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The mediating role of lean operations on the relationship between supply chain integration and operational performance

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A B S T R A C T

The current study aimed at exploring the impact of supply chain internal and external integration on the operational performance of manufacturing companies operating in Jordan, as well as addressing the possibility of a mediation effect of lean operations and practises on the proposed relationship. Achieving the study objectives necessitated using the deductive approach and the descriptive survey approach. Using a well-designed questionnaire, the primary data was collected from a 315-manager sample randomly selected from the companies. Accordingly, the nature of how supply chain integration, lean operations, and operational performance impact each other was investigated. The study results revealed that integrating the supply chain both internally and externally could increase the opportunity to attain a more desirable operational performance, particularly in terms of quality performance measures. Moreover, in the vein of adopting lean practices among manufacturing companies, a positive mediation effect was found. Thus. In light of these results, it is concluded that lean operations, as a mediating variable, positively influence the association between internal and external supply chain integration on quality measures of operational performance.

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1. Introduction

Supply chain management's core rests in the manner of supply chain integration, as enterprises view this process as a vital strategy to sustain the development process. Rajagopal et al. (2016) state that supply chain management lies in integrating significant business processes, starting from the end users relying on original suppliers to deliver data, services, and products and add value to stakeholders and customers. The interest in supply chain integration has recently doubled among academics, researchers, and specialists, as it decreases the costs of transactions by incorporating inter-organizational processes and constructing longstanding relationships (Zhao et al., 2002). The supply chain integration strategy produces value for the customers of any business and attracts customers and suppliers for the process of creating value (Vickery et al., 2003). Of late, the supply chain integration's positive effect on performance is reassessed by (Das et al., 2006). Enhanced performance is not attained with the increase of the integration with traders above a particular threshold value, supporting the idea of the existence of an ideal use of integration practices (Al Dweiri & Isa, 2019; Das et al., 2006).

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In the same mood, Aljawarneh and Atan (2018) maintain that the actual contestants are supply chain integration instead of individual organizations. The supply chain integration practices impact the operational performance of industrial companies, for these practices are viewed as central to improving any company's performance (Truong et al., 2017). The supply chain administration constructed on four practices; cooperation, data sharing, long standing relationships, and process integration is significantly and positively related to the operational performance's entire dimensions, such as small and medium enterprises (Tatoglu et al., 2016; Owusu et al., 2022).

Lean operation is an operation strategy adopted to attain easy production movement by disregarding waste and improving valuable events (Aljawarneh & Al-Omari, 2018; Abdallah et al., 2023; Abdelilah et al., 2023). Adopting lean operations as a strategy assists companies to continue to have a place in the global competition (Subashini & Kumar, 2013; Solaimani et al., 2019; Rossetti et al., 2023). Overlooking the lean strategy deprives the companies of securing an opportunity in the up-to-date international competition at lower costs, quicker delivery, and higher quality (Habidin et al., 2012; Flott, 2002; Srinivasaraghavan & Allada, 2006; Rossetti et al., 2023).

Moreover, the performance of the organization is determined by the operational performance (Al-Fawaeer& Alkhatib, 2020; Alhawamdeh et al., 2023). Attaining the organizational objectives requires the operations of industrial companies to be competent, efficient, and up-to-date (Hani, 2021). Operational performance as a concept refers to the association of the entire business units in a company to make sure that the employees mutually work to achieve the objectives of any business (Yuen. & Thai, 2016). At the level of the Arab world, research work on the concepts of lean operations, operational performance, and supply chain integration, chiefly the relationships among these elements, is still little (Al-Omari et al., 2018). This article, therefore, digs into the association between operational performance and supply chain integration using the mediating role of lean operations in Jordanian manufacturing companies.

