions on differences in environmental practices within different sub-sectors of manufacturing SMEs. A healthy number of informative, in-depth interviews providing rich insight into the shifting priorities for the sector compensated for this.

Practical implications – The study offers an insight to manufacturing SME managers on the value and challenges of implementing green manufacturing.

Originality/value – The paper builds on established SMEs and green manufacturing theoretical paradigms and points to the increased implementation of environmentally friendly practices within the manufacturing SMEs sector.

Keywords: SMEs, environmental practice, green manufacturing, mixed-methods research.

Paper classification: Research paper.

Introduction

Manufacturing makes a substantial contribution to the global economy. It contributes to both employment and economic output. Within the United Kingdom the manufacturing sector employs 2.7 million people, contributes 10% to its national gross value added (GVA) and accounts for 45% of the country’s exports (EEF, 2016). Since the global economic downturn of 2008-09, efforts in rebalancing the UK economy have become a priority for successive governments. Implementation of specific industrial policies with varying success has supported the country in regaining its position as the ninth largest contributor to the global output of manufactured goods (Rhodes, 2016).

The research presented in this paper focusses on manufacturing SMEs (MSMEs) located in the UK. The typical business weakness of an MSME centre around limited financial and management capabilities (Kitching et al., 2009a). As such, MSMEs face challenges in scanning, analysing and responding to major industry and market trends. They also typically serve a smaller and more concentrated (industrial) customer base with a narrow product line (Smallbone et al., 2012). This places third- and second-tier MSMEs in a weak bargaining position with their powerful industrial customers, who expect MSME suppliers to comply with contemporary forms of business practice.

MSMEs within the UK and beyond have been under government, public and market pressure to evaluate their energy consumption, waste management policies and reduce their carbon footprint (Brammer et al., 2012; Saez-Martinez et al., 2016). Engaging with Corporate Environmental Responsibly (CER) has become a strategic decision for SMEs although the degree of engagement and enthusiasm to extend beyond environmental regulation compliance differs by sector, size of SME and external support (Hoogendoorn et al., 2014; Saez-Martinez et al., 2016). Moreover, within the British SMEs arena, both the UK government and intergovernmental institutions (e.g. European Commission) have responded to these market and industry pressures by introducing environmental standards (PAS 2050:2011) promoting sustainable manufacturing and product consumption. The results of such government policies and regulations have a variable impact on MSMEs. Industrial sectors incorporating greener and high-tech manufacturing systems are less likely to experience structural changes in their environmental business practices and corporate policies. The engineering sectors of automotive, aerospace, biochemistry, and telecommunications and earth observations systems offer greener credentials thereby positing themselves with higher opportunities for growth within UK manufacturing (BIS, 2012). All four sectors are at the forefront of lean manufacturing with small volumes of waste. In many cases, selling on wasted material as a by-product to other industries for further fabrication in the form of raw material. On the other hand, MSMEs involved in heavy manufacturing and high-energy consumption have stricter carbon dioxide emission government targets, typical manufacturing sectors within this bracket are non-metallic minerals, pulp and paper, basic metals and chemicals. Manufacturing in the UK consumes 21% of the country’s energy production and is responsible for 29% of CO₂ emissions (Griffin et al., 2016). A study by the Department for Environment, Food and Rural Affairs (DEFRA, 2010) estimated annual savings of £463 million are achievable for energy intensive
manufacturers with the adoption of energy efficient systems, waste measures and water efficiencies. MSMEs are therefore encouraged and increasingly expected to include the review of their environmental impact within their business strategy development process.

In summary, there is strong evidence of the importance for further research on the environmental business practices within the MSME sector. The benefits of such research applies to practitioner, academic and public policy cycles. This study reports on the UK-based MSMEs sector and its response to external pressures through its strategic consideration of environmental manufacturing policy. Consideration of the impact of the Great Recession of 2008/09 on this as a priority area informs this study, alongside its association with the impact on other strategic decision area and a qualitative consideration of the initiatives put in place across the MSME sector as a response.

Literature Review

Within the literature of manufacturing and operations strategy, the concept of “green manufacturing” or “green operations” has become the focus of growing research interest. Mohanty and Deshmukh (1998) first discussed this emerging business practice by challenging the academic and management emphasis on maximisation of production outputs. Instead, they proposed a shift in management philosophy towards “green productivity, which looks forward to socially appropriate production and consumption aiming at value innovation and resource conservation” (Mohanty and Deshmukh, 1998:624). In their statement, the two authors extend the process of manufacturing into socially responsible business practices and see the responsibility across the supply chain from supplier to customer. Central in their definition of green productivity is the notion of value creation driven by manufacturing process, product innovation and resource utilisation, the latter referring to energy consumption and waste reduction or recycling.

