The Impact of Leanness on Supply Chain Sustainability: Examining the Role of Sustainability Control Systems

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Abstract

Purpose: An alignment between financial and operational measures is an essential element to capture the lean productivity improvements enabling supply chain sustainability. With the aim of supporting small and medium enterprises (SMEs) in addressing corporate sustainability challenges, this study examines (i) the impact of leanness on supply chain sustainability, and (ii) the moderating role of sustainability control systems (SCS) on the relationship between leanness and supply chain sustainability.

Design/Methodology: Drawing on lean manufacturing and the levers of control framework, survey data was collected from 106 manufacturing SMEs in Sri Lanka. Moderated multiple regression analysis was employed to test the proposed hypotheses.

Findings: The study finds that lean manufacturing practices, such as just-in-time deliveries, quality management, environmental management, and employee involvement show a significant positive impact on supply chain sustainability. As proposed, the interactive use of SCS shows a significant, positive moderating impact on the relationship between employee involvement and social supply chain sustainability. The diagnostic use of SCS negatively moderates the relationships between (i) just-in-time deliveries and economic supply chain sustainability, and (ii) environmental management and economic supply chain sustainability. However, both interactive and diagnostic uses of SCS do not show any significant moderating impact between lean manufacturing and environmental supply chain sustainability.

Originality: SMEs are more likely to focus on diagnostic control systems with the aim of promoting economic supply chain sustainability. However, the findings reveal that manufacturing SMEs in the developing country context lack strong SCS to enable supply chain sustainability.

Keywords: Leanness; Lean manufacturing; Supply chain sustainability; Management control systems, Sustainability control systems, SMEs

1. INTRODUCTION

Addressing sustainability issues arising from unprecedented human and environmental system changes is one of the biggest challenges that contemporary society has struggled with thus far (Ajmal *et al.,* 2018; Hussain *et al.,* 2018; Bastas and Liyanage, 2019; de Haan-Hoek *et al.,* 2020; Aray *et al.,* 2020; Wijethilake and Upadhaya, 2020). Growing stakeholder concerns over unsustainable manufacturing practices have forced businesses to integrate sustainability strategies within their supply chains (Carter and Washispack, 2018; Bellisario and Pavlov, 2018; Huo *et al.*, 2019; Kusi-Sarpong *et al*., 2019; de Haan-Hoek *et al.,* 2020). While traditional supply chain management practices focus largely on economic and financial performance, sustainable supply chain practices focus on effectively managing supply chain functions to facilitate stakeholder wellbeing, minimize negative environmental impact, and, in turn, enhance corporate sustainability performance (Bastas and Liyanage, 2019; Kusi-Sarpong *et al.,* 2019). Organizations with a proactive sustainability approach tend to implement management best practices, such as lean manufacturing, as a means of responding to growing sustainability challenges (Wijethilake *et al.,* 2017). However, senior management often face unprecedented challenges to achieve supply chain sustainability through leanness due to lack of management control systems (MCS)[1] that support sustainable operations (e.g., Balkau, and Sonnemann, 2010; Nawanir *et al.,* 2020; de Haan-Hoek *et al.,* 2020). Regardless of the enormous contribution made by small and medium enterprises (SMEs) to the environmental, social, economic development, little is known about how these enterprises manage their lean manufacturing practices (see Sajan *et al.,* 2017). The aim of this study is to examine the moderating role of sustainability control systems (SCS) on the relationship between leanness and supply chain sustainability in SMEs.

Lean manufacturing has been well recognised as a productivity enhancement strategy through waste elimination, inventory control, capacity enhancement, continuous improvement and operational performance (Huo *et al.* 2019; Kaufmann, 2020; Nawanir *et al.,* 2020). Despite the potential benefits deriving from lean manufacturing, organisations often struggle to implement lean strategies (Netland and Aspelund, 2014; Netland *et al.,* 2015; Nawanir *et al*., 2020). To be effective, senior management should approach lean

[1] Management control systems are "formal, information-based routines and procedures managers use to maintain or alter patterns in organisational activities" (Simons, 1995, p. 5).

strategies from a holistic perspective instead of as an isolated operation (Fullerton *et al.,* 2013, 2014). Yet, a growing number of studies highlight that organisational failure to integrate operational and financial functions substantially undermines the predicted operational achievements (Li *et al.,* 2012; Fullerton *et al.*, 2014; Netland *et al.,* 2015), and leads to resistance in implementing lean manufacturing strategies (Meade *et al.,* 2010; Nawanir *et al.*, 2020). Fullerton *et al.* (2014, p. 425) emphasize that "it is not enough for operations management to implement a well-executed lean manufacturing strategy. Instead, operations management must work with accountants to ensure that the underlying financial control data are aligned with lean manufacturing initiatives." The alignment between financial and operational measures is an essential ingredient to capture lean productivity improvements (Li *et al*., 2012). Fullerton *et al.* (2014, p. 414) further highlight that "operations and accounting personnel must partner with each other to ensure that lean MAP [management accounting practices] are strategically integrated into the lean culture."

As a supportive internal system, the role of management control systems is imperative in facilitating lean operations as they provide critical financial and cost information imperative for decision making (Fullerton *et al.,* 2013; 2014; Netland *et al.,* 2015). More specifically, the extent to which MCS are aligned with operational strategies will foster the successful implementation of lean manufacturing strategies (Liker, 2004; Kennedy and Widener, 2008; Anand *et al.,* 2009; Bititci *et al.,* 2011; Fullerton *et al.,* 2013; Netland *et al.,* 2015). However, the role of MCS in lean manufacturing has been criticized for its traditional nature of standard and rigid control practices which tend to hinder the smooth functioning of lean operations (Cooper and Maskell; 2008; Maskell *et al.,* 2012 Tillema and van der Steen, 2015). For instance, Maskell *et al.* (2012, p. 2) comment that traditional accounting "systems do not work for companies pursuing lean [. . .]; indeed they are actively harmful". Nevertheless, the role of accounting in implementing lean manufacturing strategies is essential as cost information plays a significant role in strategic decision making. It is within this context that Maskell (2000, p. 46) argues "the financial community [needs] to contribute to the implementation of lean [. . .], instead of remaining on the side-lines, waiting for improvements to show up on the bottom line."

While the importance of aligning MCS with operational systems and organisational strategies has been a focal point in mainstream discussions (e.g., Ittner and Larcker, 2001; Fullerton *et al.,* 2013; Tillema and van der Steen, 2015), to-date, little is still understood about how MCS contribute to the lean manufacturing strategies which support supply chain sustainability (see. de Haan-Hoek *et al.,* 2020). Extant research in this context reveals that lean manufacturing is systematically associated with the use of lean manufacturing accounting practices, such as value stream costing, simplified and strategic management accounting practices, and visual performance measurements (Fullerton *et al.,* 2014). Examining how the use of MCS are related to lean manufacturing programmes at factory level, Netland *et al.* (2015) reveal that dedicated lean teams (input controls), reviewing lean performance reports (process control), and the use of non-financial rewards (output controls) support successful lean practices. However, internal auditing and financial rewards do not show any significant impact in implementing lean programmes (Netland *et al.,* 2015). Instead of focusing a comprehensive view of MCS (e.g., setting boundaries, performance evaluations, and implementing strategies), prior studies have taken a narrow-focused approach to customizing individual aspects within lean manufacturing strategies (Kaufmann, 2020). As such, Fullerton *et al.* (2013, p. 50) comment that "accounting research [. . .] has been slow to recognise the importance of aligning management accounting and control practices with a lean manufacturing strategy". Irrespective of the diverse advances made to develop alternative accounting practices throughout the last two decades, such endeavours have yet to overcome the difficulties faced by senior management (Darlington *et al.,* 2016). Netland *et al.* (2015, p. 100) suggest that "future studies could investigate whether the effectiveness of management control practices vary at different stages of lean implementation". Regardless of the relevance and usefulness of MCS in lean operations (Fullerton *et al.,* 2013; IMA, 2006; Lawler, 1994; Liker, 2004), to-date, there is little evidence of how MCS facilitate the implementation of lean strategies (Worley and Doolen, 2006; Bititci *et al.,* 2011; Fullerton *et al.,* 2013, 2014; Netland *et al.,* 2015).