2. Hypothesis development

2.1 Supply Chain Integration

A supply chain (SC) is an interconnected sequence of procedures within and among enterprises, bringing services and products to satisfy consumers. Relating to that, the concept implicates the association of companies and enterprises consisting of sellers, providers and buyers or the end customers collaborating in various activities and processes to offer services and products related to customers with downstream and upstream nature (Masa'deh et al., 2022; Al Dweiri & Isa, 2019)

The SC aims at constructing the supply chain to make best use of its viable benefits and advantages and to achieve a mutual win-win outcome (Seo et al., 2014; Heizer, Render, & Munson, 2017). However, Supply chain integration (SCI) refers to the cooperation and interaction amongst the supply chain partners proposing to create a related network (Huang et al., 2014). Alternatively, Long (2014) relates a supply chain network to a network system with complex inputs and outputs, where the input elements are converted into output elements using the network structure objectives. Hence, supply chain integration can be viewed as the degree of the manufacturer's deliberately inclination to strategically collaborates with its accomplices and thoroughly manage intra- and inter-company procedures to gain efficient and competent data flows, decisions, money, services, and products to speedily customers with high level of cheap values (Flynn et al., 2010; Masa'deh et al., 2022). SCI comprises two main levels as follows: cooperation in conflict resolution and strategic collaboration among partnerships to attain jointly valuable and gainful strategic objectives based on data, contract duration (Van der Vaart et al., 2007).

2.2 Operational Performance

Operational performance as a model is the association of the entire business units in a company to make sure that the employees mutually work to achieve the objectives of the business. Operational performance revolves around the corporation's delivery time, flexibility, and order efficacy (Adams et al., 2014; Liu et al., 2016; Errassafi et al., 2019; Hani, 2021). Many researchers relate the concept to the quantifiable facets of the company's processes, such as the outcomes of the production cycle times and reliability (Abu-Taieh et al., 2022). Operational performance is also indicated as the performance of the internal operations in a company, i.e., customer satisfaction, productivity, competitive priorities, and new product development (Feng et al., 2006; Voss et al., 1997). The term is defined as the mixture of various improvements, approaches, and processes mutually making efforts to fine-tune companies in enhancing the performance of their business (Banihani & Alomari, 2014). In this article, a model that's built by Baird et al. (2011) was relied upon in measuring operational performance. According to Mohsin (2023) operational performance maintains "The measures of the quality performance consists of improved product/service quality, increased productivity, reduced costs of defects and rework, reduced delivery lead time of finished products/ services to customers, reduced customer complaints, improved customer satisfaction level and a decline in the number of warranty claims, alongside the inventory management performance; total inventory turnover, purchase material turnover, and reduced inventory obsolescence costs".

2.3 The Direct Effect of Supply Chain Integration on Operational Performance

Supply Chain Integration (SCI) combines internal and external integrations. The idea of combining both internal and external independent parties lies in leveraging the level of information sharing, coordination, integrating information systems and collaboration aiming at achieving superior performance (Masa'deh et al., 2022). Internal integration includes incorporating the processes and flows of the manufacturing company (Errassafi et al., 2019). Yu et al., 2013 stated that most companies start with internal integration and successively focus on external integration. Internal integration is defined as the company's ability to enhance organizational procedures, practices, and strategies coordinated to guarantee their ability to create value for the customers of the company (Banyhamdan et al., 2020). More notably, internal integration lies in integrating the departmental activities and functions to enhance performance in the related departments, raising the level of service provided, and guarantee a reasonable advantage (Flynn et al. 2010; Basnet 2013).

The implementation of supply chain internal integration qualifies corporations to gain the objectives of the operational performance relating to inventory performance and quality performance. In this regard, it is postulated that effective collaboration between various departments (e.g., IT, R & D, Purchasing, marketing) can assist companies in responding quickly to changing consumer expectations and develop operational performance, including cost, quality, delivery and flexibility (Droge et al., 2004). Moreover, a number of studies have investigated how to boost the overall efficiency of SC and concluded that integrating SC has a direct effect on improving SC structure by making less operating expenses (Rindfleisch, 2020; Um & Kim, 2019; Rosenzweig et al., 2003).

Therefore, it is postulated that:

H_1: *Operational performance is positively impacted by the supply chain integration in manufacturing companies.*

H_{1a}: *Quality performance measures are positively impacted by the supply chain internal integration in manufacturing companies*.

H_{1b}: *Inventory management performance is positively impacted by the supply chain internal integration manufacturing companies*.