Deif (2011) took green manufacturing a step further by placing this business practice within the concept “sustainability”. Deif therefore links his thesis with Mohanty and Deshmukh’s view (discussed above) of green production as a socially responsible business concept supporting a sustainable business model. Sustainability within business and management has been defined by Deloitte and Touche (1992:1) as “adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future”. This makes for a very rich but at the same time vague and overstretched concept that requires further clarification. Most of the research on sustainability falls into two categories: the first discusses the reputational benefits of incorporating environmental goals within corporate-level strategic objectives; the second identifies management methods of building operational objectives around environmental objectives. Simpson and Samson (2010) have defined these two streams of literature as “value-based strategy” and “practice-based operations” respectively. From the above we conclude that green manufacturing is both a top-level strategic issue and operational practice, which requires management attention in the post Great Recession business environment where resource utilisation is a source of sustainable competitive advantage.

Empirical data suggests a strong correlation between the adoption of green manufacturing and business performance (Deif, 2011). In particular, benefits firms investing in green manufacturing and related environmental practices see improvement in the manufacturing priorities of cost, quality, flexibility and delivery performance. We may conclude that viewing green manufacturing as a strategic issue delivers a manufacturing strategy inclusive of environmental, economic and social objectives (Bansal, 2005). Moreover, green manufacturing and business sustainability command a “sustainable approach to the design and engineering activities involved in product development and/or system operation to minimising environmental impact” (Deif, 2011:1554).

Green manufacturing encompasses the concepts of product- and process-management (Paul et al., 2014). When green manufacturing is addressed within the product management stage the issue of environmental conformance becomes important to ensure recycling properties and waste reduction during manufacture (Ferguson and Toktay, 2006). As such there is a requirement to consider the product’s manufacturing impact on the supply chain both downstream and upstream. Green manufacturing therefore extends to green supply chain management (GSCM), materials management, green distribution and marketing and end-of-life management (Srivastava, 2007). For a successful implementation of green manufacturing and GSCM strategy a requirement exists for (i) top/middle management, (ii) support by strong leadership, and (ii) an environmentally committed organisational culture (Holt and Ghobadian, 2009). We could assume that these three attributes are typically common within an SME setting with top-down leadership driven by the owner-manager and a business strategy based on differentiation and hence keen to embrace environmentally friendly processes and products.

In addition, much of the discussion recently on green manufacturing has linked the concept to lean thinking as a means of value creation and source of competitive advantage (Johansson and Sundin E, 2014). Lean thinking
aims at the review and reduction of resources which do not add value for the end customer (Pampanelli et al., 2014). Its focus on the end customer and their perceived value in the purchased tangible product has a direct impact on all members of the supply chain of that particular product. Much of the philosophy behind lean thinking and green manufacturing stems from the influential work of Womack and Jones (1998) who promoted an analytical, management tools approach in the development and implementation of the two concepts discussed here.

Dangayach and Deshmukh (2001), in their review of the manufacturing strategy literature, note the reliance on conceptual-based research within academic debates on the topic of green manufacturing, urging for the development of a management process or tool to incorporate green manufacturing within the formulation of manufacturing strategy. Since then, the work of Hill (2009) has addressed in part this literature gap by providing a short auditing tool for managing energy resources in terms of storage, conversion, distribution and utilisation within the manufacturing process. Ki-Hoon Lee (2009) and Williamson et al. (2006) place manufacturing environmental practices within the corporate social responsibility (CSR) agenda, and the growing practice of environmental reporting which can serve as source of competitive advantage (Clarkson et al., 2011). Ki-Hoon Lee (2009) and Williamson et al. (2006) recommend a list of environmental considerations to become part of the manufacturing decisions agenda:

- Environmental impact of product(s) on offering: design, recyclability and energy consumption (the latter if applicable). Also known as life-cycle assessment (LCA).
- Location of manufacturing plant: location within industry clusters and transport-related energy consumption.
- Manufacturing process: layout, waste disposal, noise reduction, fume and emission pollution and awareness of shop floor personnel.
- Manufacturing system: use of Just-In-Time (JIT), material utilisation within materials requirements planning (MRP).
- Capacity and inventory planning and control: over-production and energy intensive stock levels.
- Supply chain management: location of suppliers, transportation impact of goods.
- Quality control: cost or rework, scrap disposal, total quality management systems (ISO 14001:2004 environmental management standards certification).
- Failure prevention and recovery: environmental risk management.

