

Sustainable Operations Management: A Systematic Review and Future Research Agenda

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ABSTRACT

The number of professionals working in manufacturing operations who are interested in sustainable operations management (SOM) is growing. This is primarily due to an increased awareness of the negative effects that manufacturing operations have on the natural world. This article brings together empirical academic research on sustainable operations management. Via a systematic literature review, we investigate 96 articles and books on sustainable operations management published between 1994 and 2022. These studies are analyzed based on the following themes: (1) the definitions of sustainable operations management, (2) sustainable operations management practices and (3) empirical outcomes of sustainable operations management practices. Based on this analysis, we develop a more inclusive definition of sustainable operations management. We put forward three future research suggestions: (1) a holistic investigation of the relationship between SOM practices and sustainable performance (2) the consideration of all the triple bottom-line dimensions (environmental, social and economic); and (3) moving from a qualitative dominance to using quantitative methods.

Keywords: Sustainable Operations Management; Sustainable Performance

Introduction

Due to increasing pressure from stakeholders (such as investors, clients, and governments) to diminish the environmental impact of their operations, firms are increasing their commitment to incorporating sustainable practices in their operations management (Pérez-Gosende et al., 2020). Integrating the principles and strategies related to operations management (OM) into sustainability helps firms to gain sustainable competitive advantage and organizational performance (De Guimarães et al., 2019). As a result, Interest in sustainable operations management (SOM) from professionals in manufacturing operations is increasing, mainly due to increasing awareness of the harmful effects of manufacturing operations on nature, whose activities are considered to keenly contribute to the pollution of air and water, as well as environmental damage and disruption (Zaid et al., 2018; Handayani et al., 2017). Manufacturing operations bear a considerable amount of sustainability-related burdens and risks because of their rigorous consumption of resources (Ahmad et al., 2018).

Addressing sustainability in OM requires the decision-maker to incorporate economic, environmental and social criteria of sustainability simultaneously into the decision-making process (Türkay et al., 2016). There is, however, no universally accepted definition or explanation for the management of sustainable operations. SOM has several definitions; one of the reasons behind these definitions is the various explanations of the ‘sustainability’ concept: e.g., seeing sustainability as an environmental initiative; as a goal or a process; as an integration of different aspects; or as a compromise between pillars, etc. (Moldavska & Welo, 2017). Hence, it is the goal of this article to probe the various definitions and come up with a relatively all-inclusive definition of SOM.

There are also concerns throwing whether the adoption of SOM truly pays for sustainable performance (Swalehe et al., 2020; John, 2018; Esfahbodi, 2016). This paper looks at the empirical findings of researches conducted in the context of different countries to show the effect of SOM practices on achieving the sustainable performance. It should be, however, noted that sustainable performance

almost always depends on the specific practice of sustainable operations. Hence, To show the practice of sustainability in OM and its effect on sustainable performance of large manufacturing firms, it is logical to probe and primarily emphasize the widely accepted themes and decision areas of OM (Jaehn, 2016). In this study, SOM practices will be defined through a systematic literature review, checking for the most discussed topics in this area and taking care to cover operations in all phases that occur in the product life cycle, from the conception of the product project and raw material procurement to the management of production processes and supply chains.

In response to these concerns, this article provides a comprehensive overview of how SOM has been studied, addressing (1) the definitions of SOM, (2) major SOM practices in manufacturing, and (3) empirical SOM outcomes in manufacturing. Based on this, our overarching research questions are as follows:

- What definitions of SOM are being used?
- What are the major practices of SOM in manufacturing?
- What are the empirical outcomes of SOM practices in manufacturing?

The methodology for conducting the review is described in the following section. We will report using the ‘Preferred Reporting Items for Systematic Reviews and Meta-Analyses’ (PRISMA) method. The ‘Results of systematic review’ section presents the characteristics of the eligible studies discovered and answers the research questions listed above. We then draw conclusions and develop a future research agenda on SOM in manufacturing based on these findings.

Methodology

To identify eligible studies, four strategies were used. We chose the period from 1994 to 2022 to include two important publications from the mid-1990s, Elkington (1994) and Gupta and Sharma (1996). These contributed significantly to integrating sustainability dimensions in OM, resulting in an increased focus on SOM.

First, we carried out an electronic search in two databases, Scopus and SCImago, to ensure that we included a broad range of scientific output. The initial search key terms used are Sustainability AND Operations Management, Sustainable operations AND sustainable performance, Sustainability AND Manufacturing, eco-

design AND sustainable performance, Eco-process AND sustainable performance, Sustainability AND Supply chain, and Sustainable supply chain Management AND sustainable performance. This search generated more than 500 studies and was last conducted in May 2022.

Second, we looked for journal articles on SOM published in five top OM journals to see how sustainability was defined there. Production and operations management society, Journal of cleaner production, International Journal of Operations and Production Management, International Journal of Production Economics, and International Journal of Production Research were among these journals. The most recent search was conducted in May 2022, yielding 31 potential studies for inclusion. In addition, to maximize the selection of SOM articles, we added two OM-related journals, the Journal of Industrial Engineering and Management and the Journal of the operational research society. This search yielded 11 potential studies for inclusion.

Third, we searched Google Books and comparable information sources for pertinent books. The last time this search was done, in May 2022, it found 24 books that might be included.

Fourth, we searched electronic databases for pertinent conference proceedings. When this search was last run in March 2022, it found 13 potential conference proceedings that could be included.

Eligibility Criteria

In reporting the systematic review, we adhere to the widely used ‘Preferred Reporting Items for Systematic Reviews and Meta-Analyses’ (PRISMA). Studies from our original searches were included in the systematic review if they met all of the following inclusion criteria:

- Field – Studies should deal with areas of OM and sustainability.
- Objective – Only those empirical studies whose objective is to show the effect of SOM on sustainable performance were included. Thus, studies that showed the relationship theoretically were excluded.
- Sector – Empirical studies of OM in the manufacturing sector were eligible as we are interested in empirical evidences on sustainable manufacturing operations. Hence, we excluded studies on service operations and their sustainable management.

Moreover, only theoretical studies that had shown an effort to define SOM and illustrated its dimensions from a manufacturing perspective were included.

- Year of Publication – Studies were retrieved that were published in the period from January 1994 to May 2022.
- Language – Only studies written in English were considered.
- Publication Status – Only international peer-reviewed journal articles and books from well-established publishers in the field of sustainability and OM were included.

