

MEDIATING ROLE OF SUPPLY CHAIN INTEGRATION AMONG INTERNAL LEAN PRACTICES, ENTERPRISE RESOURCE PRACTICES, GREEN OPERATIONS PRACTICES AND OPERATIONAL PERFORMANCE

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Abstract: *The research investigates the impact of internal lean practices (ILP), green operations practices (GOP), and enterprise resource planning (ERP) on operational performance (OP) in Saudi Arabian manufacturing companies, with a focus on the mediating role of supply chain integration (SCI). Data from 219 employees informed the study, which employed a quantitative research approach and a cross-sectional design. SPSS multiple regression analysis revealed positive and statistically significant effects of ILP, GOP, and ERP on both SCI and OP. ILP significantly influenced SCI and, indirectly through SCI, positively affected OP. Similarly, GOP demonstrated a positive impact on both SCI and OP, indicating a mediating relationship. ERP practices significantly influenced both SCI and OP, with SCI mediating the relationship between ERP dimensions and OP. These findings contribute to theoretical understanding and offer practical insights for Saudi Arabian manufacturing companies, highlighting the strategic importance of improving ERP systems, GOP, and ILP to enhance SCI and consequently OP. The research underscores the critical role of SCI in advancing sustainability and operational efficiency.*

Keywords: *Supply Chain Integration, Enterprise Resource Planning, Operational Performance, Saudi Arabia.*

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1. Introduction

Indeed, in the contemporary competitive landscape, operational performance (OP) serves as a fundamental benchmark crucial for shaping the success and long-term sustainability of companies (Kaydos, 2020). Certainly, the significance of operational performance (OP) is underscored by its direct impact on efficiency and the organization's capacity to meet customer demands in an ever-evolving and dynamic market (Kaydos, 2020). A heightened level of OP illuminates efficient internal processes, decreased costs, and an improved awareness of evolving market needs (Khan et al., 2022a; Khan et al., 2022b). Hence, organizations that prioritize operational excellence often experience heightened customer satisfaction, improved profitability, and a distinctive advantage within the industry (Khan et al., 2022a; Khan et al., 2022b). Several factors influence OP (Khan et al., 2022a; Khan et al., 2022b), however, without an integrated approach that links internal practices and systems with supply chain integration (SCI), the potential benefits derived from internal lean practices (ILP), green operational practices (GOP), and enterprise resource planning (ERP) may be constrained (Chavez et al., 2022; Khan et al., 2022a; Zhu, Guo, & Zou, 2022). Failure to integrate these crucial components ILP, GOP, and ERP into their supply chain operations can impede the ability to enhance OP.

In theory, the New Resource-Based View (NRBV) also advocates for the significance of organizational resources and capabilities in attaining a sustained competitive advantage (Chavez et al., 2022). In this context, aligning the integration of ILP, GOP, and ERP within the supply chain underscores the strategic significance of internal capabilities and resources in improving OP (Alraja et al., 2022; Chavez et al., 2022; Sharma et al., 2022). As a result, within the realm of operational research, effectively aligning the integration of ILP, GOP, and ERP systems with SCI represents the strategic utilization of valuable internal resources to augment OP. The adoption of ILP specifically concentrates on waste reduction, process optimization, and continuous improvement, with the goal of enhancing OP through the streamlining of workflows and elimination of inefficiencies (Chavez et al., 2022). Likewise, GOP contributes not only to environmental sustainability but also to operational efficiency. Through the reduction of waste, energy consumption, and resource usage, organizations enhance their cost-effectiveness and environmental footprint, thereby contributing to an increase in OP (Jabbour et al., 2016). Furthermore, the implementation of ERP systems facilitates the integration and optimization of various business functions. Effectively deployed ERP systems enhance OP by offering real-time insights and streamlining communication across departments (Santoso et al., 2022a). Nevertheless, in the absence of a focus on SCI, the full realization of the collective impact of these practices may be compromised (Basana et al., 2022). In this scenario, the absence of integration among ILP, GOP, and ERP systems with supply chain operations may impede the smooth flow of processes, restrict information sharing, and ultimately hinder OP. Therefore, highlighting the mediating role of the supply chain is considered a significant contribution to understanding the relationships among ILP, ERP, GOP, and OP within an organizational context.

Empirical studies continue to present varied findings. Past research has focused on individual examinations of the effects of these practices on OP. For example, investigations into ERP systems have emphasized their contribution to process streamlining and enhanced decision-making, thereby contributing to the improvement of OP (Santoso et al., 2022a; Santoso et al., 2022b). Likewise, research centred on green operational practices has highlighted their capacity to diminish

waste and reduce resource consumption, exerting a positive influence on OP (Jabbour et al., 2016). Moreover, examinations of internal lean practices have illustrated their noteworthy contribution to operational excellence, thereby enhancing OP (Chavez et al., 2022). Furthermore, scrutiny has been directed towards supply chain integration and its repercussions on OP, underscoring the significance of interconnected and efficient supply chains (Yu et al., 2019a, 2019b). Nevertheless, these studies frequently exist in isolation, lacking comprehensive analyses that concurrently investigate the cumulative impact of each practice within a unified model on OP. This gap underscores the necessity for integrating these practices within a cohesive model, considering their collective influence on OP with the mediating effect of SCI. Various studies have indicated that SCI plays a pivotal mediating role in enhancing OP (Erboz, Yumurtaci Hüseyinoğlu, & Szegedi, 2022; Liu, Liu, & Gu, 2021). Numerous other studies have contended that the relationship between ILP, ERP, GOP, and OP warrants alternative testing approaches (Chavez et al., 2022; Jabbour et al., 2016; Saleh & Thoumy, 2020). Hence, considering the identified gaps in previous research, SCI could emerge as a potential mediator among ILP, ERP, GOP, and OP.

