The impact of lean management practices and sustainable oriented innovation on sustainability performance of small and medium sized enterprises: Empirical evidence from the UK

Abstract

Sustainability of small and medium sized enterprises’ (SMEs) is a major concern as they face intense competition and numerous challenges to meet the desired environmental and social targets. While, lean management helps SMEs to be efficient, sustainability oriented innovation (SOI) facilitates to adopt environmental and social practices. Although prior research looks into the effect of lean management practice (LMP) on economic performance of SMEs, less is known about the effect of LMP on sustainability performance. Studies on effect of SOI on sustainability performance are also scant. Additionally, examining the mediating effect of corporate social responsibility (CSR) practices on both LMP and SOI to achieve sustainability performance is rare. The purpose of this paper is to investigate the effect of lean management practices and sustainable oriented innovation on sustainability performance, and examine the mediating effect of environmental and social practices within SMEs in the Midlands of the UK. The study formulates a few hypotheses and applies structural equation modelling (SEM) to reveal the relationships among LMP, SOI, environmental and social practices, and economic and sustainability performance. The study uses data from 119 SMEs within manufacturing industries in the Midlands, UK that have at least more than 20 employees and doing business for more than five years in order to undertake a robust analysis. Results show that LMP and SOI facilitate achieve both economic and sustainability performance, and SOI mediates LMP to achieve sustainability performance. Additionally, although CSR practices mediate LMP to achieve sustainability performance, it does mediate SOI only borderline to achieve sustainability performance. The findings are significant to SMEs’ owners / managers and policymakers to make SMEs’ business more sustainable.

Key Words: Small and medium sized enterprises, structural equation modelling, sustainability practices and performances, lean management practices, sustainability oriented innovation.
1. Introduction

SMEs are commonly recognized as making large contributions to the global economy and results in many social benefits. National governments increasingly promote SMEs’ development in recognition of the critical role they play in the socio-economy. They have set policies and supporting measures for the purpose of economic development. Departments/Offices assisting SMEs have been set up in most countries in order to develop a policy framework and implementation plan and to act as a coordinating body for the collaboration with other agencies (White, 2012).

While it is widely accepted that SMEs play a significant role in the economic development, they also exert considerable pressure on the environment, not individually, but collectively. SMEs are voracious consumers of resources and energy and the result is a significant generation of waste by-products. Despite this, environmental measures undertaken by SMEs to date have not yielded impressive results, especially when compared to those of large companies. Available research data suggests that SMEs are responsible for more than 50% of the industrial pollution in the Asia-Pacific region and there are numerous examples which suggest that SMEs contribute significantly to environmental damage and GHG emissions (Hallinan and Jenks, 2003; Williamson et al., 2006). As per the UK environmental agency eight out of ten pollution incidents in the UK are caused by SMEs.

It is believed that the environmental damage caused by SMEs will grow unless innovative strategies are devised. There are, however, a number of barriers that prevent SMEs from achieving such innovative strategies and these include: a lack of information on the cost-benefits of improving environmental performance, weak external pressure / incentives, lack of internal capacity (e.g. financial resources, human resources, technologies, business processes and R&D activities), weak supporting frameworks and in many cases political indulgence by policy makers (Dey and Cheffi, 2012; Zhu and Sarkis, 2004).

Lean Management Practices (LMP) has been adopted by many manufacturing and service companies for waste reduction without sacrificing throughput. There is growing interest in linking LMP with environmental sustainability. Lean is economy focused and environmental friendly, as philosophically lean management focuses on waste reduction through resource optimisation. However, environmental and social sustainability of companies are not fully achieved though LMP as a few environmental and social practices are cost intensive (e.g. adopting environmental management system such as ISO 14000, specific measures for
reducing energy consumption, employee wellbeing, corporate social responsibility (CSR) projects are capital intensive). Prior literature has linked LMP with sustainability (Martinez-Jurado and Moyono-Fuentes, 2014). LMP facilitates to adopt green manufacturing principles and enhances environmental performance of many manufacturing companies. Despite the fact that LMP contributes to environmental sustainability (Moreira et al., 2010; Vinodh et al., 2011), the findings are still not conclusive, as both positive (King and Lenox, 2001) and negative (Rothenberg et al., 2001) relationships have been found to exist. Moreover, the relationship between LMP, and environmental and social management is also non-conclusive.

LMP has been extended to SMEs’ supply chain through eliminating waste, enhancing quality, reducing costs and increasing flexibility across supply chain in different tiers (Inman and Green 2018). The economic sustainability of SMEs’ supply chain is achieved through business growth, enhancing supply chain surplus, reducing supply chain cost, business risk reduction through joint investment in R&D and technology, reduced inventory, improved products and services quality, and overall reduction of waste across the supply chain (Arkader, 2001). Similarly, LMP across supply chain helps achieve environmental sustainability through collaborative relationship building across all the stakeholders, engaging with suppliers at the early stage of product development, introducing vendor manage inventory, considering environmental criteria along with others for supplier selection (Inman and Green, 2018). Environmental sustainability of supply chain could be achieved through reduction of emission and waste across the supply chain (Martinez-Conesa, 2017).

Sustainability Oriented Innovation (SOI) could be achieved through product, process and organisational innovation (Klewitz and Hansen, 2014). In order to improve sustainability performance of products, eco-design is an overarching concept. Process Innovation means the implementation of a new or significantly improved production or delivery method (including significant changes in techniques, equipment and/or software) (Adams, 2016). Cleaner production is an example of Process Innovation for environmental sustainability (Adams, 2016; Klewitz and Hansen, 2014). Implementing Environmental Management System (EMS) including ISO 14000 is a typical example of organisational innovation for environmental sustainability (Wu 2017).

