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

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## Abstract

While lean management practices (LMP) helps small and medium sized enterprises (SMEs) to be efficient, sustainability oriented innovation (SOI) facilitates to adopt environmental and social practices. Although prior research looks into the effect of LMP on economic performance of SMEs, less is known about the effect of LMP on sustainability (economic, environmental, and social) performance. Studies on effect of SOI on sustainability and economic performance are also scant. Additionally, examining the mediating effect of corporate social responsibility (CSR) practices (environmental and social practices) on both LMP and SOI achieving sustainability performance is rare. This research bridges these knowledge gaps by answering the question how LMP, SOI, CSR practices, sustainability and economic performance are correlated. Through a few hypotheses testing using structural equation modelling, this study reveals the impact of LMP, SOI, CSR (environmental and social) practices on sustainability and economic performance. The study uses data from 119 SMEs within manufacturing industries in the Midlands, UK. The analysis reveals that LMP and SOI facilitate achieve both sustainability and economic 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.

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

| List of the abbreviations | |
|---|---|
| AGFI | Adjusted Goodness-Of-Fit Index |
| AVE | Average Variance Extracted |
| CSR | Corporate Social Responsibility |
| EFA | Exploratory Factor Analysis |
| EMS | Environmental Management System |
| GDP | Gross Domestic Product |
| GFI | Goodness-of-Fit Index |
| ISO 14000 | International Organization for Standardization 14000 |
| LMP | Lean Management Practice |
| PGFI | Parsimonious Goodness-of-Fit Index |
| R&D | Research and Development |
| RMSEA | Root Mean Square Error Of Approximation |
| SEM | Structural Equation Modelling |
| SMEs | Small and Medium Sized Enterprises |
| SOI | Sustainability Oriented Innovation |
| SRMR | Standardized Root-Mean-Square Residual |
| TPM | Total Productive Maintenance |
| TQM | Total Quality Management |
| WLS | Weighted Least Squares |

## 1. Introduction

Small and medium sized enterprises (SMEs) make up around 90% of the world's businesses and they employ 50-60% of the world's population (Dey et al., 2018). The total number of SMEs in the UK is 5.7 million, and they employ approximately 15.8 million people, contributing close to 20% in the GDP (Department for Business, Energy & Industrial Strategy, 2019). An SME is a small or medium-sized enterprise. According to the EU, definition of an SME is a business with fewer than 250 employees, and a turnover of less than €50 million (Hall, 2019). The UK SMEs are likely to contribute £250 billion by 2025, which is 19% more than current figure (Global Banking & Finance Review, 2017).

It has been estimated that SMEs contribute up to 70 percent of global pollution collectively. Especially manufacturing SMEs are reported to account for 64% of air pollution whereas only a small portion of 0.4% of these SMEs complies with an environmental management system (Bonner, 2019). Recent survey reveals that SMEs consume more than 13% of total global energy demand (around 74 exajoules (EJ)). Cost-effective energy efficiency measures could shave off as much as 30% of their consumption, namely 22 EJ, which is more energy than Japan and Korea combined consume per year (IEA, 2015).

Three quarter of UK SMEs are struggling to embed sustainability practices, citing costs issues and unfavourable government policies as major stumbling blocks (Abdelaziz, et al., 2018; Anderton, 2018). While 88% of respondents claimed to value sustainability, 70% had struggled to embed practices and strategies (Mace, 2019). Although 8 out of 10 SMEs plan to introduce more ethical and sustainable practices, 40% thought that sustainable practices were too costly to implement, while 42% claimed that the UK Government wasn't doing enough to encourage sustainable business practices (Mace, 2019). When chief executives were asked on what makes a business ethical, 75% responded 'treating people fairly', 58% responded 'sourcing manufacturing materials responsibly', 51% responded 'maintaining energy efficacy', and 33% responded stakeholder engagement outside the financial backers (Newsroom, 2018). Prior studies (Dey and Cheffi, 2013; Dey et al., 2018; Zhu and Sarkis, 2004) reveal that there are number of barriers that do not allow SMEs to achieve economic sustainability. There are intense competition, cash flow issues, demand uncertainties, and business process immaturity. Additionally, SMEs suffer from skill shortage and large employee turnover (Dey et al., 2018).

Many manufacturing and service companies adopt lean management practices for achieving economic sustainability through emphasizing on waste reduction across the

business processes. Recently, 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 (Dey et al., 2019; De et al., 2018). However, a few environmental and social sustainability projects are cost intensive (e.g. adopting environmental management system such as ISO 14000, specific measures for reducing energy consumption, employee wellbeing. Corporate social responsibility projects are also considered capital intensive (Tang et al., 2018; Walker et al., 2019). There are a few constructs that are common for LMP and CSR practices and they are all economy oriented. Prior literature has linked LMP with economic 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 performance 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 is achieved through supply chain cost and risk reduction through joint investment in R&D and technology, optimised inventory, improved products and services quality, and reduction of waste across the supply chain (Arkader, 2001). Similarly, adopting LMP across supply chain helps achieve environmental and social sustainability through collaborative relationship building across all the stakeholders, engaging with suppliers at the early stage of product development, introducing vendor managed inventory, considering environmental and social criteria for supplier selection along with economic criteria (Inman and Green, 2018). Environmental sustainability of supply chain could be achieved through reduction of emission and waste across the supply chain (Martinez-Conesa et al., 2017).