In contrast to the traditional financial-oriented MCS, recent SCS integrate sustainability practices within internal control functions, enabling organizations to design and implement sustainability strategies (Wijethilake *et al.,* 2017, 2018, 2019). Wijethilake and Upadhaya (2020, p. 2) identify "SCS can be seen as a strand of MCS, which includes sustainability planning, environmental budgeting, sustainability performance measurement systems, sustainability balanced scorecard, environmental investment appraisal and so forth". In turn, whilst they facilitate sustainability strategies, SCS also improve operational efficiencies, leading to overall organizational performance (Gond *et al.,* 2012). For example, SCS may help identify the drivers of waste, measure waste in quantities, and propose actions to reduce waste (Wijethilake and Upadhaya, 2020). Responding to calls by Fullerton *et al.* (2014) and Netland *et al.* (2015), and drawing on Simons' (1995) levers of control, this study contributes to existing accounting and supply chain management literature on the role of SCS in implementing lean manufacturing strategies (e.g., Kennedy and Widener, 2008; Bititci *et al.,* 2011; Fullerton *et al.,* 2013).

The remainder of the paper is structured as follows. Section two discusses the background literature and hypotheses development. Section three presents the research design, followed by data analysis and the results in section four. Finally, empirical findings are discussed by highlighting both theoretical insights and implications for practitioners.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

Figure 1 depicts the conceptual framework of the study. First, the study hypothesizes a positive relationship between leanness and supply chain sustainability. Leanness is identified in terms of just-in-time deliveries, quality management, environmental management practices and employee involvement. Supply chain sustainability consists of three measurements: environmental, social and economic sustainability. Second, referring to Simons (1995), the study proposes that while the interactive use of SCS positively moderates the relationship between leanness and supply chain sustainability, in contrast, the diagnostic use of SCS negatively moderates the relationship. Appendix 1 provides a summary of the key literature supporting the proposed framework.

Insert Figure 1 about here

2.1 Role of leanness in supply chain sustainability

Corporate sustainability is a complex and multidimensional concept involving an organisation's internal and external environments, both of which are inextricably linked (Dos Santos *et al.,* 2014; Eriksson, and Svensson, 2016; Sajjad *et al.,* 2018; Bastas and Liyanage, 2019; de Haan-Hoek *et al*., 2020). While there are a number of definitions and conceptual explanations to describe corporate sustainability, most sustainability proponents tend to focus on three interconnected dimensions of sustainability – environmental, economic, and social, – also known as the triple-bottom-line (Elkington, 1998). These three dimensions are interdependent and reinforce each other. Rising stakeholder interests in sustainable business operations have influenced organisations to incorporate sustainability dimensions into supply chain strategies (Bellisario and Pavlov, 2018; Huo *et al.,* 2019; Kusi-Sarpong *et al.,* 2019). Organisations with a forward-looking approach tend to inculcate sustainability within their corporate strategies as a realistic means of responding to sustainability changes. More specifically, rather than waiting for external forces to influence their internal sustainability practices, proactive organisations are likely to develop supply chain sustainability strategies independently (e.g., Hussain *et al*., 2018; Bastas and Liyanage, 2019). Compared with traditional mass production, lean production aims for higher quality manufacturing through the elimination of waste materials and reduction of inputs (Nawanir *et al.,* 2020a, 2020b). In turn, proactive organizations are more likely to invest in sustainability with the purpose of minimizing expenses in the long term, despite the financial cost and investment required (Lauren and Vittal, 2008). Extant research suggests that effective implementation of lean operations not only benefits corporate sustainability performance, but also contributes to wider national sustainability initiatives (e.g., Shah and Ward, 2003; Zho, 2012). For instance, a study by Shah and Ward (2003) reveals that lean transformation contributes considerably to operational sustainability developments. Similarly, a growing number of studies also suggest that lean conversions have a significant impact on environmental sustainability in terms of energy saving, wastage and pollution reductions (Matos and Hall, 2007; Montabon *et al.,* 2007). Social sustainability is likely to be improved through work routines, working environment, teamwork efforts, and employee empowerment (Eizenberg and Jabareen, 2017; Ajmal *et al.,* 2018). Supply chain sustainability will also enhance economic sustainability in relation to profit increments, revenue growth, market share and sales (Zhu and Sarkis, 2004). Beyond the internal corporate achievements, lean supply chains also ensure stakeholder satisfaction by aligning their interests and agendas with the value chain (e.g., Liker, 2004; Hussain *et al.,* 2018). Below we propose how four lean manufacturing practices, namely just-in-time deliveries, quality management, environmental management and employee involvement, support supply chain sustainability.

Just-in-time systems and supply chain sustainability

Just-in-time is a lean philosophy that focuses on waste elimination, quality improvement, and profit enhancement techniques in the production process (Dowlatshahi *et al.,* 2009). Just-in-time facilitates the reduction of inventory levels at warehouses through frequent deliveries and maintaining good information platforms with relevant supply chain stakeholders (Liker, 2004). Fundamentally, holding high inventories correlates to numerous additional operating costs and internal control functions (Womack and Jones, 1996). In response, it is necessary to ensure that the optimum level of buffer stock, which still meets operational excellence, is maintained (Liker, 2004). Just-in-time related activities, such as data competency, value stream mapping, identification of value added and non-value-added activities, and team problem solving methods help reduce volumes of waste generated within the supply chain, and, in turn, enhances environmental supply chain sustainability (Cohen and Levinthal, 1990; King and Lenox, 2001). In terms of economic supply chain sustainability, an organisation's ability to integrate just-in-time systems within their operations will further enable waste reduction, and in turn, maximise resource utilization. As proposed in Eizenberg and Jabareen's (2017) framework of social sustainability, just-in-time systems facilitate social supply chain sustainability in terms of safety (e.g., risk and uncertainty mitigation), equity (e.g., recognition and redistribution), eco-prosumption (e.g., mitigation measures) and sustainable urban forms (e.g., sustainable transport, compactness). Proposing a framework of how companies perceive social sustainability, Ajmal *et al*. (2018) suggest that social sustainability would be supported by just-in-time systems such as safety and security (e.g., labour practices, health and safety, security), learning and growth, and community development functions, such as consumer/product responsibility. Accordingly, we propose that the extent to which organisations integrate just-in-time systems within operations is more likely to enhance environmental, social and economic supply chain sustainability.

Hypothesis 1a*: The extent to which organisations integrate just-in-time systems is positively associated with supply chain sustainability.*

Quality management and supply chain sustainability

Quality is one of the most important factors of operational excellence. Quality management implies the management functions that are concerned with quality planning and quality assurance in determining the quality policy and its implementation (Giuliano *et al.,* 2017). Blackburn and Rosen (1993) find that 85 per cent of organizations implement total quality management programmes with the purpose of rewarding people and groups for quality achievements. Similarly, considering both people and process perspectives, Flynn *et al.* (1995) classify quality management practices into: leadership, infrastructure practices, core practices, and established, causal relationships between employees. A growing number of studies claim that quality management has an important role in enabling supply chain sustainability (Kuei and Lu, 2013; Bastas and Liyanage, 2018, 2019). For instance, highlighting the importance of quality management in sustainable supply chains, Bastas and Liyanage (2018) propose the 'sustainable supply chain quality management'. In doing so, Bastas and Liyanage (2018, p. 726) suggest that "incorporation of sustainability into quality and supply chain management was identified to be a highly emerging area with multi-dimensional (financial, ecologic and social) approaches highly in need for more sustainable supply chains." Establishing the links between quality management and supply chain sustainability, Bastas and Liyanage (2018) also propose a framework that integrates ISO9001: 2005, supply chain management practices, and the three pillars of sustainability. Given the emphasis on the emerging role of quality management in sustainable supply chain management, we propose the below hypothesis.