In 2017, there are 5.6 million SMEs in the UK, which employ 15.8 million people. The combined annual turnover of SMEs was £1.9 trillion, 51% of all private sector turnover in the UK. Despite of positive contribution to gross domestic product (GDP) through economic performance, SMEs’ environmental and social performances are not impressive at all. Therefore, means for enhancing their sustainability are the need of the hour.
LMP is by default economy focused (Inman and Green, 2018). Therefore, achieving overall sustainability through lean approach enables organisations to emphasize on achieving economic sustainability. On the other hand, SOI is responsiveness focused, which allows organisations to achieve overall sustainability through right trade off among economic, environmental and social factors (Adams, 2016). Although there are studies on LMP and sustainability, and SOI through product, process, and organisation innovation, according to authors’ knowledge there is no study that links both LMP and SOI with SMEs’ supply chain sustainability performance. Moreover, although prior literatures have established that both lean and SOI are the enablers for achieving sustainability, their combined effect on sustainability performance of SMEs’ supply chain remains unexplored. Additionally, the mediating effect of environmental and social practices on LMP and SOI to achieve sustainability performance is also rare. This paper aims to investigate the effect of LMP and SOI on sustainability performance, and examine the mediating effect of CSR practices within SMEs in the Midlands, UK. Additionally, it also examines the mediating effect of SOI for LMP to achieve sustainability performance. The contributions of this research are three folds – relationship among lean management practices, sustainability oriented innovation, corporate social responsibility practices, and sustainability and economic performance of SMEs in the Midlands, UK; a diagnostic tool for SMEs’ sustainable supply chain analysis, and means for achieving sustainability across SMEs’ supply chain. The remainder of the paper is structured as follows. The next section briefly describes theoretical background of this research. Section 3 provides rational for this study. Section 4 elaborates the literature review explaining relevant constructs for sustainability analysis of SMEs’ supply chain. Section 5 develops hypotheses for this study. Section 6 formulates theorised model. Section 7 explains the methodology that has been used for analysing the data. Section 8 elaborates the results and section 9 provides discussion and conclusion.

2. Theoretical background

The theoretical underpinning of this study follows complementarity theory (Bergmiller and McCright, 2009; Narasimhan et al., 2010). Lean management practices (LMPs) and sustainability oriented innovation (SOI) are organizational competencies that enhance organizations’ competitiveness. These need strategic, policy and operational intervention to implement. LMP and SOI are complementary as one set of practices support other. Impact of each practice is less than the combined effect.
In principle, LMPs eliminate all forms of waste throughout the supply chain through appropriate supply, internal operations and demand management (Inman and Green, 2018). SOI is product, process, and organizational innovation for achieving sustainability (Adams et al., 2016; Martinez-Conesa et al., 2017). We argue that LMP and SOI in combination help achieve higher sustainability. SMEs with LMP and SOI implemented will get better advantage over other SMEs as they have capability of eliminating all waste, achieving resource and energy efficiency along with higher productivity. Additionally, LMP and SOI are complementary in waste elimination capabilities emanating from LMP will enhance a SME’s ability to successfully implement SOI for achieving higher sustainability. LMP and SOI are complementary in their impact on sustainability performance.

3. Rational for the study

There are studies on examining relationship between lean and environmental practices (Inman and Green, 2018) using varied approaches. These include questionnaire survey (Zhu and Sarkis 2004; Green et al. 2012; Hajmohammad et al. 2013; Prasad et al. 2016; Akhtar et al., 2018), reviews (Tan and Lim 2013; Hallam and Contreras 2016), secondary data collection (Hong et al. 2012), interviews (Campos and Vazquez-Brust 2016), case studies (Biggs 2009, Miller et al. 2010, Azevedo et al. 2012; Campos and Vazquez-Brust 2016; Garza-Reyes et al. 2016), and conceptual models (Carvalho et al. 2011; Pampanelli et al. 2014; Aves and Alves 2015) using data from varied countries in developed and emerging economies including the UK, US, Canada, Japan and other EU countries, Brazil, India, and China representing several industries – manufacturing, automotive, logistics, construction, process and services. Some researchers argue that lean drives environmental practices (Tan and Lim 2013; Pampanelli et al. 2014), some that environmental practices drive lean (Bergmiller and McCright 2009), and some feel that both work synergistically (Miller et al. 2010; Azevedo et al. 2012; Low and Song 2015; Garza-Reyes et al. 2016).

Sustainability oriented innovation (SOI) involves transforming organisation’s philosophy and values along with its products, and processes to achieve environmental and social objectives along with economic results (Adams et al., 2016, Arena et al., 2018). The link between SOI (product innovation, product and process innovation, and product, process and organizational innovation), and environmental and social practices are well researched but the results are non-conclusive as explained in the detailed review paper by Adams et al. (2016). Although the link between corporate social responsibility (CSR) and business value has been
investigated (Wu, 2017), a significant research gap remains when considering relationship between CSR and innovation (Martinez-Conesa, 2017).

The relationship between sustainable practices and performance in manufacturing industry has been demonstrated by Abdul-Rashid et al. (2016) and Adebanjo et al. (2016) who study the impact of external pressure and sustainable management practices on manufacturing performance and environmental outcomes. Hajmohammad et al. (2013) observe that very few studies have addressed integrated effect of environmental management practices and operation / supply chain systems on environmental performance. The outcome of the review undertaken by Contreras (2016) to study the integration between lean and green reveal that there is a very few survey methods. They note that an integrated model of the firm relating lean and green is lacking. Jabbour et al. (2016) also note that the literature is not conclusive on positive effect of integrated environmental practices and lean operations on performance. Similarly, relationship between lean management practices and SOI, and their combined effect on sustainability performance remains unexplored.

4. Literature Review
The following sub-sections briefly explain the current work on the sustainability constructs.

4.1 Lean management practices
Lean has been in industry since over 40 years and route for improving business performance (Emiliiani, 2006). Interest in the topic became widespread with the publication of The Machine That Changed the World (Womack, Jones and Roos, 1990) in 1990. Several review articles (Jasti and Kodali, 2015; Gupta and Jain, 2013; and Stone, 2012) discuss the growth of lean management practices (LMP) across the manufacturing industries. Over the period lean management principles and practices got refinement and as per Shah and Ward (2003) its main purpose is to achieve ‘zero waste’ in production, highest quality, and resource and energy optimisation. The practices of Just-in-Time, Total Quality Management, Total Preventive Maintenance and Human Resource Management ‘bundled’ together make up lean production.

4.2 Corporate social responsibility (CSR)
CSR is the combination of environmental and social practices that are strategy driven within an organisation. Environmental and social practices across supply chain is also called
green supply chain management practices, which include green product development, green design, green procurement, green manufacturing / operations, green logistics and green marketing (Luthra et al. 2014) and key aspects for achieving sustainability performance. For the green manufacturer, these processes, practices and techniques can result in lower costs, increased productivity and an enhanced image within consumers and community. Sambrani and Pol (2016) and Sarkis et al. (2011) present comprehensive literature on the subject.

4.3 Lean, and corporate social responsibility practices

Lean, and corporate social responsibility (CSR) practices have many common aspects such as – waste reduction, resource efficiency, end-to-end supply chain management, workforce empowerment, transparency, community strategy, better quality and higher productivity. Many authors (Drohomeretski et al. 2014; Tang et al., 2017) argue the main purpose of implementing green supply chain is to achieve efficiency. Through empirical survey Hajmohammad (2013) found the level of LMP to be positively associated with the CSR practices. However, a few CSR practices are capital intensive and long term efficiency is also not assured.

