Towards a Sustainability Paradigm; The nexus between Lean Green Practices, Sustainability-Oriented Innovation and Triple Bottom Line

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Abstract

Sustainable development has become a prerequisite for any organization that ensure environmental, economic, and social sustainability during the production process. However, how lean manufacturing helps to achieve each of the three dimensions of sustainability was not adequately considered by prior studies, since one type of sustainability or the concept of sustainability as a whole has been investigated. Moreover, few studies investigated the combined effect of lean practices and Sustainability-Oriented Innovation (SOI) on each type of sustainability. Therefore, this study aims to investigate the impact of lean manufacturing practices on Triple Bottom Line (TBL) by taking SOI as a mediator. Data of 392 managers from different manufacturing organizations in Jordan was collected through well-structured questionnaire. Structural Equation Modeling (SEM) was employed to check the relationship between latent and observed variables. The results reveal that both lean practices and SOI has significant and positive effect on TBL. Although lean manufacturing focus on efficiency while sustainability-oriented innovation promotes responsiveness to customers. Besides, SOI plays a partial mediating role between lean manufacturing and sustainable development. This study provides evidence that either lean practices or SOI and their combination significantly assure sustainability. The findings will assist decision-makers, supply chain managers and academicians to understand the importance of lean practices and SOI to achieve sustainability.

Keywords: Lean green practices; Triple bottom line; sustainable development; sustainability-oriented innovation

1. Introduction

Sustainability concept has taken the world by storm soon after the World Commission of Environment and Development (WCED) has brought sustainability topic into light in 1987

(Khodeir & Othman, 2018). Sustainability has three dimensions including environmental, economic, and social dimensions. Companies are moving towards lean manufacturing to achieve sustainability goals. The notion of lean has been originated from a Japanese producer named Toyota Motor Company, focusing mainly on waste reduction during production (Herron & Hicks, 2008). The purpose of lean manufacturing is to increase the productivity and reduction in operating costs, but the three dimensional sustainability concerns including economic, social and environmental have been raised (Liu et al., 2020; Resta et al., 2016; Hao et al., 2020; Ahmad et al., 2016). Though lean and sustainability integration was previously limited to ensuring operational efficiency (Stamenkov and Dika 2019; De et al., 2020), other aspects (e.g., environmental and community concerns) should be addressed (Piercy & Rich, 2015). Moreover, the number of studies found in the field of lean and sustainable manufacturing is increasing over time (Hartini & Ciptomulyono, 2015; Martínez-Jurado & Moyano-Fuentes, 2014). Hartini & Ciptomulyono (2015) explored around 58 papers showing the association between lean and sustainable manufacturing and exploring how they affect the performance of an organization. Martínez-Jurado & Moyano-Fuentes (2014) conducted a systematic literature review to investigate the relationship of lean manufacturing, supply chain practices. However, the lack of empirical research linking lean manufacturing and sustainability necessitates further investigation (Hartini & Ciptomulyono, 2015; Resta et al., 2016; Reich-Weiser & Dornfeld, 2009). Besides, there is a clear lack of study regarding the association between lean and social sustainability (Hartini & Ciptomulyono, 2015; Martínez-Jurado & Moyano-Fuentes, 2014).

Dey et al. (2020) investigated the integrated effect of corporate social responsibility (CSR), Sustainability-Oriented Innovation (SOI) and lean manufacturing on economic performance. The results showed that both lean management and SOI significantly improved sustainability and

economic performance. SOI mediated the relationship between lean management and sustainability. However, how the three specific aspects of sustainability were related to lean management with the role of SOI as a mediator remain under-researched. Whereas Ikram et al. (2019) conducted a study to check how sustainability certifications such as ISO 14001, ISO 9001 and SA8000 help to improve international exports and develop economic sustainability. The prior studies in the same field of discipline have been conducted to investigate the impact of lean principles on organizational performance (Yang et al., 2011), financial performance (Hofer et al., 2012), sustainability performance (Burawat, 2019; De et al., 2020; Iranmanesh et al., 2019) and environmental outcome (Bandehnezhad et al., 2012). Nonetheless, these studies focused on the area regarding the impact of lean manufacturing on all the three dimensions of sustainability. Carvajal-Arango et al. (2019) reviewed a total of 117 articles and found positive associations between lean practices implemented during the construction of projects and dimensions of sustainability. However, it is necessary to extend the understanding the impact of lean practices on three dimensions of sustainability which remains unexplored (Carvajal-Arango et al., 2019; Liu et al., 2019). Moreover, only 16% of 117 articles reviewed were found to apply survey and interview methods to assess the relationship between lean and sustainability. So, more empirical investigations are needed to assess the link between lean manufacturing and each aspect of sustainability (e.g., environmental, social and economic sustainability) (Resta et al., 2016).

Many recent studies investigated the relationship between lean practices and one type of sustainability or sustainability performance as a whole concept (Bandehnezhad et al., 2012; Iranmanesh et al., 2019; Dey et al., 2020; Dieste et al., 2020; Singh et al., 2020). Along the same vein, some studies examined the relationship between SOI and sustainability performance (Adams et al., 2016; Khurana et al., 2020). Since SOI entails changing an organization's philosophy and

principles, as well as its products and operations, in order to meet sustainability goals while also achieving financial outcome (Adams et al., 2016). The synergetic effect of lean practices and SOI is a major concern for companies and studies showed that the relationship among the three constructs; lean practices, SOI and sustainability performance; still under researched (De et al., 2020; Dey et al., 2020). Besides, the results of these studies are non-conclusive which means that there should be more research in this area (Jabbour et al., 2013; Dey et al. 2019). Moreover, the relationship between the combined effect of lean practices and SOI on sustainability performance remains unexplored particularly in developing countries (Dey et al. 2019; De et al., 2020; Dey et al., 2020). As a result, this study contributes in various ways. To fill the literature gap, this study develops a multidimensional framework in a broader way to examine the integrated relationship of lean manufacturing practices and three dimensions of environmental, economic, and social sustainability. Further, this study investigates how sustainability-oriented innovation as mediator play a vital role to improve the sustainability performance of manufacturing organization in Jordan. Moreover, lean practices will lead to higher adoption of sustainability-oriented innovation, which again leads to higher sustainability performance. Finally, this study is first of its kind to investigate the impact of lean manufacturing practices on environmental, economic, and social sustainability in context of Jordan manufacturing companies as a developing country. To do, the application of structural equation modeling was used to investigate the useful connection between latent and construct variables.

The structure of paper is organized into several parts. First, a summary of the related literature is presented, followed by hypotheses and the creation of the conceptual model. Research methods are then discussed, including sampling, data collection, measurement of variables and analysis plan. Next, data analysis and findings are presented. Discussion section provides a

meaningful description of current results and their comparisons to previous studies. Finally, the paper presents a conclusion with study limitations and guidelines for future studies in the last section of paper.

2. Literature review

Complementarity theory (Nawanir et al., 2016; Inman and Green, 2018) provides the theoretical foundation for this study. Organizational competencies that improve competitiveness include lean management and SOI practices. To be executed, these will require strategic, policy, and operational involvement, because one set of practices complements the other, therefore, lean practices and SOI are complimentary. In order to accomplish efficiency, lean practices reduces all types of waste across the supply chain by implementing proper suppliers' management, internal operations, and demand management (Inman and Green, 2018). SOI stands for product, process, and organizational innovation with the goal of establishing long-term sustainability (Adams et al., 2016). Through proper trade-offs among economic, environmental, and social aspects, lean practices and SOI in combination are anticipated to assist attain higher sustainability performance.