Being a second element of supply chain integration, external integration speaks of the bringing together of operational practices and procedures in the company and among partners using a binary viewpoint consisting of integration of supplier and customer as well (Agyei-Owusu et al., 2022; Petersen et al., 2005; Flynn et al., 2010). The supply chain external integration embodies the supplier's partnership degree with its external associates to construct inter-organizational processes, procedures, and policies into cooperative and coordinated strategies. Moreover, supply chain integration positively impacts the improvement of the corporation's performance and reasonable advantage (Stank et al., 2001; Danese & Romano, 2010). External integration helps in furnishing the internal integration with essential customer-oriented support, qualifying the company to control and plan the transportation process so that the market needs are properly met (Ji et al., 2019). Therefore, it is essential to have external and internal integrations to guarantee a coordinated and continuous flow of resources across and within the supply chain, chiefly in industrial companies (Sundram et al., 2019). This can lead to improving the ability to communicate and share information (Masa'deh et al., 2022). Employing supply chain external integration enables companies to gain the goals of the operational performance associated with inventory and quality performance.

H_{1c}: *Quality performance measures are positively impacted by the supply chain external integration manufacturing companies.*

H_{1d}: *Inventory management performance is positively impacted by the supply chain external integration manufacturing companies.*

2.4 Lean Operations' Mediating Effect

Lean operation is a manufacturing-based philosophy concentrating on supplying the customers with a product with a high quality, no delay, and low price (El Nsour, 2021; Hopp & Spearman, 2021; Liker & Wu, 2000). As stated by Worley (2004), the lean operation requires the entire members in all departments of the value stream to systematically remove the various wastes (Mahafzah et al., 2020). Reducing the intensity of waste can be achieved in many forms, for instance, by abbreviating inventory, business process flow rates, or non-value-added activities (Rossetti et al., 2023).

Lean operations are also viewed as diminishing the level of inputs in the production structure for a specified output level by taking the wastes out of the structure (Lewis, 2000; Al-Da'abseh, et al., 2018; Hani, 2021). The manufacture-based lean system is a group of techniques approved to classify wastes so that they are removed (Anvari, et al., 2010). In other words, Womack et al. (1990) asserted that once the lean approach is adopted, all matters and things in the entire industry-choices are changed for consumers, the work character, and manufacturing fortune by uniting the profits of huge capacities and production.

The manufacture-based lean system consists of various procedures and practices to furnish customers with improved efficacy, awareness, and quality (Rose et al., 2014). More than nine rules relating to lean operations execution were designed based on

preceding studies and research in manufacturing work; these practices and standards are utilized for future analyses about implementing lean approach (Yadav et al., 2010; Chaple et al., 2014). Accordingly, it is possible to analyze the association between operational performance and supply chain integration using diverse practices of lean processes (Hatamlah et al., 2023).

In this article, it is necessary to measure the level that lean operations can mediate the association between operational performance and supply chain integration, relying on the ten necessary lean principles acknowledged measuring the state of implementing the lean processes in the companies (Shah & Ward, 2007). Thus, it is postulated that:

H_2: *Lean operations are positively impacted by the supply chain integration in manufacturing companies.*

H_{2a}: *Lean operations are impacted by the supply chain internal integration*.

H_{2b}: *Lean operations are affected by the supply chain external integration*.

H_3: *Operational performance is positively affected by lean operations in manufacturing companies.*

H_{3a}: *Quality performance measures are positively affected by the lean operations.*

H_{3b}: *Inventory management performance is positively affected by the lean operations.*

H_4: *Lean operations mediate the association between supply chain internal and external integration and operational performance in manufacturing companies.*

H_{4a}: *Lean operations mediate the impact of the supply chain internal integration on quality performance.*

H_{4b}: *Lean operations mediate the impact of the supply chain internal integration on inventory management performance.*

H_{4c}: *Lean operations mediate the impact of the supply chain exernal integration on quality performance.*

H_{4d}: *Lean operations mediate the impact of the supply chain external integration on inventory management performance.*

2.5 Conceptual Framework

Several academics have focused attention on the mediating effect between a dependent and an independent variable. Therefore, this present research is designed to examine the effect of supply chain internal and external integration on operational performance by addressing the lean operations' mediating role in Jordanian manufacturing companies; the relationships combining these three variables are studied in a 2-by-2 method as a first step. Secondly, it was necessary to evaluate the lean manufacturing principles' mediating role in the relationship of the other two variables. With the nature of the three variables, the model adopted in this research is shown in Fig. 1.