Hypothesis 1b: *The extent to which organisations integrate quality management practices is positively associated with supply chain sustainability.*

Environmental management systems and supply chain sustainability

In dealing with rising energy and natural resource costs, manufacturing companies have been struggling with rising pollution and environmental waste within their supply chains (Kevin *et al.,* 2004). With the aim of reducing their environmental impact, organizations increasingly search for methods which emphasize waste reduction, and process and product redesign (e.g., certified or non-certified (e.g., ISO14001)) environmental management systems. Organisations may also develop written environmental policies and guidelines, environmental training for employees, internal and external environmental audits, and environmental performance measurement systems (Darnall *et al.,* 2008; Wijethilake *et al.,* 2017). For example, the use of environmentally friendly materials facilitates the continued sustainability of the supply chain through leanness (Munasinghe *et al.,* 2016). Studying the supply chain of a garment manufacturing company, Munasinghe *et al.* (2016) found that the use of eco-friendly materials and various environmental management practices substantially helped the company to reduce its carbon and energy footprint throughout the value chain. Munasinghe *et al.* (2016, p. 51) suggest that "incremental improvements are possible through consumer behavioral changes; sustainable procurement policies; energy/carbon efficient technologies; grid electricity mix and management practices can influence final footprint values." Arguing that environmental management systems and green supply chain management complement each other, Darnall *et al.* (2008) suggest that not only do organisations benefit within their boundaries, but that such benefits will also expand to a wider network of stakeholders throughout the supply chain. In support of the above, we propose the below hypothesis.

Hypothesis 1c: *The extent to which organisations integrate environmental management practices is positively associated with supply chain sustainability.*

Employee involvement and supply chain sustainability

Lean manufacturing creates a convincing platform to extend employees' responsibilities and to empower employees to engage with sustainability strategies (Shah and Ward, 2003; Tu *et al.,* 2006). A growing number of studies identify human capital as an important component in facilitating the reduction of emissions and implementing operational improvements pertaining to waste reduction (Russo and Fouts 1997; Cohen-Rosenthal 2000; Wijethilake *et al.,* 2017). Empirical evidence shows that employee involvement practices, such as formal training programmes, problem-solving groups, self-managed work teams and autonomous problem-solving in lean production processes, have substantially facilitated waste reduction across the supply chain (Tu *et al.,* 2006; Shah and Ward, 2007). Haugh and Talwar (2010) note that if sustainability learning capabilities are not aligned with employees' interests and expectations, sustainability learning would not be successful. If organisations consider sustainability as the basis for competitive advantage, sustainability learning is the fundamental core competency (Haugh and Talwar, 2010). Innovative human resource management practices inherent in lean manufacturing (e.g., work standardization, teamwork, and the existence of improvement groups) and a culture of continuous improvement facilitate the adoption of environmental management principles (Rothenberg *et al.,* 2001; Soltero and Waldrip, 2002). For instance, Wijethilake and Upadhaya (2020, p. 12) note that "organisations with a strong sustainability culture can motivate employees' behaviour towards sustainability practices and ensure their engagement and support to accomplish sustainability goals." Accordingly, we argue that the extent to which organisations involve employees in their sustainability strategies would have a positive impact on supply chain sustainability.

Hypothesis 1d: *The extent to which organisations involve employees in lean operations is positively associated with supply chain sustainability.*

2.2 The role of management control systems in lean manufacturing: a levers of controls perspective

This study refers to Simons' (1995) levers of control framework to examine the role of SCS in implementing lean manufacturing practices. Simons (1995) proposes four levers of controls: belief systems, boundary systems, diagnostic control systems, and interactive control systems. First, organisations use belief systems to express their commitment and communicate core values. Second, boundary systems represent various control practices aimed to avoid strategic risks. Third, diagnostic control systems facilitate organisations to identify and measure performance. Finally, interactive control systems support organisations to avoid strategic uncertainties. Based on the nature of controls, prior studies suggest that while belief and interactive control systems denote a positive connotation, in contrast, boundary and diagnostic control systems denote a negative connotation (Tessier and Otley, 2012). The purpose of this study is to examine the opposing uses of SCS (interactive vs diagnostic) in (re)aligning the association between lean manufacturing practices and supply chain sustainability.

Simons' (1995) levers of control framework has received increasing attention from a sustainability perspective, with a particular focus on designing and implementing sustainability strategies (Gond *et al.,* 2012; Wijethilake *et al.,* 2018, 2019). For instance, based on levers of control, Gond *et al.* (2012) propose a conceptual framework recommending how to implement sustainability strategies within an organisation. Wijethilake *et al.* (2018) referred to enabling and controlling uses of control to study the association between environmental innovation strategies and organisational performance. However, referring to four levers of controls, Narayanan and Boyce (2019) uncover that management controls do not play a transformative role in organisational change towards sustainability. In a recent study, de Haan-Hoek *et al.* (2020) suggest that the application of levers of control provides a holistic perspective to sustainable supply chain management.

Interactive use of sustainability control systems

Interactive use of controls promotes cohesion among employees, encourages proactive initiatives and develops novel strategic directions within an organisation (Simons 1995; Kober *et al.,* 2007). Interactive controls foster employee involvement and sustainability learning capabilities by promoting relational networks in terms of organising, coordinating, and circulating information and knowledge among stakeholders (Wijethilake *et al.,* 2017;

Centobelli *et al.,* 2019). Following interactive use of SCS, organizations may encourage their suppliers to keep inventory at supplier premises in addition to providing open purchase orders to satisfy demand for production, enabling organizations to make savings on inventory holding costs. In turn, interactive use of SCS may encourage suppliers to deliver goods to comply with just-in-time by maintaining good supplier relationships. Because interactive use of SCS creates novel avenues and offers incentives, organisations may focus on employees' sustainability training and quality management practices as a means of strengthening their skills and expertise to support the sustainability agenda (Starik and Rands, 1995; Daily and Huand, 2001). Interactive use of SCS may also involve, for example, routinely directing senior management's attention to sustainability supply chain practices, exchanging best practices with major stakeholders to castle sustainability innovations, and promoting sustainability learning among all employees (e.g., Al-Qubaisi and Ajmal, 2018; Wijethilake and Upadhaya, 2020). For instance, Al-Qubaisi and Ajmal (2018, p. 3374) suggest that "learning as an activity should be an integral part of an organization's daily practices and instead of seeing it as a cost; it should be seen as an investment to better the future of the company."

Sustainability strategies that promote interactive control systems represent senior managers' continuous attention on sustainable supply chain strategies, widespread organisational communications providing sustainability information, and adopting best practices from stakeholders (Arjaliès and Mundy 2013; Wijethilake *et al.,* 2018). In turn, interactive SCS depict several notable features that enable lean manufacturing practices and supply chain sustainability: organisational adaptability, open and flexible approaches for learning, decentralised decision making, and unobstructed flows of sustainability information. Teece (2007, p. 1355) highlights that as a way of promoting sustained strategies and dynamic capabilities "… decentralisation must be favoured because it brings top management close to new technologies, the customer, and the market." Accordingly, this study argues that the inherent proactive nature of interactive control systems promotes an effective alliance with organisational strategies such as lean manufacturing.

Hypothesis 2: *Interactive use of sustainability control systems positively moderates the relationship between just-in-time deliveries (H2a), quality management (H2b), environmental management (H2c) employee involvement (H2d) and supply chain sustainability.*

Diagnostic use of sustainability control systems

Organisations impose boundary conditions to minimize employees' propensity to become involved in risky operations and activities outside the accepted norms and domains (Simons, 1995; Widener, 2007). In turn, diagnostic control systems monitor employee behaviour as a means of delivering tasks and responsibilities within organisational boundaries (Simons, 2000). As diagnostic controls are likely to constrain and focus on compliance with predesigned policies and standards, such measures are perceived as negative forces (Henri, 2006). Simons (1995, p. 91) argues that diagnostic control systems "constrain innovation and opportunity-seeking to ensue predictable goal achievement needed for intended strategies."