Moreover, empirical studies have predominantly concentrated on other developed and developing economies (Chavez et al., 2022; Khan et al., 2022a; Khan et al., 2022b; Zhu et al., 2022). However, there has been limited focus on Saudi Arabia's manufacturing companies in the existing literature. This research gap is particularly noteworthy in the context of Saudi Arabia, given the rapidly evolving manufacturing sector spurred by economic diversification efforts, technological advancements, and heightened globalization (Sallam, 2021). As a prominent economy in the Middle East, Saudi Arabia has experienced significant expansion in its manufacturing industry, rendering it a pivotal sector for the nation's economic advancement (Saleh, 2023; Sallam, 2021). Examining the impact of ERP, GOP, ILP, and SCI on OP in Saudi Arabia's manufacturing sector is crucial. These variables are highly significant for manufacturing companies, especially in the dynamic market of Saudi Arabia. The research aims to investigate the influence of ERP, GOP, and ILP on OP with the mediating effect of SCI integration in Saudi Arabia's manufacturing companies.

This research aims for a thorough exploration of the interconnections among ILP, GOP, ERP, SCI, and OP in Saudi Arabian manufacturing firms. With a sample of 300 executives and managers selected through purposive sampling, the study gains insights from individuals highly informed about their company's operations, ensuring credible and relevant findings. The quantitative approach, using SPSS multiple regression analysis, offers robust statistical evidence for the positive impacts of ILP, GOP, and ERP on both SCI and OP. Identifying the mediating role of SCI enriches the understanding of these dynamics in Saudi Arabian manufacturing. The study emphasizes the strategic importance of optimizing ERP systems, GOP, and refining ILP to enhance SCI and improve OP, highlighting the critical role of SCI in sustainability and operational efficiency.

2. Literature review and Hypothesis Development

2.1 Internal Lean Practices and Operational Performance

ILP involve systematic methods aimed at streamlining processes, eliminating waste, and fostering continuous improvement within an organization (Shah & Ward, 2003). Crucial for improving operational performance, these practices minimize

waste, optimize processes, and promote continuous improvement. Abundant empirical evidence addresses the impact of ILP on OP (Al-Doori, 2020; Negrão et al., 2020), regarding competitive priorities or operational capabilities (Sansone, Hilletoft, & Eriksson, 2017). The primary goal of ILP is to enhance productivity by reducing waste, making cost improvement a common benefit associated with the lean paradigm, thereby contributing to increased OP (Möldner, Garza-Reyes, & Kumar, 2020). The direct association between cost reduction, continuous improvement, and the identification of root causes of waste constitutes fundamental measures for quality enhancement, thereby contributing to the augmentation of OP (Shah & Ward, 2007). Considering the evidence presented in the literature, we anticipate a positive and significant correlation between ILP and OP.

H1: *Internal lean practices has significant impact on operational performance.*

2.2 Green Operation Practices and Operation Performance

GOP encompass a suite of strategies and methodologies centred on diminishing environmental impact, minimizing waste, and fostering sustainability within an organization's operational framework (de Mello Santos et al., 2022a, 2022b). The correlation between green practices and OP has been a central focus within the domain of operational research. Inman and Green (2018) and (Dadhich, Purohit, & Bhasker, 2021) identified a substantial and positive influence of green practices on OP. de Mello Santos et al. (2022a, 2022b) investigated that the integration of green practices, encompassing cleaner production techniques and eco-friendly technologies, not only enhances environmental sustainability but also exerts a positive influence on OP through cost reduction, enhanced resource efficiency, and the stimulation of innovation. Similarly, Dadhich et al. (2021) underscores that the adoption of eco-friendly initiatives results in operational improvements through heightened process efficiency, waste reduction, and overall productivity enhancement, consequently yielding a positive impact on the financial performance of organizations. Thus, the study posits the following research hypotheses:

H2: *Green operational practices has significant impact on operational performance.*

2.3 Enterprise Resource Planning and Operational Performance

Enterprise Resource Planning (ERP) systems play a crucial role in augmenting OP within organizations. Furthermore Madanhire and Mbohwa (2016), illustrate a positive correlation between ERP implementation and OP. ERP systems consolidate diverse business functions into a unified platform, facilitating streamlined communication, data accessibility, and process integration across departments. This integration promotes operational efficiency, mitigates redundant tasks, minimizes errors, and enhances decision-making capabilities. Hwang and Min (2015) further substantiated the relationship by underscoring how ERP systems enhance OP through the standardization and automation of processes. This, in turn, results in cost reductions, improved productivity, and heightened responsiveness to market demands. Facilitating the alignment of organizational activities, these systems optimize resource utilization and, consequently, enhance overall OP metrics Motwani (2017). also emphasizes the impact of ERP systems on OP. They discovered that successful ERP implementations notably contribute to operational enhancements, including reduced cycle times, lower inventory levels, and improved on-time deliveries. The centralization of data management through

ERP integration allows real-time information access across business units, empowering managers for prompt, informed decision-making. This enhances operational agility and adaptability to changing market conditions (de Mello Santos et al., 2022b). The authors contend that ERP, encompassing dimensions of information quality, data quality, and system quality, has a significant impact on OP (Ifinedo, 2007). These studies underscore the empirical association between ERP systems and heightened OP. As a result, the following hypothesis is posited:

H3: *Enterprise resource planning has significant impact on operational performance.*

H3a: *Enterprise resource planning informational quality has significant impact on operational performance.*

H3b: *Enterprise resource planning data quality has significant impact on operational performance.*

H3c: *ERP system quality has significant impact on operational performance.*

2.4 Mediating Role of Supply Chain Integration

The scholarly interest in operations management regarding the impact of ILP on SCI has been noteworthy. Lean practices, directed at enhancing operational efficiency and minimizing waste, wield substantial influence on SCI. Studies by Qi et al. (2017) have underscored the substantial contribution of ILP to the enhancement of SCI through the promotion of closer collaboration, information sharing, and synchronization among diverse supply chain partners. These practices improve communication and coordination, reducing lead times, inventory levels, and costs, while enhancing quality and responsiveness in the supply chain network (Hausman, 2004).