Sustainability oriented innovation 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 et al., 2016). Cleaner production is an example of process innovation for environmental sustainability (Adams et

al., 2016; Klewitz and Hansen, 2014). Implementing environmental management system (EMS) including ISO 14000 is a typical example of organisational innovation for environmental sustainability (Candi et al., 2018; Wu, 2017). Appendix A provides the definitions of Lean Management Practices (LMP), sustainability Oriented Innovation (SOI), Corporate Social Responsibility (CSR) practices, Sustainability Performance (SP) and Economic Performance (EP), the variables that are used in this study.

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 et al., 2016; Yu et al., 2019). 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 scant. The overarching goal of this research is to make SMEs sustainable. This paper aims to address the questions on how LMP and SOI are correlated to sustainability and economic performance, and if there is any mediating effect of CSR practices on the above relationship within SMEs in the Midlands, UK. Additionally, it also examines the mediating effect of SOI for LMP to achieve sustainability performance. This study uses structural Equation Modelling (SEM) through AMOS software to reveal the stated relationship. The statistical software is widely used by researchers for SEM analyses due to certain advantages, such as the support for advanced SEM methods, the ability to create path diagrams or the direct access to fit indices for model validation. 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. Section 2 elaborates the literature review explaining relevant constructs for sustainability analysis of SMEs' supply chain along with identifying knowledge gaps. Section 3 develops hypotheses for this study along with

theorised model. Section 4 explains the methodology that has been used for analysing the data. Section 5 illustrates the results and section 6 provides discussion and conclusion of the study.

## 2. Literature review

The theoretical underpinning of this study follows complementarity theory (Bergmiller and McCright, 2009; Mahapatra et al., 2010). Lean management practices and sustainability oriented innovation 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 the other.

In principle, LMP eliminates all forms of waste across the supply chain through appropriate supply, internal operations and demand management (Inman and Green, 2018) to achieve efficiency. SOI is product, process, and organizational innovation for achieving sustainability (Adams et al., 2016; Martinez-Conesa et al., 2017). LMP and SOI in combination are likely to help achieve higher sustainability through appropriate trade-off among economic, environmental and social criteria.

A systematic literature review is undertaken in order to explore the current state of knowledge on the relationship among LMP, SOI, CSR practices, sustainability performance and economic performance, and identify knowledge gaps. The following sub-sections first briefly define the sustainability constructs (lean management practices, corporate social responsibility, sustainability oriented innovation, and sustainability performance) that are considered in this study. Secondly, the correlations among the constructs are explored from prior literature. Finally, the knowledge gaps are established with appropriate rational for the current research.

### *2.1 Lean management practices*

Lean has been in industry since over 40 years and route for improving business performance (Emiliani, 2006). Interest in the topic became widespread with the publication of The Machine That Changed the World in 1990 (Womack et al., 1990). Several review articles (Gupta and Jain, 2013; Jasti and Kodali, 2015; Stone, 2012) discuss the growth of lean management practices across the manufacturing industries. Over the period lean management principles and practices got refinement and as per Shah and Ward (2007) 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 (Shah and Ward, 2002).

### *2.2 Corporate social responsibility*

CSR is the combination of environmental and social practices that are strategy driven within an organisation (Martinez-Conesa et al., 2017). Environmental and social practices across supply chain are 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., 2011) 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 CSR.

### *2.3 Sustainability oriented innovation*

Adams et al. (2016) via review presents a model for achieving sustainability oriented innovation. 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 $CO_2$ emission (Despeisse et al., 2012; Fang et al., 2011; Jayal et al. 2010; Pajunen et al., 2012), sustainable supply chain management through sustainable warehousing (Carter and Jennings, 2002), sustainable packaging (James et al., 2005), reverse logistics (Prahinski and Kocabasoglu, 2006), environmental purchasing (Jimenez and Lorente, 2001), sustainable end-of-life management through reuse, and remanufacturing or recycling (Abdul-Rashid et al., 2017).

The above paragraphs reveal that there are commonalities and differences among LMP, CSR practices and SOI. LMP is efficiency focused, whereas CSR practices and SOI are responsiveness oriented. In other words, by adopting LMP SMEs are assured of achieving cost reduction but not guaranteed for better environmental and social performance. On the other hand, Practicing CSR and SOI will help SMEs to achieve superior environmental and social performance but will not assure achieving higher efficiency.

### *2.4 Sustainability performance*

Sustainability from corporate perspective is defined as the right combination of economic, environmental and social aspects (Elkington, 1994). A growing number of businesses are adopting green initiatives in order to achieve sustainability (Teixeira et al., 2012). Organisations achieve sustainability 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 leads to economic performance. Environmental performance is highly dependent on energy usage, resource optimisation and waste reduction, which have direct relationship with $CO_2$ emissions (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 making profits, but also ensures that industrial activities do not cause social degradation (Tsai et al., 2009).

### *2.5 Economic performance*

Economic performance is one of the pillars of sustainability performance and equivalent to business performance, which is measured through – productivity, cost reduction, revenue, profit, cash flow, and business growth.

### *2.6 Lean and corporate social responsibility practices*

Lean, and corporate social responsibility 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 and Tang, 2017) argue that the main purpose

of implementing green supply chain is to achieve efficiency. Through empirical survey Hajmohammad et al. (2013) found the level of LMP to be positively associated with the CSR practices. However, a few CSR practices are capital intensive, and both short and long term efficiency is also not assured.