While it remains important that organizations implement policies to ensure quality procedures are followed and punishments for cases of breaching quality policies are enacted, such practices will limit employee motivation and interest to involve in sustainability practices, such as environmental innovation (Wijethilake *et al.,* 2018). Diagnostic use of SCS may also focus on implementing workflow procedures and inventory controlling polices such as designing controls on the level of buffer stocks. Organisations may use diagnostic controls to monitor key performance measures related to supply chain sustainability by forecasting and benchmarking industry targets. For instance, these measures may include standardised quality assurance benchmarks, periodic and continuous reviews and evaluations of performance achievements and deviations, environmental and social audits, reporting requirements, and use of environmental and quality management techniques such as ISO14001; ISO9001: 2005; 5s, Kaizen, and Hoshin Kanri (e.g., Khan *et al.,* 2018; Wijethilake *et al.,* 2018). Prior studies suggest that due to the nature of diagnostic control systems, there seems to be a natural misalignment with strategies (Henri, 2006). Subsequently, the study proposes that the extent to which organisations use diagnostic controls negatively moderates the relationship between lean manufacturing practices and supply chain sustainability.

Hypothesis 3: *Diagnostic use of sustainability control systems negatively moderates the relationship between leanness just-in-time deliveries (H3a), quality management (H3b), environmental management (H3c) employee involvement (H3d) and supply chain sustainability.*

3. METHODOLOGY

3.1 Research context and sample: SMEs manufacturing in Sri Lanka

The sample of the study was drawn from manufacturing SMEs operating in Sri Lanka. The manufacturing sector accounted for 15.95 percent of Sri Lanka's GDP in 2017 (Department of Census and Statistics, 2017). The Central Bank of Sri Lanka categorises SMEs as enterprises with an annual turnover not exceeding Rs. 750mn (Central Bank report, 2017). Given the significant contribution of SMEs in Sri Lanka, the study focused on the manufacturing sector as the research context. An SME was identified as an organization that employs less than 250 employees and is registered under the Ceylon Chamber of Commerce for the year of 2018. 573 manufacturing SMEs were registered under Ceylon Chamber of Commerce in 2018. Subject to available data, 158 organizations were randomly selected. In early May of 2018, a total of 158 online surveys were sent to managers in supply chain, logistics, procurement, inventory and warehouse, and operations management. Dillman's (2000) survey techniques were used to design and distribute the online survey. Respondents' email addresses were obtained from organizations' websites, annual reports and other available databases. Representing a 67 percent response rate, a total of 106 questionnaires were received. Two responses were eliminated due to incomplete details.

3.3 Variable Definitions and Measurements

Survey responses were measured on a Likert scale of 1 to 5, where 1 represents "strongly disagree" and 5 represents "strongly agree". All the survey measurement items were adopted from validated prior literature. Ensuring the internal consistency of variables, Cronbach's alpha values were noted as exceeding the acceptable norm of 0.7 (Hair *et al*., 2014).

3.3.1 Independent Variables

Just-in-time deliveries: As suggested in prior studies, this study identifies just-in-time deliveries as a group of interconnected practices and deliveries for managing production flow (Shah and Ward, 2003; Swink *et al.,* 2005). Just-in-time deliveries were measured using five items: maintaining a reliable supplier base, minimize lead time, minimization of excessive inventory, and employees' knowledge about just-in-time flow activities. All measures were adapted from Shah and Ward (2003) and Swink *et al.* (2005). The Cronbach's alpha value is 0.907.

***Quality Management*:** Quality management is defined as a group of interconnected initiatives to assure the standard of products and equipment used to manufacture them (McKone *et al.,* 1999; Fullerton *et al.,* 2003; Shah and Ward, 2007; Linderman *et al.,* 2006).

Referring to Flynn *et al.* (1994) the study adapted five items to measure quality management: ISO quality certification, production safety monitoring procedures, documentation of production safety policies, production control systems, and employee awareness about production safety best practices. The Cronbach's alpha value is 0.919.

Environmental Management Practices: In line with Montabon *et al.* (2007), environmental management practices are recognized as a set of programmes that enhance environmental performance, processes and products within the varieties of environmental management systems, such as life cycle analysis and environmental certification. Environmental management practices were measured using five items as referenced by Matos and Hall (2007): waste management strategy, fostering waste prevention, promoting reuse of waste, engage in waste treatment activities, and obtaining environmentally friendly packaging standards by the organizations. The Cronbach's alpha value is 0.898.

Employee Involvement: The human component of lean manufacturing includes formal training programmes, problem solving groups, self-directed work groups and autonomous problem-solving practices (Shah and Ward; 2003, 2007; Tu *et al.,* 2006). Adapting from prior studies (Shah and Ward, 2003, 2007; Tu *et al.,* 2006), employee involvement was measured using four items: whether employees are authorized to engage in sustainable initiatives, employee involvement in waste reduction efforts, formal employee training programmes in sustainability supply chains, and employee involvement in problem solving. The Cronbach's alpha value is 0.903.

3.3.2 Dependent Variables

Supply Chain Sustainability: According to Tseng *et al.* (2015), sustainable supply chains represent three aspects: economic, environmental and social performance.

Environmental performance: Eight items to measure environmental supply chain performance were adapted from Zhu and Sarkis (2004), Miettinen and Hamalainen (1997) Sroufe (2003), Matos and Hall (2007) and Montabon *et al.* (2007). These items include, for instance, promoting sustainable resource management, reducing the environmental impact of production processes, scaling back waste by streamlining processes, using waste as input, disposing of waste responsibly, and handling or storing toxic industrial waste responsibly. The Cronbach's alpha value is 0.894.

Social performance: Referring to prior studies (Zhu and Sarkis, 2004; Mason *et al.,* 2008), five items were used to measure social performance: creation of job opportunities, investing in human capital development, supporting community projects, and guaranteeing well-being and protection of the employees. The Cronbach's alpha value is 0.900.

Economic performance**:** Adapting from Zhu and Sarkis (2004), the study referred to five items used to measure economic performance: solid waste product for revenue, cost savings and productivity improvements due to lean practices, lean strategies improving gross margins, promoting lean strategies, and engaging in sustainability learning and knowledge management. The Cronbach's alpha value is 0.903.

3.3.3 Moderating Variables

Interactive use of sustainability control systems: Referring to Wijethilake *et al.* (2018), interactive use of SCS were measured by six items: senior management's regular attention to sustainability control practices; senior management regularly interpreting information on sustainability practices; operating managers frequently involved in sustainability practices; regular meetings with senior sustainability managers and operational managers; exchange with major stakeholders on best practices to share sustainability innovations; and use of intranet systems for communities of practitioners. The Cronbach's alpha value is 0.895.

Diagnostic use of sustainability control systems: Referring to Wijethilake *et al.* (2018), six items were used to measure diagnostic use of SCS: standardized reporting processes; environmental management systems; benchmarking sustainability practices with competitors; senior management's reviews of performance achievements; environmental and social audits (both internal and external); and use of management tools. The Cronbach's alpha value is 0.900.

Control variables**:** The study also controlled three variables, namely: industry category, revenue, and number of employees that seem to have impact on the implementation of sustainable supply chain management practices and sustainability control systems (Zhu, 2006; Walker *et al.,* 2008; Wijethilake *et al.,* 2018).

4. RESULTS

4.1 Data analysis

The study employed moderated hierarchical multiple regression analysis to test hypotheses. Prior to creation of the interaction terms, both independent and moderator variables were mean centred to mitigate the possible issues associated with multicollinearity (Aiken and West, 1991). The variance inflation factor related to each regression coefficient reported less than 5, suggesting no major concern over the multicollinearity. Table 1 presents descriptive statistics including maximum, minimum values, variances, means, standard deviations and Cronbach alpha values.

Insert Table 1 about here

Table 2 presents the results of correlation analysis. The analysis shows that there are no significant multicollinearity issues among variables.

Insert Table 2 about here

Table 3 depicts the results of the hierarchical moderated linear regression analysis for the proposed four models. First, Model 1 was tested with control variables and independent variables. Next, moderating variables were examined in Model 2. Finally, the full model including the interaction terms was tested in Model 3 (Baron and Kenny, 1986).

Insert Table 3 about here

As shown in Model 1, the industry category has no statistically significant impact on environmental performance, social performance or economic performance. Revenue shows a positive significant impact only on environmental performance. The findings indicate that number of employees only shows a statistically significant impact on social performance. Table 4 summarises the results of the hypotheses testing. As predicted, Hypothesis 1a (just in time deliveries), Hypothesis 1b (quality management), Hypothesis 1c (environmental management) and Hypothesis 1d (employee involvement) are significantly associated with environmental, social and economic supply chain sustainability performance at $p = .001$. Hypotheses 2 and 3 tested the moderating impacts of interactive and diagnostic uses of SCS, respectively. As proposed in Hypothesis 2d, the interactive use of SCS only shows a significant positive moderating impact between employee involvement and social sustainability performance. The diagnostic use of SCS negatively moderates the relationships between just-in-time deliveries (Hypotheses 3a), environmental management (Hypothesis 3c), and economic supply chain sustainability.