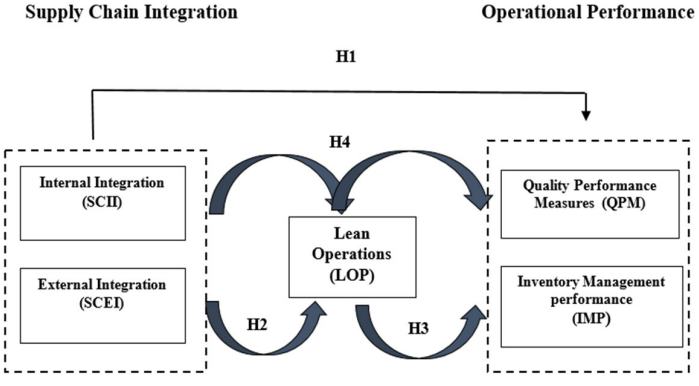

Fig. 1. Research Conceptual Model

3. Method

The nature of this study as applied-descriptive research requires the study model to be interpretive. Attaining the findings by constructing the approved realities also necessitates adopting the deductive approach. Additionally, an investigation with a holistic and detailed perspective is also assumed to make the analysis method and use the quantitative method (Al-Share et al., 2020). Being a study with field research, the descriptive survey is employed as the research strategy. Besides, the 4-set questionnaire is used to collate the data (Al-Bourini et al., 2020). Set (1) consists of the demographic characteristics of the

participants: age, education, position, and experience. The 16-indicator model demonstrating supply chain outer (supplier) integration and supply chain inner integration was based on Errassafi et al. (2019) and used to construct the items in set (2).

Likewise, the 10-factor model measuring the lean operations by Shah and Ward (2007) is adopted to structure the ten items in set (3). What is more, the research of Baird et al. (2014) measuring the operational performance is used to design the ten items in the set (4). The 5-point Likert scale was utilized to measure the entire constructs with a score system of very low -1, low -2, medium -3, high -4, and very high -5 in a row. The study population consists of all managers employed in Jordanian manufacturing companies operating in different sectors (construction, cosmetics, pharmaceutical and chemical, lastly, plastic and rubber), with a study sample consisting of (380) randomly selected managers; the utilized sampling process was targeted at collecting data from managers who are held accountable for their actions toward supply chain operations and logistical functions, as also as in procurement practices. Out of the 400 managers sample, 373 agreed to participate in the study. Hence, a total of 373 questionnaires were disseminated; however, 315 questionnaires have been returned, and a bundle of 11 questionnaires were removed due to lack of information; the remaining 304 questionnaires were used to conduct the analysis, demonstrating an 80% response rate. Notably, the 1-industry focus enables to give a better insight into the practices and processes, facilitating the company-based comparison (Tsikriktsis, 2007).

3.1 Data Analysis & Hypotheses Testing

Inferential and descriptive statistics are used to analyze the collated data. One Sample T-test is also employed to analyze the research hypotheses and data and pinpoint the position of the research variables. In the meantime, the selected model is measured with the use of the confirmatory Factor Analysis (CFA). The data normality is tested with the help of the (K-S test) the Kolmogorov-Smirnov test. Lastly, the hypotheses testing process relies on the use of Structural Equation Modeling (SEM) and Spearman's Ranks Correlation Test after approving the applied scale. Thus, PLS and SPSS programs are utilized in the required analyses. The statistical correlation techniques, i.e., linear regression, are utilized to analyze data.

4. Findings

4.1 Participants & Demographic Characteristics

Table 1 gives a thorough insight into the demographic characteristics of the selected 304 participants.