4.4 Sustainability oriented innovation

Adams et al. (2016) via review presents a model for achieving sustainability oriented innovation (SOI). They reveal that SOI could be initiated through product, process and organisation level innovation to achieve higher sustainability performance. Operational optimisation (eco-efficiency), organisational transformation (new market opportunities) and system building (societal change) lead to SOI (Adams et al. 2016). Based on product life cycle concept, SOI could be achieved through sustainable product design and development using eco-design, design for the environment as well as for sustainability (Khor and Udin, 2013), reducing and eliminating hazardous materials, minimizing wastes (Zsidisin and Siferd, 2001), improving resource efficiency and preservation (Duflou et al. 2012), increasing resource recovery by recycling, designing for reuse and remanufacturing (Lee et al. 2001), as well as increasing the aspects of sustainability (Jaafar et al. 2007); sustainable process through reducing energy consumption, waste reduction, and resource optimisation with the aim to reduce CO₂ emission (Fang et al. 2011; Despeisse et al. 2012; Pajunen et al. 2012; Jayal et al. 2010); Sustainable supply chain management through sustainable warehousing (Carter and Jennings, 2002), sustainable packaging (James et al. 2005), reverse logistics (Prahinski and Kocabasoglu, 2006) and environmental purchasing (Jimenez and Lorente, 2001); and
sustainable end-of-life management through reuse, and remanufacturing or recycling (Abdul-
Rashid et al. 2017).

4.5 Sustainability performance

Sustainability from corporate perspective is defined as the right combination of
economic, environmental and social aspects (Elkington, 1994). Growing number of businesses
are adopting green initiatives in order to achieve sustainability (Teixeira and Jabbour, 2012).
Organisations achieve sustainability through economic performance through economic
outcomes and operational outcomes. Economic outcomes are financial benefits through return
on investment and reduction of cost across the supply chain (Eltayeb et al. 2011). Business
growth is another measure for economic outcomes. Operational outcomes (i.e. productivity)
have direct relationship with sustainability performance, which lead to economic performance.
Environmental performance is highly dependent on energy usage, resource optimisation and
waste reduction, which have direct relationship with CO$_2$ emission (Yusuf et al. 2013). Social
performance refers to enhancing quality of life of all the concerned stakeholders (Yusuf et al.
2013). This is measured through CSR project investments, employee wellbeing initiatives,
reduction of accidents etc. Social sustainability not only ensures that industries taking profits,
but also ensures that industrial activities do not cause social degradation (Tsai et al. 2009).

4.6 Lean and sustainability performance

Research on link between lean and sustainability performance is somewhat scant as
indicated by Negrao et al. (2017) in their review paper. However, through case studies
(Azevedo et al. 2012) and analysis of secondary data (Hong et al. 2012) studies have reported
positive results of LMP on green performance. However, Hajmohammad et al. (2013) via
survey among Canadian manufacturing companies found that a positive association between
level of LMP and environmental performance was not supported. Hallam and Contreras (2016)
note that while LMP, and environmental and social practices share waste reduction as an
objective, both the philosophies may also work against each other. LMP alone may not be able
to achieve sustainability performance targets and never be enough to address all sustainability
issues (Inman and Green 2018).

4.7 Sustainability oriented innovation and sustainability performance

New product development following sustainability practices (e.g. eco-design) enhance
environmental and social performance. However, achieving economic performance is not
assured. In a few cases, social performance may not get effected. With effective energy management not only there would be reduction of energy consumption in turn carbon footprint, but help achieve efficiency. Increasing resource recovery by recycling, designing for reuse and remanufacturing (Lee et al. 2001) enhance sustainability performance. With effective energy management, the cost of manufacturing operations can be reduced significantly with increased flexibility and improved quality (Schonsleben, 2007). Sustainable supply chain practices since it integrates various processes – inbound and outbound logistics, internal operations, and both demand and supply sides management, SOI across supply chain will have strong impact on sustainability performance. Sustainable end-of-life management has considerable effect on sustainable performance (Wu 2017). According to Khor and Udin (2013) one should focus on recovering end-of-use products at the earliest opportunity. Recycling is the most common practice for sustainable end-of-life management since it creates economic value. Even though remanufacturing has less environmental impact compared to reuse and recycling, it is less implemented in practice as it requires extensive infrastructure (Amelia et al. 2009).

Though, LMP and SOI are two driving forces of today’s business success, they are fundamentally different concepts, and some aspects of innovation may negatively impact a firm’s ability to be successful by incorporating certain types of innovations. For example, should ideas/innovation that do not add value straightaway, but are likely to create value in the future, be eliminated from the current agenda following the lean principles? It is worth investigating, how innovation can be promoted by maintaining a good level of lean practices. This will require an investigation into impact of different supply chain practices on the performance measures. According to Brown and Duguid (2002) business practices and innovation need to be established at the same time. Lack of practices and creativity will result in less innovative ideas. The authors suggest that a balance between practices and innovative processes will help to attain sustainability in the firm.

Due to intense competition SMEs business needs to be economy focused with reasonable agility. Many SMEs adopt LMP formally and informally in order to achieve efficiency that help them to become environment friendly to certain extent. SMEs also have adopted various innovations (product, process and organizational levels), the main driver for which is achieving efficiency. SOI is lacking among the SMEs as achieving superior environmental and social performance is perceived as cost intensive. Moreover, supply chain integration through collaboration with customers and suppliers in different tiers are almost
absent within SMEs across the world. Prior studies (Adebanjo et al. 2016) reveal that these are mainly driven by customers and policymakers.

5. Conceptual model and Hypotheses Development

In view of the above, this study explores the combined impact of lean management practices (LMP) and sustainability oriented innovation (SOI) on economic and sustainability performance. In this study, a conceptual framework is developed based on the literature review and tested using structural equation modelling (SEM). The key constructs are also proposed to formulate the framework. The framework can be used as a guideline to select the most appropriate LMP and SOI practices to achieve desired sustainability performance.

5.1 Impact of lean management practices on economic and sustainability performance

Prior literatures reveal that Lean Management Practices (LMP) emphasize on resource efficiency, waste reduction, and productivity enhancement, which in fact contribute to better economic performance through cost reduction (Martinez-Jurado and Moyono-Fuentes, 2014). However, LMP may cause lower environmental and social performance SMEs as LMP may abstain from implementing cost intensive environmental and social measures (e.g. replacing energy inefficient machine, undertaking CSR projects, employee wellbeing initiatives) (Rothenberg et al., 2001). Energy efficiency in operating systems helps achieve lean as well as desired environmental and social targets, could be the best candidate to achieve overall sustainability of any type of organisation (Viesi et al. 2017). However, capital cost of achieving energy efficiency could be a concern for many organisations and put them off from adopting this. Accordingly, we formulate the Hypothesis 1 and 2.