Insert Table 4 about here

Confirming the above hypotheses, Figure 2 plots the moderating impact of interactive use of SCS on the relationship between employee involvement and social supply chain sustainability. Figure 3 depicts the moderating impact of diagnostic use of SCS on the relationship between just-in-time and economic supply chain sustainability performance. Finally, Figure 4 shows moderating impact of diagnostic use of SCS on relationship environmental management and economic supply chain sustainability performance.

Insert Figures 2, 3 and 4 about here
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5. DISCUSSION AND CONCLUSION

An extensive body of literature reveals implications on the role of environmental management systems in enabling sustainability strategies and performance consequences. However, little is known about the alignment between the different uses of SCS in implementing lean manufacturing practices that enable supply chain sustainability. The present study argues that while implementing lean manufacturing practices is important to support supply chain sustainability, an alignment should exist between operational and financial mechanisms. In response, the purpose of this study was to examine (i) what is the impact of leanness on supply chain sustainability? and (ii) to what extent interactive and diagnostic uses of SCS moderate the relationship between leanness and supply chain sustainability. Based on the survey data collected from 106 manufacturing SMEs in Sri Lanka, the findings reveal some important implications for leanness, supply chain sustainability and SCS literature. In doing so, this study responds to the call for research to examine the impact of leanness on supply chain sustainability (Zho, 2012; Carter and Washispack, 2018; Bastas and Liyanage, 2019) and whether interactive and diagnostic use of SCS moderate the relationship between leanness and supply chain sustainability (Wijethilake *et al.,* 2017, 2019).

The study finds that lean manufacturing practices, such as just-in-time deliveries, quality management, environmental management and employee involvement are positively associated with environmental, social and economic supply chain sustainability. Our findings support the proposition that lean operations minimize the environment cost as a result of implementing green management practices in SMEs (Sajan *et al.,* 2017; Nawanir *et al.,* 2020). In line with Rao and Holt (2005), the findings confirm that environmental management and employee involvement have a positive relationship with economic supply chain performance. Our findings also support previous claims that lean manufacturing practices improve stakeholder relationships, reduce business risk through joint investment research and development, reduce inventories, improve product quality, promote collaborative product design, and reduce wastage throughout the supply chain (Arkader, 2001; Pérez *et al.,* 2010; So and Sun, 2010). In doing so, our study responds to prior inconsistent and inconclusive findings between lean manufacturing and environmental supply chains sustainability performance (King and Lenox, 2001; Rothenberg *et al.,* 2001; Vinodh *et al.,* 2011).

In terms of moderating impact, interactive use of SCS positively moderates the relationship between employee involvement and social supply chain sustainability. In contrast, the diagnostic use of SCS negatively moderates the relationships between just-in-time deliveries, environmental management, and economic supply chain sustainability. However, both interactive and diagnostic uses of MCS do not show any significant moderating impact on environmental performance. As Gond *et al.* (2012, p. 208) argue, the results imply that most Sri Lankan SMEs are likely to apply traditional MCS which are "seen to be limited in incorporating the interests of a broad range of stakeholders other than shareholders and in addressing environmental and social issues as well as their interrelationships with financial issues." Given the nature of the research context - manufacturing SMEs in a developing country - the findings reveal the lack of strong SCS to enable supply chain sustainability practices (e.g., Nawanir *et al.,* 2020). This may be due to a lack of financial resources, limited access to technological knowhow and expertise capabilities. Within this context, SMEs seem to be more focused on implementing diagnostic control systems with the aim of maximizing economic supply chain sustainability. Findings also imply that SMEs are likely to focus on short term benefits instead of investing in social and environmental systems that will generate yields in the long term (e.g., Sajan *et al.,* 2017; Nawanir *et al.,* 2020).

Our findings support prior theoretical arguments on the opposite role of the interactive and diagnostic uses of SCS on strategy implementation (e.g., Wijethilake *et al.,* 2017; 2018). With an emerging focus on the usefulness of MCS in addressing sustainability challenges (Wijethilake and Ekanayake, 2019), this study enhances our understanding of the importance of SCS research in supporting societal relevance for decision making, with a particular focus on the adoption of lean manufacturing practices that enable supply chain sustainability. More specifically, the study sheds some light to the strand of literature focusing on the role of traditional MCS in lean operational processes as a means of achieving supply chain sustainability (Kennedy and Widener, 2008; Bititci *et al.,* 2011; Fullerton *et al.,* 2014; Netland *et al.,* 2015). This is particularly important as attention has predominantly focused on areas such as lean production or value stream mapping, instead of adopting a holistic view of the entire lean process. This study's core argument that SCS have potential in responding to lean manufacturing practices supports Bromley and Powell's (2012, p. 519) view that managers should "focus thoughtfully on shaping tools, such as systems of reporting, monitoring, and evaluation, in ways that are more directly linked to their organisation's core activities". By providing empirical insights into the interactive and diagnostic use of controls, this study contributes to the levers of control literature in the sustainability context (e.g., Gond *et al.,* 2012; Arjaliès and Mundy 2013; Wijethilake *et al.,* 2018).

Managerial implications

Conceptual arguments and empirical evidence proposed in this study can assist managers in better understanding the avenues of using MCS in improving supply chain sustainability performances rather than using them on an ad hoc basis. The findings suggest that it is not sufficient for organizations to achieve improved financial results, they must also be aware of how to manage their business responsibly and should be mindful of the impact their business operations have on the entire supply chain. The findings are also helpful for managers to identify specific sustainability issues to integrate into strategic decision-making processes and to determine respective sustainable controls to implement in each stage of the supply chain. Findings suggest that managers need to pay special attention to promoting the long-term benefits of investing in environmental and social aspects. The study reveals that even though SMEs in Sri Lanka have various non-critical (e.g., charities) social and environmental programme expenditure, they are yet to understand the importance of investing in core aspects of leanness, such as just-in-time, quality management, environmental management and employee involvement. The findings also deliver an important message to SME managers to convince their stakeholders to integrate lean manufacturing practices as a means of enabling supply chain sustainability.

Managers should also take into account that simply integrating sustainability into strategy will not automatically lead to improved performance, but should be supported by well-designed MCS to effectively facilitate lean operations. Therefore, the adoption and integration of MCS into the lean decision-making process is important to achieve supply chain sustainability goals. Senior management also need to provide adequate financial, as well as other, resources to middle and lower level managers responsible for the operationalisation of supply chain sustainability projects and practices. In particular, it is important to delegate the authority in clear written statements so that responsible employees would be motivated, empowered and engaged with supply chain sustainability activities. Managers should also be aware of the potential resistance in an attempt to implement lean manufacturing practices as employees are more likely to misperceive the benefits as a threat of losing their employment. Given the importance of SMEs in addressing sustainability challenges, policy makers need to pay attention to promote sustainable business models and provide necessary training and expertise knowhow appropriately.

Limitations and future research

The following limitations should be taken into account in interpreting the results and implications of this study. First, the study refers to supply chain sustainability as environmental, social and economic sustainability. As these concepts represent broader perspectives of sustainability, and no consensus on how to measure has yet been agreed, future studies may focus on other variables that might capture different perspectives of supply chain sustainability. Second, future researchers may further extend the role of SCS (including all four control systems – belief, boundary, interactive and diagnostic) in examining the impact of leanness on supply chain sustainability. Third, this study has considered a sample of manufacturing SMEs in the Western province in Sri Lanka. The results should be carefully generalized to other manufacturing organizations in Sri Lanka, and beyond. Finally, future studies may also investigate the impact of leanness on supply chain sustainability by using alternative methodologies, such as multiple case studies.