### *2.7 Lean and sustainability performance*

Research on link between lean and sustainability performance is somewhat scant as indicated by Negrão et al. (2017) in their review paper. However, through case studies (Azevedo et al., 2012) and analysis of secondary data (Hong et al., 2014) 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).

### *2.8 Sustainability oriented innovation and sustainability performance*

New product development following sustainability practices (e.g. eco-design) enhances environmental and social performance (Boons et al., 2013). 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 also help achieve efficiency through cost reduction. Increasing resource recovery by recycling, designing for reuse and remanufacturing (Lee et al., 2001) may 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 (integrating various processes – inbound and outbound logistics, internal operations, and both demand and supply sides management, along with 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).

### *2.9 Lean manufacturing practices, Sustainability oriented innovation and sustainability performance*

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 (Dey et al., 2019; Malesios et al., 2018a,b). 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 so as to adapt to the dynamic business environment quickly (Boiral et al., 2013). Many SMEs adopt LMP formally and informally in order to achieve efficiency that help them to become environment friendly to certain extent (e.g. resource efficiency). SMEs also have accomplished several innovations in product development, process reengineering and organizational transformation, the main driver of which is achieving strategic fits through customer satisfaction and 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 is almost absent within SMEs across the world. Prior studies (Adebanjo et al., 2016; Dey and Cheffi, 2013) reveal that the adoption of various CSR practices is mainly driven by customers and policymakers.

### *2.10 Knowledge gaps and rational for this research*

There are studies on examining relationship between lean and environmental practices (Inman and Green, 2018) using varied approaches. These include questionnaire survey (Akhtar et al., 2018; Green et al., 2012; Hajmohammad et al., 2013; Prasad et al., 2016; Zhu

and Sarkis, 2004), reviews (Dües et al., 2013; Hallam and Contreras, 2016), secondary data collection (Hong et al., 2014), 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, 2015), and conceptual models (Alves and Alves, 2015; Carvalho et al., 2011; Pampanelli et al., 2014) using data from varied countries in developed and emerging economies including the US, Canada, Japan, UK 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 (Dües et al., 2013; Pampanelli et al., 2014), others that environmental practices drive lean (Bergmiller and McCright, 2009), and some feel that both work synergistically (Azevedo et al., 2012; Garza-Reyes, 2015; Miller et al., 2010).

Sustainability oriented innovation 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 CSR and business value has been investigated (Wu, 2017), a significant research gap remains when considering relationship between CSR and innovation (Martinez-Conesa et al., 2017).

Abdul-Rashid et al. (2017) reveal the co-relationship of sustainable practices and performance in manufacturing industry and Adebanjo et al. (2016) study the impact of external pressure and sustainable management practices on manufacturing performance and environmental performance. 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 Hallam and Contreras (2016) to study the integration between lean and green reveals that there are very few survey methods. They note that an integrated model of the firm relating lean and green is lacking. Jabbour et al. (2013) also note that the literature is not conclusive on positive effect of integrated environmental practices and lean operations on economic performance. Similarly, relationship between lean management practices and SOI, and their combined effect on sustainability performance remains unexplored. Accordingly, this research intends to reveal the correlation of lean management practices and sustainable oriented innovation with sustainability performance and economic performance. This will

enable SMEs to formulate right strategies and plans to achieve greater sustainability and economic performance.

## 3. Conceptual model and hypotheses development

In view of the above, this study explores the combined impact of lean management practices and sustainability oriented innovation on economic and sustainability performance. In doing this, a conceptual framework is developed based on the literature review and tested using structural equation modelling. 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.

### *3.1 Impact of lean management practices on economic and sustainability performance*

Prior literatures reveal that 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 of SMEs as LMP may abstain from implementing cost intensive environmental and social measures (e.g. by replacing energy intense machine, undertaking CSR projects, taking employee wellbeing initiatives) (Rothenberg et al., 2001). Energy efficiency in operating systems, by helping 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: LMP helps SMEs to enhance economic performance
H2: LMP helps SMEs to enhance sustainability performance

### *3.2 Impact of sustainability oriented innovation practices on economic and sustainability performance*

Sustainability oriented innovation in SMEs could be performed 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: SOI helps SMEs to enhance economic performance
H4: SOI helps SMEs to enhance sustainability performance

### *3.3 Impact of lean management practices on sustainability performance with sustainability oriented innovation as a mediator*

Although there are synergies 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; Inman and Green, 2018; Wu, 2017), however, the means for achieving the desired targets following both the philosophies are different. Therefore, it is worth empirically studying the impact of LMP on sustainability performance with SOI as a moderator. Accordingly, hypothesis 5 has been formed.

H5: LMP affect sustainability performance positively with mediating effect of SOI

### *3.4 Impact of lean management practices on sustainability performance with mediating effect of corporate social responsibility (CSR) (i.e. environmental and social practices)*

CSR (i.e. 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: LMP positively impact sustainability performance through mediating effect of corporate social responsibility practices

### *3.5 Impact of sustainability oriented innovation practices on sustainability performance with corporate social responsibility as mediator*

Sustainability oriented innovation happens across economic, environmental and social practices covering new product development, 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 et al., 2017). Accordingly, we introduce hypothesis 7.

H7: SOI positively impact sustainability performance through mediating effect of corporate social responsibility practices

### *3.6 Theorised model*

The theoretical model incorporating seven hypotheses 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 model is designed to test the combined impact of LMP and SOI on sustainability performance of SMEs.