H1: Lean management practices (LMP) helps SMEs to enhance economic performance

H2: Lean management practices (LMP) helps SMEs to enhance sustainability performance

5.2 Impact of sustainability oriented innovation practices on economic and sustainability performance

Sustainability oriented innovation (SOI) in SMEs could be done within new product development, operational processes, organizational level and across the supply chain through
most appropriate tradeoff among economic, environmental and social aspects (Adams et al. 2016; Wu 2017). SOI is responsiveness focused (Adams et al. 2016) compared to LMP, which is efficiency focused (Piercy and Rich 2015). Therefore, although SOI may not facilitate SMEs to achieve their economic performance, but quite likely to facilitate achieve environmental and social performance. Accordingly, hypotheses 3 and 4 are formulated.

H3: Sustainability oriented innovation (SOI) helps SMEs to enhance economic performance

H4: Sustainability oriented innovation (SOI) helps SMEs to enhance sustainability performance

5.3 Impact of lean management practices on sustainability performance with sustainability oriented innovation as a mediator

Although there are synergy between LMP and SOI as both the approaches aim to achieve resource efficiency, energy efficiency, and waste reduction with enhanced productivity (Adams et al. 2016; Wu, 2017; Inman and Green, 2018). However, the means for achieving the desired targets following both the philosophies are different. Therefore, it’s worth empirically studying the impact of LMP on sustainability performance with SOI as a moderator. Accordingly, hypothesis 5 has been formed.

H5: Lean management practices (LMP) affect sustainability performance positively with mediating effect of SOI

5.4 Impact of lean management practices on sustainability performance with mediating effect of corporate social responsibility (CSR) (e.g. environmental and social practices)

CSR (e.g. Environmental and social practices) across the supply chain has been named as green supply chain initiatives. Prior research reveal that there are synergies between both ‘lean’ and ‘green’ approaches as they emphasize on research and energy efficiency; waste and emission reduction with higher productivity (Inman and Green, 2018). Additionally, although lean and green individually helps achieve sustainability of SMEs’ supply chain, LMP through mediating effect of environmental and social practices effect economic, environmental and social performance to achieve overall sustainability performance. Accordingly, hypothesis 6 is formed.
H6: Lean management practices (LMP) positively impact sustainability performance through mediating effect of corporate social responsibility

5.7 Impact of sustainability oriented innovation practices on sustainability performance with corporate social responsibility as mediator

Sustainability oriented innovation (SOI) happens across economic, environmental and social practices covering new product develop, business processes, supply chain management processes and organization level (Adams et al. 2016) in order to achieve enhanced sustainability performance. Moreover, CSR mediates SOI positively to achieve enhanced sustainability performance. However, as SOI and CSR practices have many common goals their integration may not be cost effective (Martinez-Conesa, 2017). Accordingly, we introduce hypotheses seven.

H7: Sustainability oriented innovation (SOI) positively impact sustainability performance through mediating effect of corporate social responsibility practices

6. Theorised model

The theoretical model is depicted in figure 1. The model incorporates five constructs (lean management practices, sustainability oriented innovation, Environmental and social management practices, sustainability performance and economic performance) and seven hypotheses. The definitions of constructs are shown in the table 1. The model is designed to test the combined impact LMP and SOI on sustainability performance of SMEs.
**Figure 1. Theoretical Model with hypotheses.**

**Table 1. Construct Definitions**

<table>
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<tr>
<th>Constructs</th>
<th>Definition</th>
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<tr>
<td>Lean management practices (LMP)</td>
<td>A management improvement program comprised of lean practices with suppliers and customers that emphasise setup time reduction, pull systems, continuous flow, statistical process control, preventive maintenance and employee involvement designed to eliminate all forms of waste from all supply chain processes (Shah and Ward 2003, 2007). LMP emphasize on any type waste reduction (Inman and Green 2018).</td>
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<tr>
<td>Sustainability oriented innovation (SOI)</td>
<td>Innovation plays an important role in enhancing sustainability performance (Matos and Silvestre 2013). SOI is the integration of social aspects into products, processes, and organisational structure (Martinez-Conesa et al., 2017). SOI describes a direction, which to follow requires the deliberate management of economic, environmental and social aspects (Hansen et al. 2009)</td>
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<tr>
<td>Corporate social responsibility (CSR)</td>
<td>CSR is usually associated as approach to integrate social and environmental aspects into corporate activities (Baumgartner, 2004; Martinez-Conesa et al., 2017)</td>
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<td>Sustainability performance</td>
<td>Sustainability performance is the combination of economic, environmental and social performance (Abdul-Rashid, 2016)</td>
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Economic performance is measured by productivity, profit, turnover, cost reduction and business growth etc. (Abdul-Rashid, 2016)

7. Methodology

The study adopts primary research using survey method (Green et al., 2012) to reveal the role of LMP and SOI for facilitating SMEs to achieve sustainability. A structural equation modelling (SEM) methodology is used to process the data collected from SMEs in order to test the proposed seven hypotheses (Hussey and Eagan, 2007), according to the hypothesized sustainability model (figure 1).

7.1 Data collection

The data used for this study has been collected from randomly selected manufacturing SMEs in the Midlands, UK. Manufacturing SMEs have been chosen for this study as manufacturing industry is one of the most polluted industries but also have undertaken several measures for reducing their impact. Manufacturing industries currently contribute 11% of GDP in the UK economy. Although this has been substantially reduced from 25% in 1970, UK is likely to be within World’s first 5 countries in manufacturing outputs by 2021 (current position is 8th). Midland is the heart of manufacturing with the home of many manufacturing maestros – original equipment manufacturers such as Rolls Royce; Jaguar and Land Rover, JCB, Bombardier, East Midlands train, Toyota, etc. Midlands is the home of many tier one and other suppliers that are within small and medium sized enterprise (SMEs) sector (employee number not more than 250).

A survey questionnaire has been designed using the latent variables of the constructs (LMP, SOI, CSR, sustainability performance and economic performance) to gather quantitative data on sustainability practices and performances of SMEs in the UK. Table 2 shows the constructs, latent variables and proxies.