Study Selection

We screened about 608 studies in total. We eventually included 96 studies in our analysis based on the eligibility requirements. Fig. 1 displays our selection process. We began by screening the studies by reading the titles and abstracts. Here, we verified that our inclusion criteria—field, language, and year—had been satisfied. For instance, one of our requirements for inclusion was that the title and/or abstract mention the associated OM area. This was not the case for a lot of studies. Additionally, we discovered studies done in the service industry (e.g. hospitals and education) or other languages (e.g. Greek). Duplicates were also eliminated in this step.

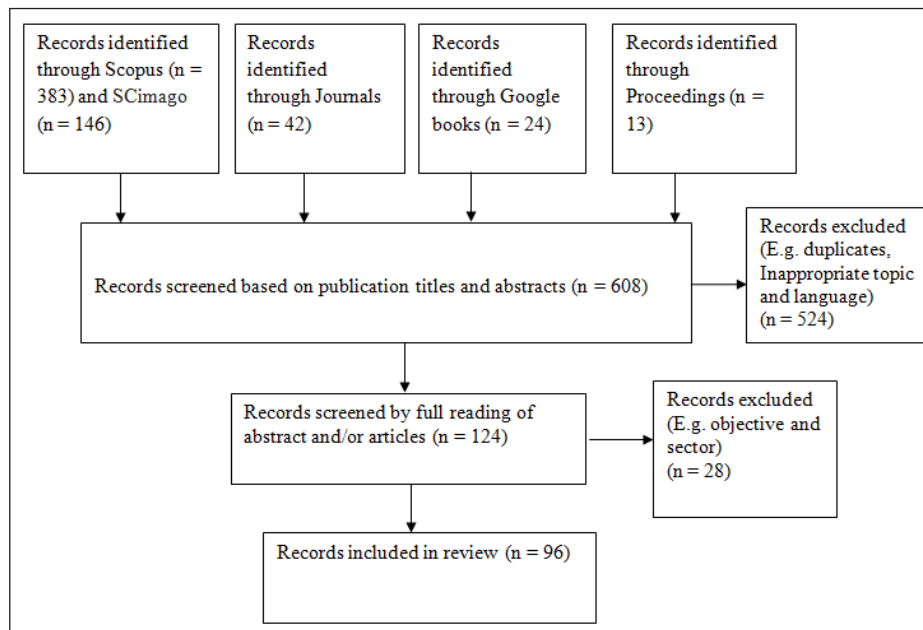


Fig. 1: PRISMA Flow Diagram

We screened studies in the second step by reading the complete abstract and/or the full text. We created a data extraction form to list the author(s), publication year, study objective, SOM area, sustainability dimension, methods used, definition(s), sample data, and findings for each empirical study. Regarding the first goal of this study, we created a tabular form to summarize the author(s), publication year, and definitions used for each theoretical study.

To address the second and third objectives of this study, for each empirical study, we developed a tabular form to summarize the author(s), publication year, the objective of the study, SOM area, sustainability dimension, methods used, sample data and findings.

Results of Systematic Review

The articles that were considered for inclusion in the systematic review were originally published in a total of 49 distinct journals. Several were published in the *Journal of Cleaner Production* (7), *International Journal of Operations and Production Management* (5), *International Journal of Production Economics* (5) and *International Journal of Production Research* (4).

When looking at the various book publishers, the vast majority of the books that were included were published by reputable publishing houses like Pearson and Palgrave Macmillan. The findings that were compiled from all of the records found indicate that the number of studies has

increased noticeably over the past few years. 39% of all of the studies that were chosen were published between the years 2017 and 2022, while the remaining studies were published between the years 1994 and 2016.

The majority of the research that was looked at was qualitative in nature (69; 72%). Quantitative studies were performed much less frequently (27; 28%).

Definitions Used for Sustainable Operations Management

In this part of the article, we will examine the different definitions that were used in the SOM studies. Table 1 demonstrates that SOM can be interpreted in a number of different ways. One of the reasons that these definitions exist is because there are many different ways to explain the concept of “sustainability.” For example, some people see sustainability as an environmental initiative, while others see it as a goal or a process, while still others see it as an integration of various aspects, and yet others consider it to be a compromise between pillars (Moldavska & Welo, 2017).

Table 1: Definitions of Sustainable Operations Management

Definition	Author(s)
SOM assimilates environmental OM principles in the decision-making process of transforming inputs into usable products. It is a strategic level of OM since it mainly focuses on product and process design.	(Gupta & Sharma, 1996)
SOM is the set of skills and notions that allow a company to arrange and manage its business processes to realize sustainable performance.	(Kleindorfer et al., 2005)
SOM is the operations strategies, tactics and techniques, and operational policies to maintain both the environmental and the economic goals.	(Gunasekaran et al., 2014)
SOM is the quest for social, economic and environmental objectives within operations of a specific firm and operational linkages that extend beyond the firm to include the supply chain and communities.	(Walker et al., 2014)
SOM refers to the principles that plan to undertake OM efficiently and successfully while emphasizing firm’s impact on the environment.	(Sharif et al., 2014)
SOM practices in manufacturing can be defined as a firm’s intra- and inter-organizational practices that combine environmental, economic and social aspects into operational and business activities.	(Hami et al., 2015)

Definition	Author(s)
SOM is the management of the transformational process to reduce resource consumption, pollution and waste while benefiting employees, customers and communities in order to reduce short-term risks and hire up long-term cash flows.	(Sanders & Wood, 2015, p. 261)
SOM is a field of research that models the quantitative aspects of business administration, which in addition to economic objectives aims equally at sustainability in the environmental and/or social sense, and applies methods from Operations Research to solving these models.	(Jaehn, 2016)
SOM comprises coordinating, integrating and directing the activities inside and outside organizational boundaries that offers the flow which fulfills the requirements of the users/consumers.	(Andersen, 2019)

Looking at Table 1, however, one may bring out the major concepts residing in each of the SOM definitions. Kleindorfer et al. (2005) recognized SOM as a set of skills to structure business processes with due regard to society and the environment. Walker et al. (2014), on the other hand, emphasize that SOM is all about the search for social, economic and environmental objectives in the internal and external operations of a firm. Likewise, Gunasekaran et al. (2014) approached SOM as an operations strategy to achieve environmental and economic goals. Andersen (2018) and Sharif et al. (2014) alternatively focus on the management aspects of SOM. Similarly, Sanders and Wood (2015) realized SOM as the management of the transformational processes to gain an economic, environmental, and social advantage. Considering all these facets of SOM, this paper operationalizes SOM as the design, planning, and control of a firm’s internal transformational processes and external activities, that is, the supply chain, to achieve economic, environmental, and social goals.