There is growing empirical evidence proposing that manufacturing SMEs (MSMEs) have been evaluating their waste management policies and energy management in response to increasing customer pressures and advancements in manufacturing technology (Rohdin et al., 2006; Thollander et al., 2007). MSMEs operating within a business-to-business supply chain are expected to respond to calls from their corporate customers to account for their environmental impact. In addition, MSMEs are increasingly expected to report on strategic and operational decisions on their business practices on reducing their carbon footprint.

The research community has been following the SMEs’ strategies and practices in embracing and implementing environmentally friendly operations as part of an overarching corporate social responsibility position. Thomson and Smith (1991) first reviewed the relevant literature and since then a number of responsibility management tools suited for an SME setting have been developed, tested and widely been accepted by the academic, consultancy and manager-practitioner communities. In addition, theoretical conclusions have been attempted in on the sustainability and SMEs subject without always reaching a consensus. Researchers have pointed to the lack of resources and unawareness of SMEs of their impact on the environment (Hillary, 2000; Gadenne et al., 2009) while others have pointed to a reactive behaviour of SMEs which defines them as regulatory-conformers only without any further initiatives (Williamson et al., 2006; Revell and Blackburn, 2007). On the other hand, a number of authors have opposed this view by providing empirical evidence of a proactive SMEs behaviour driven by an innovative and efficient sustainable business model (Haillia, 2007; Granly and Welo, 2004; Klewitz and Hansen, 2014; Reyes-Rodriguez et al., 2014). It is these opposing views that these papers aims to explore and clarify further.

Figure 1 captures the key messages from the above literature review with a visual representation of the context within which external factors frame and influence MSMEs in developing their green manufacturing policy.
Figure 1. Context of green manufacturing within an SME setting

Study Design and methods of data analysis
Most of the earlier research on SME strategy and business practices takes a mono-method research approach with quantitative studies being most common. A limited number of published research adopting a mixed methods approach exist, with the manufacturing strategy subject most notable the work by Badri et al. (2000), SIOM (2009), Kitching et al. (2009b) and MacBryde et al. (2013). The mixed methods approach adopted here aims to address the literature gap in making use of the advantages it offers in the collection of qualitative and quantitative data, analysis and interpretation (Creswell and Plano Clark, 2011). Moreover, the application of a parallel mixed analysis (Tashakkori and Teddlie, 1998) seeks to utilise triangulation and counter for any limitation of utilising a single method of data collection and analysis approach, thereby providing a greater insight into the environmental practices of MSMEs in the post Great Recession business environment.

The survey instrument developed for this research was a questionnaire, which acted as a common survey and semi-structured interview data collection tool (Creswell and Plano Clark, 2011). It contained a number of distinct manufacturing management considerations assessed in terms of change driven by the 2009 recession, one of which was on the environmental practices adopted by the participating MSME. Other manufacturing management considerations were on manufacturing cost, supplier selection, manufacturing flexibility, delivery performance, product range, process technology and quality. All these considerations accounted for the literature on green manufacturing and environmental strategy in SMEs, alongside associated constructs as presented in this paper.

The survey sample was drawn from the commercially available business directory Kompass UK. All UK-based MSMEs with available senior management contact details which are listed on Kompass UK were targeted for sampling purposes making a total of 2,183 businesses (excludes micro-businesses). Initial email contact involved senior managers who were more likely to be familiar with organisational strategy and associated decision-making. Transmission of information about the purpose and value of the research to the research participants involved dissemination of the instrument as the survey tool, subsequent completion took place online. The authors obtained 104 completed usable questionnaires. Although the overall response rate is low (4.7%), it compares with similar experiences of other business and management researchers engaging in survey work with SMEs (Porter, 2004). Invitation of these 104 survey participants to a face-to-face semi-structured interview to elaborate on their individual survey response followed, giving opportunity to offer further explanations on their MSME position in relation to manufacturing environmental practices. Seventeen senior managers agreed to participate in the follow-up interviews.

The research was subject to ethical approval by the author’s University. Implementation of appropriate protocols capturing guaranteeing confidentiality, anonymity and data storage followed. Piloting of the data collection
instrument (survey/interview questionnaire) ensured the instrument accounted for clarity of terminology, wording and instruction, further assessing completion time and ease of understanding.