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<th>Constructs</th>
<th>Latent variables</th>
<th>Proxies</th>
<th>References</th>
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<tbody>
<tr>
<td>Lean management practices</td>
<td>All form of waste reduction practices</td>
<td>With suppliers</td>
<td>Shah and Ward 2003, 2007</td>
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<td></td>
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<td>With customers</td>
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<td>Within operations</td>
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<td>Productivity enhancement program</td>
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<td>Statistical process control</td>
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<td>Stakeholder management practices</td>
<td>Supplier relationship management</td>
<td>Customer relationship management</td>
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<td>Employee involvement</td>
<td>Management commitment</td>
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<tr>
<td>Sustainability oriented innovation</td>
<td>Eco-design</td>
<td>Design of products for reduced consumption of resources</td>
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<td>Design of products for reuse, recycle, and recovery</td>
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<td>Design of products to reduce emission</td>
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<td>Green supply chain management</td>
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<td>Organisational strategy</td>
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<td>Corporate social responsibility practices</td>
<td>Environmental management practices</td>
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<td>Wellbeing of concerned stakeholders</td>
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<td>Undertaking CSR projects</td>
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<td>Sustainability performance</td>
<td>Economic performance</td>
<td>Productivity</td>
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<td>Turnover/sales</td>
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<td>Cost reduction</td>
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<td>Environmental performance</td>
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<td>Social performance</td>
<td>Employee turnover</td>
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<td>Accident reduction</td>
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<tr>
<td>Economic performance</td>
<td>CSR investment</td>
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</tbody>
</table>

In doing this, initially a workshop was organized with the involvement of selected researchers and owner/managers of a few SMEs along with a few representatives of policymakers (Birmingham and Derby City Council) to derive the suitable questionnaire for achieving the objectives of the study. Secondly, an initial pre-sample survey was conducted on 20 SMEs in the Midlands, UK. The final data has been collected from a total of 119 SMEs in the Midlands. We have chosen SMEs on the basis of their maturity of business and adoption of environmental management system. In particular, we have contacted close to three hundred
SMEs in the Midlands of the UK and received around 150 responses, out of which considered 119 responses eligible for detailed analysis. The sample of SMEs is from manufacturing industries that are generally impact environment more than SMEs in other industries (table 3 shows demographic summary of the SMEs that responded to our survey).

Table 3. Sample demographics summary

<table>
<thead>
<tr>
<th>Title</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>23</td>
</tr>
<tr>
<td>Production manager</td>
<td>31</td>
</tr>
<tr>
<td>Marketing manager</td>
<td>15</td>
</tr>
<tr>
<td>Supply chain manager</td>
<td>8</td>
</tr>
<tr>
<td>Purchasing manager</td>
<td>13</td>
</tr>
<tr>
<td>Quality manager</td>
<td>10</td>
</tr>
<tr>
<td>Maintenance manager</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary metal manufacturing</td>
<td>24</td>
</tr>
<tr>
<td>Fabricated metal product manufacturing</td>
<td>17</td>
</tr>
<tr>
<td>Machinery manufacturing</td>
<td>13</td>
</tr>
<tr>
<td>Electrical equipment and components manufacturing</td>
<td>23</td>
</tr>
<tr>
<td>Chemical manufacturing</td>
<td>10</td>
</tr>
<tr>
<td>Food and beverage manufacturing</td>
<td>17</td>
</tr>
<tr>
<td>Apparel manufacturing</td>
<td>10</td>
</tr>
<tr>
<td>Wood product manufacturing</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
</tr>
</tbody>
</table>

The random sample of SMEs ensures the validity of the results. The variables from the questionnaire related to the current analysis are described in Table 2. All variables have been measured at a 5-point likert scale. Specifically, we measure lean management practices, sustainability oriented innovation, corporate social responsibility, economic performance, and sustainability performance through a variety of questions related to these constructs.

7.2 Statistical Analysis
Our main hypothesis is that LMP and SOI are both important factors that directly influence a SMEs’ sustainability performance. The hypothesized model and its initial visual presentation with relative research hypotheses has already presented in section 6 (Figure 1).

For the purposes of the current study we utilize structural equation modeling (SEM) (Bollen, 1989; Jöreskog et al., 1979; Hussey and Eagan, 2007) to process the quantitative information of each SME and examine relations between sustainable supply chain performance of SMEs with LMP and SOI as this is the most appropriate method to derive causal relationships among the various observed variables and latent constructs objectively. All latent constructs used in our analyses are measured via the indicator variables developed from the responses obtained from the interviews with the SMEs’ managers (Appendix 1).

More specifically, in order to test the influence of the various latent variables of interest on the latent construct of sustainability, we fit structural equation model, as hypothesized in section 6.

Structural equation models are a system where causal relationships are modeled between variables. The distinguishing feature is that variables here – in contrast to typical regression analysis techniques – can be either directly observed or latent or a mixture of both of these. SEM allows for simultaneously analyzing the relationship of different proxies on the dependent measure. Structural equation models essentially consist of multiple regression equations for both observed and latent items that can be visually illustrated by graphical structures usually known as “SEM diagrams” or “path diagrams”. We opted for this statistical methodology due to the certain characteristics of the latter, matching with the specific nature of our data and conceptual model. SEM allows the dependent and independent variables to be either observed or latent (i.e. not directly measurable item), a feature that cannot be addressed e.g. by a typical regression model. In addition, SEM allows fitting model structures of different layers, another characteristic of our hypothesized modeling structure. Finally, SEM has the ability of inclusion of more than a single dependent variable, notably the three constructs of economic, environmental and social performance.

Fitting a SEM model with maximum likelihood assumes multivariate normal data. However, with non-normal data, for instance to apply structural equation modeling with ordinal variables, there exist alternative methods such as the method of Weighted Least Squares (WLS) (Jöreskog, 1994), which is the estimation method followed in the current analysis.

As regards assessing the fit of our SEM model, there exist a large variety of goodness-of-fit measures that are mostly functions of the model’s chi-square. We test the validity of our models by using several alternative fit statistics (Marsh and Balla, 1994), such as the GFI
(goodness-of-fit index), the AGFI (adjusted goodness-of-fit index) and the PGFI (parsimonious goodness-of-fit index), with AGFI adjusting the GFI for the complexity of the fitted model. Typically, for a good fit the indices should be above 0.9, however this cut-off threshold has been often criticized. Another popular measure is the Root Mean Square Error of Approximation (RMSEA) and the residuals-based fit index of the standardized root-mean-square residual (SRMR). If the fit of the model is good, GFI and AGFI should approach one, whereas RMSEA and SRMR should be small (typically RMSEA less than 0.05 and SRMR less than 0.07).