From the above definitions and discussions, it can be understood that sustainable development requires a responsible approach from OM to ensure that the natural resources and the environment which we enjoy today remain accessible to future generations (Bedi, 2013). Newer systems, skills, alternative philosophies, and approaches to several OM practices in an organization may be used to implement the SOM system (Mahadevan, 2015). Integrating SOM into the business strategy provides the means to go from reacting to government regulations and consumer expectations to anticipating future requirements and integrating them into product and process design (Gupta & Sharma, 1996). With the TBL in mind (economic, environmental, and social aspects), the

next section of this article discusses how sustainability is integrated into SOM.

OM and Economic Sustainability

The economic sustainability pillar refers to the firm's intention to undertake its business operations in a way that allows it to persist for a long period of time, thus focusing on long-term financial performance and competitiveness and cost efficiency (Corbett, 2009). According to Steurer et al. (2005), the key issues in economic sustainability are a corporation's financial performance, long-term competitiveness, and the company's economic impact on stakeholder groups. Through the achievement of sustainable operations, firms may gain economic sustainability – that is, they may obtain cost reduction and/or positive financial gains (Fernández, 2015). Since organizations use a variety of resources and engage in the design, production, distribution, recycling, and recovery of used products and services, OM practices are at the core of economic sustainability (Mahadevan, 2007).

OM and Environmental Sustainability

Historically, environmental regulations have focused on manufacturing operations (e.g., pollution control) (Hassini et al., 2012). Environmental sustainability represents the energy and other resources exploitation and the footprint organizations leave behind as a result of their operations (Fernández, 2015; Gimenez et al., 2012). It focuses on the firm's preservation of natural capital to the possible extent, thus emphasising the issue around the use of resources and emissions and the impact of the company's operations on the environment (Corbett, 2009). The concern about resources is related to the responsible use of renewable and non-renewable natural resources in procurement, product design, production, distribution/logistics and consumption (Steurer et al., 2005). Environmental sustainability, in SOM, is commonly associated with energy efficiency, emissions reduction, a decrease in the consumption of hazardous/harmful/toxic materials, waste reduction, pollution reduction, a decrease in the frequency of environmental accidents, etc. (Gimenez et al., 2012; Mahadevan, 2007).

Therefore, OM practices will have to change to address these aspects. They may have to account for the energy and other resources they use and the resulting ecological footprint they leave behind. The supply chain structure may also need some change to respond to these requirements. The new product design philosophy may also require some changes to address these. Recognition

of the relationship between manufacturing operations and the natural environment has become an important factor in decision-making among industrial societies (Rosen & Kishawy, 2012).

OM and Social Sustainability

Traditionally operations' functions revolved around manufacturing. The general perception was synonymous with a factory system that was equated with smoke-spitting chimneys, crumpled workspaces, noise, hazardous atmosphere, sweating people, layouts with poor light and ventilation, and strenuous working conditions. All these changed with rising concern for the safety and welfare of the people - social sustainability in and around the industries (Mahadevan, 2007). Social sustainability refers to an organization's ability to offer equitable opportunities, encourage diversity, promote connectedness within and outside the community, ensure the quality of life and provide democratic processes and accountable governance structures (Elkington, 1994). Social sustainability can be realised when firms assist in the preservation and creation of skills and capabilities of current and future generations, encourage health and provide equal and democratic treatment within and outside its borders (McKenzie, 2004).

OM may have a significant effect on sustainability's social dimension as it is one of the functions of an organization employing the most personnel (Gimenez et al., 2012). The social dimension of sustainability in OM consists of facets ranging from workers' well-being within a production system to the impact of a production system, such as noise, heavy traffic, and health on local communities (Taylor & Vachon, 2018). Hence, social systems considered in SOM include the staff of an enterprise, their families, the people of a certain town where the firm is operating, and all human beings on earth (Jaehn, 2016). In line with OM, the best practices as part of internalising social sustainability include better product design, improved process management, reduced packaging materials, energy conservation, safety and welfare of the workforce, improved product design to minimise material content, designing for recyclability and reuse, safe waste disposal, and better resource management (Mahadevan, 2007).

Core Areas of Sustainable Operations Management

Because they are the source of wealth and jobs in society, manufacturing operations are the heart of

industrialized society (Jovane et al., 2008). Moreover, SOM in manufacturing pursues social, economic and environmental performance both within the operations of a particular firm and operational linkages that extend beyond the firm to include the supply chain and society (Walker et al., 2014). Firms' operations, as a result, may contribute individually towards sustainable development by innovating in their products and processes so as to improve their image, mitigate the risks emanating from environmental responsibility or improve working conditions, and use raw materials more efficiently (Jiménez & Lorente, 2001).

The scope of SOM is dependent on the goals of the researcher and the problems at hand (Zhu et al., 2008; Srivastava, 2007). Since we suggest future research adopting a survey strategy to test the developed gaps, it is the interest of this paper to focus on those subfields of OM where survey research has been employed. Although sustainability can be embedded within the assorted areas of OM, few are considered decisive, thus lending themselves to be empirically tested for their relationship with sustainable performance (Swalehe et al., 2020). SOM practices adopted by manufacturers usually focus on sustainable product design, sustainable manufacturing processes, and sustainable supply chains (Millar & Russell, 2011). Likewise, as per the implication of the literature review, this paper mainly focuses on these areas considered critical for SOM practices - areas that have been empirically and relatively studied time after time. Thus, this section explains the critical aspects of SOM - sustainable product design, sustainable manufacturing processes, and sustainable supply chain management.

Sustainable Product Design

Designing a product constitutes a vital stage that determines the behaviour of the product in the later stages. SOM requires sustainable product design as this influences the TBL of sustainable performance objectives (Gunasekaran et al., 2014). Sustainable product design and development is aimed at decreasing or eradicating harmful substances, minimizing wastes, improving resource recovery, preservation and efficiency, and designing for reuse and remanufacturing, as well as adding to the sustainability aspects (Swalehe et al., 2020). From an environmental sustainability point of view, a sustainable product design is assumed to be recyclable, easily disassembled, and can be refurbished (Li et al., 2019). Designing products with ecological/recyclable materials, designing products for easy disassembly and designing products in association with life cycle analysis can ensure environmentally

sustainable product design (Mitra & Datta, 2014). Earlier, Zhu and Sarkis (2004) measured sustainable product design, particularly from an environmental and economic sustainability perspective, through the design of products for reduced consumption of material/energy, design of products for reuse, recycling, recovery of material, component parts; and design of products to avoid or reduce the use of hazardous of products and/or their manufacturing process. Moreover, the adoption of ecological design could control 80% of the product and process-related impacts on the environment (Luthra et al., 2016).