2.1 Lean manufacturing practices

The concept of lean manufacturing practices was originally introduced by manufacturing philosophy of Toyota Production System (TPS) and have been widely used across the world. This philosophy stimulates the companies to achieve efficient level of productivity in manufacturing processes (Lee and Jo, 2007). Therefore, numerous studies identified various lean practices for manufacturing companies as shown in Table 1 (Bandehnezhad et al., 2012; Dey et al., 2020; Hofer et al., 2012; Iranmanesh et al., 2019; Resta et al., 2016; Vinodh et al., 2011; Yang et al., 2011). This was supported through a study by Carvajal-Arango et al. (2019) that conducted a comprehensive literature review to identified a total of 78 lean principles applied by the

construction industry between 1992 and 2018. The focal point of lean manufacturing is that manufacturing practices should aim at two main goals: maximizing production efficiency and eliminating waste (Lee and Jo, 2007; Rajesh, 2020). Consequently, lean manufacturing comprises on set of processes to emphasis the improvement of manufacturing systems through reduction and recycling of waste (Vinodh et al., 2011; Sartal et al., 2017). Moreover, as shown in Table 1, lean manufacturing features can be grouped into unique bundles of organizational practices (e.g. Just-in-time processes, pull approaches, human resources management) since lean manufacturing is a multi-dimensional concept. The key lean practices applied in this study were based on inline manufacturing processes, system of quality management and employee engagement (Yang et al. (2011). These three categories were almost found in each study reviewed which is presented in table 1. The first category of lean practices is Just-in-time flow that is defined as a collection of interrelated activities for controlling the flow of output or production. The second category is quality management, which refers to a series of interrelated measures to ensure the quality of the goods and equipment used to produce them. Finally, the third category is employee involvement that denotes the human aspects including lean manufacturing feature, such as structured training programs, problem-solving groups, autonomous problem solving and self-directed teams (Yang et al., 2011).

Table 1. Lean practices identified by past studies

Author	Lean manufacturing practices
Vinodh et al. (2011)	Pull approaches, cellular based manufacturing, value stream mapping, 5s, total preventive maintenance, six sigma, production planning and control, kaizen, visual controls, lean supplier networks and poka-yoke.
Yang et al. (2011)	Inline process, quality management systems and employee engagement
Bandehnezhad et al. (2012)	Process and equipment, Production planning and control, sustainable human resource practices, innovative product design, supplier engagement and customer satisfaction
Hofer et al. (2012)	External lean practices, (supplier involvement, just in time delivery, customer engagement and satisfaction, supplier involvement in product

	design and innovation) , internal lean practices (pull, flow, set up, sustainable product planning, employee involvement and total preventive maintenance).
Godinho Filho et al. (2016)	Supplier feedback, JIT delivery by suppliers, supplier development, customer involvement, internal lean practices, total quality management, inline process, reduction of managerial loss during production, assurance of quality control, employee involvement and scheduled and preventive maintenance.
Resta et al. (2016)	Just-in-time delivery, total quality management and continuous improvement, total preventive maintenance (TPM) and green human resource management (HRM) practices.
Iranmanesh et al. (2019)	Process and equipment, production planning and control, sustainable human resource practices, product development, supplier commitment and customer satisfaction.
Dey et al. (2020)	sustainable waste reduction practices, efficient productivity and continuous improvement, production planning and control, inventory management system, resource utilization and exploitation, stakeholder engagement, customer complaint mechanism, employee motivation and organization commitment, green waste management and recycling practices, wastewater treatment practices.

2.2 Sustainability-Oriented Innovation (SOI)

SOI defines as the set of processes involve in sustainable product development, to fulfill organization's social, economic and environmental commitment (Klewitz & Hansen, 2014). "SOI emphasis the organizational changes by adopting the sustainability practices in order to develop environmental friendly products, fulfill social commitment and getting additional economic returns (Ikram et al., 2020; Adams et al., 2016). Although the SOI emphasizes responsiveness and the lean concept focuses on efficiency (De et al., 2020). However, organizational capabilities including practices of lean management and SOI enable companies to become competitive in the market (Dey et al., 2020). SOI consists primarily of product innovation, process innovation and, innovation in organizations that mainly focuses on the enhancement of the organization's sustainability (Klewitz & Hansen, 2014; Wang et al., 2020). Moreover, SOI includes product

design in a way which reduces environmental harms, sustainable supply chain practices and the strategy of having an environmental management system including ISO 14000 (Dey et al., 2020).

From a systematic review of 84 research papers published between 1987 and 2010, Klewitz & Hansen (2014) came up with several findings and contributions to existing literature related to sustainability-oriented innovation. The findings of the study revealed five types of SMEs strategic sustainability behaviors including resistant, reactive, anticipatory, innovation-based, and sustainability-rooted as well as three forms of SOI including product, process, and organizational innovation. In addition, the findings showed that research on eco-innovation is stronger than innovation related to the three-dimensional sustainability (economic, social, and environmental) also known as triple bottom line approach. This emphasizes on the importance of studies that connect SOI forms with sustainability aspects. Product innovation as a form of SOI is related to development of innovative product and product design improvement. Process innovation denotes producing goods and services in a way where eco-efficiency or eco-effective can be augmented. Finally, organizational innovation includes the reorganization of company routines and processes and new ways of management. This form of innovation typically deal with individuals and the organization of work (Klewitz & Hansen, 2014). Another systematic review of 100 journal articles published between 1992 and 2012 conducted by Adams et al. (2016) reveals several observations and contributions related to SOI that is consistent with previous studies of SOI in the literature. The contribution made by their studies includes SOI's definition, how it was conceptualized, and a general inability to add practices that are more contemporary.

Thus, the study adopted SOI practices suggested by Dey et al., (2020) since most of previous studies conceptualizes SOI in terms of product, processes and practices a company must adopt in order to achieve environmental goals along with financial returns (Klewitz & Hansen,

2014; Adams et al., 2016; Wu, 2017). Companies can reflect SOI practices through eco-product designs, green supply chain operations, and adoption of environmental strategy (Dey et al., 2020).

2.3 Dimensions of sustainability

Sustainability concept has various aspects based on the context of the study, for example, Carvajal-Arango et al. (2019) conducted a research and showed that 27 topics/aspects can be applied during the construction project under the dimensions of sustainability. On the other hand, numerous studies emphasizes that sustainability concept includes three key aspects including environmental or ecological, economic and social sustainability (Martínez-Jurado & Moyano-Fuentes, 2014; Resta et al., 2016; Ikram et al., 2021) which are also called Elkington Triple Bottom Line (TBL) (Elkington, 2013). Martínez-Jurado & Moyano-Fuentes (2014) defines sustainability at the business level as "meeting the needs of a firm's direct and indirect stakeholders, without compromising its ability to meet the needs of future stakeholders." Environmental sustainability is related to emphasizing the outcome from waste disposal, consumption of energy and natural resources, whereas economic perspective of sustainability denotes enhancement of financial outcomes generated from both inner and outer stakeholders and finally, social sustainability relates to the human side which maximizes internal and external stakeholders' well-being (Martínez León & Calvo-Amodio, 2017). Wang & Dai (2018) assessed the impact of a firm's internal and external sustainable supply chain management practices on sustainability performance including environmental, economic, and social dimension. In addition, the findings show the positive effect on environmental performance and social performance through internal sustainable supply chain management practices activities. Besides, environmental and social performance are positively connected to economic performance. Piercy & Rich (2015) examined the relationship between lean operations and sustainability outcomes of the organization through a longitudinal multiyear

and multi-case analysis. The findings revealed that the effects of the lean operation on sustainability performance were not confined only to environmental sustainability. The sustainable benefits also included supply monitoring, transparency, workforce treatment and community engagement. However, various previous studies observed that specific focus on each of the aspect of sustainability remains under-researched and thus, more studies are required in this field (Burawat, 2019; Dey et al., 2020; Iranmanesh et al., 2019; Singh et al., 2020). Moreover, how sustainability is defined and measured remains uncertain (Adams et al., 2016), therefore, the present study considered each dimension of sustainability as a single construct in the model development.

Numerous studies investigated the relationship between lean practices and various sustainability aspects as summarized in Table 2. The literature synthesis of past relevant studies in Table 2 shows that two variables were emphasized in most of the review studies including lean practices/manufacturing and sustainability, few studies focused on SOI, and to the best of authors' knowledge very limited number of studies investigated the relationships between lean practices, SOI, and sustainability. As a result, this study fills this gap in the literature.