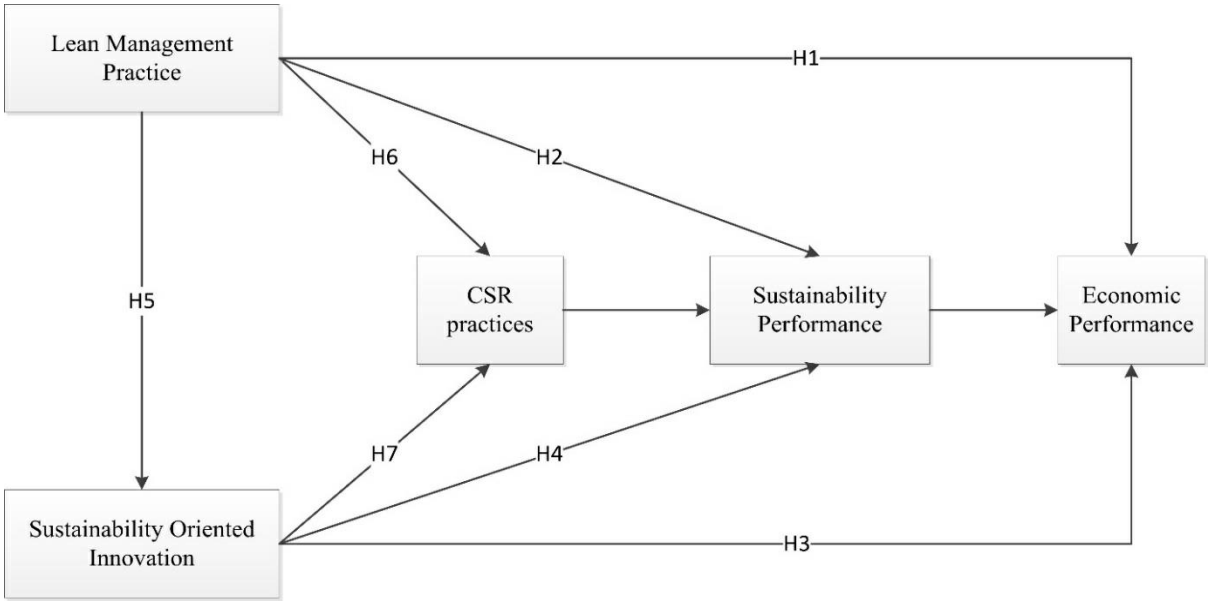


Figure 1. Theoretical model with hypotheses.

## 4. 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).

### *4.1 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 polluting 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 a 25% in 1970, UK is likely to be within World's first 5 countries in manufacturing outputs by 2021 (current position is 8$^{th}$). Midlands 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 SMEs sector (employee number not more than 250).

A survey questionnaire (Appendix B) 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, instead of collecting secondary data, e.g., by using GRI reports (Gold et al., 2017). Table 1 shows the constructs, latent variables and proxies.

Table 1. Latent variables of constructs for the conceptual model

| Constructs | Latent variables | Proxies | References |
|---|---|---|---|
| Lean management practices | All form of waste reduction practices | With suppliers<br>With customers<br>Within operations | Shah and Ward (2007); Inman and Green (2018) |
| | Productivity enhancement program | Total quality management<br>Total productive maintenance<br>Statistical process control<br>Inventory management<br>Capacity utilisation | |
| | Stakeholder management practices | Supplier relationship management<br>Customer relationship | |

| | | | |
|---|---|---|---|
| | | management<br>Employee involvement<br>Management commitment | |
| Sustainability oriented innovation | Eco-design | Design of products for reduced consumption of resources<br>Design of products for reuse, recycle, and recovery<br>Design of products to reduce emission | Matos and Silvestre (2013); Martinez-Conesa et al. (2017);<br>Hansen et al. (2009);<br>Wu (2017) |
| | Green supply chain management | Green procurement<br>Green manufacturing<br>Green marketing | |
| | Organisational strategy | Environmental management system<br>ISO 14000 | |
| Corporate social responsibility practices | Environmental management practices | Energy management<br>Waste management<br>Resource management | Baumgartner (2013); Martinez-Conesa et al. (2017) |
| | Social management practices | Employee wellbeing<br>Wellbeing of concerned stakeholders<br>Undertaking CSR projects | |
| Sustainability performance | Economic performance | Productivity<br>Turnover/sales<br>Cost reduction<br>Business growth | Abdul-Rashid et al. (2017); Adebanjo et al. (2016) |
| | Environmental performance | Energy efficiency<br>Waste reduction<br>Resource efficiency | |
| | Social performance | Employee turnover<br>Accident reduction<br>CSR investment | |
| Economic performance | Productivity | | Abdul-Rashid et al. (2017) |
| | Turnover/sales | | |
| | Cost reduction | | |
| | Business growth | | |