From an economic sustainability perspective, a sustainable product design is expected to significantly influence the cost of disassembly, component inspection and repair, and remanufacturing and recycling (Gunasekaran et al., 2014). The common impact that a sustainable product design has on economic performance is tied to profitability, wages, and employment (Rainock et al., 2018). For example, designing a product that does not have any toxic materials and can be disassembled easily reduces recycling costs (Waage, 2007).

Sustainable Manufacturing Processes

The manufacturing process refers to the conversion activities that transform inputs into outputs (Russell & Millar, 2014). Making processes greener and more sustainable becomes extremely important in today's manufacturing operations management (Dallinger & Kappe, 2017). A sustainable manufacturing process is one of the most important steps in SOM activities (Çankaya & Sezen, 2019). To grasp SOM, manufacturing process design has to consider waste minimization starting from the early stages of process development (Halim & Srinivasan, 2009). Jawahir et al. (2013) also noted six factors that can be regarded as significant to make a manufacturing process sustainable: energy consumption, manufacturing cost, environmental impact, operational safety, personnel health, and waste reduction. Traditionally, the design of the manufacturing process has been observed and designed in the pursuit of higher profits (Zhou et al., 2017). Currently, however, society has been developing an increasing level of awareness for environmental sustainability, and manufacturers have been realizing that economic objectives ought no longer to be their sole concern (Pinto-Varela & Carvalho, 2018). Consequently, the design of a safe, robust and cost-effective manufacturing process is essential (Dallinger & Kappe, 2017).

A sustainable manufacturing process selection and design lead to lower costs, good production environments, and green manufacturing (Zhou et al., 2017). The goal of sustainable manufacturing process design is to minimize the negative environmental, economic and social effects of processes (Gupta & Sharma, 1996). Corresponding to the three sustainability pillars, Jovane et al. (2008) suggested how manufacturing processes could cope with environmental, economic, and social challenges. From an environmental sustainability point of view, Jovane et al. (2008) stated that a sustainable manufacturing process might tackle environmental challenges through the adoption of minimal use of non-renewable natural resources and managing them in the best possible way while reducing environmental impact. It is also concerned with the reduction of energy and natural resource consumption in operations, production planning and control (Çankaya & Sezen, 2019; Corbett, 2009). The need for environmentally sustainable manufacturing process design requires practices such as reducing energy usage and resource consumption during production, reducing emissions and generation of solid and liquid wastes and using non-conventional sources of energy (Mitra & Datta, 2014). The lessening of environmental challenges, thus, requires the adoption of sustainable manufacturing (Chien & Shih, 2007). The manufacturing processes may also respond to the economic challenges of sustainability through the promotion of wealth and new services that ensure the development and competitiveness of the firm through time; the manufacturing process can also tackle social challenges by upholding the improved quality of life and social development (Jovane et al., 2008).

Sustainable Supply Chain Management

Operations can take place across multiple companies in a supply chain (Sodih, 2015), and sustainable supply chain management (SSCM) practices are getting recognition among operations managers, particularly those who are searching for sustainable performance in their operations (Islam et al., 2017). Thus, through the integration of upstream (input) and downstream (output) partners into the boundary of investigation and management, firms have started redefining the concept of OM using the supply chain perspective (Brandenburg et al., 2014). Downstream members of the supply chain include awareness level of customers, end-of-life management and association with local recycling organizations. In contrast, upstream supply chain members are vendors and suppliers, and manufacturers cannot produce sustainable products without the support of these members (Luthra

et al., 2013). Accordingly, in the past few decades, the focus on optimizing operations has moved from a specific facility or organization to the entire supply chain (Linton et al., 2007). Supply chain management is one of the elements of OM (Walker et al., 2014), as the latter, in the current context, focuses on designing and directing the overall nature of internal and external operations (Andersen, 2019).

The conversion of raw materials into more sustainable products through sustainable manufacturing processes requires careful coordination of various activities across and within the organizations that span the closed-loop supply chain (Jawahir et al., 2013). Moreover, in order for a business to stay competitive, it is inadequate for operations managers to promote sustainability only within their own company; instead, the entire companies in the supply chain have to be managed in a sustainable mode (Drake & Spinler, 2013; Tan et al., 2009). All companies, thus, throughout the supply chain, are required to apply practices and instigate activities on economic, environmental, and social aspects to maintain and enhance their sustainability performance (Tekin et al., 2015). Incorporating sustainability ideas require the modification of the supply chain for sustainability (Mahadevan, 2015). Sustainable supply chain management addresses the impact of supply chain activities on the level of environmental or social sustainability efforts and practices throughout the supply chain (Taylor & Vachon, 2018). Green supply chain management and sustainable supply chain management (SSCM) are the accustomed interchangeable labels for the concept of sustainability in the supply chain. This study labels the concept of sustainability in the supply chain as sustainable supply chain management – a label that has received popularity over recent years in the OM literature (Taylor & Vachon, 2018). Through the use of literature, this paper recognizes four sustainable practices such as sustainable warehousing (Abdul-Rashid et al., 2017; Tekin et al., 2015), sustainable packaging (Agostini et al., 2017; Tekin et al., 2015; Ninlawan et al., 2010), reverse logistics (Abdul-Rashid et al., 2017; Ninlawan et al., 2010; Rao & Holt, 2005) and sustainable purchasing (Agostini et al., 2017; Abdul-Rashid et al., 2017; Luthra et al., 2016; Tekin et al., 2015; Ninlawan et al., 2010; Rao & Holt, 2005) to achieve sustainability in supply chain management. As in Islam et al. (2017), this study merges “end-of-life practices” with “reverse logistics” “end of life practices”.