Table 2. Variables used by past studies

Author(s)	Independent variables					Dependent variable				Mediator/moderator variable					
	LP	LM	LSOI	TL	SL	EOP	FEP	SUS	MP	IL	LC	EMP	EP	CSR	GSCM
Yang et al. (2011)		√					√		√			√	√		
Bandehnezhad et al. (2012)	√					√									
Hofer et al. (2012)		√					√			√					
Burawat (2019)		√		√	√			√							
Iranmanesh et al. (2019)	√							√			√				
De et al. (2020)			√					√							

Dey et al. (2020)	√	√		√	√	√	
Dieste et al. (2020)	√		√				
Singh et al. (2020)	√				√		√

Note: LP = Lean practices; LM = Lean production/manufacturing; LSOI = Lean and sustainability-oriented innovation; TL = Transformational leadership; SL = Sustainable leadership; EOP = Environmental outcomes/performance; FEP = Financial/economic performance; SUS = Sustainability; MP = Market performance; IL = Inventory leanness; LC = Lean culture; EMP = Environmental Management Practices; EP = Environmental Performance; CSR = Corporate social responsibility activities; GSCM = Green supply chain management.

2.4 Lean manufacturing practices, Triple Bottom Line and sustainability-oriented innovation

Sustainability has various benefits which can be gained through lean practices were highlighted by Vinodh et al. (2011) including reducing the use of materials, energy use, hazardous waste, water use and so forth. Lean practices significantly influenced sustainability performance (Burawat, 2019) and organizational performance (Godinho Filho et al., 2016). Several studies were reviewed by Martínez-Jurado & Moyano-Fuentes (2014) and Martínez León & Calvo-Amodio (2017) linking the relationship between lean management and TBL. Khodeir & Othman (2018) observed a significant interaction between lean construction and principles of TBL. The sustainable performance was significantly and positively influenced by practices of lean including production planning and control, product development, supplier commitment and customer satisfaction (Iranmanesh et al., 2019). Whereas, lean practices such as green human resource practices, innovative product design, customer complaint mechanism were found to have a significant and positive impact on environmental performance (Bandehnezhad et al., 2012).

Moreover, the importance of lean manufacturing practices that they have a significant impact on financial performance (Hofer et al., 2012; Yang et al., 2011). Lean manufacturing increases efficiency and decreases a company's asset base contributing to better financial performance, thus having a positive net effect on its financial performance (Yang et al., 2011) and

this could be connected to economic sustainability aspects of manufacturing firms. Likewise, lean management has positively association with environmental practices in supply chain management which in turn affects sustainable supply chain management practices (Baliga et al., 2019). In addition to environmental and economic sustainability, ensuring social sustainability through lean practices is also essential to manufacturing firms that aim to improve sustainability performance (Iranmanesh et al., 2019). Finally, few studies investigated the relationship between lean manufacturing and SOI. It is believed that lean manufacturing practices are antecedents to SOI practices, which means that lean adoption requires to have SOI (Piercy & Rich, 2015) while a study by De et al. (2020) considered both lean and SOI as antecedents to supply chain sustainability. Based on the above discussion, the following hypotheses are formulated.

H1: Lean practices positively influence the firm's environmental sustainability.

H2: Lean practices positively influence the firm's economic sustainability.

H3: Lean practices positively influence the firm's social sustainability.

H4: Lean practices positively influence the sustainability-oriented innovation (SOI)

2.5 Association of sustainability-oriented innovation (SOI) and Triple Bottom Line

De et al. (2020) observed that jointly SOI and lean practices significantly assist an organization to achieve supply chain sustainability. As SOI focuses on responsiveness, it may not ensure economic advantages, however, environmental and social sustainability can be driven by SOI (Dey et al., 2020). They noted that jointly lean management and SOI help to achieve sustainable development through harmony between environmental, social, and economic parameters. Through a systematic literature review, past studies tried to identify the link between SOI and TBL (Adams et al., 2016; Klewitz & Hansen, 2014). Kuzma et al. (2020) investigated the effect of innovation on TBL through metanalytic approach. The study revealed that there is a significant strong association between innovation and sustainability performance. Moreover, two

types of innovation namely, economic innovation and environmental innovation found to have the strongest associations with sustainability performance. Thus, it is believed that innovation has a big influence on various sustainability aspects. According to SOI and sustainability evidence in literature the following hypotheses are formulated.

H5: Sustainability-oriented innovation (SOI) positively influence the firm's environmental sustainability.

H6: Sustainability-oriented innovation (SOI) positively influence the firm's economic sustainability.

H7: Sustainability-oriented innovation (SOI) positively influence the firm's social sustainability.

2.6 Mediating effect of sustainability-oriented innovation (SOI)

Several past studies investigated the effects of lean manufacturing on sustainability and organizational performance (Burawat, 2019; Iranmanesh et al., 2019; Dey et al., 2020). However, few studies investigated SOI as a mediator between lean manufacturing practices and various types of sustainability ((De et al., 2020; Dey et al., 2020). Moreover, Hofer et al. (2012) conducted a study to investigate the nexus between inventory leanness, lean practices and financial performance. They observed that the inventory leanness partially meditates the relationship between lean production and financial performance that could represent the economic aspect of sustainability. In addition, organization's supply chain sustainability can be enhanced by utilizing both lean and SOI (De et al., 2020). Thus, SOI should be investigated as a mediating factor between lean management practices and TBL performance (Dey et al., 2020). According to evidence from literature the following hypotheses are formulated.

H8a: Sustainability-oriented innovation (SOI) significantly mediates the relationship between lean practices and environmental sustainability.

H8b: Sustainability-oriented innovation (SOI) significantly mediates the relationship between lean practices and economic sustainability.

H8c: Sustainability-oriented innovation (SOI) significantly mediates the relationship between lean practices and social sustainability.

Figure 1. presents the conceptual framework operationalized in this study. The framework has been developed based on all previously mentioned hypotheses stated above is demonstrated below. The model demonstrates lean practices used in this study including inline processes, continuous improvement and employee engagement, which form the higher-order or second-order construct named 'Lean practices' that is considered as an independent or exogenous construct. All the three aspects of sustainability are considered as dependent or endogenous constructs. Sustainability-oriented innovation is considered as both the endogenous and exogenous construct. Moreover, sustainability-oriented innovation is taken as a mediating variable in this study to assess the indirect effects of lean practices on sustainable aspects.

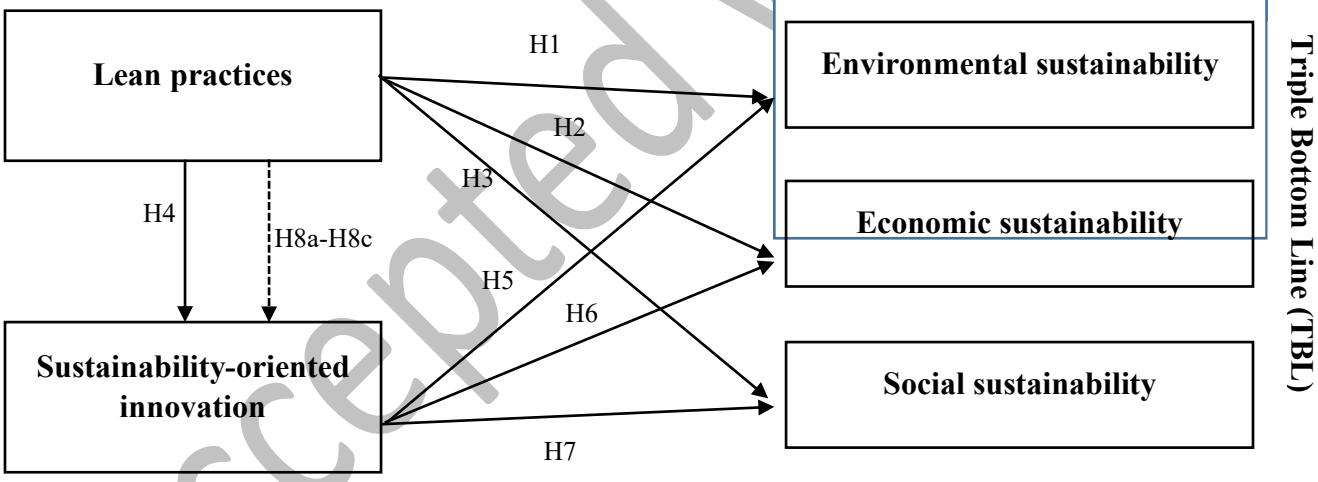

Figure 1. Conceptual framework

3. Methodology

3.1 Sampling process and data collection

The target population of this study consisted of manufacturing companies from Jordan. Supply chain managers or similar positions from production companies in Amman, Irbid, and Zarqa the largest three cities of Jordan, were included in the sampling frame. The specific manufacturing