Contrarily, the impact of SCI on OP has been extensively studied in operations research literature, highlighting a consistently positive relationship. For instance Vanpoucke, Vereecke, and Muylle (2017), and Jacobs and Chase (2018) indicates that elevated levels of SCI, involving information sharing, collaboration, and coordination among supply chain partners, result in enhanced OP metrics, including reduced lead times, inventory levels, increased flexibility, higher service levels, and overall efficiency. Furthermore, the study by Wong, Sancha, and Thomsen (2017) highlights that SCI positively influences OP by streamlining processes, cutting costs, and improving responsiveness to customer demands, ultimately securing competitive advantages in the marketplace.

Moreover, the relationship between ILP, SCI, and OP has been a subject of significant research in operations research Tortorella, Miorando, and Marodin (2017). contends that proper ILP within the organization has an indirect impact on OP. Moreover, Danese, Molinaro, and Romano (2020) further underline the significance of supply chain for OP. When an organization effectively implements SCI throughout its supply chain network, it fosters a cohesive flow of materials, information, and processes, leading to shared vision and goals among partners. This results in enhanced OP metrics, including increased responsiveness, reduced production lead times, and improved overall efficiency. The relationship emphasizes the need to integrate ILP and SCI in a unified model, considering their collective influence on OP, with SCI playing a crucial mediating role, as indicated in various studies (Erboz et al., 2022; Liu et al., 2021). Several studies have also asserted the need to examine the relationship between ILP, ERP, GOP, and OP from alternative perspectives (Chavez et al., 2022; Jabbour et al., 2016; Saleh & Thoumy, 2020). Therefore, considering the identified gaps

in previous research, SCI could potentially serve as a mediator among ILP, ERP, GOP, and OP. Consequently, the study formulates the following research hypotheses;

H4: *Internal lean practices has significant impact on supply chain integration.*

H5: *Supply chain integration has significant impact on operational performance.*

H6: *Supply chain integration significantly mediates between internal lean practices and operational performance.*

Conversely, the connection between green practices and SCI has been thoroughly investigated. [Vijayvargy, Thakkar, and Agarwal \(2017b\)](#) and [Chen, Zhu, and Sarkis \(2023\)](#) highlights the intrinsic link between green initiatives and SCI [Vijayvargy, Thakkar, and Agarwal \(2017a\)](#). emphasizes that integrating environmental considerations into supply chain practices enhances collaboration, coordination, and information sharing among partners, resulting in improved environmental performance and overall supply chain efficiency. Similarly, [Chen et al. \(2023\)](#) highlights that the positive influence of integrating green practices on SCI is manifested through the facilitation of the exchange of environmentally friendly ideas, technologies, and processes among members of the supply chain. On the other hand, nexus between SCI and OP by [Radhi and Hariningsih \(2021\)](#) [Radhi and Hariningsih \(2021\)](#) and [Alahmad \(2021\)](#) positive and significant impact of SCI on OP [Radhi and Hariningsih \(2021\)](#). [Radhi and Hariningsih \(2021\)](#)underscores that successful integration among supply chain partners, especially in terms of information sharing and collaboration, results in improved operational performance indicators, including decreased lead times, enhanced product quality, and heightened overall efficiency [Leuschner, Rogers, and Charvet \(2013\)](#). underscored that SCI has a positive impact on OP by optimizing processes, cutting costs, and enhancing responsiveness to market demands, ultimately leading to competitive advantages and enhanced overall performance within the supply chain network. In a separate study, it was discovered that SCI significantly affects OP when applied in different contextual relationships ([Ataseven & Nair, 2017](#)). While [Hajmohammad et al. \(2013\)](#) contended that the implementation of green practices could influence OP. When organizations implement green practices, it leads to an increase in SCI, subsequently contributing to the improvement of OP. The preceding relationship indicates the significant role of GOP in enhancing OP through the mediating effect of SCI. This underscores the imperative to integrate these practices into a unified model, considering their collective impact on OP, with SCI playing a crucial mediating role, as evidenced in various studies ([Erboz et al., 2022](#); [Liu et al., 2021](#)). Numerous additional studies have suggested the need for alternative testing approaches in examining the relationships between ILP, ERP, GOP, and OP ([Chavez et al., 2022](#); [Jabbour et al., 2016](#); [Saleh & Thoumy, 2020](#)). Therefore, considering the identified gaps in previous research, SCI could potentially serve as a mediator among ILP, ERP, GOP, and OP. Consequently, the study formulates the following research hypotheses;

H7: *Green practices has significant impact on supply chain integration.*

H8: *Supply chain integration significantly mediates between green practices and operational performance.*

Moreover, the association between ERP systems and SCI has been a central focus in literature addressing operational efficiency and collaboration. Notable [Sutduean et al. \(2019\)](#), and [Lenny Koh, Saad, and Arunachalam \(2006a\)](#); [Lenny Koh, Saad, and Arunachalam \(2006b\)](#) investigates into the relationship between ERP systems and SCI