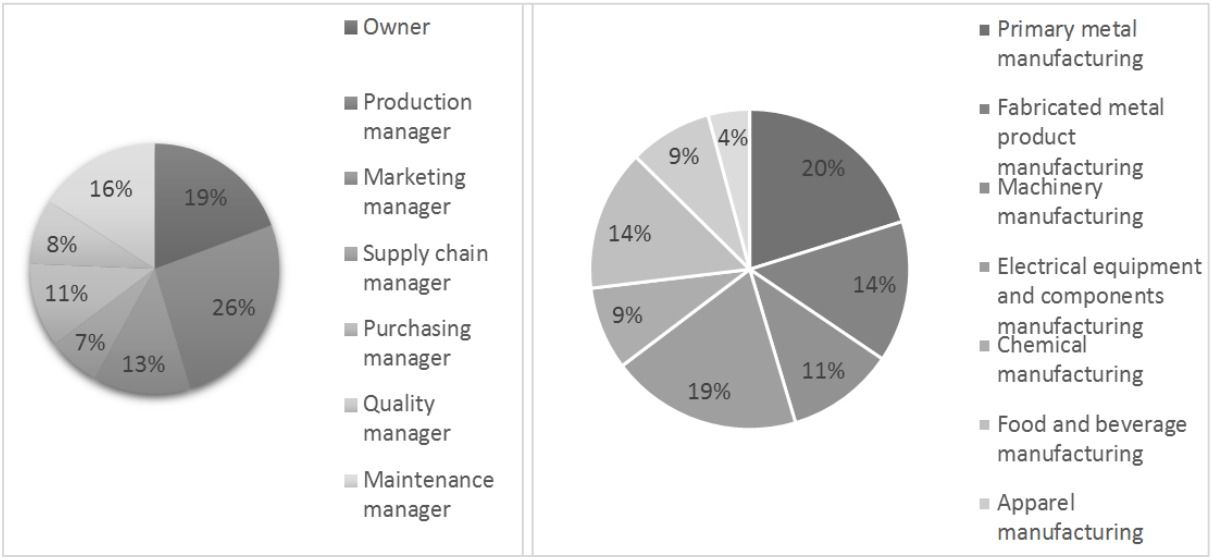


Figure 2: Respondents of the survey (left) and industry type (right).

Initially a workshop was organized with the involvement of relevant researchers and SME managers along with a few representatives of policymakers (Birmingham and Derby City Council) to validate the questionnaire (Appendix B). Secondly, an initial pre-sample telephone survey was conducted on 20 SMEs in the Midlands, UK. This was accomplished in a period of one week. This helped to finalise the questionnaire following feedback from the pilot survey. The final data has been collected from a total of 119 SMEs in the Midlands. We have chosen SMEs from the region on the basis of their maturity of business and adoption of environmental management system.

Sampling was done based on the snowballing strategy. In particular, we have contacted close to three hundred SMEs in the Midlands of the UK via email and received consents for taking part in this research from around 150 SMEs. Interviews were done with few selected SMEs and further surveys were done by sending questionnaire through federation email. Hence the sample was small, focused and consisted of potential respondents. This ensured a high response rate of 50% and a minimum data cleaning effort in the survey. We interviewed each SME's representative via telephone or in person. Only 119 responses were considered eligible for detailed analysis. The sample of SMEs is from manufacturing industries that generally impact environment more than SMEs in other industries (Figure 2 shows demographic summary of the SMEs that responded to our survey). The entire data collection took close to six months.

All variables in the questionnaire 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 the questions as depicted in Appendix B.

### *4.2 Statistical analysis*

This section demonstrates statistical analysis using structural equation modelling (Bollen, 1989; Hussey and Eagan, 2007; Jöreskog et al., 1979) to test the proposed hypotheses (H1 to H7) establishing correlations among LMP, SOI, CSR, sustainability performance and economic performance (Figure 1). All the latent constructs used in the analyses are measured via the indicator variables developed from the responses obtained from the interviews with the SMEs' managers / owners (Appendix B). More specifically, in order to test the influence of the various latent variables of interest on the latent construct of sustainability, we fit a structural equation model, as hypothesized in section 6.

Structural equation models are a system where causal relationships are modelled between variables and latent factors. SEM consist of multiple regression equations for both observed and latent items that can be visually illustrated by graphical structures called “SEM diagrams” or “path diagrams”. We have chosen the specific statistical method since the complex higher order structure of our research hypotheses constitute a typical SEM application. Further, SEM allows for observed or latent variables to be included as predictors or dependent variables and can handle the fit of complex model structures that assume different layers, such as the hypothesized structure of our modelling framework. Finally, SEM include more than one dependent variable.

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, the method of Weighted Least Squares (WLS) is a typical alternative (Jöreskog, 1994), which is the estimation method followed in the current analysis.

In addition to the SEM analysis, we test for mediating effects as posed through the research hypotheses H5-H7. 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). In the current study, the formal significance test for deciding on the absence or presence of a mediation effect, relying on a nonparametric bootstrapping procedure is utilized (Preacher and Hayes, 2004). The bootstrap test for the significance of an indirect effect is based on bootstrapping the sampling distribution of the mediation effect and subsequently deriving a confidence interval with the obtained bootstrapped sampling distribution. The advantage of this procedure is that no assumption about the shape of the distributions of the variables is made and can be applied to small samples with more confidence (Preacher and Hayes, 2004). Hence, we analyzed and calculated the mediating effects (i.e. both direct and indirect effects) through the bootstrap approach.

To assess fit of our SEM model, several alternative fit statistics are utilized (see, e.g., 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). 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). For a good model fit, 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).