firm was the unit of analysis in this study. According to the World Bank's collection of development indicators compiled from officially recognized sources, Jordan's manufacturing value added (percentage of GDP) was reported at 17.27 percent in 2020 (Trading Economics, 2021). Jordan's future vision for the next ten years is outlined, as is the general framework that should govern the country's economic, social, environmental, and cultural policies (United Nations, 2017). It was suggested that Jordanian businesses prioritize the development of a new business model that ensures sustainability. Furthermore, they proposed that the government provide support packages to help businesses meet the 2030 Agenda for Sustainable Development (United Nations, 2017). Among two sampling approaches (e.g., probability sampling and non-probability sampling), a convenience sampling method was used under non-probability sampling due to cost and time consideration. However, strong estimates of population parameter can also be made by non-probability sampling (Malhotra, 2010). A quantitative survey methodology was applied to conduct the study and data were collected via a structured questionnaire. Quantitative study designs allow researchers to objectively analyze the hypothesized relationships between the study constructs and generalize the sample results in a wider context (Creswell, 2009; Hair et al., 2019). The sample size has been determined based on the guidelines of Hair et al. (2019), which is 200 and greater as the number of variables and the expected number of variables increase. The sample size was calculated based on a confidence level of 95% and a margin of error of 5%, and it was estimated to be 376 companies in total (Sekaran and Bougie, 2016). Manufacturing firms were contacted to fill out an online questionnaire. 600 questionnaires were distributed and 392 were usable, representing a 65.3% response rate. Some steps have been taken to increase response rates. First, send a reminder to companies that have not responded. Second, having a short questionnaire that can be answered in 5-10 minutes is preferable; shorter questionnaires typically have higher

response rates. Finally, clear instructions and an appealing layout keep the questionnaire from appearing bulky. The survey was conducted during November 2020 to January 2021. The questionnaire is attached in appendix section (Table A1)

3.2 Developing the measurement instrument

The measurement items related to each construct were adopted from relevant past studies. As shown in Table 4, the constructs of lean principles was measured using three dimensions including just-in-time flow, quality management and employee involvement that were adopted from Yang et al. (2011). SOI was measured using five items which were adopted from Dey et al. (2020). Measurement items related to sustainability were adopted from Iranmanesh et al. (2019) where environmental and economic sustainability have six items each and social sustainability has five items. The first part of the questionnaire includes general information about respondents covering demographic variables. The second part includes questions related to the main constructs of the conceptual model: lean principles, sustainability-oriented innovation and the three dimensions of sustainability. Items of lean principles and sustainability-oriented innovation were measured on a 5-point Likert scale for the degree of implementation ranging from 1 = not at all and 5 = to a very great extent. Finally, the items of sustainability were measured on a 5-point scale to assess dimensions of sustainability ranging from 1 = strongly disagree to 5= strongly agree.

Table 4. Constructs and measurement items

Constructs	Code	Measurement items
Just-in-time flow (JIT)	JIT1	Restructuring and reconfiguring the manufacturing units based on inline processes
	JIT2	Streamlining the production units, internal suppliers-to-internal customers
	JIT3	By taking action plans to reduce managerial losses and save lead time by using different approaches top-down approach, kanban systems approach.

Quality management (QM)	QM1	Introducing the quality improvement programs such as Total Quality Management (TQM), International Organization for Standardization (ISO) 9001, quality and processes improvement trainings
	QM2	Implementation of quality control programs and tools such as Six Sigma, Kaizen, and 6s projects.
	QM3	Planning and controlling of equipment maintenance such as scheduled and preventive maintenance to avoid disruption during productions
Employee involvement (EIN)	EIN1	Implementing the employee of the month programs based on workers production performance. Actively participate the employees in the product development process.
	EIN2	Conducting the in-house training to share the importance of lean manufacturing practices.
	EIN3	Arrange the external trainings and lead certified courses to develop skills for implementing leans practices in organization.
Sustainability-oriented innovation (SOI)	SOI1	Developing the product by using the scarce resources for less resource consumption.
	SOI2	Emphasis on recycle, reuse and recovery of material for product design
	SOI3	Eliminating the hazardous substances during the product design process to reduce emission
	SOI4	Ensuring the green logistics practices such as green procurement, green transportation, and green marketing
	SOI5	Implementation of Environmental Management Systems e.g., ISO 14000, EMAS, ECO-Label
Environmental sustainability (ENS)	ENS1	Cut down the consumption of fossil fuels to reduce the emission
	ENS2	Usage of energy efficient equipment's to save energy
	ENS3	Adopting the green technology for cleaner production and less consumption of material
	ENS4	Reduction in hazardous materials consumption in product development and production process.
	ENS5	Treatment of wastewater and sludge dumping
	ENS6	Ensuring the compliance of international and local environmental laws and standards
Economic sustainability (ECS)	ECS1	Increased the market share and growth rate
	ECS2	Increased in sale growth and revenue
	ECS3	High production and improved quality
	ECS4	Increase in profitability
	ECS5	Decrease in expenditures and unit cost of production
	ECS6	Mechanism to handle customer complaints
Social sustainability (SOS)	SOS1	Improved the customer relationship through just in time delivery, and quality products
	SOS2	Improved the brand image through social commitment to society
	SOS3	Installation of health and safety equipments to provide safe and healthy work environment to employees

SOS4	Investment in community welfare operations for better living standards
SOS5	Constantly give donations to charity firms and to society in response towards the firm's action

The demographic characteristics of the respondents including gender, age, years of experience, education level, position, number of employees, and type of firms were analyzed using frequency distribution and bar chart. Figure 2 shows that the majority of the firms (17.1%) were from food and supply industry followed by plastic products (15.6%), and then chemicals (11.7%).

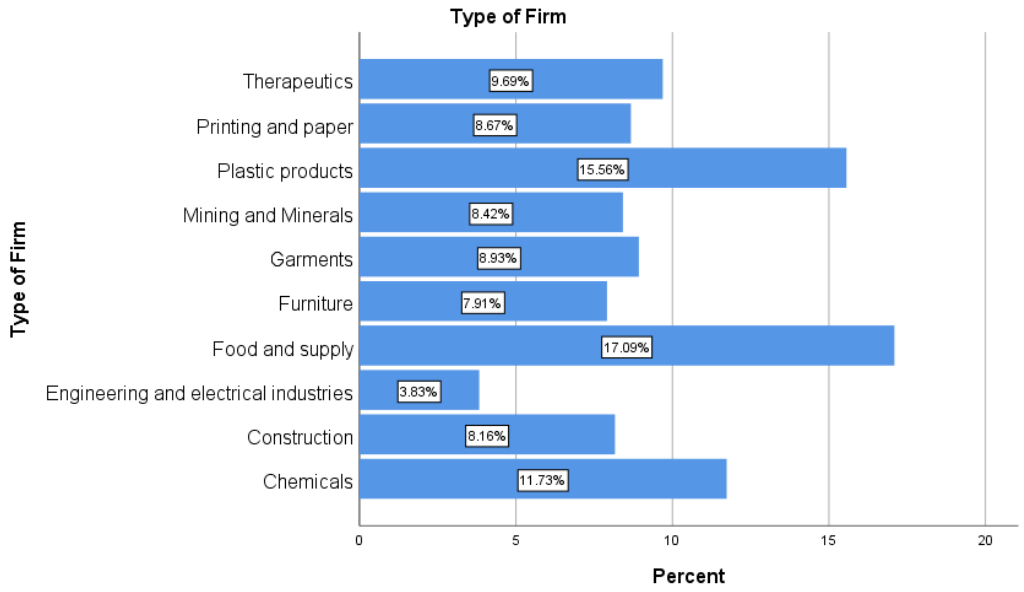

Figure 2. Bar chart (the type of firms)

As shown in table 3, the study received responses from 91.8% male respondents and 8.2% female respondents. Majority of the participants belonged to the age group 31 – 40 years (47.4%) followed by 21 – 30 years (26.3%), 41 – 50 years (15.1%) and above 50 year (11.2%). The majority of participants had experience between 5 to 10 years (40.1%) followed by respondents with more than 10 years (32.1%) and respondents with less than 5 years (27.8%). Moreover, 81.9% participants had bachelor's degree, 14.0% had master's degree and above and 4.1% had diploma degree. 71.7% of the participants were first line managers, 17.3% were middle managers and

11.0% were top managers. Finally, the sample has been classified into small, medium, and large organizations, according to the number of employees. Majority of the companies are medium-sized (49.7%) followed small companies (37.5%), and large companies (12.8%).