One of the core elements within the supply chain is warehousing (Tan et al., 2009). It comprises the process of receiving, storing, retrieving and shipping raw

materials, work in process or final products (Indrawati et al., 2018). Warehousing has a significant influence on the goals of sustainable development (Amjed & Harrison, 2013; Tan et al., 2010). For the sake of minimizing cost and energy, many firms have gradually understood the criticality of sustainable warehousing (Islam et al., 2017). A sustainable warehouse practice is a set of organizational and technological solutions intended for the efficient realization of the warehouse process while preserving the maximum social standards and minimizing the environmental impact with regard to financial efficiency (Malinowska et al., 2018). It includes activities, such as terminal and warehouse location and development of efficient routes for proper storing and disposing of hazardous materials, donation of excess or obsolete inventory to local communities, and training in how to safely operate material handling equipments and ensuring that employees use personal safety equipment (Abdul-Rashid et al., 2017; Zailani et al., 2012; Carter & Jennings, 2002). Similarly, according to Tekin et al. (2015), sustainable warehousing includes choosing the location of warehouses that considers all relevant environmental and social issues, providing healthy and safe storage for products, storing hazardous material without threatening the environment, and offering spare or extra materials for the benefit of the society. Through the review of literature, Islam et al. (2017) also Identified three practices of sustainable warehousing, namely, a decrease in inventory levels, investment recovery sale of excess inventories/materials, and sale of excess capital equipment.

Thus, sustainable warehousing practices and decisions consider economic, environmental and social issues when aiming to achieve higher sustainable performance in supply chain management sustainability (Ishizaka et al., 2020).

Since purchasing plays a major role in supply chain operations, this function earns more attention from the perspective of SOM (Gunasekaran et al., 2014; Laosirihongthong et al., 2013). Purchasing can contribute to sustainability by addressing issues such as the reduction of waste produced, material substitution through environmental sourcing of raw materials, and waste minimisation of hazardous materials (Rao & Holt, 2005). Moreover, sustainable purchasing can be a vital activity to extend the sustainability concept to the suppliers as it selects the right suppliers that also implement sustainability concepts in their own processes (Tekin et al., 2015). From an environmental point of view, purchasing strategies arguably orbit around two important issues, the

evaluation of suppliers' environmental performance and mentoring to aid suppliers to improve this performance (Mitra & Datta, 2014; Rao & Holt, 2005). Moreover, Selecting the right supplier and managing the purchasing process by implementing a strategic and collaborative understanding with the suppliers have a significant effect on meeting a company's sustainability goals (Çankaya & Sezen, 2019). Sustainable purchasing allows firms to pursue key environmental information from suppliers, which in turn instigates suppliers to be more oriented towards sustainable practices (Baah & Jin, 2019).

From the TBL perspective, Mann and Kaur (2019) explained sustainable purchasing as an activity to procure goods and services from local and small producers. The authors further noted that sustainable procurement from local and small organizations would have a positive impact on the economic and environmental performance of sustainability as it may result in less transportation and, therefore, less pollution; at the same time, purchasing from local suppliers may positively influence the society through the generation of employment for the local workers (Mann & Kaur, 2019). Sustainable purchasing is all about taking social aspects (i.e. issues such as ethical sourcing, human rights and employee conditions) and environmental aspects (i.e. the environment that the product has over the entire value chain) into consideration alongside economic aspects in making purchasing decisions (Renukappa et al., 2016).

Packaging characteristics such as shape, size, and materials have an impact on the management of supply chains as they particularly influence the transport characteristics of the product (Ho et al., 2009; Ninlawan et al., 2010). Due to its waste, the packaging does not only serve to protect the main product but is also expected to be environmentally friendly to reduce environmental problems (Auliandri et al., 2018). In this sense, packaging should be sustainable. That is, it should adopt sustainable design and use sustainable materials while invariably keeping in mind that products must be effective and safe for human health and the environment (Wandosell et al., 2021; Pauer et al., 2019). Sustainable packaging is showing a progressively important part in greening the supply chain (White et al., 2014). According to Gustavo et al. (2018), sustainable packaging is defined as one that uses clean production technologies; renewable energy; healthy materials; is physically designed to optimise materials and energy; is beneficial, safe and healthy for both individuals and communities; and is able to be effectively recovered and utilised in biological and/or industrial closed loop cycles. Because sustainable packaging provides product

safeguard, waste prevention, operational efficiency, and safe use, packaging can make a valuable contribution to the TBL of sustainable performance (Norbisimi Nordin & Selke, 2010). Sustainable packaging practices require the use of minimal and lightweight packaging materials and should not have any unfavourable impact on the environment. It should also be recyclable and biodegradable (Mitra & Datta, 2014). From an economic sustainability point of view, sustainable packaging should reduce materials usage, increase warehouse and trailer space utilisation, and reduce the amount of handling required (Ho et al., 2009; Wu & Dunn, 1995).

The other significant practice of SSCM is reverse logistics (Islam et al., 2017; Rao & Holt, 2005). Because it combines environmental, economic and social factors, reverse logistics plays an important role in improving the environmental, social and economic performance of supply chain management (Simões et al., 2017; Mutingi, 2014). Unlike logistics, which is a forward activity to deliver goods from manufacturers or distributors to customers, reverse logistics is a term used to represent the movements of goods back from customers to manufacturers or distributors (Islam et al., 2017). It is also defined as the process by which a manufacturer systematically retrieves formerly dispatched products or parts from the point-of-consumption for possible remanufacturing, recycling or disposal (Dowlatshahi, 2010). Moreover, reverse logistics refers to a group of manufacturers' responsibilities that include collection, transportation, inspection, recovery and/or disposal of returns (Mitra & Datta, 2014; Ninlawan et al., 2010). It is the process of repossessing the product from the final consumer for the purposes of capturing value or appropriate disposal (Ho et al., 2009). This practice of SSCM, accordingly, has been a key solution to OM to recollect defective and unused items from the customers (Islam et al., 2017).

Reverse logistics practices that have been identified in previous studies include proper disposal of returned products, training of employees on new recovery methods in order to reduce the destruction of returned products without trying to recapture the value associated, recapturing value from returned products, and product collection (Simões et al., 2017). Lai et al. (2013) identified six broad aspects of practising reverse logistics, which embrace waste management, recycling, reuse, reprocessing, materials recovery, and design for reverse logistics. According to Dowlatshahi (2010), a reverse logistics system constitutes a sustainable supply

chain to systematically manage the flow of parts and products destined for remanufacturing, recycling, or disposal activities. Mitra and Datta (2014) outlined the dimensions of reverse logistics that include awareness and cooperation of customers, centralized/decentralized facility for collection/inspection/recovery, integration of recovery activities with normal production operations or outsourcing of product recovery to third parties, environment-friendly disposal of returns and pricing and market for recovered products. Reverse logistics includes things with regard to the post-use processes such as recovery, reuse, repair, disassembly, remanufacturing and recycling that came together with all associated facilities (e.g. collection and inspection centres), transportation and operations (Varsei, 2017). Through the review of literature, Islam et al. (2017) also identified the practices of reverse logistics as the recovery of the company's end-of-life items, resale or reuse of used parts or components, obsolete items being used or replaced, and recondition and refurbishing of used parts or components.