## 5. Data analysis and results

The research hypotheses presented in the introduction section have been tested via the application of SEM modeling, and specifically through the utilization of the weighted least squares method (Jöreskog, 1970). Model estimation was performed with the use of the AMOS software (Arbuckle, 2014). Sample size selection for valid analyses and fit of SEM models in AMOS often depends on out-dated general rules of thumb, however recent studies suggest sample sizes ranging between 30 and 450 observations, depending on the complexity of the fitted model (see, e.g., Sideridis et al., 2014; Wolf et al., 2013). The medium complexity, strong factor loadings of our fitted SEM model and minimum missing values indicates that the sample size of 119 responses is sufficient for correct model identification (Wolf et al., 2013).

An exploratory factor analysis (EFA) has been performed in order to obtain information about the formulation of the latent factors and test their reliability and validity. Hence, the constructs and latent variables indicated by EFA and subsequently utilized for the SEM analysis are described below (Table 2). The Cronbach's α (Bollen, 1989) along with and the percentage of variance of the selected items explained by each of the latent factors is also presented. 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 2. Reliability and validity measures for constructs and latent variables

| Constructs | Latent variables | Cronbach's α | % of explained variance |
|---|---|---|---|
| Lean management practices (LMP) | All form of waste reduction practices | 0.684 | 61.31 |
| | Productivity enhancement program | | |
| | Stakeholder management practices | | |
| Sustainability oriented innovation (SOI) | Eco-design | 0.622 | 57.99 |
| | Green supply chain management | | |
| | Organisational strategy | | |

| | | | |
|---|---|---|---|
| Corporate social responsibility practices (CSR) | Environmental management practices | 0.836 | 76.39 |
| | Social management practices | 0.754 | 67.26 |
| Sustainability performance | Economic performance | 0.652 | 64.07 |
| | Environmental performance | 0.592 | 54.03 |
| | Social performance | 0.603 | 55.40 |
| Economic performance | Productivity | 0.752 | 59.01 |
| | Turnover/sales | | |
| | Cost reduction | | |
| | Business growth | | |

Next Table (Table 3), shows the correlations among the five latent constructs along with the square root of the Average Variance Extracted by the constructs (AVE), presented in the diagonal of the table (except for the two observed items of LMP and SOI).

Table 3. Correlation matrix of the construct correlations (square root of the Average Variance Extracted by the constructs (AVE) are provided in the diagonal)

| | **LMP** | **SOI** | **Sustainability performance** | **CSR** | **Economic performance** |
|---|---|---|---|---|---|
| **LMP** | **---** | | | | |
| **SOI** | 0.155 | **---** | | | |
| **Sustainability performance** | 0.589* | 0.503* | **0.82** | | |
| **CSR** | 0.741* | 0.24* | 0.747* | **0.65** | |
| **Economic performance** | 0.459* | 0.461* | 0.732* | 0.613* | **0.59** |

**Correlation is significant at the 0.01 level.*

The above results are indicative of adequate reliability and consistency in the data, thus can be deemed suitable for conducting SEM analysis. SEM modelling 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 LMP and SOI constructs (explanatory variables).

In the remaining of this section we present the derived results of structural equation analysis. The results are summarized in Figure 3.

Previous to this, fit statistics for the evaluation of the good fit of the model are presented in Table 4. Fit statistics show that the SEM model tested provided a good fit, since that most of the fit indices are higher or near the borderlines of the acceptable limits for good fit.

Table 4. Values of goodness-of-fit measures for assessing SEM model fit

| | Fit statistics | | | | |
|---|---|---|---|---|---|
| | **PGFI** | **GFI** | **AGFI** | **RMSEA** | **SRMR** |
| SEM MODEL | 0.709 | 0.915 | 0.89 | 0.031 | 0.0085 |

SEM results in the form of standardized path coefficients are displayed in Figure 3 and corresponding significances along with support for the four direct hypotheses (H1-H4) are summarized in Table 5. As one observes from the fit of the Model (Figure 3 below and Table 5), LMP 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).

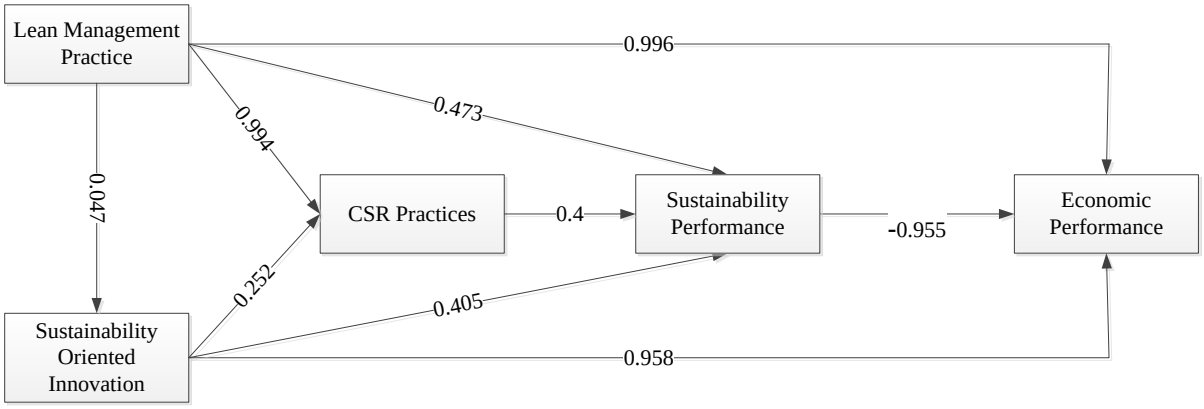


Figure 3. Path diagram of SEM model along with standardized regression weights (see also Table 5)

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. 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 6.