Table 3. Profile of the respondents

Category	Classification	Frequency (n)	Percent (%)
Gender	Male	360	91.8
	Female	32	8.2
Age	21 – 30 years	103	26.3
	31 – 40 years	186	47.4
	41 – 50 years	59	15.1
	Above 50 year	44	11.2
Years of experience	Less than 5 Years	109	27.8
	5-10 Years	157	40.1
	More than 10 Years	126	32.1
Education level	Diploma degree	16	4.1
	Bachelor's degree	321	81.9
	Master's degree and above	55	14.0
Position	First-line managers	281	71.7
	Middle managers	68	17.3
	Top managers	43	11.0
Number of employees	Less than 20	147	37.5
	20 - 99	195	49.7
	100 and more	50	12.8

3.3 Data analysis plan

Data cleaning and preparation, descriptive statistics and reliability analysis were primarily conducted using 'SPSS' version 25. Structural equation modelling (SEM) was conducted to test the conceptual model and proposed hypotheses. Analyses of SEM included measurement model evaluation, e.g., convergent validity by factor loading, composite reliability and average variance extracted (AVE), discriminants validity and model fit assessment. SEM analysis included the measurement of path coefficients, the predictive ability of the structural model and hypothesis testing.

4. Results

Data analysis and findings from a total of 392 respondents were included. Descriptive statistics of the study variables and reliability tests were run in statistical package for social sciences (SPSS) version 25. Besides, measurement model analysis, validity and model fit assessments and structural equation modelling with hypothesis testing using AMOS version 24 were also included.

4.1 Descriptive statistics

As illustrated in Table 5, descriptive statistics included mean, standard deviation, skewness, and kurtosis values of the study constructs. For each of the latent construct (e.g., just-in-time flow), single composite scores were calculated by combining the corresponding measurement items related to the latent constructs. Sustainability-oriented innovation, as shown in Table 5, had the highest mean score (M=4.19, SD=1.05). On the other hand, employee involvement (M=3.17, SD=.78) provided the lowest mean value. The other variables generated moderated mean scores.

Table 5. Descriptive statistics of survey data (N=392).

Construct	Mean	Std. Deviation	Skewness	Std. Error	Kurtosis	Std. Error
Just-in-time flow	3.97	.89	-1.71	.123	3.262	.246
Quality management	3.87	.97	-1.45	.123	2.134	.246
Employee involvement	3.17	.78	-.94	.123	.533	.246
Sustainability-oriented innovation	4.19	1.05	-1.84	.123	2.175	.246
Environmental sustainability	3.98	.92	-2.01	.123	3.589	.246
Economic sustainability	4.03	.88	-2.19	.123	3.797	.246
Social sustainability	3.88	.88	-1.75	.123	3.112	.246

As illustrated in Table 5, descriptive statistics included the sub-constructs of lean practices. The employee involvement has the lowest mean score (M=3.17) this is mainly due to lack of implementing the employee of the month programs based on workers production performance. As for quality management, the mean score (M=3.87) showed a high implementation and the main

issue that should be improved is implementing quality control programs and tools in the manufacturing companies. The just-in-time has the highest score mean as a sub-construct of lean practices (M=3.97), the high implementation is due to the action plans taken to reduce managerial losses and save lead time by using different approaches such as Kanban systems approach. SOI construct showed a high implementation score in the manufacturing companies. The most practices were observed under SOI are developing the product by using the scarce resources for less resource consumption and ensuring the green logistics practices such as green transportation. Finally, the manufacturing companies who adopted lean practices and SOI activities showed high sustainability performance. The issue of giving donations constantly to charity firms and to society in response towards the firm's action mainly contributed significantly to the performance of social sustainability. Cutting down the consumption of fossil fuels to reduce the emission contributed significantly to improve the performance of environmental sustainability. The issues related to decrease expenditures and unit cost of production, handling customer complaints and having high production with improved quality contributed significantly to the improvement of economic sustainability.

4.2 Confirmatory Factory Analysis (CFA) and goodness of fit indices (GOF)

Within the study we used Confirmatory Factor Analysis (CFA) is used to validate the items to be loaded on the specific constructs that the required theory predicts (Hair et al., 2019). Further, the goodness of fit (GOF) of the complete measurement model is examined with measurement model review (Byrne, 2013; Hair et al., 2019). We investigated the association between observed or measured variables (measurement items) and a latent variable (construct) in this study. Since the latent variable cannot be calculated explicitly, multiple variables with numerical values obtained from the research participants are used (Hair et al., 2019).

CFA has two key phases in which the measurement model is checked with appropriate GOF values in the first step. If the goodness of fit (GOF) values are not sufficient, one-factor congeneric models for individual constructs are evaluated in a completely revised model in a combined manner or modification indices are used. In the second involves the discriminant and convergent validity tests to analyze the reliability and validity of the measurement model (Hair et al., 2019).

Table 7 shows that GOF values should be satisfactory for a measurement model to be fit and valid and it contains acceptable GOF values suggested by different research.

Table 7. Goodness of fitness indices threshold values

Statistics	**Acceptable values**
The ration of $\chi 2$ to degrees of freedom ($\chi 2$/df)	≤ 3.0 or between 1.0 - 5.0
Goodness of fit index (GFI)	Values close to 0.90 or above
Adjusted goodness of fit index (AGFI)	≥ 0.80
Comparative fit index (CFI)	≥ 0.90
Tucker-Lewis index (TLI)	≥ 0.90
Normed fitness index (NFI)	≥ 0.90
Root mean square error of approximation (RMSEA)	≤ 0.08
Standardized root mean residual (SRMR)	≤ 0.09
Coefficient Alpha	> 0.60 is adequate
Standard regression weight	>0.45
Chi-square (with associated degrees of freedom and probability of significantly different)	P>0.05 (at equals to 0.05 level)

Source: Adopted from Byrne (2013) and Hair et al. (2019)

The initial measurement model will all the items were analyzed for model fit which is shown in Table 8.

Table 8. Goodness of fit indices values for the measurement models

Full measur	**$\chi 2$/df ≤ 3.0**	**P ≥ .05**	**GFI ≥ .90**	**AGFI ≥ .80**	**CFI ≥ .90**	**TLI ≥ .90**	**NFI ≥ .90**	**RMSE A**

ement models								≤ .08
Initial Model	4.411	.000	.757	.709	.908	.897	.885	.093
Final Model	2.058	.000	.882	.854	.972	.968	.948	.052

As the results were not satisfactory, modification indices were used. Modification indices of approximately 4.0 or higher imply that the fit could be substantially enhanced by freeing up the required path to be estimated (Hair et al., 2019). Table 8 compares the GOF indices between the initial model with all the measurement items and the final model after freely estimating paths with larger modification indices. The GOF indices values presents the improvement for the final complete measurement model. Further, reliability and validity of final measurement model can be tested. If the value of p is .05 or more, it is better, but the p-value can be less than .05 when the data set is small. In that case, it is suggested to calculate $\chi 2$/df value if the value is less than 3 then it can be said that the model is fit (Hair et al. 2019). In this study, $\chi 2$/df value is 2.058. According to $\chi 2$/df statistics criteria, the model is fit for the test. RMSEA is a badness of fit where RMSEA should be less than 0.08 but if it is .05 then it is best. In this case RMSEA value is .052 which is less than .08. Other GOF indices also showed acceptable results, as shown in Table 8.

Convergent and discriminant validity methods are used to check the validity of assessment model. Convergent validity is calculated by factor loading and extracted average variety (AVE) with a value greater than 0.50 (Hair et al., 2019; Ling & Ding, 2006). An AVE of 0.50 or more means that, on average, the latent construct accounts for 50% or more of the variance in the variables observed. Besides, composite reliability (CR) above 0.70 is deemed relevant (Hair et al., 2019). In table 9, factor loading, CR and AVE suggest strong convergent validity of each latent. The CR values range between 0.86 and 0.966 and fall above the suggested threshold range. AVE

values range from 0.673 to 0.906, which were above the suggested AVE threshold value of 0.50 (Hair et al., 2019).