Empirical Outcomes of Sustainable Operations Management Practices

Although few were studied in Africa, most SOM and related research have been conducted in Europe and Asia regions to examine the integration of environmental concepts and OM. From the empirical review (see Table 2), one can realize that several researchers have investigated the relationship between some aspects of SOM practices with one or some of the dimensions of sustainable performance of manufacturing firms, albeit conclusive results have not yet been yielded. This lack of an apparent relationship between SOM adoption and improved performance results has become a barrier for manufacturing companies that seek to justify SOM implementation. Moreover, the above systematic literature review indicates that empirical studies on sustainability have been extremely dominated by the environmental pillar of sustainability performance, and there seems to be little empirical data with regard to the implementation of social sustainability in manufacturing operations. It can also be noted that the impact of SOM on sustainable manufacturing performance has not been thoroughly researched in third-world countries. Thus, the literature has yet to furnish an accepted explanation of whether a positive relationship exists between SOM Practices and firm performance.

Table 2: Summary of Selected Empirical Studies Investigating the Effect of SOM Practices on Sustainable Performance of Manufacturing Firms

Author	Objective of the Study	Sustainable Manufacturing OM Area	Sustainability Aspect	Methodology	Sample Data	Findings
(Adebambo et al., 2015)	To investigate the influence of sustainable environmental manufacturing practices on firm performance.	Production process	Environmental and economic	A survey questionnaire was used to collect data	Data was collected from 103 manufacturing companies in Malaysia	Significant relationship between sustainable environmental manufacturing practices and environmental performance, but could not find an evidence of a significant relationship between sustainable environmental manufacturing practices, and financial and operational performance.
(Partalidou et al., 2020)	To examine the impact of the different dimensions of corporate social Responsibility performance on the financial performance of food companies.	Not mentioned	Environmental, social and governance aspects	Secondary data source (aggregate financial index of firms)	45 food firms Listed in the Thomson Reuter Global Equity Index for the period 2012–2017 were employed.	Higher level of environmental performance, positively affect the financial performance.
Eshikumo and Odoek (2017)	To establish the relationship between green manufacturing practices and operational performance	Process Design, Modifications and Upgrades (Recycled Waste)	Economic	Secondary data was collected for a period of 4 years from 2011–2014.	A cement manufacturing firm in Kenya was chosen and because of its age, production capacity and linkage with other companies	Significant relationship between green manufacturing practices and operational performance.
Abdul-Rashid et al. (2017)	To examine the relationship between sustainable manufacturing practices and sustainability performance	Sustainable product design and development, Sustainable manufacturing process, Sustainable supply chain management, Sustainable end-of-life management	The environmental, economic and social aspects were taken into consideration simultaneously.	A survey questionnaire was prepared	443 Manufacturers with ISO 14001 certification in Malaysia.	Sustainable manufacturing process has the most significant impact on sustainability performance.
(Afum et al., 2020)	To examine the explanatory link of green supply chain integration between green manufacturing practices and sustainable performance	Green manufacturing and green supply chain integration	Economic, environmental and social	Structured questionnaires were used to collect data from (SMEs).	178 Ghanaian small and medium-sized manufacturing enterprises	Green manufacturing practices have a significant positive effect on sustainable performance

Author	Objective of the Study	Sustainable Manufacturing OM Area	Sustainability Aspect	Methodology	Sample Data	Findings
Zaid et al. (2018)	To investigate the linkage between green human resource management bundle practices and green supply chain management (i.e. external and internal practices), as well as their impact on the Triple Bottom Lines of sustainability performance (i.e. environmental, social, and economic performance).	Eco design	Environmental, social, and economic performance	A quantitative method is applied in which data is collected from a customized survey	121 firms functioning in the most Pollutant manufacturing sectors in Palestine.	Internal green supply chain management practices positively mediate between green human resources management practices and sustainable performance, whereas external green supply chain management practices mediate only the relationship between GHRM bundle practices and environmental dimension of sustainable performance
Sezen and Çankaya (2013)	To investigate the influence of green manufacturing and eco-innovation on corporate sustainability performance	Eco design and eco process	Economic, environmental, and social performance.	Data were collected through a questionnaire-based survey	53 companies from automotive, chemistry and electronic sectors in Turkey were used.	Eco-process had positive effects on corporate sustainability performance (Sezen & Çankaya, 2013). However, eco-product was not found to have a significant effect on any of the three types of performance.
(Hami et al., 2015)	To analyze the effect of Sustainable manufacturing practices on economic sustainability and the mediated effect of innovation performance.	Internal and external operations	Economic sustainability	Data were collected through a questionnaire-based survey	Data collected from 150 Malaysian manufacturers	Internal sustainable manufacturing practices have a positive effect on economic sustainability and process innovation partially mediates this internal link. However, relationship between external sustainable manufacturing practices and economic sustainability is not significant,
Yang (2013)	To investigate how a focal firm addresses all three aspects of sustainability in the supply chain.	Environmental product design, environmental process design, Quality management practices, just in time practices, Environmental Recycling Practices, and environmental management system, corporate social responsibility practices.	Economic, environmental, and social aspect.	Data were collected through email survey	212 U.S. manufacturing firms.	Firms' strategic sustainability performance is positively related to their implementation of sustainable operations management practices
Haddach et al. (2016)	To show the impact of different combinations of lean, environmental and social practices on firm financial, environmental, social, and overall performance.	Just-in-time, Kanban, total productive maintenance, environmental management, use of resources, pollution, work condition, health and security, and labor rights.	Economic, environmental, and social aspect.	Case study – interview	Three (Big, medium-sized, small firms) from Tangier Free Zone (TFZ) in southern Morocco were chosen randomly	Lean, environmental and social (LES) practices contributes significantly to sustainability performance.