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Table 1: Results of descriptive analysis

Variables	Max	Mini	Variance	Mean	SD	Alpha
Environmental performance	5.00	2.25	.335	4.04	0.57	0.894
Social performance	5.00	2.50	.286	4.35	0.53	0.900
Economic performance	5.00	1.00	.334	4.08	0.57	0.903
Quality management	5.00	2.00	.546	4.16	0.73	0.919
Employee involvement	5.00	2.00	.323	4.14	0.56	0.903
Environmental management	5.00	2.00	.278	4.05	0.52	0.898
Just in time	5.00	2.00	.299	4.14	0.54	0.907
Interactive use of MCS	5.00	2.00	.332	4.17	0.57	0.895
Diagnostic use of MCS	5.00	2.00	.357	4.14	0.59	0.900

Table 2: Correlation analysis

Variables	1	2	3	4	5	6	7	8	9
1. Just-in-time	1								
2. Quality management	.344	1							
3. Employee involvement	.547	.410	1						
4. Environmental management	.485	.442	.701	1					
5. Interactive use of SCS	.501	.394	.610	.725	1				
6. Controlling use of SCS	.481	.411	.508	.610	.691	1			
7. Environmental performance	.525	.551	.546	.668	.697	.652	1		
8. Social performance	.587	.460	.480	.520	.691	.586	.649	1	
9. Economic performance	.448	.361	.497	.561	.629	.565	.660	.607	1

Correlation coefficients above 0.344 were significant at $p < .01$ level (2-tailed).

Table 3: Summary of regression analysis

Predictors	Environmental Performance				Social Performance				Economic Performance			
	Model 1	**Model 2**	**Model 3**	**VIF**	**Model 1**	**Model 2**	**Model 3**	**VIF**	**Model 1**	**Model 2**	**Model 3**	**VIF**
Control variables												
Industry Category	-0.010	-0.054	-0.058	1.216	-0.008	-0.056	-0.060	1.216	-0.063	-0.100	-0.104	1.216
Revenue	0.204**	0.220**	0.150**	1.088	0.053	0.071	0.006	1.088	0.062	0.076	0.002	1.088
No. of Employees	0.103	0.147	0.070	1.251	0.142	0.191**	0.119	1.251	-0.042	-0.005	-0.086	1.251
Independent variables												
Just in Time	0.525***	0.234**	0.234**	1.336	0.587***	0.322***	0.321***	1.336	0.448***	0.177**	0.176**	1.336
Quality Management	0.551***	0.327***	0.327***	4.695	0.460***	0.223**	0.223**	1.184	0.361***	0.134	0.135	1.184
Environmental management	0.668***	0.342***	0.342***	2.111	0.520***	0.041	0.039	2.111	0.561***	0.221**	0.229**	2.111
Employee involvement	0.546***	0.192**	0.193**	1.592	0.480***	0.095	0.094	1.592	0.497***	0.181*	0.188**	1.592
Moderator variables												
Interactive use of SCS		0.580***	0.577***	1.373		0.529***	0.515***	1.373		0.540***	0.498***	1.373
Diagnostic use of SCS		0.520***	0.525***	1.352		0.395***	0.376***	1.352		0.454***	0.415***	1.352
Interaction												
JIT * Interactive use of SCS			-0.018	1.038			-0.077	1.038			-0.219	1.038
JIT * Diagnostic use of SCS			0.021	1.048			-0.089	1.048			-0.180**	1.048
Quality Management* Interactive use of SCS			0.023	1.045			-0.077	1.045			-0.223	1.045
Quality Management * Diagnostic use of SCS			-0.003	1.059			-0.030	1.059			-0.186	1.059
Environmental Management * Interactive use of SCS			-0.004	1.089			0.042	1.089			-0.161**	1.089
Environmental Management * Diagnostic use of SCS			0.016	1.064			-0.019	1.064			-0.155**	1.064

Employee Involvement * Interactive use of SCS			-0.022	1.054			0.003**	1.054			-0.235**	1.054
Employee Involvement * Diagnostic use of SCS			0.000	1.020			-0.084	1.020			-0.271	1.020
F for the Regression	39.59	57.51	38.01		54.68	64.07	43.29		26.13	37.12	29.57	
Change in F	39.59	54.90	0.067		54.68	48.48	1.328		26.13	38.65	8.827	
R^2	0.276	0.528	0.528		0.587	0.745	0.748		0.448	0.647	0.682	
Adjusted R^2	0.269	0.518	0.514		0.338	0.546	0.547		0.201	0.419	0.465	

Note: *p <= 0.10**p <= 0.05***p <= 0.001

Table 4: Summary of hypotheses results

Hypotheses	Variables and Relationship	Environmental supply chain sustainability	Social supply chain sustainability	Economic supply chain sustainability
H1a	Just in time	Supported (p <= .001)	Supported (p <= .001)	Supported (p <= .001)
H1b	Quality management	Supported (p <= .001)	Supported (p <= .001)	Supported (p <= .001)
H1c	Environmental management	Supported (p <= .001)	Supported (p <= .001)	Supported (p <= .001)
H1d	Employee involvement	Supported (p <= .001)	Supported (p <= .001)	Supported (p <= .001)
H2a	Just-in-time * Interactive use of SCS	Not Supported	Not Supported	Not Supported
H2b	Quality Management * Interactive use of SCS	Not Supported	Not Supported	Not Supported
H2c	Environmental Management * Interactive use of SCS	Not Supported	Not Supported	Not Supported
H2d	Employee Involvement * Interactive use of SCS	Not Supported	Supported (p <= .05)	Not Supported
H3a	Just-in-time * Diagnostic use of SCS	Not Supported	Not Supported	Supported (p <= .05)
H3b	Quality Management * Diagnostic use of SCS	Not Supported	Not Supported	Not Supported
H3c	Environmental Management * Diagnostic use of SCS	Not Supported	Not Supported	Supported (p <= .05)
H3d	Employee Involvement * Diagnostic use of SCS	Not Supported	Not Supported	Not Supported

Appendix 1: Literature Summary

Literature	Just-in-time	Quality management	Environmental management	Employee involvement	Environmental performance	Social performance	Economic performance	Interactive controls	Diagnostic controls
Giuliano *et al*, (2017)		*							
Bastas and Liyanage, (2019)		*			*	*	*		*
Carter and Washispack, (2018)					*	*			
Bellisario and Pavlov, 2018		*		*				*	*
Bergmiller and McCright, (2009b)				*	*		*		
Bicheno and Holweg, (2009)		*		*					
Mollenkopf *et al.*, (2010)	*	*		*	*				
Hussain *et al.*, (2018)				*					*
Huo *et al.*, (2019)									*
Bose and Pal, (2012)			*						
Shi *et al.*, (2012)			*						
Dowlatshahi *et al.*, (2009)	*							*	*
de Haan-Hoek *et al.*, 2020					*	*	*	*	*
Matos and Hall, (2007)			*		*				
Montabon *et al.*, (2007)			*		*		*		
Vinodh *et al.*, (2011)					*		*		
Justin *et al*, (2009)				*				*	
Gond *et al.*, (2012)					*	*	*	*	*
Wijethilake *et al.*, (2017)					*	*	*	*	*