8. Data Analysis and Results

8.1 Quantitative analysis results

In order to empirically test the validity of research hypotheses presented in the introduction section, we have fitted a SEM model by the weighted least squares method (Jöreskog, 1970) to derive the parameter estimates associated with research hypotheses of the current study. For the fit of the SEM model we have used the latter estimation method due to the nature of the data. Model estimation was performed with the use of the AMOS software (Arbuckle, 2014).

Prior to SEM, an exploratory factor analysis (EFA) has been performed in order to obtain information about the formulation of the latent factors that are subsequently utilized for SEM analysis and test their reliability and validity. Hence, the constructs and latent variables utilized for the SEM analysis are described below (Table 4), along with the Cronbach’s $\alpha$ values (Bollen, 1989) and the percentage of variance of the selected items explained by each of the latent factors. As we observe, the constructs utilized for the statistical analysis are adequately addressing the reliability and validity. In addition, the collected data do not seem to suffer from Common Method Bias, since that the total percentage of variance explained by each single factor is much higher than 50%.

Table 4. Reliability and validity measures for constructs and latent variables

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Latent variables</th>
<th>Cronbach’s $\alpha$</th>
<th>% of explained variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean management practices (LMP)</td>
<td>All form of waste reduction practices</td>
<td>0.684</td>
<td>61.31</td>
</tr>
</tbody>
</table>
Productivity enhancement program
Stakeholder management practices

<table>
<thead>
<tr>
<th>Sustainability oriented innovation (SOI)</th>
<th>Eco-design</th>
<th>0.622</th>
<th>57.99</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Green supply chain management</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organisational strategy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Corporate social responsibility practices (CSR)</th>
<th>Environmental management practices</th>
<th>0.836</th>
<th>76.39</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Social management practices</td>
<td>0.754</td>
<td>67.26</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sustainability performance</th>
<th>Economic performance</th>
<th>0.652</th>
<th>64.07</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Environmental performance</td>
<td>0.592</td>
<td>54.03</td>
</tr>
<tr>
<td></td>
<td>Social performance</td>
<td>0.603</td>
<td>55.40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Economic performance</th>
<th>Productivity</th>
<th>0.752</th>
<th>59.01</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Turnover/sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cost reduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Business growth</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The above results show that in general the utilized factors are exhibiting adequate reliability and consistency, thus are suitable for subsequently conducting SEM analysis and deriving valid results.

SEM modeling enables us to obtain the estimates of beta coefficients of the regression equations that relate each latent construct of sustainability (response variables) with the
selected individual items or latent factors of Lean Management Practices and Sustainability Oriented Innovation constructs (explanatory variables).

In the remaining of this section we present the derived results of structural equation analysis. Specifically, the SEM results are summarized in the form of the standardized regression coefficients depicted in the path diagram of Figure 2.

Previous to this, fit statistics for the evaluation of the good fit of the model are presented in Table 6. Fit statistics for the examined SEM model show that the path analysis structure tested provided a good fit, since that most of the values of fit indices are higher or near the borderlines of the acceptable limits, especially when considering the goodness-of-fit measures of GFI and AGFI. The worst fit indicated by the PGFI index could be attributed to the limited number of data since that the index adjusts for sample size.

Table 6. Values of goodness-of-fit measures for assessing SEM model fit.

<table>
<thead>
<tr>
<th>Fit statistics</th>
<th>PGFI</th>
<th>GFI</th>
<th>AGFI</th>
<th>RMSEA</th>
<th>SRMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEM MODEL</td>
<td>0.709</td>
<td>0.915</td>
<td>0.89</td>
<td>0.031</td>
<td>0.0085</td>
</tr>
</tbody>
</table>

Next, we turn our attention on the estimates of the fitted SEM model. SEM results in the form of standardized path coefficients are displayed in Figure 2 and corresponding significances along with support for the four direct hypotheses (H1-H4) are summarized in Table 7. As one observes from the fit of the Model (Figure 2 below and Table 7), Lean Management Practices is proven to be a significant factor for achieving sustainability (path coefficient is +0.473; significant at the 0.05 level), thus verifying research hypothesis H2. Also, looking at the standardized regression weights, it is seen that LMPs are highly positively associated with economic performance, completely verifying hypothesis H1 (path coefficient is +0.996; significant at the 0.01 level). Regarding research hypotheses H3 and H4, we see that both of the latter are supported by the data, with a stronger verification being observed however, for the H3 hypothesis (path coefficient is +0.958; significant at the 0.01 level), indicating a positive and very strong association between SOI and economic performance. SOI is also a significant moderator of sustainability as revealed by the SEM results (path coefficient is +0.405; significant at the 0.05 level).
Next, we examine the support by our data of the indirect research hypotheses H5-H7, associated with mediating effects of SOI and environmental/social practices on LMP and SOI, respectively. A variable may be considered a mediator to the extent to which it carries the influence of a given independent variable to a given dependent variable. The bootstrap approach introduced by Preacher and Hayes (2004) is one of the most widely used methods to test the mediation hypotheses (see, e.g. Adebanjo et al., 2016). Hence, we analyzed and calculated the mediating effects (i.e. both direct and indirect effects) through the bootstrap approach and the corresponding results are shown in Table 8.

First, our findings seem to support an indirect mediation effect of SOI in the relationship between LMP and sustainability (hypothesis H5). Indeed, while the direct effect of LMP and sustainability is negligible (direct effect is 0.049; non-significant), the indirect effect of the former construct on sustainability through SOI is statistically significant (direct effect is +0.327; significant at the 0.05 level).

Similarly, regarding hypothesis H6, it is observed that indeed CSR (environmental and social) practices is a mediator factor between LMP and sustainability, since that the indirect effects of SOI on the association between LMP and sustainability are statistically significant at the 0.01 level of significance (direct effect is 0.569).

Finally, although we do not have strong evidence to reject research hypothesis H7, since the indirect association between SOI and sustainability through the CSR mediator is statistically significant (indirect effect is +0.103; significant at the 0.1 level), however
significance is at the borderline while the direct effect between SOI and sustainability is strong and positive (direct effect is 0.517; statistically significant at the 0.01 level of significance). In overall thus, the bootstrap analysis results for mediation effects offer in general support for hypotheses H5-H7.