Author	Objective of the Study	Sustainable Manufacturing OM Area	Sustainability Aspect	Methodology	Sample Data	Findings
Nnenna and Carol (2016)	To examine the impact of corporate social responsibility on profitability of Nigerian manufacturing firms for the period 2004 to 2013.		Economic performance	Secondary data	Data were sourced from financial statements and company's annual reports from 10 randomly selected manufacturing firms in Nigeria for the period 2004 to 2013	The result showed that with CSR, the impact of corporate social responsibility has positive and significant impact on net profit of manufacturing firms in Nigeria.
Yurdakul and Kazan (2020)	To study the effect of eco-innovation on environmental and financial performance	Eco design and eco process	Environmental and economic	Data were obtained by collecting surveys completed by	219 manufacturing companies in Turkey.	Eco-innovation has a direct effect on pollution prevention, resource saving and recycling; furthermore, it has an indirect positive effect on cost reduction and thus on economic performance.
Chien and Shih (2007)	To examine the pressures or drives to implement green supply chain management practices and the relationship between GSCM practices and environmental performance as well as financial performance were also studied.	External operations which include Green procurement practices, Establishing a control list of environmentally hazardous substances, Profiles for raw materials containing no prohibited substances, Assessment tables for the environmental management of suppliers, Green product approval data, An auditing mechanism for green management, Green manufacturing practices, Green design, Manufacturing of green products, Recovery and reuse of used products, Green products standards	Environmental and economic performance	In depth interviews and questionnaire surveys.	500 Questionnaires were sent by mail to the electrical and electronic companies in Taiwan, located in Hsinchu Science Park	Green supply chain management practices have a positive relationship with the environmental and financial performance.

Author	Objective of the Study	Sustainable Manufacturing OM Area	Sustainability Aspect	Methodology	Sample Data	Findings
Baliga et al. (2019)	To develop an integrated study which uses antecedent-practices-performance principles in order to determine the drivers of sustainable supply chain management practices, and the impact of these practices on sustainable supply chain performance.	Sustainable product design, sustainable process design, waste minimization, packaging improvement, environmentally responsible purchasing, green and reverse logistics, customer sustainability information, environmental certification Human rights, safety and health, equity and ethics, philanthropy and social welfare, employee welfare, socially responsible purchasing, customer social responsibility	Environmental, social, economic and operational performance	survey questionnaire	211 operations and supply chain managers and functional heads from the Indian manufacturing industry.	Sustainable supply chain management has a positive relationship with sustainable supply chain management performance
Agostini et al. (2017)	To examine the relationship between sustainable operations practices (SOP) and performance	Sustainable product design, Green supply chain, Cleaner production, and Reverse logistics	Environmental, economic, operational, and organizational performance	The study was conducted through a systematic literature review.	Major periodicals in the area of OM. The available databases used were Emerald, Sage, Scientific Electronic Library Online, Science Direct and Scopus	Sustainable product design practices, cleaner production, and reverse logistics were found to be positive in all categories of performance. Due to insufficient data, however, the relationship between reverse logistics and organizational performance was not analyzed. Regarding Green supply chain practices, a significant positive relationship with all performance categories was identified, except for economic performance.
Gimenez et al. (2012)	To analyze the impact of Internal and external environmental management programmes on each dimension of the triple bottom line	Internal and external operations	Environmental, social and economic performance.	Questionnaires were mailed or e-mailed to the Director of Operations/Manufacturing or the person with the equivalent position in the organization.	Sample consists of 678 manufacturing plants from 19 countries, with an average response rate of 18.3%.	The findings suggested that internal environmental programmes have a positive impact on the three components of the triple bottom line, whereas internal social initiatives have a positive impact on only two components: Social and environmental performance. Regarding the external or supply chain initiatives, the supply chain assessment has no impact on the triple bottom line, unlike supply chain collaboration which contributes to improve all three elements.

Author	Objective of the Study	Sustainable Manufacturing OM Area	Sustainability Aspect	Methodology	Sample Data	Findings
Çankaya and Sezen (2019)	To explore the impact of the dimensions of green supply chain management (GSCM) on economic, environmental and social performance.	Green purchasing, manufacturing, distribution, packaging, marketing, environmental education, internal environmental management and investment recovery	Economic, environmental and social performance.	E-mail survey	Data collected from manufacturing firms in Turkey.	Except for green purchasing, all GSCM dimensions are found to be related with at least one of the performance dimensions.
Green et al. (2012)	To empirically investigate the impact of green supply chain management practices on performance.	Internal environmental management, Green information systems, Green purchasing, Cooperation with customers, Eco-design, and Investment recovery	Environmental, economic, operational, and organizational performance	E-mail survey	Data collected from 159 US manufacturing organizations manufacturing managers.	GSCM practices by manufacturing organizations leads to improved environmental performance and economic performance, which, in turn, positively impact operational performance and organizational performance
Zailani et al. (2012)	To investigate the extent of implementation of sustainable supply chain management practices and examine the outcomes of these practices on sustainable supply chain performance.	Supply Chain Management, Purchasing, and Packaging	Economic, environmental, social performance and operational	A survey via mail was carried out	400 manufacturing firms in Malaysia	The study found that environmental purchasing has a positive effect on economic, social and operational; whereas sustainable packaging has a positive effect on environmental, economic and social outcomes.
Swalehe et al. (2020)	To examine the effect of SOM Practices on the competitive advantage of manufacturing firms in Kenya.	Product design and development, Material use, Manufacturing process, Distribution, Product use, End-of-life	Cost advantage and Differentiation advantage	Primary data was gathered using a designed questionnaire by way of 'drop and pick later' method.	A sample size of 300 Manufacturers was used.	SOM Practices lead to minimized operating costs, enhanced satisfaction of employees, and environmental improvement leading to competitive advantage.
Cousins et al. (2019)	To explore the moderating effects of two practices unique to sustainable supply chain – ecocentricity and supply chain traceability – on a firm's environmental and operating cost performance.	Internal environmental management, green purchasing, supplier selection and investment recovery	Environmental and cost-based performance	Survey were used	248 UK manufacturing firms	The results suggest that green supply chain management (GSCM) practices are associated with improvements in both environmental and cost-based performance
Rao and Holt (2005)	To identify potential linkages between green supply chain management, as an initiative for environmental enhancement, economic performance and competitiveness amongst a sample of companies in South East Asia.	Inbound logistics, production, outbound logistics, and reverse logistics.	Environmental enhancement, economic performance and competitiveness	Data collected using a structured questionnaire mailed to companies in South East Asia	A sample of leading edge ISO14001 certified companies in South East Asia	Greening the different phases of the supply chain leads to an integrated green supply chain, which ultimately leads to competitiveness and economic performance