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 SOI is negligible (direct effect is 0.049; non-significant), the indirect effect of the former construct on sustainability through SOI is statistically significant (indirect effect is +0.327; significant at the 0.05 level).

Table 5. SEM model results

| **Model Link** | | | **Std. coefficients** | **Significance (p-value)** | **Hypotheses support** |
|---|---|---|---|---|---|
| LMP | ---> | SOI | 0.047 | n.s. | |
| SOI | ---> | CSR | 0.252 | * | |
| LMP | ---> | CSR | 0.994 | *** | |
| SOI | ---> | Sustainability | 0.405 | ** | H4: supported |
| LMP | ---> | Sustainability | 0.473 | ** | H2: supported |
| CSR | ---> | Sustainability | 0.400 | ** | |
| Sustainability | ---> | Social performance | 0.987 | *** | |
| Sustainability | ---> | Environmental performance | 0.979 | *** | |
| Sustainability | ---> | Economic performance | -0.995 | *** | |
| CSR | ---> | Environmental practices | 0.847 | *** | |
| CSR | ---> | Social practices | 0.728 | *** | |
| LMP | ---> | Economic performance | 0.996 | *** | H1: supported |
| SOI | ---> | Economic performance | 0.958 | *** | H3: supported |

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

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 (indirect 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 6. Mediation bootstrap test of research hypotheses H5-H7

| **Effects** | **Hypotheses** | **Estimate** | **Significance** |
|---|---|---|---|
| Direct effect | | 0.049 | n.s. |
| Indirect effect | H5 | 0.327 | ** |
| Total effect | | 0.377 | ** |
| Direct effect | | -0.176 | * |
| Indirect effect | H6 | 0.569 | *** |
| Total effect | | 0.393 | ** |
| Direct effect | | 0.414 | ** |
| Indirect effect | H7 | 0.103 | * |
| Total effect | | 0.517 | ** |

Support for the seven (direct and mediation effects) hypotheses as obtained from the current study is summarized in Table 7. Table 7 additionally includes past research support for comparisons.

Table 7. Comparison of study findings on the direct (H1-H4) and mediation effects (H5-H7) hypotheses

| **Direct effects Hypothesis** | **Supported** | **Not supported** | **This research** |
|---|---|---|---|
| Positive relationship between lean management practices and economic performance (H1) | Martinez-Jurado and Moyono-Fuentes (2014) | Pannizzolo et al. (2012) | Supported |
| Positive relationship between lean management practices and sustainability performance (H2) | Moreira et al. (2010); Vinodh et al. (2011); King and Lenox (2001); Viesi et al. (2017); Dües et al. (2013) | Rothenberg et al. (2001) | Supported |
| Positive relationship between sustainability oriented innovation | Klewitz and Hansen (2014) | Piercy and Rich (2015) | Supported |

| | | | |
|---|---|---|---|
| practices and economic performance (H3) | | | |
| Positive relationship between sustainability oriented innovation practices and sustainability performance (H4) | Lee et al. (2001); Khor and Udin (2013) | Altenburg and Pegels (2012) | Supported |
| **Mediation effects Hypothesis** | **Supported** | **Not supported** | **This research** |
| Sustainability oriented innovation mediate lean management practices and sustainability performance (H5) | Adams et al. (2016) | Achanga et al. (2006) | Supported |
| Corporate social responsibility practices mediate lean management practices and sustainability performance (H6) | Inman and Green (2018) | | Supported |
| Corporate social responsibility practices mediate sustainability oriented innovation and sustainability performance (H7) | Adams et al. (2016); Rantala et al. (2018) | Ratnawati el al. (2018); Martinez-Conesa et al. (2017) | (Borderline) Supported |

## 6. Discussion and conclusion

This section first discusses the findings of this research in line with the research questions along with illustration of the theoretical contribution. Secondly, the limitations of the study are elaborated. Thirdly, the practical implications of this research are explored and finally, the scope for future work is stated.

### *6.1 Discussion on results / findings*

Sustainability could be achieved through the right combination of economic, environmental and social factors and it is the major concern of today's business (Dey et al., 2019; 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. However, SMEs contribute negatively to environment not individually but collectively. Therefore, the drivers that contribute towards enhancing sustainability of SMEs

need attention. SMEs are different from larger organisations with respect to their policies and strategies (Perrini, 2006), and therefore, SMEs supply chain sustainability has been discussed separately in literature. Lean management practices lead to achieving sustainability (Dey et al., 2019). However SMEs find it difficult to implement. SMEs struggle with finance to adopt lean management practices (Chiarini, 2012; Moreira et al., 2010). The sustainability oriented innovation of SMEs is discussed as a facilitator for their sustainability (Klewitz, and Hansen, 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 collectively 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 and economic performance empirically. Additionally, we examine the mediating effect of CSR practices to correlate LMP and SOI with sustainability performance. This enables SMEs to identify means for achieving sustainability through right combination of LMP, SOI and CSR through their respective constructs.

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 more sustainable. The main purpose of this empirical research is to investigate the potential effects of LMP and 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 practices in the relationship between LMP and sustainability performance and (c) the mediating effects of CSR practices 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 et al., 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 performance 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, the mediating effect of CSR practices on both LMP and SOI to achieve sustainability performance is rare (Adams et al., 2016; Inman and Green, 2018). Our analysis also reveals that improvement in sustainability performance of the UK SMEs do not come only through LMP and SOI, but also mediating effect of CSR practices. On one hand, LMP along with SOI help to achieve SMEs sustainability performance. On the other hand, both LMP and SOI through implementation of CSR practices enable achieving enhanced sustainability performance.