Wijethilake *et al.,* (2020)			*	*
Henri and Journeault, (2010)	*	*		*

Note(s): *It indicates that the lean practices are discussed in the literature

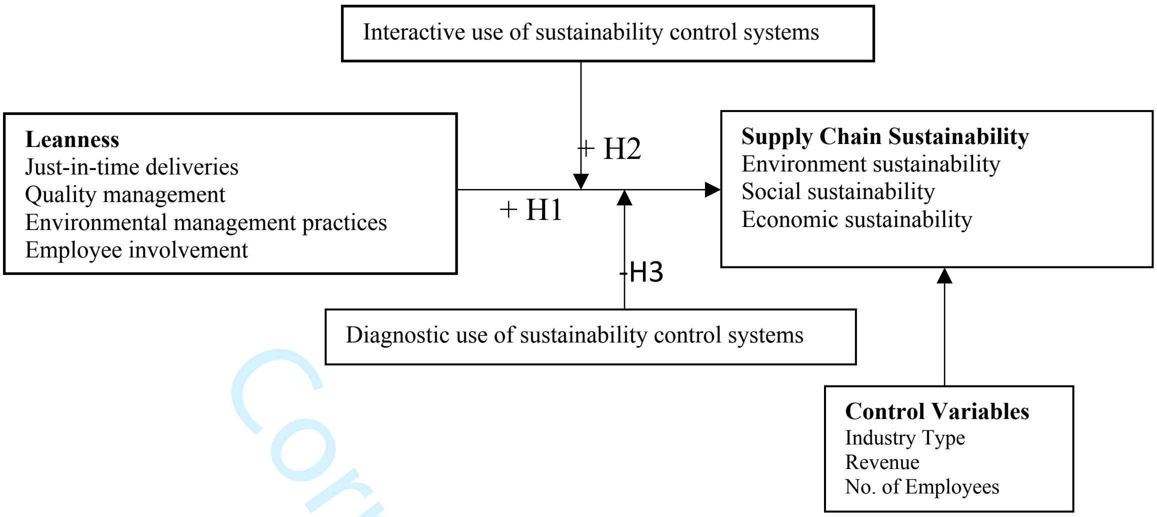

Figure 1: Conceptual Framework

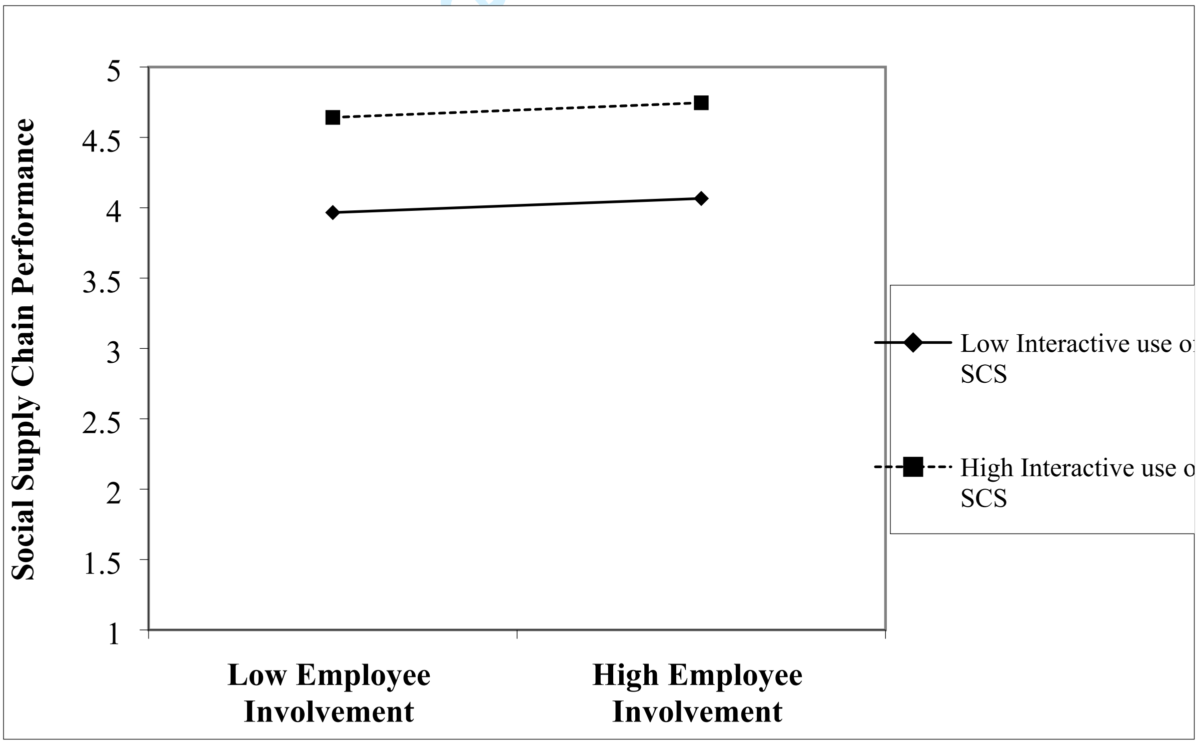

Figure 2: Moderating impact of interactive use of SCS on the relationship between employee involvement and social supply chain sustainability.

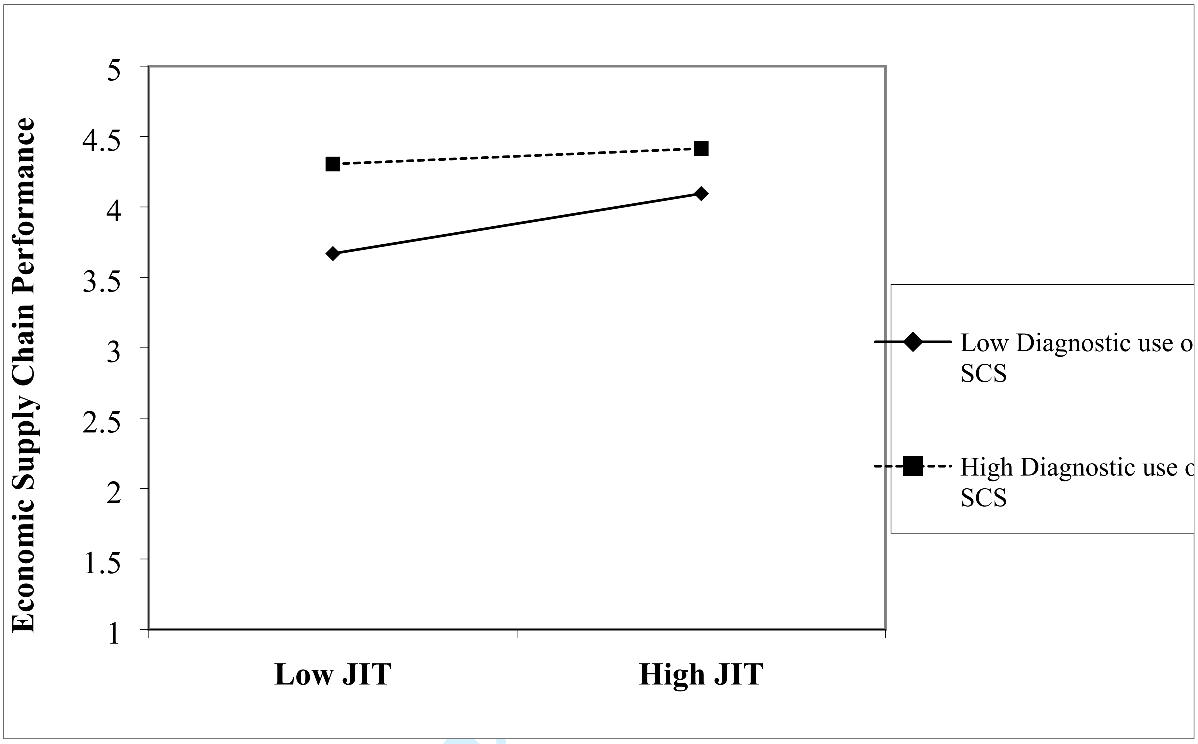

Figure 3: Moderating impact of diagnostic use of SCS on the relationship between JIT and economic supply chain sustainability performance