Sutduean et al. (2019). emphasize that ERP systems function as a cornerstone for SCI, offering a centralized platform for information sharing, communication, and process standardization across diverse functions within an organization. This results in enhanced supply chain coordination and operational efficiency. Similarly Tarigan, Sebayang, and Basana (2021), underscore the pivotal role of ERP systems' integration capabilities in nurturing collaboration and connectivity among supply chain partners. This enables the seamless flow of information and resources, thereby enhancing the overall performance of the supply chain. In essence, ERP systems play a crucial role in augmenting SCI, thereby enhancing OP within organizations. These systems offer a centralized platform facilitating the integration and coordination of diverse business functions, including manufacturing, inventory management, sales, and finance. The earlier correlation indicates the significant role of ILP in boosting OP through SCI. This emphasizes the necessity to integrate these practices into a unified model, considering their collective influence on OP, with SCI acting as a mediating factor. Various studies have identified that SCI plays a crucial mediating role in enhancing OP (Erboz et al., 2022; Liu et al., 2021). Other studies have contended that the relationships between ILP, ERP, and GOP with OP should be examined using alternative approaches (Chavez et al., 2022; Jabbour et al., 2016; Saleh & Thoumy, 2020). Consequently, considering the identified gaps, SCI could serve as a potential mediator among ILP, ERP, GOP, and OP. Therefore, the study proposes the following research hypotheses;

H9: *Supply chain integration significantly mediates between enterprise resource planning and operational performance.*

H9a: *Supply chain integration informational quality significantly mediates between enterprise resource planning and operational performance.*

H9b: *Supply chain integration significantly mediates between enterprise resource planning data quality and operational performance.*

H9c: *Supply chain integration significantly mediates between enterprise resource planning system quality and operational performance.*

2.5 Objective and Material

The research aimed to investigate the mediating impact of supply chain integration on the relationships among enterprise resource planning, green sustainable practices, internal lean practices, and operational performance in manufacturing companies in Pakistan. To achieve this objective, a quantitative research methodology was employed. The primary goal of quantitative research is to gain deeper knowledge and comprehension of the social world. Researchers utilize quantitative methods to observe situations or events that influence people (Lazaraton, 2005). Indeed, quantitative research generates objective data that can be precisely communicated using statistical analyses and numerical representations (Lazaraton, 2005). Our research had an explanatory nature, offering substantial value by elucidating the underlying reasons behind observed phenomena Bentouhami, Casas, and Weyler (2021a); (Bentouhami, Casas, & Weyler, 2021b). Explanatory research provides researchers with the opportunity to delve deeper into causation and connections that may not be immediately apparent through alternative research methodologies. Through elucidating the fundamental mechanisms and enriching our comprehension of complex issues, explanatory research plays a crucial role in facilitating well-informed decision-making and the development of effective solutions for real-world problems (Bentouhami et al., 2021a). Additionally, we employed a cross-sectional research design, involving the

collection of data at a single point in time through a self-administered questionnaire (Spector, 2019). Cross-sectional studies are often preferred over longitudinal studies due to their faster implementation (Spector, 2019).

2.6 Research Instrument and research Framework

The research tool was derived from prior studies. The study included three types of variables: GOP, ERP, and ILP served as independent variables. Among these, Green operational practices were assessed using 11 items adapted from the research conducted by (Jabbour et al., 2016). ILP were assessed using 6 items adapted from the study of (Chavez et al., 2022). ERP was measured through three dimensions: ERP data quality, ERP system quality, and ERP information quality. Each dimension was assessed using three items adopted from the study of (Ifinedo, 2007). SCI was assessed using six items adopted from the study of (Prajogo & Olhager, 2012). Whereas, the dependent variable, OP, was measured using 6 items adopted from the study of (Flynn, Huo, & Zhao, 2010). All the items mentioned above were assessed on a five-point Likert scale, with a ranking of 1 for strongly agree and 5 for strongly disagree. The variables mentioned above are depicted in Figure 1 below.

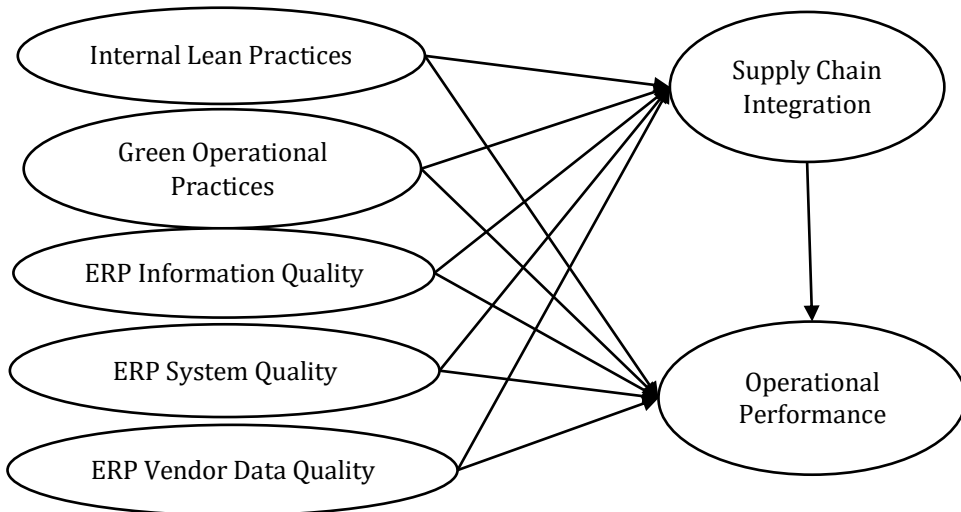


Figure.1: Conceptual Framework

2.7 Population and Sampling Techniques

The study's population consisted of employees from manufacturing companies in Saudi Arabia engaged in operational activities, as these respondents were knowledgeable about the company's operations. The study utilized a purposive sampling technique, a method that entails the selection of specific individuals or cases based on their distinctive characteristics to address the specific objectives of a study or research (Etikan, Musa, & Alkassim, 2016). The researcher utilized the individual unit of analysis since data was collected from multiple employees within the manufacturing companies (Etikan et al., 2016). A total of 550 respondents were initially selected, from which 219 questionnaires were returned. The collected data was then entered into an Excel spreadsheet and subjected to both descriptive and inferential analyses using SPSS software.