Table 1
Participants' Profile (N = 304)

Variable		Frequency	Percentage
Age	Less than 30 years	12	4
	30-40	78	26
	41-50	100	32
	More than 50	114	38
Education	Bachelor	236	78
	Master	49	16
	Doctorate	19	6
Position	General Manager	180	59
	Vice Manager	25	8
	Department Head	99	33
Experience	Less than 5 years	68	22
	5 – Less than 10	74	25
	More than 10	162	53

Table 2
Study Variables' Descriptive Statistics

Variable	Components	Mean	STD
Supply Chain Integration	Internal	4.69	0.58
	External	4.61	0.69
Lean Operations	1. Supplier Feedback	4.36	0.52
	2. suppliers' Delivery/ JIT	4.20	0.74
	3. Supplier Development	4.62	0.47
	4. Customer Involvement	4.53	0.45
	5. Pull systems	3.22	0.68
	6. Continuous Flow	4.78	0.59
	7. Reducing Setup Time	4,34	0.43
	8. Bundles of Total Protective and Productive Maintenance	4.13	0.60
	9. Controlling Processes Statistically	4.85	0.51
	10. Involvement of the Employees	4.43	0.81
Operational Performance	Measures of Quality Performance	4.52	0.49
	Inventory / Stocks Management	4.63	0.42

4.2 Study Variables' Descriptive Statistics

Table 2 demonstrates that the supply chain integration elements' mean values range between 4.61 for external integration and 4.69 for internal integration, with a standard deviation of (0.58-0.69). The mean values of the elements of the lean operations also range between the highest mean of 4.85 for Controlling Processes Statistically and the lowest mean of 3.22 for Pull systems used in preventive upkeep with a standard deviation of (0.43-0.81). Besides, the operational performance's mean value is 4.52 for quality performance measures, while the mean value for the inventory management performance is 4.63 with a standard deviation of (0.42-0.49). However, the standard deviation values demonstrate more homogeneous and rigorous data thanks to the small variability and dispersion level.

4.3 Instrument Validity & Reliability

Ensuring the construct validity necessitates using a confirmatory factor analysis (CFA). As stated by (Fornell & Larcker, 1981), discriminate validity is recognized once the average variance extracted (AVE) tops the squared correlations. Table 3 demonstrates that the entire values of the AVE ranging between (0.558) and (0.782) are higher than the squared values of correlations amongst the constructs (off-diagonal), and greater than the 0.5 threshold level offered by (Fornell & Larcker, 1981; Bagozzi & Yi, 2012). Table 3 also indicates that average shared variance and maximum shared variance (MSV) are

less than the average variance extracted, broadly supporting discriminate validity. Concerning the entire constructs, these figures' values, mentioned within the recommended levels, demonstrate satisfactory convergent validity (Hair et al., 2013). Measuring the questionnaire reliability involves using Cronbach's Alpha coefficient, as displayed in (Table 3). Each construct's reliability has Cronbach's Alpha indexes more significant than the recommended value (0.7). Thus, it is regarded as acceptable and designates that good internal consistency is employed to construct the study instrument (Hair, et al., 2013). The internal surface of the model evaluated using composite reliability (CR) embodies the measure variance's proportion thanks to the essential trait for each first-ordered construct the model has used. The entire values of the composite reliability ranging between (0.867) and (0.939) tops the mentioned 0.7 level, indicating that the model and adequate consistency are regarded reliable (Hair et al., 2013).