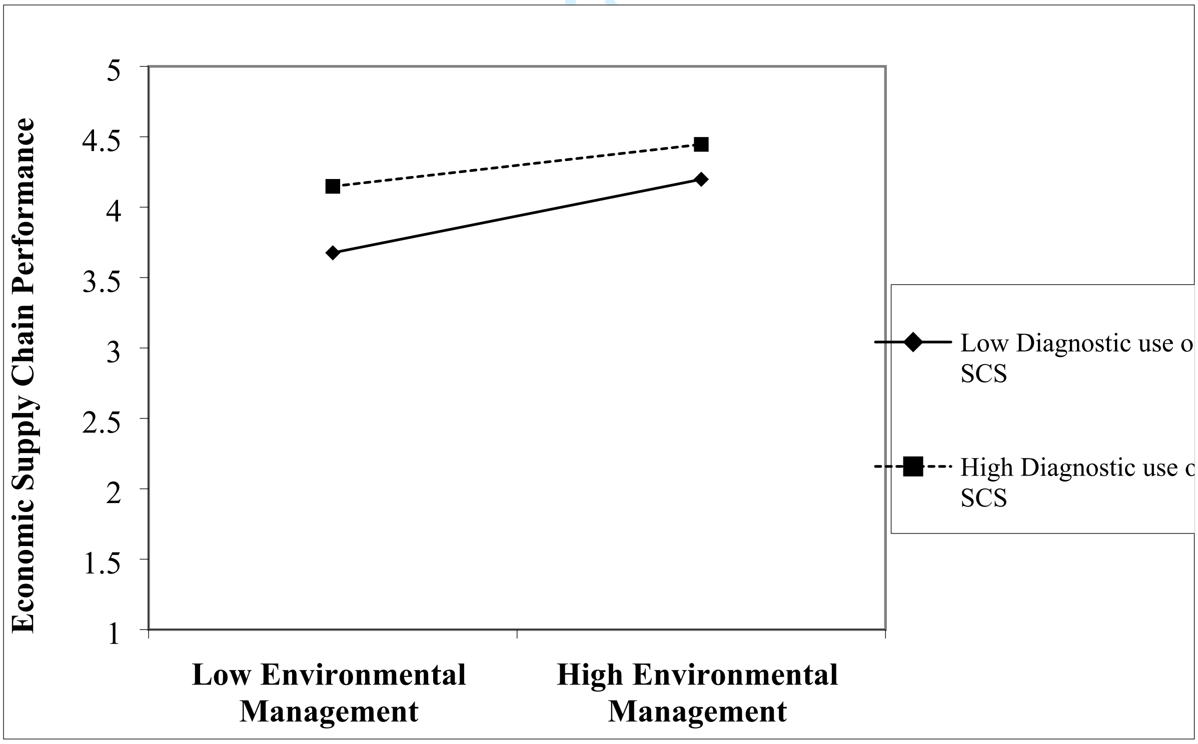

Figure 4: Moderating impact of diagnostic use of SCS on the relationship environmental management and economic supply chain sustainability performance

Questionnaire

Industry Category: ☐ Manufacturing ☐ Services

Nature of Company: ☐ Sole Proprietary ☐ Partnership

☐ Company (Private/ Public)

If the company is a group of companies,

Number of branches/ subsidiaries: _______________

Revenue Range (per year):

☐ Below Rs.1, 000,000 ☐ Rs.2, 500,000 ☐ above Rs. 5,000,000

Number of employees: _______________

Number of customers dealing with: _______________

Number of supplier companies dealing with: _______________

Your position: ____________________________

Gender: Male ☐ Female ☐

Age: ☐ Below 30 ☐ 30-40 ☐ 41-50 ☐ Above 50

Your highest educational qualification:

☐ PhD

☐ MA/M. Com/MBA/MSC

☐ BA/B. Com/BSC

Other: ________________

Place of your tertiary education: ☐ Sri Lanka ☐ Overseas

Years of experience in the field:

☐ Below 5 years ☐ 5 – 10 years ☐ 11 – 15 years ☐ More than 15 years

1. Please indicate the extent to which your company uses the following mechanisms to communicate sustainability core values.

	Not at all 1	2	3	4	To a great extent 5
1.Vision and mission statements	☐	☐	☐	☐	☐
2. Strategic plans and policies	☐	☐	☐	☐	☐
3.Sustainability reports, corporate social responsibility reports, annual reports etc.	☐	☐	☐	☐	☐
4.Company-wide conferences, forums, workshops & training sessions etc.	☐	☐	☐	☐	☐
5. Intranet, websites, posters, booklets etc.	☐	☐	☐	☐	☐
6. Top management communications (e.g. minutes of board meetings)	☐	☐	☐	☐	☐

2. Please indicate the extent to which your company adheres to the following.

	Not at all 1	2	3	4	To a great extent 5
1. Regular assessments of sustainability code of conducts	☐	☐	☐	☐	☐
2. Ethical and professional guidelines	☐	☐	☐	☐	☐
3.Guidelines on sustainability related best practices	☐	☐	☐	☐	☐
4. Global Reporting Indicator (GRI)	☐	☐	☐	☐	☐
5. Internal sustainability policies, structures and activities.	☐	☐	☐	☐	☐

3. Please indicate the extent to which the following statements apply to your company

	Not at all 1	2	3	4	To a great extent 5
1. Having reliable suppliers	☐	☐	☐	☐	☐

2. Minimization of lead times	☐	☐	☐	☐	☐
3. Minimization of excessive inventory of raw materials	☐	☐	☐	☐	☐
4. Employees' knowledge capacity related to JIT flow activities	☐	☐	☐	☐	☐
5. Differentiation of value-added tasks	☐	☐	☐	☐	☐

4. Please indicate the extent to which the following statements apply to your company

	Not at all 1	2	3	To a great extent 4	5
1. Obtain ISO quality certification	☐	☐	☐	☐	☐
2.Having Food Safety related monitoring procedures	☐	☐	☐	☐	☐
3. Having documented food safety policy, food safety procedures	☐	☐	☐	☐	☐
4. Having proper pest control system	☐	☐	☐	☐	☐
5. Awareness about food safety	☐	☐	☐	☐	☐

5. Please indicate the extent to which the following statements apply to your company

	Not at all 1	2	3	To a great extent 4	5
1. Employees are involved in the decision making process	☐	☐	☐	☐	☐
2. Employees are involved in waste reduction efforts	☐	☐	☐	☐	☐
3. Employees are given formal training programs	☐	☐	☐	☐	☐
4. Employee are involved in problem solving groups	☐	☐	☐	☐	☐

6. Please indicate the extent to which your company uses the following mechanisms to evaluate sustainability performance

	Not at all 1	2	3	4	To a great extent 5
1. Standardized reporting processes (e.g. GRI & UN Global compact)	☐	☐	☐	☐	☐
2. Environmental Management Systems (EMS)	☐	☐	☐	☐	☐
3. Benchmarking sustainability practices with competitors	☐	☐	☐	☐	☐
4. Top management's reviews of performance achievements	☐	☐	☐	☐	☐
5. Environmental and social audits (both Internal and external)	☐	☐	☐	☐	☐
6. Use of management tools (e.g. Kaizen, Hoshin Kanri, 5s, Just in Time (JIT))	☐	☐	☐	☐	☐

7. Please indicate the extent to which your company uses the following mechanisms for managing sustainability related uncertainties

	Not at all 1	2	3	4	To a great extent 5
1. Top management's regular attention to sustainability control practices	☐	☐	☐	☐	☐
2. Top management regularly interprets information on sustainability practices	☐	☐	☐	☐	☐
3. Operating managers are frequently involved in sustainability practices	☐	☐	☐	☐	☐
4. Regular meetings with top sustainability managers and operational managers	☐	☐	☐	☐	☐
5. Exchange with major stakeholders of best practices to share sustainability innovations	☐	☐	☐	☐	☐
6. Use of intranet systems for communities of practitioners	☐	☐	☐	☐	☐

8. Please indicate the extent to which the following statements apply to your company

	Not at all	To a great extent

	1	2	3	4	5
1. Chose inputs from sources that are remediated or replenished	☐	☐	☐	☐	☐
2. Reduced environmental impacts of production processes or eliminated environmentally damaging processes	☐	☐	☐	☐	☐
3. Reduced operations in environmentally sensitive locations	☐	☐	☐	☐	☐
4. Reduced likelihood of environmental accidents through process improvements	☐	☐	☐	☐	☐
5.Reduced waste by streamlining processes	☐	☐	☐	☐	☐
6. Used waste as inputs for own processes	☐	☐	☐	☐	☐
7. Disposed waste responsibly	☐	☐	☐	☐	☐
8. Handled or stored toxic waste responsibly	☐	☐	☐	☐	☐

9. Please indicate the extent to which your company performed better in the following elements as compare to your competitors

	Not at all				**To a great extent**
	1	**2**	**3**	**4**	**5**
1. Impact of lean strategies on production cost	☐	☐	☐	☐	☐
2. Cost savings & productivity improvements due to lean practices	☐	☐	☐	☐	☐
3. Lean strategies improve gross margins	☐	☐	☐	☐	☐
4. Lean strategies promote higher operational performance	☐	☐	☐	☐	☐