Table 9. Assessment of convergent validity

Constructs	Items	Factor Loading	CR	AVE
Just-in-time flow	JIT1	.939	0.954	0.873
	JIT2	.958		
	JIT3	.905		
Quality management	QM1	.955	0.966	0.906
	QM2	.922		
	QM3	.977		
Employee involvement	EIN1	.775	0.860	0.673
	EIN2	.852		
	EIN3	.832		
Sustainability-oriented innovation	SOI1	.925	0.966	0.851
	SOI2	.914		
	SOI3	.924		
	SOI4	.921		
	SOI5	.927		
Environmental sustainability	ENS1	.964	0.957	0.787
	ENS2	.857		
	ENS3	.836		
	ENS4	.962		
	ENS5	.862		
	ENS6	.830		
Economic sustainability	ECS1	.924	0.944	0.739
	ECS2	.790		
	ECS3	.807		
	ECS4	.935		
	ECS5	.843		
	ECS6	.849		
Social sustainability	SOS1	.901	0.959	0.823
	SOS2	.946		
	SOS3	.915		
	SOS4	.921		
	SOS5	.848		

Since the outcomes of the convergent validity evaluation for all the constructs were shown in Figure 3. If the square root of AVE is greater than the correlation coefficients between all the constructs, discriminant validity is achieved (Fornell & Larcker, 1981). The purpose of

discriminant validity to check the high among the constructs. To attain a one-dimensional feature of the model, it also means that there should be less cross-loading. The discriminant validity support the construct by square root of the AVE value for each construct to surpass its correlation value with other constructs (Hair et al., 2019).

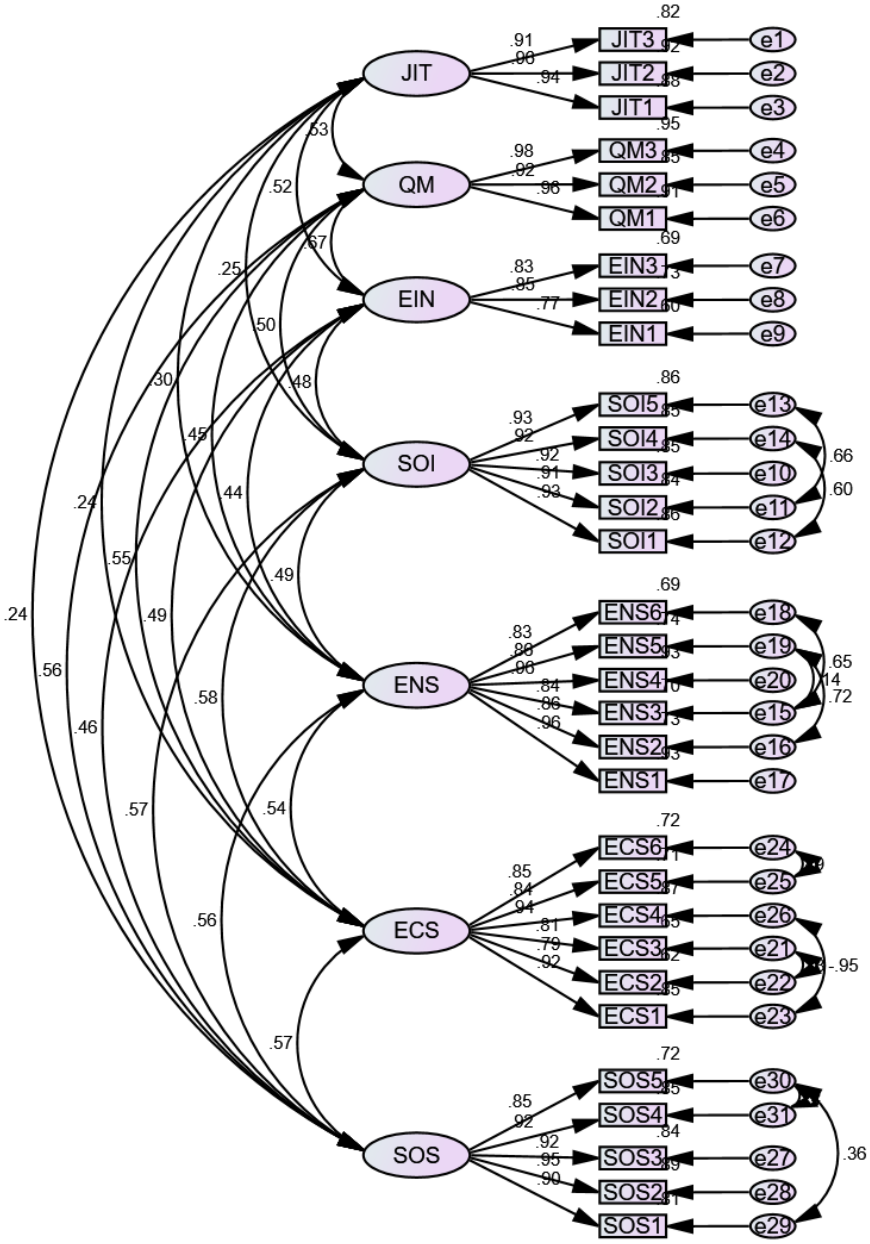

Figure 3. Measurement model assessment

Subsequent to convergent validity, the discriminating validity shows there is no high correlation values exist in construct after the evaluation of all the constructs. Table 10 reveals that all square root values of AVE were higher than all the correlations between the latent constructs. The discriminating validity of the model has thus been attained.

Table 10. An overview of discriminant validity assessment

Constructs	JIT	QM	EIN	SOI	ENS	ECS	SOS
JIT	0.934						
QM	0.534	0.952					
EIN	0.518	0.670	0.820				
SOI	0.248	0.497	0.478	0.922			
ENS	0.296	0.454	0.439	0.490	0.887		
ECS	0.241	0.554	0.487	0.581	0.543	0.860	
SOS	0.241	0.561	0.458	0.566	0.556	0.574	0.907

Note: Diagonal elements are the square root of AVE and off-diagonal elements are correlation coefficients.

4.3 Structure Equation Modeling (SEM)

SEM is used to test the hypothesis after the verification of validity of the complete measurement model (Hair et al. 2019). Analysis of the structural model accepts or rejects the mentioned hypotheses that indicate the significance of the relationship (Byrne, 2013; Schumacker & Lomax, 2004). In the process of SEM, sufficient GOF index values are needed. This analysis tests GOF values for the structural model, including $\chi 2/df$, GFI, AGFI, CFI, TLI, NFI, and RMSEA were shown in Table 11.

Table 11. GOF Values of the Structural Model

Mode	$\chi 2/df$ ≤ 3.0	P ≥ .05	GFI ≥ .90	AGFI ≥ .80	CFI ≥ .90	TLI ≥ .90	NFI ≥ .90	RMSEA ≤ .08
Final Structural Model	2.208	.000	.873	.848	.967	.963	.942	.056

The results of Table 11 suggests that most of the structural model's GOF values fall within the suggested threshold values. This demonstrates that the structural model's fitness is achieved. Therefore, the structural model can be run for path analysis as shown in Figure 4.