3. Data Analysis and Interpretation

The researchers employed both descriptive and inferential statistics through the use of SPSS. In the initial phase, descriptive statistics were applied, followed by the utilization of inferential statistic.

3.1 Diagnostics Test

In SPSS version 24, the treatment of missing data entailed identifying the minimum (1) and maximum (5) values. The presence of less than 5% missing values in the data suggests that there are no significant issues in the data analysis process (Beale & Little, 1975). Evaluations of skewness and kurtosis revealed values below 2 and +2, respectively, affirming a standard univariate normality in the data (Park, 2015). The measurements, with skewness and kurtosis values not exceeding 2, strengthen the claim of a normally distributed univariate. Furthermore, the Variance Inflation Factor (VIF) values for all research variables were found to be below 5, signifying the absence of multicollinearity issues in our study (Becker et al., 2015). Additionally, the value of common method bias was below 50%, indicating no significant concern with common method bias (Becker et al., 2015).

3.2 Correlation Matrix

Table 2 presents the predicted values for multicollinearity, including VIF and correlation coefficients among different management and accounting practices within a manufacturing context. These metrics are crucial for evaluating the interrelationships and potential multicollinearity among the variables. VIFs, in particular, serve as indicators of multicollinearity, a condition where the independent variables in a regression model exhibit a high degree of correlation. In Table 2, the VIFs for each variable are relatively low, with none exceeding 2.12. This implies that multicollinearity is not a significant concern among these variables. Low VIFs are desirable in regression analysis, as they indicate that the independent variables can be included in a model without the risk of inflating the standard errors of the coefficients (Craney & Surles, 2002). The correlation matrix further illustrates the relationships among various organizational factors. ILP exhibit a moderate positive correlation with operational performance (OP) ($r = 0.372$, $p < 0.01$), indicating that the adoption of efficient internal processes positively influences OP. Moreover, GOP demonstrate a weak positive association with ILP ($r = 0.143$, $p < 0.05$), suggesting a slight connection between environmentally conscious practices and ILP. Additionally, enterprise resource planning data quality (ERPDQ) exhibits a moderately strong positive correlation with ILP ($r = 0.446$, $p < 0.001$), indicating that higher data quality within ERP is associated with the implementation of ILP. Likewise, enterprise resource planning information quality (ERPIQ) shows a moderate positive relationship with ILP ($r = 0.457$, $p < 0.01$), underscoring that high-quality information within enterprise systems aligns with the implementation of ILP. Additionally, enterprise resource planning system quality (ERPSQ) demonstrates a moderate positive association with ILP ($r = 0.332$, $p < 0.01$), suggesting that higher system quality within enterprise systems aligns less strongly with the implementation of internal lean practices. Additionally, OP is positively correlated with all factors, ERPDQ ($r = 0.549$, $p < 0.01$), ERPIQ ($r = 0.544$, $p < 0.01$), ERPSQ ($r = 0.387$, $p < 0.01$), and ILP ($r = 0.372$, $p < 0.01$), indicating that superior OP tends to be associated with higher ERPDQ, ERPIQ, and ILP. All of the aforementioned results are presented in Table 1.

Table.2: Correlation Matrix

Construct	VIF	ILP	GOP	ERPDQ	ERPIQ	ERPSQ	SCI	OP
ILP	2.12	1						
GOP	1.23	0.143*	1					
ERPDQ	1.78	0.446***	0.345***	1				
ERPIQ	1.45	0.457**	0.245*	0.315**	1			
ERPSQ	1.67	0.332**	0.425**	0.516**	0.289**	1		
SCI	1.89	0.352**	0.453**	0.537**	0.553**	0.351**	1	
OP	0.372**	0.422**	0.549**	0.544**	0.387**	0.321**	1

Note: ILP-internal lean practices, GOP-green practices, ERPDQ-enterprise resource planning data quality, ERP-enterprise information quality, ERPSQ-enterprise resource planning system quality, OP-operational performance.

3.3 Construct Descriptive statistics and Reliability

Table 2 displays the results of descriptive and inferential statistics. The descriptive statistics reveal that the mean values for all constructs exceed 3, indicating that respondents provided ratings above the average. Prior to hypothesis testing, the researchers placed significant emphasis on ensuring the face and content validity of the research instrument. To achieve this, a comprehensive process was undertaken. Initially, a pilot study phase was conducted in collaboration with esteemed field professors, whose expertise and feedback played a crucial role in refining the questionnaire items, aligning them with the research objectives. Moreover, we actively sought validation from industry experts, leveraging their practical insights to enhance the appropriateness of our instrument. Additionally, construct validity was addressed through an Exploratory Factor Analysis (EFA) employing varimax rotation (Stapleton, 1997). The primary objective was to ensure that items related to a specific construct consistently loaded onto a single factor, and items with loadings below 0.5 were excluded from further analysis. To validate the appropriateness of our factor analysis, we performed the Kaiser-Meyer-Olkin (KMO) test to assess sampling adequacy and Bartlett's test of sphericity to evaluate the homogeneity of variances for the measurement scales (Shrestha, 2021). Results from these tests demonstrated the strong suitability of our factor analysis, enhancing its credibility. Additionally, the reliability of our instrument was evaluated through Cronbach's α -coefficient, a crucial aspect of the validation process (Peterson & Kim, 2013). The α values for all constructs exceeded 0.70, indicating the reliability of the constructs (Peterson & Kim, 2013). The aforementioned results are displayed in Table 3 below.