Table 3
Hypothesized Model Reliability & Validity Indices

Variable	Factors	Loading	Cronbach's Alpha	CR	AVE	MSV	ASV	R^2
SCII,	SCIIf1	0.669	0.901 – 5items	0.922	0.664	0.562	0.336	0.57
	SCIIf2	0.751						
	SCIIf3	0.841						
	SCIIf4	0.897						
	SCIIf5	0.911						
SCEI	SCEIf1	0.754	0.921- 5items	0.936	0.679	0.545	0.335	0.59
	SCEIf2	0.693						
	SCEIf3	0.764						
	SCEIf4	0.932						
	SCEIf5	0.941						
LOP	LOP f1	0.795	0.895- 10items	0.939	0.782	0.517	0.353	0.56
	LOP f2	0.771						
	LOP f3	0.899						
	LOP f4	0.863						
	LOP f5	0.634						
	LOP f6	0.899						
	LOP f7	0.889						
	LOP f8	0.721						
	LOP f9	0.734						
	LOP f10	0.818						
QPM	QMf1	0.921	0.854- 6items	0.928	0.586	0.512	0.329	0.53
	QMf 2	0.621						
	QMf 3	0.713						
	QMf 4	0.615						
	QMf 5	0.806						
	QMf 6	0.951						
IMP	IMf1	0.641	0.884- 6items	0.867	0.558	0.513	0.462	0.52
	IMf 2	0.885						
	IMf 3	0.894						
	IMf 4	0.658						
	IMf 5	0.747						
	IMf 6	0.667						

4.4 Model "Goodness-of-Fit" Test

Measuring a prospective Structural Equation Models' (SEM) "goodness-of-fit" can be achieved with the use of enormous methods, the most used are Parsimonious, incremental and absolute indices. According to Hair et al., 2013 and Hooper, et al., 2008 and as displayed in Table 4, 14 indices are utilized as the 'goodness-of-fit' measures in this study.

Table 4
Goodness-of-Fit Indicators of structural equation model

Measures		**Value**	**Threshold**
Parsimonious fit	Parsimonious Normed Fit Index (PNFI)	0.763	0.5 & Above
	Parsimonious Goodness-of-Fit Index (PGFI)	0.685	0.5 & Above
Incremental Fit	Tucker-Lewis Index (TLI)	0.960	0.95 & Above
	Normal Fit Index (NFI)	0.929	0.9 & Above
	Non-Normal Fit Index (NNFI)	0.948	0.9 & Above
	Comparative Fit Index (CFI)	0.939	0.9 & Above
	Incremental Fit Index (IFI):	0.942	0.9 & Above
	Relative Fit Index (RFI)	0.922	0.9 & Above
Absolute Fit	Chi-square value	742.21	
	p-value	0.000	
	Degree of Freedom	288	
	Normed Chi-square	2.29	≤ 3
	Goodness-of-Fit statistics (GFI)	0.837	≥ 0,08 0r 0.09
	Root Mean Squared Error of Approximation (RMSEA)	0.049	≤ 0.08

Table 4 presents the 'goodness-of-fit' indices' for the entire measures. And as shown above in the table, the results were very good and can satisfy the mentioned values, and therefore, this model is well-built and acceptable.

4.5 The Predictive Power of the Model

Haier et al. (2013) states that the determination coefficient $\mathbf{R^2}$ values evaluate the model's predictive power, demonstrating the variance level in the construct expounded by the model. Table 3 illustrates that 56% of the variance in lean manufacturing ($\mathbf{R^2}$= 0.56) is elucidated by the model. However, 59 % of the variance is explained in the measures of the quality performance ($\mathbf{R^2}$= 0.53), while 52% of the variance is explained in inventory management performance ($\mathbf{R^2}$= 0.52). Consequently, the resultant determination coefficients' ($\mathbf{R^2}$) emphasizes the fact that operational performance and lean operations are affected by other factors except the factors indicated in the model.

4.6 Hypotheses Testing

The procedure of PLS/ bootstrapping was employed to assess relevance and significance of the structural model's elements. Hypotheses were assessed in two clusters. Firstly, the direct effect of supply chain integration components was examined on operational performance factors, the second path focused on the indirect mediating effect of lean operation performance on the so-called relationship. Table 5 illustrates the findings of testing the study model's structural links.

4.6.1 Supply Chain Internal Integration

Table 5 demonstrates coefficient values resulting from testing the direct effect of the main hypotheses; the values indicated that supply chain internal integration significantly and statistically affects QPM (t=6.262; at $p < 0.001$) (β= 0.363), hinting at accepting the alternative hypothesis (H1a) that quality performance measures are factually affected by the practices of supply chain interior integration, and thus Hypothesis (H1a) is supported. The findings also specify that the effect of supply chain internal integration is mediated by the lean operations in measuring the quality performance (β= 0.356; t =6.124; at $p< 0.01$), and thus postulating that Hypothesis (H4a) is also supported.