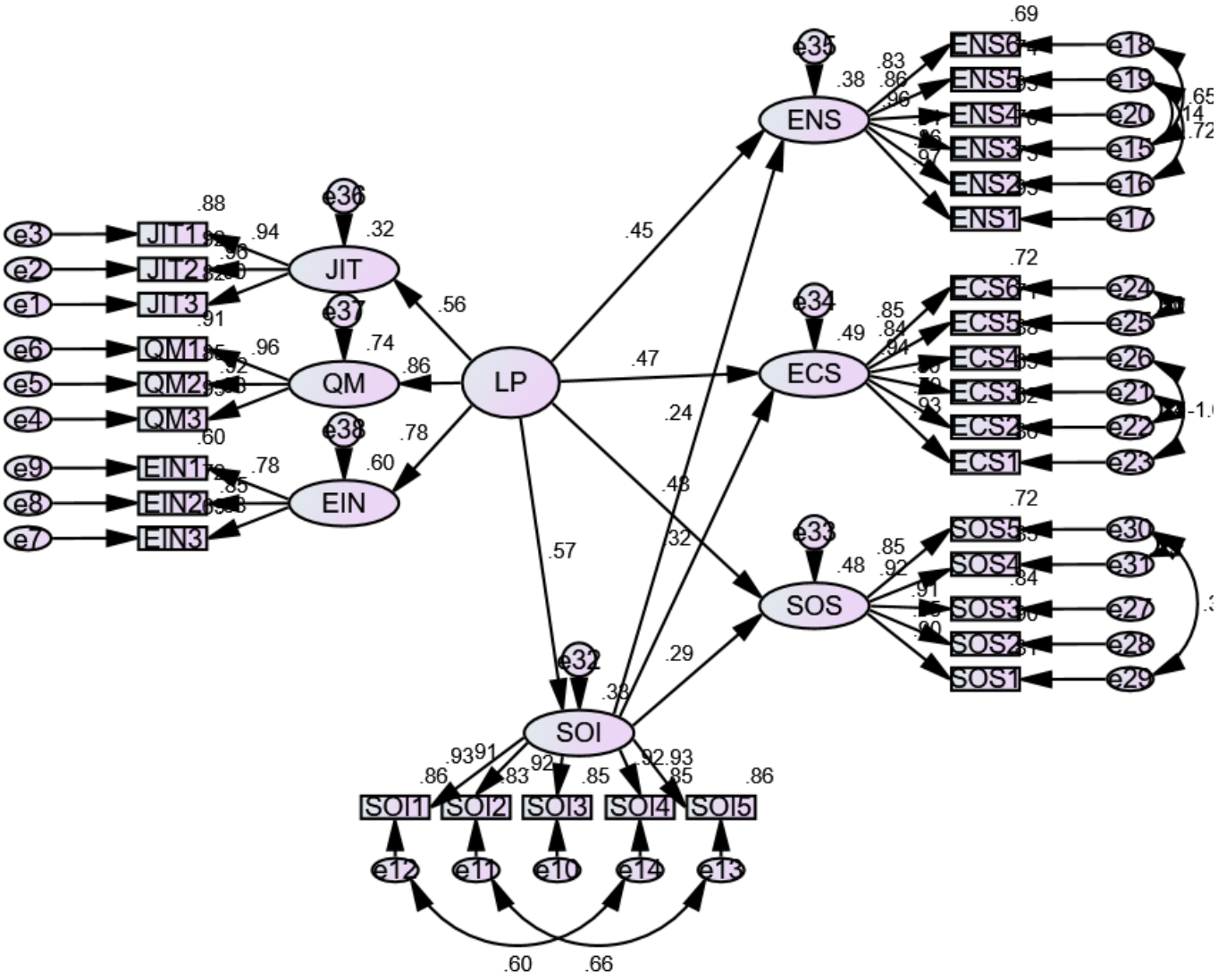

Figure 4. Structural model assessment

Different statistics including the standardized regression weight, probability (p) values and significance tests to evaluate the SEM model. The t value is statistically significant in the two-

tailed test when the p-value is smaller than 0.05 (Byrne, 2013). Table 12 shows a summary for the results of hypotheses testing.

Table 12. Summary of SEM results (Direct – Indirect)

Effects	Direct	Indirect
H1: Lean practices → Environmental sustainability	.451 (.001) **	
H2: Lean practices → Economic sustainability	.467 (.001) **	
H3: Lean practices → Social sustainability	.484 (.001) **	
H4: Lean practices → Sustainability-oriented innovation	.570 (.001) **	
H5: Sustainability-oriented innovation → Environmental sustainability	.239 (.011) *	
H6: Sustainability-oriented innovation → Economic sustainability	.315 (.007) **	
H7: Sustainability-oriented innovation → Social sustainability	.295 (.011) *	
H8a: Lean practices → Sustainability-oriented innovation → Environmental sustainability		.168 (.004) **
H8b: Lean practices → Sustainability-oriented innovation → Economic sustainability		.180 (.003) **
H8c: Lean practices → Sustainability-oriented innovation → Social sustainability		.136 (.005) **

Note: p-values in parentheses. **p<0.01, *p<0.05 based on two-tailed test; t=1.96.

In Table 12, the findings of direct effects between main constructs of the study showed that lean practice was strongly and positively linked to environmental sustainability, economic sustainability, social sustainability and sustainability-oriented innovation at p<0.01 level. Sustainability-oriented innovation significantly influenced environmental sustainability, social sustainability at p<0.05 and economic sustainability at p<0.01 level. Thus, hypotheses number including H1, H2, H3, H4, H5, H6 and H7 were supported. Moreover, lean practices had the largest effect on sustainability-oriented innovation (beta = .570) which suggest that sustainability-oriented innovation will be increased by 0.570 unit when lean practices are increased by 1 unit.

In addition, the indirect of lean practices on environmental sustainability, economic sustainability and social sustainability through sustainability-oriented innovation was also significant at $p<0.01$ level. In other words, sustainability-oriented innovation significantly mediated that relationship between lean practices and environmental sustainability, lean practices and economic sustainability, lean practices, and social sustainability. As all the direct and indirect effects were significant, it can be said that sustainability-oriented innovation had partial mediation between lean practices and sustainability dimensions. Therefore, hypotheses number including H8a, H8b and H8c were supported.

5. Discussion

This study aims to investigate the impact of lean manufacturing practices on the three-dimensional sustainability and analyzed how SOI mediates the relationship between lean manufacturing practices and sustainability. Some recent papers were reviewed (Bandehnezhad et al., 2012; Burawat, 2019; De et al., 2020; Dey et al., 2020; Dieste et al., 2020; Hofer et al., 2012; Iranmanesh et al., 2019; Singh et al., 2020; Yang et al., 2011), however, more empirical investigations are required in these fields. In addition, quantitative research did not adequately focus on how each aspect of sustainability (e.g., environmental, economic, and social) is related to lean practices and sustainability-oriented innovation. The results of the study proved all the hypotheses formulated in the conceptual model.

Results of the study revealed that environmental, economic, and social sustainability were significantly influenced by lean practices of manufacturing firms in Jordan. The findings are in line with previous studies (Bandehnezhad et al., 2012; Burawat, 2019; Godinho Filho et al., 2016; Hofer et al., 2012; Iranmanesh et al., 2019; Khodeir & Othman, 2018; Martínez León & Calvo-Amodio, 2017; Martínez-Jurado & Moyano-Fuentes, 2014; Yang et al., 2011). Still, rare studies

investigated the relationships between lean practices and SOI with sustainability dimensions. Studies supported the relationship between lean practices and economic performance (Hofer et al., 2012; Dey et al., 2020), however, the study of Pannizzolo et al. (2012) was against these results. Although, Baliga et al. (2019) found a significant association between lean management and environmental practices in supply chain management and Dieste et al. (2020) found a significant link between lean practices and environmental performance of an organization in the long run. However, the significant effect of lean practices on social sustainability in the current study is not supported by Baliga et al. (2019) who did not found any significant impact of lean management on social practices in supply chain management. Moreover, both environmental and social practices of supply chain management found to be significantly related to sustainable practices in supply chain management (Baliga et al., 2019). Moreover, studies supported the relationship between lean practices and environmental performance (Bandehnezhad et al., 2012; Dieste et al., 2020). Furthermore, significant sustainability benefits which were not limited to environmental benefits only were achieved through lean operations, as found by Piercy & Rich (2015). Therefore interrelationship between lean operation and environmental sustainability performance was established (Piercy & Rich, 2015). However, up to the researcher knowledge there are limited studies on the relationship between lean practices and social performance (Baliga et al., 2019), as most studies focused on the sustainability performance including social dimension (Dey et al., 2020; Singh et al., 2020). For example. Dey et al. 2019 and Dey et al., 2020 investigated the effect of lean practices on sustainability performance and demonstrated that the predictor of lean practices had a highly statistically significant effect on the overall sustainability of SMEs. This study supports up the previous findings, but it applies these findings to three different types of sustainability performance. Furthermore, Dey et al. 2019 and Dey et al., 2020 claimed that through

the mediation effects of process innovation, sustainability practices significantly improve the sustainability performance of SMEs. This study differs in that we demonstrated that lean practices had a significant effect on the three types of sustainability performance via the mediation effect of sustainability-oriented innovation not only for SMEs but also for companies of various sizes in a developing country context. This study differs from previous studies since it showed the effect of lean practices on each type of suitability along with the strength of their effect. The findings of this study showed that lean practices in Jordanian manufacturing firms had the highest effects on social sustainability (beta=.484) followed by economic sustainability (.467) and environmental sustainability (.451).