Table 7. SEM model results

<table>
<thead>
<tr>
<th>Model Link</th>
<th>Std. coefficient</th>
<th>Significance (p-value)</th>
<th>Hypotheses support</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMP ---&gt; SOI</td>
<td>0.047</td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>SOI ---&gt; CSR</td>
<td>0.252</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>LMP ---&gt; CSR</td>
<td>0.994</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>SOI ---&gt; Sustainability</td>
<td>0.405</td>
<td>**</td>
<td>H4: supported</td>
</tr>
<tr>
<td>LMP ---&gt; Sustainability</td>
<td>0.473</td>
<td>**</td>
<td>H2: supported</td>
</tr>
<tr>
<td>CSR ---&gt; Sustainability</td>
<td>0.400</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>Sustainability ---&gt; Social performance</td>
<td>0.987</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>Sustainability ---&gt; Environmental performance</td>
<td>0.979</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>Sustainability ---&gt; Economic performance</td>
<td>-0.995</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>CSR ---&gt; Environmental practices</td>
<td>0.847</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>CSR ---&gt; Social practices</td>
<td>0.728</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>LMP ---&gt; Economic performance</td>
<td>0.996</td>
<td>***</td>
<td>H1: supported</td>
</tr>
<tr>
<td>SOI ---&gt; Economic performance</td>
<td>0.958</td>
<td>***</td>
<td>H3: supported</td>
</tr>
</tbody>
</table>

*** p-value<0.01; ** p-value<0.05; * p-value<0.1; n.s.: non-significant

Table 8. Mediation bootstrap test of research hypotheses H5-H7

<table>
<thead>
<tr>
<th>Effects</th>
<th>Hypotheses</th>
<th>Estimate</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct effect</td>
<td>0.049</td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>Indirect effect</td>
<td>H5</td>
<td>0.327</td>
<td>**</td>
</tr>
<tr>
<td>Total effect</td>
<td>0.377</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>Direct effect</td>
<td>H6</td>
<td>-0.176</td>
<td>*</td>
</tr>
<tr>
<td>Indirect effect</td>
<td>0.569</td>
<td>***</td>
<td></td>
</tr>
</tbody>
</table>
Support for the seven hypotheses as obtained from the current study is summarized in Table 9. In addition, Table 8 includes past research support for comparisons.

Table 9. Comparison of study findings

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Supported</th>
<th>Not supported</th>
<th>This research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive relationship between Lean management practices and economic performance</td>
<td>Martinez-Jurado and Moyono-Fuentes (2014)</td>
<td>Pannizzolo et al., 2012</td>
<td>Supported</td>
</tr>
<tr>
<td>Corporate social responsibility practices mediate lean management practices and sustainability performance</td>
<td>Inman and Green (2018)</td>
<td></td>
<td>Supported</td>
</tr>
<tr>
<td>Corporate social responsibility practices mediate sustainability oriented innovation and sustainability performance</td>
<td>Adams et al. (2016), M. Saunila et al. (2018)</td>
<td>Ratnawati et al., 2018</td>
<td>(Borderline) Supported</td>
</tr>
</tbody>
</table>
9. Discussion and Conclusion

9.1 Discussion on results

Business sustainability is achieved through the right combination of economic, environmental and social factors and it is the major concern of today’s business (Dües et al., 2013). SMEs’ sustainability is crucial for every economy as they contribute largely to gross domestic product and additionally employ a major portion of workforce of any economy. Therefore, the drivers that contribute to enhance sustainability of SMEs need attention. SMEs have different characteristics from larger organisation in policy and strategy (Perrini, 2006), and hence SMEs supply chain sustainability has been discussed separately in literature. Lean management practices leads to achieving sustainability. However SMEs find it difficult to implement. SMEs struggle with finance to adopt lean management practices (Andrea Chiarini, 2012). However implementation of lean management practices facilitates sustainability (Moreira et al., 2010). The sustainability oriented innovation of SMEs is discussed as a facilitator for their sustainability (Klewitz, et al., 2014).

Prior studies reveal that LMP and SOI are the enablers for achieving sustainability of supply chain. Although prior studies examined the impact of each LMP and SOI separately on sustainability performance there is no work that reveals the impact of both LMP and SOI on sustainability performance of SMEs’ supply chain (Piercy and Rich, 2015). The present study explores and investigates the combined impact of lean management practices and sustainability oriented innovation on SMEs’ supply chain sustainability performance empirically. This enables SMEs to be more sustainable by identifying means for their sustainable performance improvement through right combination of LMP, SOI and CSR.

The underpinning of this research is to answer the question of whether lean management practices in combination with sustainable oriented innovation could enable right trade off among Economic, Environmental and Social Performance in order to make SMEs sustainable. The main purpose of the conducted empirical research is the investigation of the potential effects of lean management practices (LMP) and sustainable oriented innovation (SOI) on sustainability performance and economic performance. Additionally, we have examined three under-examined associations, relating to (a) the mediating effects of SOI in the relationship between LMP and sustainability performance, (b) the mediating effects of CSR in the relationship between LMP and sustainability performance and (c) the mediating effects of CSR in the relationship between SOI and sustainability performance within SMEs in the Midlands of the UK.
We reveal that LMP and SOI are both positively associated with sustainability performance. Our findings are at a large part consistent with prior research. In particular, we have found that LMP effects sustainability performance in a positive way, in accordance with the findings of Inman and Green (2018), Moreira et al. (2010), Vinodh et al. (2011) and King and Lenox (2001), and despite the contrasting results of Rothenberg et al. (2001). We additionally contribute to the limited research on the effect of SOI on sustainability performance, finding again a positive effect of the former on the latter latent construct, through SEM modelling. These results come as verification to our initial argument that LMP and SOI in combination may help SMEs to achieve higher sustainability performance levels. Hence, we may say that LMP and SOI are complementary practices since they support each other in enhancing sustainability.

Our results also verify the economic focus of LMP, since we have found a strong and positive effect of LMP on the latent structure of economic performance. Similar strong positive effects, however, have been found for the SOI on the economic performance, in contrast to existing research (see Piercy and Rich, 2015), since that SOI is perceived as more responsiveness focused compared to LMP, which is efficiency focused.

According to previous research, the associations between SOI and CSR practices are non-conclusive (see Adams et al., 2016), thus a significant research gap remains when considering relationship between CSR and SOI (Martinez-Conesa, 2017). We contribute on this issue, by finding moderate positive associations between the two constructs, for the UK SMEs. Previous literature argues in favour of positive effects of SOI on environmental and social performance (Piercy and Rich, 2015). On the other hand, however, noteworthy is the finding of the strong and positive direct effect of LMP on CSR practices. This finding is in contrast with previous research which argues that LMP causes lower environmental and social performance for SMEs (Rothenberg et al., 2001).