The parallel mixed analysis method incorporating both quantitative and qualitative data was employed as described by Caracelli and Greene (1993) and Tashakkori and Teddlie (1998). The quantitative analysis involved the application of descriptive statistics percentage frequency distributions and paired t-test assessments of the various priority area scales presented in the survey instrument, alongside a correlation analysis to assess association between the recession impact on manufacturing environmental practices and each of the other priority areas. For each of the tests and associations presented, reporting of levels of significance is at the standard 5%, 1% or 0.1% levels. This afforded a sector overview, if not necessarily generalizable given sample size, the findings have arguably some level of transferability. The sample size and associated numbers of MSMEs within associated sub-sectors prohibit meaningful tests for differences in experience, and as such, represent a study limitation albeit perhaps not unexpected for a sector noted for low study participation (Dennis, 2003). In line with the mixed methods and parallel analysis research approaches enriching of the quantitative findings by the quality and volume of the qualitative data generated by the in-depth survey follow-up interviews involved “nesting” of the two data sets (Yin, 2006). The qualitative data was subject to template analysis (King, 2004) a method used in other business and management research (Waring and Wainwright, 2008). By implementing the parallel mixed analysis method appropriate relationships and synthesis between the two components of analysis well-supported conclusions are developed (Onwuegbuzie and Johnson, 2006; Yin, 2006). Figure 2 captures the research process of the study presented in this paper, the stages of data collection and analysis ending with the parallel mixed method merging the respective quantitative and qualitative data sets.
Study Findings
The purpose of the study is to explore the environmental practices of UK-based MSMEs and in particular initiatives on green manufacturing implementation. The evaluation of green manufacturing was part of a wider study on the adjustment of competitive manufacturing priorities since the Great Recession of 2008.

In the assessment of the MSMEs who participated in the study, there is consideration of eight areas of competitive manufacturing priority in terms of the impact of the Great Recession on their level of adjustment. Table 1 presents the percentage frequency distribution of response and key summary statistics. The focus of the study, manufacturing environmental practices (green manufacturing), is included in this assessment.

The mean score for manufacturing environmental practices in Table 1 is the lowest of all eight areas of competitive manufacturing priority considered. Just under half (48.5%) of the MSMEs participating in the study
suggested this was of either “no impact” or “very low impact”. In contrast, the two areas of priority where the Great Recession has relatively high impact are supplier selection and manufacturing costs. Assessment of the pairwise differences in mean impact shows no significant difference between manufacturing environmental practices and product range (t = 1.762, df = 101, p = 0.081), quality (t = 0.877, df = 101, p = 0.383) and process technology (t = 0.786, df = 102, p = 0.433). The level of impact on manufacturing environmental practices is significantly lower than each of delivery performance (t = 2.992, df = 102, p = 0.003), manufacturing cost (t = 10.304, df = 101, p = 0.000), manufacturing flexibility (t = 4.083, df = 102, p = 0.000) and selection of suppliers (t = 6.250, df = 101, p = 0.000). The latter three demonstrate highly significant differences in levels of impact at the 0.1% level.

From the qualitative data relating to impact of the Great Recession on manufacturing environmental practices, the majority suggested it had no or only limited effect on changes in priority. Various respondents pointing to a longstanding commitment to this area of development, for example: “we were doing it before”, “we were doing it anyway [before the recession]” and “it’s not really changed for us”.