Author	Objective of the Study	Sustainable Manufacturing OM Area	Sustainability Aspect	Methodology	Sample Data	Findings
Sarwar et al. (2021)	To investigate the impact of green supply chain management dimensions on economic, environmental, and social performance	Green purchasing, green manufacturing and remanufacturing, environmental education, internal environmental management, and investment recovery.	Economic, environmental, social performance	A survey questionnaire	A sample of 145 Pakistani manufacturing organizations	Green supply chain management practices have a positive impact on environmental, economic, and social performance.
Lai et al. (2013)	To investigate reverse logistics practices and sustainable performance	Reverse logistics	Economic, environmental, social performance	Survey data collected	Chinese export-oriented manufacturers	Reverse Logistics Practices generate substantial environmental and financial gains, but not social benefits.
Mann and Kaur (2019)	To study the impact of sustainable supply chain management on the financial performance of the firms in India. The	Sustainable Sourcing, Sustainable Procurement, Sustainable Production, Sustainable Utilization, and Resource Saving	Financial performance	Secondary data was used	data from the top 100 listed companies by market capitalization on Bombay Stock Exchange	Sustainable sourcing and resource utilization activities have a significant positive impact on the financial performance of the firm.
John (2018)	To explore the consequences of GSCM practices on the performance of manufacturing firms in Kenya.	Green procurement, green manufacturing, green distribution, reverse logistics	Cost efficiency and environmental differentiation	A semi-structured questionnaire was administered through the e-mail survey.	Manufacturing firms registered as members of the Kenya association of Manufacturers as at 2014 and the respondents were the designated heads of supply chain management of these firms.	The study found that Green Procurement, Green Manufacturing, Green Distribution and Environmentally Oriented Reverse Logistics were individually predictors of firm performance with Green Manufacturing being the most significant predictor.
Das (2018)	To investigate the adoption of Sustainable Supply Chain Management practices amongst manufacturing and process based organizations in India and its impact on firm performance encompassing all three dimensions of sustainability.	Environmental Management Practices, Socially Inclusive Practices for Employees, Socially Inclusive Practices for Community, Operations Practices, and Supply Chain Integration	Environmental Performance, Employee-centred Social Performance, Community-centered Social Operations Performance, and Competitiveness	Survey was carried out in manufacturing and process industries operating in India.	255 responses from companies engaged in manufacturing automobiles, auto-components, engineering goods, consumer electronics and electricals, IT and telecom products, textiles, consumer goods; processing steel and steel products; processing oil, gas and petroleum products; generating and distributing power etc.	An environmental management practice does not have any significant association with operations performance, nor does it result in competitiveness. Socially inclusive practices for community have significant negative association with competitiveness.

Looking at the above empirical findings conducted in the context of different countries, some found a positive and significant impact of SOM practices on achieving sustainability performance, while others didn't. For example, on one hand, Green et al. (2012) disclosed that sustainable supply chain management practices by manufacturing organizations lead to improved environmental and economic performance. Yang (2013) further confirmed that firms' strategic sustainability performance is positively associated with their implementation of SOM practices. Sezen and Çankaya (2013) also found that a sustainable manufacturing process had positive effects on corporate sustainability performance. Furthermore, Hami et al. (2015) revealed that internal SOM practices, such as sustainable product design and sustainable manufacturing processes, have a positive effect on economic sustainability.

Similarly, Eshikumo and Odock (2017) asserted as there is a significant positive relationship between green manufacturing practices and economic performance. Moreover, Abdul-Rashid et al. (2017) showed that a sustainable manufacturing process has the most significant impact on sustainability performance. Based on their empirical finding, Yurdakul and Kazan (2020) suggested that decision-makers should adopt sustainable product design due to its cost advantage. Besides, Afum et al. (2020) found that Green manufacturing and green supply chain integration practices have a significant positive effect on economic, environmental and social performances. Recently, Sarwar et al. (2021) found out that green supply chain management practices have a positive impact on environmental, economic, and social performance.

On the other hand, Zhu and Sarkis (2007) noted that implementing sustainable supply chain initiatives has no significant effect on economic performance. Similarly, Gimenez et al. (2012) found that external or supply chain initiatives do not impact the triple bottom line. Sezen and Çankaya (2013) empirically noted that sustainable product design has no significant effect on any of the three types of sustainability performance. Moreover, Hami et al. (2015) disclosed that external SOM practices, such as sustainable supply chains, have no significant relationship with the economic aspect of sustainability performance. Adebambo et al. (2015) stated that they could not find evidence of a significant relationship between sustainable environmental manufacturing practices and economic performance. Esfahbodi's (2016) findings also further suggested that the practice of sustainable product design does not necessarily lead to improved cost performance. Likewise, Agostini et al. (2017) disclosed that green

supply chain practices have no significant positive relationship with economic performance.

All in all, from the aforementioned discussions, one can realize that several researchers have investigated the relationship between some aspects of SOM practices with one or some of the dimensions of sustainable performance of manufacturing firms, albeit conclusive results have not yet been yielded (Partalidou et al., 2020; Zeng et al., 2010). This lack of an apparent relationship between SOM adoption and improved performance results has become a barrier for manufacturing companies that seek to justify SOM implementation (Zhu et al., 2012).

Conclusion and Future Research Agenda

Based on the above discussions with regard to SOM definitions and practices, two important aspects need to be highlighted. On the one hand, to achieve sustainability in their operations, manufacturing firms should engage in TBL (economic, environmental, and social issues). On the other hand, SOM extends the boundaries of the firm. It includes not only the implementation of internal sustainable practices (e.g., sustainable product design and sustainable manufacturing process) that improve the firm's sustainability performance but also the extension of sustainable practices to the supply chain that advances the firm's sustainability performance (Mann & Kaur, 2019).

From the aforementioned discussions, one can also realize that several researchers have investigated the relationship between some aspects of SOM practices with one or some of the dimensions of sustainable performance of manufacturing firms, albeit conclusive results have not yet been yielded (Partalidou et al., 2020; Zeng et al., 2010). This lack of an apparent relationship between SOM adoption and improved performance results has become a barrier for manufacturing companies that seek to justify SOM implementation (Zhu et al., 2012). Therefore, this research recommends future studies to fill this gap through the holistic investigation of the relationship between SOM practices and sustainable performance.

Besides, a systematic literature review indicates that empirical studies on sustainability have been extremely dominated by the environmental pillar of sustainability performance, and there seem to be little empirical data with regard to the implementation of social sustainability in manufacturing operations (Mesquita & Missimer, 2021; Sarwar et al., 2021; Taylor & Vachon, 2018; Das, 2018; Abdul-Rashid et al., 2017; Touboulic & Walker, 2015). This research recommends, however, a holistic and balanced approach. Thus, sustainable performance

will be examined through the consideration of all the TBL dimensions (environmental, social and economic).

The systematic literature review also suggests that the study on the effect of SOM practices on sustainable performance, thus far, is dominated by qualitative aspects. To minimize this methodological gap, this study suggests future researchers take into account quantitative aspects to arrive at empirical findings.

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