Since most studies investigated lean practices as a whole in the reviewed studies. This study focused on the combined effect of three categories that were common on the reviewed studies to represent lean practices for manufacturing firms. For example, Just in time, total quality management and green supply chain management had been significantly linked to each other and their combined effects on the environmental performance of organization was also significant (Green et al., 2019). However, it was indicated that, in order to improve just-in-time flow, action plans be designed to reduce managerial losses and reduce lead time by utilizing distinct quality improvement strategies. Furthermore, implementing quality improvement programs like Total Quality Management (TQM) and ISO 9001 are major considerations to consider when it comes to quality management. Employee involvement is the final aspect to consider when implementing lean processes. Employee of the month programs must be implemented in Jordanian firms based on worker productivity. Organize external trainings and lead certified courses to create skills for applying lean methods in the organization, as well as fully involve employees in the product

development process. all these findings are supported by previous studies (Yang et al., 2011; Resta et al., 2016; Iranmanesh et al., 2019; Dey et al., 2020).

The other finding of the current study suggests a significant relationship between lean practices and SOI and this was supported by the past literature (De et al., 2020; Piercy & Rich, 2015). Besides, the effect of lean practices on sustainability-oriented innovation generated the largest coefficient (beta = .570). An interesting fact that there is two different goals are achieved by lean and SOI, while lean ensures cost efficiency, SOI ensures responsiveness (Dey et al., 2020). However, the current study observes a significant positive association between lean and SOI. Besides, all the dimensions of sustainability including environmental, economic and social sustainability were significantly influenced by SOI. Similar findings are observed by other studies (Adams et al., 2016; De et al., 2020; Dey et al., 2020; Klewitz & Hansen, 2014). Dey et al. (2020) found that there were significant correlations between sustainability-oriented innovation practices and economic performance, SOI, lean manufacturing practices and sustainability performance. Kuzma et al. (2020) conducted a meta-analysis study to assess the relationship between innovation and sustainability by considering a total of 15 articles which included 37 studies. A huge total effect was found between the two constructs and the study revealed a significant association between innovation and sustainability performance. the most important issue in the context of SOI is that Jordanian companies should focus on designing products that efficiently use scarce resources, as well as assuring green logistics practices such as green sourcing and green shipping. Moreover, each aspect of sustainability including economic, social and environmental sustainability was significantly and positively related to innovation. This supports the findings of the study that showed more detailed results in that sustainability-oriented innovation largely

influenced economic sustainability (beta = .315) followed by social sustainability (beta = .295) and environmental sustainability (beta = .239).

Finally, the empirical analysis of the study also supports the mediating effect of SOI on the relationship between lean practices and sustainability dimensions. Past studies also support these results as Dey et al. (2020) found the significant mediating effect of SOI between lean and sustainability. As all the direct relationships between lean practices and sustainability dimensions are significant, SOI plays a partial mediation. In other words, lean practices solely are sufficient for the achievement of sustainable development, however, adoption of sustainability-oriented innovation will further assist to achieve higher sustainability levels (Ikram et al., 2019). Thus, the indirect effects of lean practices of manufacturing firms in Jordan on sustainability dimensions through sustainability-oriented innovation showed that lean practices had the highest indirect effect on economic sustainability (beta = .180) followed by environmental sustainability (beta = .168) and social sustainability (beta = .136). As previously said, previous studies focused on one type of sustainability or the concept of sustainability as a whole; however, this study focuses on the most significant issues that contribute to each type of sustainability in the context of Jordan as a developing country. Economic sustainability focused on the increased profitability that is linked to increasing production and improving product quality, decreasing expenditures and unit cost of production, and developing a process to handle consumer complaints. These results are supported by several studies such as (Hofer et al., 2012; Dey et al., 2020). Moreover, in the context of environmental sustainability, Jordanian companies should limit their use of fuels to reduce emissions, utilize energy-efficient equipment to help the environment, and use green technologies for cleaner manufacturing and reduced material usage in order to achieve environmental sustainability. Furthermore, assuring conformity with international and local environmental

standards to help in boosting product sales mainly in developed countries and partially in developing countries. These findings were supported previous studies of (Bandehnezhad et al., 2012; Dieste et al., 2020). Finally, a new result for this study, the findings showed that in order to increase social sustainability, Jordanian companies are improving their corporate image through donating to charitable organizations and society, as well as investing in community welfare activities.

6. Conclusion

This study concludes that environmental, economic and social sustainability are significantly improved through lean practices and SOI practices of manufacturing firms in Jordan. Besides, sustainability-oriented innovation has partial mediation between lean practices and dimensions of sustainability. In other words, the significant contribution of lean practices toward sustainability is also enhanced by the presence of sustainability-oriented innovation. This study provides empirical evidence for the study hypotheses by considering a relatively larger sample size (n=392). However, more generalization of the findings is limited due to non-probability sampling and future studies can consider a probability sampling method. This study has considered only three practices of lean including just in time flow, quality management and employee involvement and thus, future studies should consider other practices validated by past studies to extend the concept of lean practices. Besides, future studies can apply the research model in other contexts, e.g., different countries, industries and so forth. The study has several practical implications. This study is one of the few that provides practical guidance to businesses interested in improving the balance of their sustainable performance through SOI while also focusing on improving their lean practices. This study divided lean practices into three categories: just-in-time delivery, quality management, and employee involvement. It recommended that, in order to improve just-in-time flow, action

plans be developed to reduce managerial losses and save lead time through the use of various approaches such as the Kanban systems approach. In terms of quality management, implementing quality improvement programs such as Total Quality Management (TQM), International Organization for Standardization (ISO) 9001, and quality and process improvement trainings are critical issues to consider. The final issue to consider when implementing lean practices is employee involvement. Jordanian businesses must implement employee of the month programs based on worker production performance. In addition, engage employees actively in the product development process, as well as arrange external trainings and lead certified courses to develop skills for implementing lean practices in the organization.

In the context of SOI, Jordanian companies should concentrate on developing products that use scarce resources efficiently, as well as ensuring green logistics practices such as green procurement and green transportation. Furthermore, Jordanian businesses should strike a balance between the three types of sustainability in order to improve their sustainability performance. Economic sustainability is critical to a company's survival; as a result, increasing profitability is linked to increasing production and improving product quality, decreasing expenditures and unit cost of production, and developing a mechanism to handle customer complaints. In terms of environmental sustainability, Jordanian businesses should reduce their use of fossil fuels to reduce emissions, use energy-efficient equipment to save energy, and adopt green technology for cleaner production and less material consumption. Furthermore, ensuring compliance with international and local environmental laws and standards to support product sales, particularly in developed-country markets. Finally, in order to improve the level of social sustainability, it is recommended to make donations to charitable organizations and to society, as well as to invest in community

welfare operations such as increasing family benefits to workers, in order to have a better brand image through social commitment to society.

In addition, the study has several implications for academicians. First of all, the study enrich relevant literature with an empirical study that supports the hypothesized relationships in the proposed conceptual model since it has been noticed that there is a lack in empirical studies investigating the relationship between lean practices and dimensions of sustainability (Carvajal-Arango et al., 2019). Secondly, based on the results of SEM analysis, the model fit, validity and validity measures indicate a sufficient fit for the proposed model and thus, the model can be replicated in future studies. Thirdly, the past studies (Burawat, 2019; Dey et al., 2020; Iranmanesh et al., 2019; Singh et al., 2020) investigated the effects on sustainability as a whole, except some studies such as Wang & Dai (2018) who investigated the impact of internal and external sustainable supply chain management on each aspect of sustainability performances. However, the effects of lean practices and SOI on each of the aspect of sustainability remain unclear. Therefore, this study proves that each of the dimension of sustainability is significantly linked with lean practices and sustainability-oriented innovation. Lean practices have the highest influence on social sustainability and sustainability-oriented innovation has the highest influence on economic sustainability. The findings can assist supply chain managers and decision-makers in Jordan and other countries to consider these issues while planning for production, making various supply chain decisions, and improving sustainability aspects according to their importance by manufacturing firms in Jordan.

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