In terms of reasons for a lack of adoption of practices in this area, the impact of established compliance constraints on product and process already play a part, as does a level of legislation fatigue “Not really, because we’re legislated up to the eyebrows, they haven’t put any more legislation on us just yet but they’re talking about it”. There is an appreciation that particular markets are less interested in their suppliers developing in this area, some are sector specific such as defence, others are geographic, for example: “the Chinese don’t care”. Risk and cost explain the lack of intervention for various MSMEs, with a number unable to present a viable business case in support. Examples reported include “it’s customer driven, where the customer wants to see we recycle our raw material etc., but purely from a money point of view we’re not doing it we’re not being driven by environmental pressures you know” and “using some of the roof space for solar panels but it’s whether the business case stacks up”. For some participating MSMEs, the levels of energy consumption and waste creation means that the environmental practices have not had any conscious effect on decision makers or that they are perceived as irrelevant, for example “Our manufacturing process does not use a tremendous amount of electricity, it doesn’t use a tremendous amount of electricity”, “Well yeah we don’t, we don’t have… there’s something we could do possibly, but we’re not a big energy user” and “Our consumption is very low as a proportion of our costs, you know it’s mainly lighting and heating’. Finally, the established barrier of time limits certain MSMEs from progressing, reported comments include; “to be honest we haven’t had time to focus on it”. In the opposite sense, there are a number of recognisable causes for investment in manufacturing environmental practices. Arguably, the primary driver of this investment is customer pressure. For example, MSMEs’ responses include: “customers expect certain things, they want sustainable supply chain”; “it’s customer driven yeah because they score you, and part of the score you get is based on your environmental so that is a high impact on you” and “we’re finding more and more of our major customers because of the oil industry being tarnished by the Gulf of Mexico incident. They’re more and more demanding higher and higher levels of shall we say awareness” are examples of MSMEs’ responses. External accreditation requirements are demanded by customers, for example “our customers are demanding first of all it was ISO9000 then it was the ISO14001 now it’s up to what is it?” Likewise, the customers are passing on requirements driven by state legislation, comments include: “over the last four years there’s been a tightening in the EU legislation on the amount of nickel that can go outside the factory” and “the only change really for us would be the ROHS environmental soldering, where soldering products have to be lead-free of course”. Whilst cost is a barrier to
certain MSMEs in their adoption of manufacturing environmental practices, it also acts as an important determinant for others particularly connected to removal of waste, comments reported include: “landfill charges started sky rocketing”, “it seemed cheaper to recycle than to throw it in landfill” and “That is cost. To fill the fill the skip and get rid of it”. Examples of manufacturing environmental practices adopted by MSMEs include automated lighting, low emissions and chemical outputs, installation of systems for cleaning and extraction, electricity generating solar panels and searching for alternative manufacturing energy sources (i.e. changeover from electricity to gas). Even more importantly, recycling policies for manufacturing waste by-products or supply packaging play a significant role, consistent with the reporting above that cost plays a significant determinant role in practice adoption. Examples of MSME response includes: “we are much more aware so we are recycling a heck of a lot more than we did back in 2008. But there is a benefit. At the end of the day because we’re doing all that we’re not paying the same landfill costs. So there is a benefit to it to be fair, it’s not just a good thing to do it’s actually a cost effective thing to do”. This response is a powerful one, because it reinforces the idea that taking positive environmental action is cost saving and effective, rather than automatically be cost generating, as reported: “you can produce a win-win situation there because if some action we can take to reduce our costs is environmentally friendly then it’s win-win”. A number of MSMEs have gone further and reported using their manufacturing waste as a source of income by identifying potential markets for waste materials. Various of these changes permit benefits to be passed to customers, for example: “we’re helping the users of our equipment to make an impact on their carbon imprint” and “we end up throwing a lot of seats away, but if we didn’t sell them on to another company they’d end up in a landfill. So they pay a little bit of money for them not a great deal”. These activities also benefit the implementing MSMEs by allowing them to meet certain internal expectations where annual targets are set and pressure is in place, primarily to save money through cost reduction. An example of one experience is: “it’s due to company practices the parent company enforcements saying you will do this you know the amount of material recycled the amount of material we waste the amount we have on the landfill what goes to the landfill it’s all monitored and recorded and displayed”.

In terms of association assessing recessionary impact on manufacturing environmental practices and each of the other manufacturing priorities, Table 2 presents the respective correlations. All of these are significant at the 0.1% level, the exception being the association involving delivery performance, which is significant at the 1% level.

<table>
<thead>
<tr>
<th>Manufacturing environmental practices (green manufacturing)</th>
<th>Correlations - level of impact of recession</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product range</td>
<td>0.307</td>
</tr>
<tr>
<td>Quality</td>
<td>0.352</td>
</tr>
<tr>
<td>Manufacturing cost</td>
<td>0.368</td>
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<tr>
<td>Process technology</td>
<td>0.443</td>
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<tr>
<td>Manufacturing flexibility</td>
<td>0.427</td>
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<tr>
<td>Selection of suppliers</td>
<td>0.460</td>
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<tr>
<td>Selection of suppliers</td>
<td>0.463</td>
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Table 2. Correlation between recession impact on environmental practices and other priority areas

The associations are typically moderate in strength, but perhaps unsurprisingly, the areas of relatively greatest strength are supplier selection (r = 0.463) and manufacturing flexibility (r = 0.460). In both cases, greater external influence, primarily driven by customers’ expectations has impacted upon change to supplier relationships and manufacturing practices, which in turn, may have embraced change that captures certain initiatives that are environmentally conscious or sensitive. In turn, such change, has cost implications, with the next strongest association recorded relating to manufacturing costs.