In addition to that, Table 5 also points out that supply chain internal integration significantly and statistically affects (t=4.676, at $p< 0.05$) (β= 0.267) in inventory management performance, hinting at accepting the alternative hypothesis (H1b) that the supply chain internal integration impacts inventory management performance, and thus Hypothesis (H1b) is supported. The statistical findings specify that the impact of supply chain internal integration is mediated by the lean operations in inventory management performance (β= 0.372; t =6.785; at $p< 0.05$), and thus Hypothesis (H4b) is supported.

4.6.2 Supply Chain External Integration

Table 5 demonstrates that supply chain external integration significantly and statistically affects (t=7.184, at $p< 0.01$) (β= 0.365) quality performance measures, hinting at accepting the alternative hypothesis (H1c), stipulating "Supply chain external integration affects quality performance measures", and thus Hypothesis (H1c) is supported. The statistical findings point out that the impact of supply chain external integration is mediated by the lean operations in quality performance measures (β= 0.323; t =7.210; at $p< 0.01$), and thus Hypothesis (H4c) is supported. Likewise, Table (5) designate that supply chain external integration significantly and statistically affect inventory management performance (t=5.738, at $p< 0.01$) (β= 0.346), hinting at accepting the alternative hypothesis (H1d), stipulating "Inventory management performance is affected by the supply chain external integration", and thus Hypothesis (H1d) is supported. The statistical findings specify that the impact of supply chain external integration is mediated by the lean operations in inventory management performance (β= 0.345; t =6.684; at $p< 0.05$), and thus Hypothesis (H4d) is supported.

4.6.3 Lean Operations & Supply Chain Integration

Table 5 specifies that supply chain internal integration significantly and statistically affect lean operations (t=12.147; at $p< 0.05$) (β= 0.449), implying to accept the alternative hypothesis (H2a) that lean operations are impacted by the supply chain internal integration, and thus Hypothesis (H2a) is supported. Moreover, Table 5 specifies that supply chain external integration significantly and statistically affect lean operations (t=4.400; at $p< 0.01$) (β= 0.285), involving accepting the alternative hypothesis (H2b) that lean operations are affected by the supply chain external integration, and thus Hypothesis (H2b) is supported.

4.6.4 Lean Operations & Operational Performance

Table 5 points out that lean operations significantly and statistically affect measures of the quality performance (t=6.230; $p< 0.05$) (β= 0.340), implying to accept the alternative hypothesis (H3) that quality performance measures are affected by the lean operations, and thus Hypothesis (H3a) is supported. As well, Table (5) specifies that lean operations significantly and statistically affect inventory management performance (t=6.562; at $p< 0.05$) (β= 0.367), demonstrating to accept the alternative hypothesis (H3) that inventory management performance is affected by the lean operations, and thus Hypothesis (H3b) is supported.

Table 5
Direct and mediating Effect

Direct Effect					
	(β)	Standard Bootstrapping Statistics			
Hypotheses		Std. error	T	Sig.	Result
H1a SCII on QPM	0.363	0.040	6.262	p < 0.001	Supported
H1b SCII on IMP	0.267	0.036	4.676	p < 0.05	Supported
H1c SCEI on QPM	0.365	0.033	7.184	p < 0.01	Supported
H1d SCEI on IMP	0.346	0.042	5.738	p < 0.01	Supported
H2a SCII on LOP	0.449	0.020	12.147	p < 0.05	Supported
H2b SCEI on LOP	0.285	0.045	4.400	p < 0.01	Supported
H3a LOP on QPM	0.340	0.036	6.230	p < 0.05	Supported
H3b LOP on IMP	0.367	0.038	6.562	p < 0.05	Supported
Mediating Effect					
H4a SCII – LOP - QPM	0.356	0.040	6.124	p < 0.01	Supported
H4b SCII – LOP - IMP	0.372	0.037	6.785	p < 0.05	Supported
H4c SCEI – LOP - QPM	0.323	0.026	7.210	p < 0.01	Supported
H4d SCEI – LOP - IMP	0.345	0.034	6.684	p < 0.05	Supported

After evaluating the direct impact, the mediating effect of lean operations was also assessed. The bootstrapping results, as illustrated in Table 5 indicate that lean operations essentially mediated the impact of SCII and SCEI on QPM and IMP. Thus, a manufacturing company that focuses on practicing lean operations in managing its procedures, practices, and strategies, as well as its relationships with its supply chain allies, significantly elevates operational performance in terms of quality performance measures and inventory management performance.