Table.3: Descriptive and Reliability Results

Variable	Mean	Standard Deviation	Alpha
ILP	3.48	0.67	0.895
GOP	3.06	0.89	0.812
ERPDQ	3.35	0.75	0.871
ERPIQ	4.11	0.82	0.821
ERPSQ	3.06	0.81	0.812
SCI	3.45	0.65	0.891
OP	3.21	0.73	0.841

Note: ILP-internal lean practices, GOP-green practices, ERPDQ-enterprise resource planning data quality, ERP-enterprise information quality, ERPSQ-enterprise resource planning system quality, OP-operational performance.

4. Hypothesis Results

The research employed multiple regression analysis to examine the study

hypothesis. The results obtained from SPSS multiple regression indicate a positive and significant influence of ILP on OP. The high beta value of 0.56, coupled with a low standard error of 0.08, signifies a robust positive relationship. This implies that the implementation and prioritization of lean practices within the Saudi Arabian manufacturing sector significantly contribute to enhancing operational performance. Likewise, the influence of GOP on operational performance appears considerable (beta value of 0.43 and a low standard error of 0.07). This suggests that incorporating environmentally friendly methods into operations significantly contributes to the enhanced operational performance within the manufacturing industry in the country. Moreover, the results also reveal that enterprise resource planning data quality (ERPDQ), enterprise information quality (ERPIQ), and enterprise resource planning system quality (ERPSQ) exert statistically significant positive impacts on operational performance. This underscores the importance of upholding high standards in data, information, and systems for attaining superior operational performance within the manufacturing firms of Saudi Arabia. Furthermore, the positive and significant impact of ILP on both SCI and OP emphasizes the crucial role of optimizing internal practices, sustainability initiatives, and information quality in driving the operational performance of Saudi Arabian manufacturing companies.

The results further demonstrate a significant and positive impact of ILP on SCI, suggesting that Saudi Arabian manufacturing companies gain advantages from streamlined internal processes, contributing to more integrated supply chains. Additionally, ILP exhibits a positive and significant effect on OP with the mediating effect of SCI. This underscores that internal lean practices not only directly impact operational performance but also indirectly influence the OP of manufacturing firms in Saudi Arabia. Similarly, GOP shows a positive and significant impact on OP with the indirect mediating effect of SCI. The findings indicate that manufacturing companies in Saudi Arabia play a key role in leveraging GOP to enhance their SCI, thereby increasing OP. Additionally, the study identifies a positive and significant mediating role of SCI in the relationships between ERPDQ, ERPIQ, ERPSQ, and OP within the context of Saudi Arabian manufacturing companies. These results underscore the crucial mediating role of SCI among ERP, GOP, ILP, and OP, as all hypotheses are supported. The discussed results are presented in table 4.

Table.4: Hypothesis Testing

Hypothesis	Beta	Standard Error	T-Value	Sig. Level	Result
ILP-OP	0.56	0.08	7.00	<0.001***	Supported
GOP-OP	0.43	0.07	6.14	<0.001***	Supported
ERPDQ->OP	0.38	0.09	4.22	<0.001***	Supported
ERPIQ->OP	0.41	0.11	3.73	0.001***	Supported
ERPSQ->OP	0.47	0.12	3.92	0.001***	Supported
ILP->SCI	0.52	0.06	8.67	<0.001***	Supported
SCI->OP	0.61	0.05	11.20	<0.001***	Supported
ILP->SCI ->OP	0.58	0.07	8.29	<0.001***	Supported
GOP->SCI	0.49	0.08	6.20	<0.001***	Supported
GOP->SCI ->OP	0.54	0.09	6.00	<0.001***	Supported
ERPDQ->SCI	0.39	0.10	3.99	<0.001***	Supported
ERPIQ->SCI	0.43	0.12	3.41	<0.001***	Supported
ERPSQ->SCI	0.49	0.13	3.76	<0.001***	Supported
ERPDQ->SCI->OP	0.33	0.14	2.36	<0.05**	Supported
ERPIQ->SCI->OP	0.37	0.14	2.64	<0.05**	Supported
ERPSQ->SCI->OP	0.45	0.15	2.98	<0.05**	Supported

Note: ILP-internal lean practices, GOP-green practices, ERPDQ-enterprise resource planning data quality, ERP-enterprise information quality, ERPSQ-enterprise resource planning system quality, OP-operational performance.