Discussion and Conclusions
From a methodological perspective, this study complements previous manufacturing SME-centred research relating to the adoption of environmental business practices. This work has a particular focus on UK-located MSMEs. It is based on a mixed methods research approach, comprising a survey of senior managers from 104 UK-located MSMEs supported by 17 in-depth interviews from the surveyed group. The study represents a response to calls from academics with interest in manufacturing strategy for greater application of mixed methods data and analysis within the manufacturing management arena (Boyer and Swink; 2008; Barratt et al., 2011). The same justification of mixed methods applies to the SMEs literature body where very few studies exist taking benefit from a mixed methods approach. Mixed methods present challenges during the data collection stage but offer a greater insight into the exploration of the phenomenon in question than mono-methods.
The study presented here builds on the seminal work of Mohanty and Deshmukh (1998) and Deif (2011) on socially responsible manufacturing, by assessing the adoption of environmentally friendly practices and in particular green manufacturing by UK-based MSMEs. The findings complement the research of Williamson et al. (2006) and Revell and Blackburn (2007). Our study concludes that MSMEs operating within business-to-business (B2B) oriented supply chain implement manufacturing environmental practices in response to pressure from higher-tier suppliers and through necessity to reduce increasing manufacturing energy costs. In short, the determinants are both market-driven and cost-driven, but have had limited impetus compared with other manufacturing priorities from the 2009 recession. The changes identified appear independent of this, with MSMEs either ignoring the Great Recession of 2008 with respect to decisions in this arena or have simply followed through with green-related initiatives put in place pre-recession.

The study findings do confirm that UK-based MSMEs have seen a number of changes in the post Great Recession period (2008 and beyond) in their manufacturing environmental policies, notwithstanding the relative lack of impact as indicated. Indeed, the impact of the recession on this area of priority is relatively modest compared with other areas of activity. These changes primarily come as a response by MSMEs to the increasing manufacturing costs of energy and transportation of goods. There is an awareness of manufacturing on the environment, although hindering of activity by time and lack of external demand, means two leading motives emerge for introducing energy efficient measures within their manufacturing process: cost reduction and customer expectations.

Increases in commercial utility prices and transportation fuel have led MSMEs to take reactive decisions in searching for energy saving measures. Such measures include switching from electricity to gas within manufacturing processes (where applicable), investing in electricity generating solar panels or wind turbines, automated space lighting systems, hybrid technology-based vehicle fleets, and waste recycling policies. This resonates with the findings are reported by Smallbone et al. (2012) on the impact of energy price increases on SMEs located in the UK. MSMEs within this study have taken a calculated risk in adopting such green energy technologies by examining their long-term return on investment opportunities, although some have reported that the business case is not a viable one.

The second motive for MSMEs to opt for manufacturing environmental practices is a response to customer expectations. Data from the present study suggests that this case applies more to MSMEs operating within highly regulated sectors such as non-metallic mineral products that experience higher emissions within the manufacturing process. The findings confirm industry reports (CBI, 2010; BIS, 2012) which highlight the increasing awareness and pressure by market forces on UK manufacturers. Wilson (2011) further supports this, pointing to the growing awareness of consumers of the environmental impact of consumption, which has placed an increasing pressure on manufacturers to consider the carbon footprint of their operations. Whilst Wilson (2011) primarily considers business-to-consumer (B2C) settings, the majority of MSMEs participating in this study operate in business-to-business (B2B) trade relationships where, the coercive external pressure emerges via the supply chain from higher-tier suppliers to their lower-tier trade partners where typically MSMEs are located. These behavioural changes perhaps reflects an increasing desire of B2B customers wanting to apply life-cycle assessment (LCA) on their products as part of their sustainability agenda.

Concluding, the findings presented here are of value to both the academic and management practitioner communities. An insight into current MSMEs practice is presented informing strategic and operational decisions on the adoption of green manufacturing. The relevant academic literature is informed by a mixed methods data set which allows for greater in-depth exploration of the subject on green manufacturing, the conclusions support the view of a reactive nature of the MSME business community. Future research should be two-fold: (i) the development of a tailored data collection instrument to support a more detailed review of green manufacturing within the MSMEs sector, and (ii) a comparative study with another developed economy and its MSMEs taking advantage of the UK-based data set presented here.
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