5. Results & Discussion

The present study spotted the lights on the mediating effect of LOP on the associations between SCII - SCEI and QPM - IMP, this is of a crucial importance for manufacturing companies that are attempting to build a high ground in their aptitude of joining the universal supply chains and aiming to be vastly integrated with them.

Despite the fact that the practices of SCI are deemed as a basis of fundamental competence that help in getting competitive advantage (Abdelilah, 2023; Gilanli & Cetin, 2022; Bani hani, 2021), The present study shows that additional supply chain integration practices are necessary in the Jordanian manufacturing divisions for them to attain their required operational performance, this can be attributed to the complex nature of modern supply chains. Moreover, in the vein of the impact on operational performance, the present study findings are indicative to the emphasis placed by (Masa'deh et al., 2022; Alsafadi et al., 2020; Al Dweiri & Isa, 2019; Rajaguru & Matanda, 2018; Flynn et al., 2010; an der Vaart et al., 2007) who argued that the entire elements of supply chain integration (inner and outer) positively influence operational performance.

Likewise, the findings assert the suppositions of the study that by means of using lean operations, supply chain internal and external integrations could evidently enhance the operational performance of the reviewed Jordanian manufacturing companies; this study outcome goes in line with (Rossetti et al., 2023; Aljoghaiman et al., 2022; Gilanli & Cetin, 2022; Bani hani, 2021), The cooperation among the supply chains assists the manufacturing companies in identifying and meeting the needs of the customers. Cooperators creating mutually lean operations reduce the disruptions of the supply chain and adequately handle the market demand and its new changes. Thus, manufacturing companies deem lean operations as a competitive advantage given the highly uncertain environments of almost all manufacturing organizations in the world.
As mentioned above, placing these Jordanian manufacturing organizations on the global supply chain requires additional SCI and, therefore, extra internal and external integration practices. This explains why external integration highly impacts operational performance. Despite the significant impact of internal integration, the external integration's size effect is more significant than the internal integration (Bani Hani, 2021; Aljawarneh, 2016).
In consequence, more activities of the lean operations are incorporated into the interaction of the SCII - SCEI and QPM - IMP. With that being said, Jordanian manufacturers are encouraged by this interaction to enlarge the integration with suppliers. The findings of this empirical study demonstrate insightful evidence that supports the positive and robust relationship between operational performance and supply chain integration of Jordanian manufacturing companies and contribute to the extant body of knowledge addressing these interrelated relationships in this field (Alkhawaldah et al., 2023; Aljoghaiman et al., 2022; Bani hani, 2021; Al Dweiri & Isa, 2019; Yuen & Thai, 2016; Alfalla-Luque et al., 2015).

6. Conclusion

The current empirical study highlighted the effect of supply chain (internal and external) integration on operational performance, namely (quality performance measures and inventory management performance) by addressing lean practices' mediating role. Besides, the nature of how supply chain integration, lean practices, and operational performance impact each other in manufacturing companies is also investigated. A number of key findings emanated from this study in that practising the process of supply chain integration can increase the opportunity to attain operational performance by using lean practices among Jordanian manufacturing companies. Thus, a positive relationship is found to combine both supply chain integration and lean operations with operational performance. In light of these relationships, it is concluded that lean operations as a mediating variable positively influence the association between operational performance and supply chain integration and especially the association between quality performance measures and supply chain integration. More importantly, future studies shall be conducted to address the significant influence of supply chain integration on operational performance by adopting or implementing lean operations in other commercial and administrative sectors in Jordan.

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