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. Data collected using the proposed performance measurement framework can be processed using multiple criteria decision-making method. Dey and Cheffi (2013) demonstrate a multiple criteria based sustainability performance measurement framework, which uses the Analytic Hierarchy Process.

Lean management practices and sustainability oriented innovation are organizational competencies that not only help achieve efficiency but also responsiveness in line with stakeholders' satisfaction. LMP brings efficiency and SOI emphasizes on responsiveness. Combining both LMP and SOI, SMEs achieve sustainability across their supply chain. Additionally, CSR practices helps enhance sustainability performance. This clearly depicts the alignment of the findings of this research with complementarity theory.

### *6.2 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 responsivity practices 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 B). 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.

### *6.3 Practical implications*

Figure 4 demonstrates the correlation between lean management practices, sustainability oriented innovation, economic performance and sustainability performance. Although LMP assures higher economic performance, LMP alone is not adequate for SMEs to achieve higher sustainability performance. 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. Similarly, SOI alone may also help achieve higher economic performance. However, sustainability performance of SMEs improves marginally when only SOI implemented. Adopting CSR practices through appropriate environmental and social measures along with LMP and SOI will help SMEs achieve higher sustainability performance. The effectiveness of implementing LMP, SOI and CSR will depend on the roles of each stakeholder across the SMEs' supply chain. Individual SME owners/managers must undertake diagnostics of their current state through sustainability analysis using the constructs, and in line with the findings of the analysis, improvement measures will be pursued. Both industry consortium and policymakers need to foster positive environment for motivating SMEs to implement a combined lean management practices, CSR and sustainability oriented innovation planning. Both customers and suppliers must incorporate sustainability constructs in their procurement contracts.

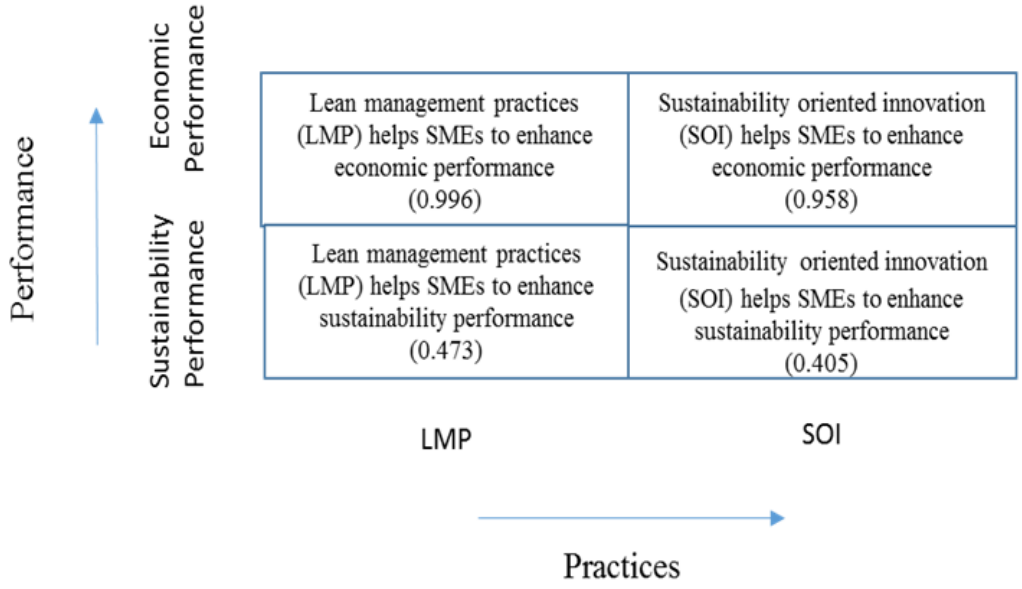


Figure 4. Correlation between LMP and SOI practices, and sustainability and economic performance.

### *6.4 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, SOI, CSR practices on sustainability and economic 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 and economic 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. Finally, we did not consider identifying the commonalities and differences of LMP, CSR and SOI as one of our research objective / question in this study. Additionally, economic performance is considered as one of the pillars of sustainability performance. Therefore, we did not develop any hypothesis to examine the correlation between economic and sustainability performance. Future studies may look at the commonalities and differences of all these variables.

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## Appendix A. Construct Definitions

| Constructs | Definition |
|---|---|
| Lean management practices (LMP) | 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). |
| Sustainability oriented innovation (SOI) | Innovation plays an important role in enhancing sustainability performance (Matos and Silvestre, 2013, Yu et al., 2019, Candi et al., 2018). 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) |
| Corporate social responsibility (CSR) practices | CSR is usually associated as approach to integrate social and environmental aspects into corporate activities (Baumgartner, 2013; Martinez-Conesa et al., 2017, Walker et al., 2019; Tang et al., 2018) |
| Sustainability performance | Sustainability performance is the combination of economic, environmental and social performance (Abdul-Rashid et al., 2017) |
| Economic performance | Economic performance is measured by productivity, profit, turnover, cost reduction and business growth etc. (Abdul-Rashid et al., 2017) |

## Appendix B. 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 et al., 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, 2013; 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. 2017; 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

**Economic performance** (Abdul-Rashid et al., 2016; Zhu, Sarkis and Lai, 2008)

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