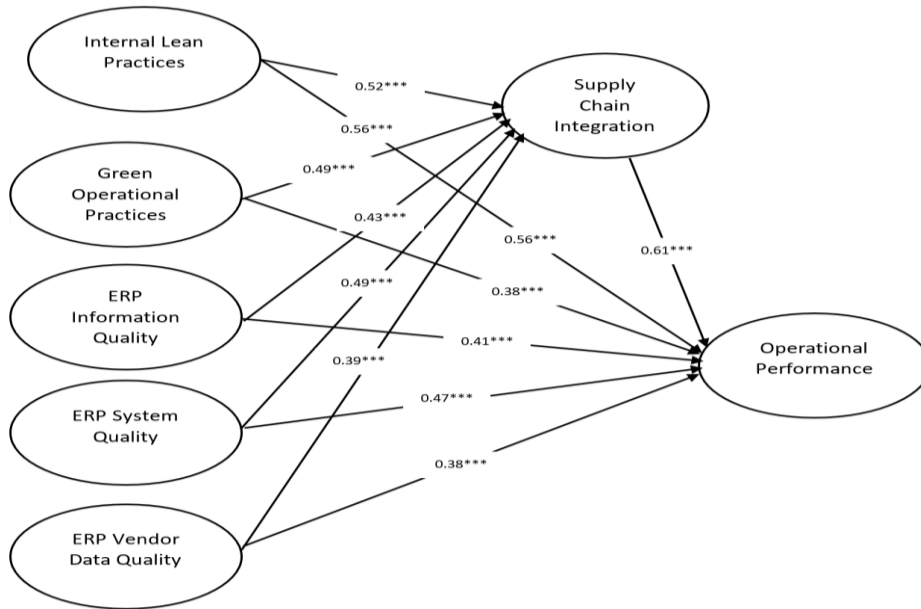


Figure.2: Beta and Significance Values

5. Discussion and Implications

The research aimed to examine the impact of ILP, GOP, and ERP on OP, with a focus on the mediating effect of supply chain integration in Saudi Arabian manufacturing companies. Data was collected from employees engaged in company operations and analysed using SPSS, employing multiple regression analysis for insights into the relationships between the variables. The outcomes of the multiple regression analysis reveal a positive and significant impact of ILP on OP within the context of Saudi Arabian manufacturing firms. This finding aligns with previous studies, affirming that the implementation of lean principles has consistently demonstrated positive effects on operational performance across various industries [Tortorella, Giglio, and van Dun \(2019\)](#). [Tortorella et al. \(2019\)](#) emphasized that embracing lean practices led to improvements in operational performance within the manufacturing sector. Further study of [Belekoukias, Garza-Reyes, and Kumar \(2014\)](#) also identified the positive impact of lean practices on operational efficiency within the manufacturing sector. The study's findings consistently align with previous research, indicating that an increase in GOP positively influences OP. For instance, [Hajmohammad et al. \(2013\)](#) underscores that incorporating environmentally friendly practices substantially enhances OP. Further, [Gupta and Nagpal \(2020\)](#) The research findings also revealed that environmental initiatives positively influenced operational performance in the manufacturing sector. Moreover, the study indicated that ERP practices, including ERPDQ, ERPIQ, and ERPSQ, significantly impact OP. Indeed, the findings underscore the pivotal role of ERP systems in enhancing operational performance within manufacturing companies in Saudi Arabia, aligning with the conclusions drawn in numerous prior studies. For instance [Xu et al. \(2002\)](#), suggested that high-quality data, information, and system standards were crucial in enhancing operational performance in organizations adopting ERP systems. Similarly, studies in the field of

information systems and management, like those by [Al-Mamary, Shamsuddin, and Aziati \(2014\)](#) and [Lin \(2010a, 2010b\)](#) results emphasize the notable influence of maintaining high-quality information and system standards on organizational performance, providing valuable insights applicable to the context of the Saudi Arabian manufacturing sector.

These findings underscore the positive and significant impact of ILP on the SCI of manufacturing companies in Saudi Arabia. The results suggest that by optimizing internal processes, these companies can play a crucial role in fostering more integrated supply chains. Several relevant studies [Cagliano, Caniato, and Spina \(2006\)](#) and [Qi et al. \(2017\)](#) findings support the idea that the implementation of lean practices contributes to more integrated supply chains, emphasizing the interconnectedness of internal process improvements and supply chain integration.

The study further illustrates that ILP exerts an indirect influence on OP through the mediating effect of SCI. This suggests that the impact of ILP on OP is not only direct but also operates indirectly through their influence on SCI. This aligns with similar findings reported in studies investigating the relationship between IP and OP. For instance [Tortorella et al. \(2021\)](#), results showcased that the implementation of lean principles led to a substantial improvement in operational performance through the streamlining of processes and enhancement of overall efficiency. This indicates that, within the context of Saudi Arabian manufacturing, the strategic implementation of internal lean practices played a crucial role in enhancing operational performance through SCI, thereby significantly contributing to improved performance. Additionally, further results demonstrate that GOP has a positive and significant effect on SCI, highlighting the crucial role of manufacturing companies in Saudi Arabia in leveraging green practices to enhance their SCI. Studies by researchers such as [Cousins et al., 2019](#) have delved into the affirmative correlation between GOP and SCI, indicating that environmentally conscious practices positively influence operational improvements. Additionally, SCI serves as a significant mediator in the relationship between GOP and OP, aligning with the outcomes observed in the Saudi Arabian manufacturing context. This underscores the strategic importance of green practices in fostering supply chain integration, consequently impacting operational performance. Previous studies have similarly advocated for the indirect influence of GOP on OP.

Further results shown that ERP systems dimensions ERPDQ, ERPIQ, and ERPSQ also have positive and significant impact on SCI. [Alawamleh, Ismail, and Mazzawi \(2018\)](#) emphasize the positive relationship between ERP and SCI. These findings underscore the crucial role of the ERP system as a key driver of increased SCI within the specific context of Saudi Arabian manufacturing companies. Furthermore, the dimensions of ERP, specifically ERPDQ, ERPIQ, and ERPSQ, exhibit a significant impact on OP, mediated by SCI. This suggests that SCI plays a critical mediating role among ERP dimensions and OP, emphasizing its importance in the operational performance of manufacturing firms. [Langenwalter \(2020\)](#) and [Tarigan, Siagian, and Jie \(2021\)](#) highlight the pivotal role of ERP systems in enhancing SCI, subsequently contributing to improved OP within the specific context of Saudi Arabian manufacturing companies. The results underscore the significance of SCI as a mediator between ERP and OP, suggesting that optimizing ERP components can enhance SCI, thereby positively influencing operational performance—a pattern observed in various industry contexts according to relevant academic research.