There is scant literature for examining the mediation effects of SOI on the relationship between LMP and sustainability performance. Hence, it is useful to empirically examine the impact of LMP on sustainability performance with SOI as a mediator. Our findings indicate a significant positive indirect effect from LMP to sustainability through the mediation of SOI. This implies that midlands based SMEs with lean management practices will achieve better sustainability performance if they also have sustainability oriented innovation implemented. This is in line with the complementarity theory.
Additionally, analysing the mediating effect of corporate social responsibility (CSR) practices on both LMP and SOI to achieve sustainability performance is rare (Inman and Green 2018; Adams et al. 2016). Our analysis examines both indirect associations to find that in both the cases that CSR is a significant mediator, especially for the link between LMP and sustainability performance. This finding in other words suggests that improvement in sustainability performance for the UK SMEs do not come explicitly directly through LMP, but also from improving CSR practices through the implementation of sustainability oriented innovation.

This study also contributes a conceptual framework for sustainability performance measurement with four major constructs – lean management practices, sustainability oriented innovation, corporate social responsibility and sustainability performance. The latent variables act as sub-constructs and data could be gathered in line with the proxies related to each sub-construct. The framework will enable to measure the current state of SMEs sustainability performance and means for improvement.

Lean management practices (LMP) and sustainability oriented innovation (SOI) are organizational competencies that not only help achieve efficiency but also responsiveness through stakeholders’ satisfaction. LMP brings efficiency and SOI emphasizes responsiveness. Combining both LMP and SOI, SMEs achieve sustainability across their supply chain. This clearly depicts the alignment of the findings of this research with complementarity theory.

9.2 Limitations of the study

This study focuses on the lean management practices and sustainability oriented innovation of SMEs (manufacturing) in the Midlands of the UK. Additionally, only corporate social responsibility is considered as mediator. There are many studies that have conceptualized the sustainability performance measurement through different constructs and antecedents. External pressure from customers and policymakers, and internal obstacles are the popular moderators for the sustainability analysis in many recent studies. The data has been gathered from limited number of SMEs (119) in the UK. The latent variables and proxies are also limited (see table 3 and Appendix 1). Average experience of the responders is 12 years. As SEM uses perceptions of the responders, the correctness of the perceptions is very important in order to
reveal the overall results. Last but the not the least, we have used AMOS software for our data analysis. There are many other software that might produce different results.

9.3 Scope for future work

A similar study could be undertaken in other industries and varied geographical locations. Additionally, comparative analysis across the industries and geographical locations would be very interesting. The objective of the study is to reveal combined effect of LMP and SOI on sustainability performance and accordingly the model has been formulated with limited constructs. However, the model could be more robust with several constructs and moderators (external pressure, internal obstacles etc.). Effect of lean management practices and sustainability oriented innovation on sustainability performance could be derived using other quantitative methods (e.g. data envelopment analysis, multiple criteria decision-making techniques such as the analytic hierarchy / network process, goal programming, fuzzy theory etc.) and qualitative approaches such as ethnographic study, case study, and grounded theory. This study uses complementarity theory. However, resource based and institutional theories could also be deployed.

9.4 Practical implications

Lean management practice alone is not sufficient for SMEs to achieve sustainability. SMEs managers / owners aspiring greater sustainability performance need to implement sustainability oriented innovation through eco-design, green supply chain management and adopting environmental management system in strategic level along with lean management practices. SMEs managers / owners can expect higher economic performance through lean management practices. Similarly, sustainability oriented innovation also helps achieve economic higher economic performance. However, sustainability performance of SMEs improves substantially when both lean management practices and sustainability oriented innovation implemented along with corporate social responsibility practices (e.g. environmental and social management practices). Similarly, in order to make SMEs sustainable policymakers need to foster positive environment for motivating SMEs to implementing a combined lean management practices and sustainability oriented innovation. Currently, the UK Government is funding SMEs to reduce their carbon footprint across their supply chain through energy and resource efficiency, and waste reduction. These promote combined lean and innovation.
Bibliography


Appendix 1. Measurement scales

Lean management practices (Shah and Ward 2003, 2007; Inman and Green 2018)

Please indicate the extent of implementation of the following practices in your organisation.
(1 = no implementation; 2 = below average implementation; 3 = average implementation; 4 = effective implementation; 5 = benchmark implementation)

All forms of resource waste management
1. We have implemented resource waste management program with suppliers
2. We have implemented resource waste management program with customers
3. We have implemented resource waste management program in our operations

Productivity enhancement programs
1. We have implemented TQM effectively
2. We have implemented TPM effectively
3. We have adopted statistical process control in our production
4. We have inventory reduction program in place
5. We have achieved capacity utilisation

Stakeholders’ management

1. We use effective supplier relationship management practices
2. We use effective customer relationship management practices
3. Our employees are totally involved and committed to organisation
4. Our organisation’s management is totally committed to organisation

**Sustainability oriented innovation** (Zhu, Sarkis, and Lai 2008; Matos and Silvestre 2013; Martinez-Conesa 2017; Hansen et al. 2009; Wu 2017)

Eco-design

1. Design of products for reduced consumption of resources
2. Design of products for reuse, recycle, and recovery
3. Design of products to reduce emission

Green supply chain management

1. We undertake green procurement
2. We undertake green manufacturing
3. We undertake green marketing

Organisational strategy

1. We have organisation wide integrated environmental management system
2. We have implemented ISO 14000

**Corporate social responsibility practices** (Baumgartner, 2004; Martinez-Conesa et al. 2017; Zhu, Sarkis, and Lai 2008)

Environmental management practices

1. We practice energy management program
2. We practice waste management program
3. We practice resource optimisation program

Social management practices

1. We have implemented employee wellbeing program
2. We have concern for every stakeholder (e.g. customers, suppliers, community etc.)
3. We have undertaken several improvement projects for communities

**Sustainability performance** (Zhu, Sarkis and Lai 2008; Inman and Green 2018; Abdul-Rashid et al. 2016; Adebanjo et al. 2016)

*Please indicate the extent to which you perceive that your organisation has achieved each of the following during the past year (five point scale: 1 = not at all; 2 = a little bit; 3 = to some degree; 4 = relatively significant; 5 = significant)*

Economic performance

1. Our productivity has improved
2. Our turnover has increased
3. Our cost has reduced
4. Our business experiences growth

Environmental performance

1. We have reduced energy consumption
2. We have reduced waste across the supply chain
3. We have achieved resource efficiency across the supply chain

Social performance

1. Our employee turnover have reduced
2. We have reduced accident
3. We have enhanced our investment in community based projects


1. Our productivity has improved
2. Our turnover has increased
3. Our cost has reduced
4. Our business experiences growth