The research findings carry substantial theoretical and practical implications. The study contributes significantly to understanding how various organizational practices—namely ERP, GOP, and ILP—influence OP, mediated by SCI. The results demonstrate that the effective implementation of ERP systems, coupled with the adoption of green and lean practices, not only directly impacts OP but also indirectly affects it through SCI. These findings contribute to expanding existing literature by providing empirical evidence within the Saudi Arabian manufacturing context, thereby enhancing the understanding of how organizational strategies and practices interrelate to drive performance outcomes. The theoretical contribution of the study extends to the underexplored area of Saudi Arabian manufacturing, offering valuable insights into the dynamic relationships among ERP, GOP, ILP, SCI, and OP, shaping a more comprehensive understanding of OP determinants. The research also adds to the body of literature, paving the way for new areas of research in the future.

Practically, the findings offer valuable insights for Saudi Arabian manufacturing companies seeking to enhance their OP. Validating the positive and significant impacts of ERP, GOP, and ILP on both SCI and OP underscores the strategic significance of these practices in gaining a competitive edge. The study suggests that optimizing ERP systems, incorporating environmentally friendly practices, and refining internal lean processes can improve SCI, leading to enhanced OP. This encourages companies to holistically integrate these practices for operational efficiency, potentially fostering competitive advantage and improved performance outcomes. The findings provide actionable guidance for organizational decision-makers in Saudi Arabia to strategically invest in and align these practices, enhancing overall OP in the competitive manufacturing landscape.

6. Limitations and Future directions

Despite offering valuable insights, this research possesses a few limitations that warrant attention in future studies. Initially, the data collection predominantly targeted individuals in senior management positions, potentially overlooking insights from lower-level employees who could provide varied perspectives based on their direct involvement in operations. Subsequent research endeavours could employ a more inclusive sampling strategy to encompass a diverse range of perspectives. Moreover, the cross-sectional design of the study impedes causal inference, necessitating longitudinal research to monitor the evolving dynamics of relationships among ERP, GOP, ILP, SCI, and OP over time. As the research focused exclusively on Saudi Arabian manufacturing companies, broadening the scope to encompass other industry sectors or engaging in international comparative studies could enhance the generalizability of findings and explore potential cultural or contextual variations.

7. Conclusion

The study investigates the impact of ILP, GOP, and ERP on OP with SCI as a mediator in the Saudi Arabian manufacturing context. It establishes the significant positive effects of ILP, GOP, and ERP on both SCI and OP, highlighting their pivotal role in enhancing operational efficiency. Notably, these organizational practices not only directly influence OP but also indirectly affect it through the mediating role of SCI. The

research advances theoretical understanding, providing a strategic roadmap for investments in ILP, GOP, and ERP to drive operational performance and sustainability in the Saudi Arabian manufacturing landscape. Nevertheless, future research has the potential to mitigate limitations by broadening participant representation and employing longitudinal studies to establish causality. This approach would further investigate the evolving dynamics of these relationships over time, thereby contributing to a more nuanced understanding of these pivotal associations across diverse industries and cultural contexts.

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Mediating Role of Supply Chain Integration Among Internal Lean Practices, Enterprise Resource Practices, Green Operations Practices and Operational Performance of Manufacturing Companies

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1. Appendix

Research Instrument

Variables	Items	Adopted from
Internal Lean practices	Shop-floor employees lead product/process improvement effort	(Chavez et al., 2022)
	We maintain all our equipment regularly	
	We use extensive use of statistical techniques to reduce process variance	
	We have low set up times of equipment in our plant	
ERP system quality	We use a "pull" production system	(Ifinedo, 2007)
	Equipment is grouped to produce a continuous flow of families of products	
	Our ERP has accurate data.	
ERP information quality	Our ERP is easy to use.	(Ifinedo, 2007)
	Our ERP is easy to learn.	
ERP data quality	The information on our ERP is understandable.	(Ifinedo, 2007)
	The information on our ERP is relevant	
Supply chain integration	Our ERP vendor/consultant is trustworthy	(Praiojo & Olhager, 2012)
	Our ERP vendor/consultant is experienced and provides quality training and services	
	Our ERP vendor/consultant provides quality training and services	
	Inter-organizational logistic activities are closely coordinated	
	Our logistics activities are well integrated with suppliers' logistics activities	
	We have a seamless integration of logistics activities with our key suppliers	
	Our logistics integration is characterized by excellent distribution, transportation, and/or warehousing facilities	
	Process standardization and visibility	
	The inbound and outbound distribution of goods with our suppliers is well integrated	
	Replacement of polluting or hazardous materials or components	
Green Operation practices	Product development focused on reducing consumption of material and waste generation during production and distribution	(Jabbour et al., 2016)
	Product development focused on reducing consumption of material and waste generation during consumption	
	Emission filters and pollution controls at the end of the production process	
	Production process designed with a focus on reducing energy and resource consumption	
	Production planning and control focused on reducing waste and optimising the consumption of materials	
	Acquisition of cleaner technologies and equipment	
	Preference for green products in purchases	
	Environmental criteria in supplier selection	
	Selection of less polluting transportation	
	Reusable or recyclable packaging in logistics activities	
Operational Performance	Our company can quickly modify products to meet our major customer's requirements	(Flynn et al., 2010)
	Our company can quickly introduce new products into the market	
	Our company can quickly respond to changes in market demand.	
	Our company has an outstanding on-time delivery record to our major customer	
	The lead time for fulfilling customers' orders (the time which elapses between the receipt of customer's order and the delivery of the goods) is short.	
	Our company provides a high level of customer service to our major customer.	