DrivingBusinessPerformancethroughLeanandCloud-BasedSupplyChainIntegration:EvidencefromtheOilandGasSector

by Djohan Gunawan

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Driving Business Performance through Lean and Cloud-Based Supply Chain Integration: Evidence from the Oil and Gas Sector

Muhammad Habifian Sultan[1*], Djohan Gunawan Hasan[1], Mohammad Annas[1]

[1]*Universitas Multimedia Nusantara, Indonesia*

**Corresponding Email: Muhammad.habifian@student.umn.ac.id*

Abstract

This study examines the synergistic impact of Lean Supply Chain Management (LSCM) and Cloud-Based Supply Chain (CSSC) integration on business performance within Indonesia's oil and gas sector. Amidst global supply chain disruptions and Indonesia's transition toward sustainable energy, optimizing supply chain efficiency has become a strategic imperative. While prior research highlights the benefits of LSCM in developed markets, its interaction with digital technologies in emerging economies remains underexplored. Adopting a positivist approach, this study employs a quantitative methodology, collecting data from 217 professionals in Indonesia's oil and gas industry through structured questionnaires. Using Partial Least Squares Structural Equation Modeling (PLS-SEM), the research evaluates the direct and mediated effects of Just-In-Time (JIT) and Total Quality Management (TQM) practices on business performance, with CSSC as a mediator. Results confirm that both JIT and TQM significantly enhance business performance, with CSSC playing a pivotal mediating role by improving supply chain visibility, agility, and operational efficiency. The findings underscore the importance of integrating lean practices with cloud-based digital solutions to drive resilience and competitive advantage in volatile markets. This study contributes actionable insights for practitioners seeking to align operational excellence with digital transformation, offering a model for sustainable supply chain management in resource-intensive industries.

Keywords: Business performance, cloud-based supply chain, digital transformation, lean supply chain management, oil and gas industry.

1. Introduction

The oil and gas sector has consistently been a cornerstone of Indonesia's economy (Juli Christanto, Aprius Sutresno, Mavish, Afrianto Singgalen, & Dewi, 2024), acting as both a primary energy supplier and a major contributor to state revenue. As a resource-rich nation, Indonesia's upstream oil and gas activities have played a strategic role in ensuring energy security and fostering industrial development (Indonesian Petroleum Association, 2024). However, the sector is now contending with multifaceted challenges arising from both internal inefficiencies and external pressures. Global geopolitical uncertainties—exacerbated by the COVID-19 pandemic, ongoing Russia-Ukraine conflict, and resulting supply chain disruptions—

have significantly impacted the stability of energy markets (Elsayed, Hoque, & Billah, 2025; Sun, Cao, Liu, Cao, & Zhu, 2024; Toygar & Yildirim, 2023), emphasizing the urgent need for robust operational resilience and supply chain agility (Coşkun & Erturgut, 2023).

Simultaneously, Indonesia is navigating a critical transition toward sustainable development (Putra & Satria, 2025). The government has articulated its commitment to achieving net-zero carbon emissions by 2060 (Husada & Joesoef, 2022; Nasir & Bengi, 2024), a goal that requires a delicate balance between accelerating domestic production and adhering to global environmental standards. Investment trends reinforce this dual ambition. In 2022 alone, upstream oil and gas investments reached USD 12.3 billion—approximately 93% of the national target—signaling a strong governmental drive to enhance exploration and production efficiency despite external market volatilities (Kementerian Energi dan Sumber Daya Mineral, 2023). Yet, challenges remain. Domestic crude oil output continues to lag escalating demand, necessitating reliance on imports to bridge the consumption-production gap.

In this context, effective supply chain management is no longer a peripheral concern but a strategic imperative for oil and gas firms aiming to sustain profitability and long-term viability. Traditional supply chains are increasingly inadequate in coping with the complexities of today's energy sector, marked by fluctuating prices, regulatory shifts, and heightened environmental scrutiny. Lean Supply Chain Management (LSCM) emerges as a transformative framework that integrates waste minimization, continuous improvement, and value creation across supply chain activities (Khawka et al., 2024). Rooted in the principles of Lean Manufacturing, LSCM focuses on optimizing inventory levels, reducing lead times, and enhancing responsiveness without compromising quality or cost-efficiency (Cudney & Elrod, 2010).

While LSCM presents a strong foundation for operational excellence, its effectiveness is significantly enhanced when coupled with digital technologies. In particular, the adoption of Cloud-Based Supply Chain (CSSC) systems has revolutionized the way firms manage data, communicate, and coordinate across functions and partners. Cloud computing enables real-time access to critical information, facilitates end-to-end visibility, and supports strategic decision-making by integrating procurement, logistics, and production functions into a unified digital ecosystem (Khan & Sinha, 2022; Lu, Chen, Song, & Zhou, 2022). This digital convergence not only increases supply chain transparency but also empowers firms to anticipate disruptions, respond swiftly to market changes, and sustain competitive advantage in volatile environments.

Empirical studies in developed markets have demonstrated the potential benefits of LSCM (Garcia-Buendia, Moyano-Fuentes, Maqueira, & Avella, 2023; Khawka et al., 2024; Rossini, Powell, & Kundu, 2023), yet limited research has explored its synergy with CSSC in the unique context of emerging economies, particularly in capital-intensive and regulation-heavy sectors like oil and gas. Indonesia's energy industry offers a compelling environment to investigate how lean practices and cloud technologies can jointly influence business performance metrics such as cost efficiency, operational agility, and financial outcomes.

Therefore, this study aims to investigate the interaction and influence between Lean Supply Chain Management and Cloud-Based Supply Chain (CSSC) systems in driving business performance within Indonesia's oil and gas servicing sector. Specifically, the research seeks to evaluate how the implementation of Just-In-Time (JIT) and Total Quality Management (TQM) practices on Business Performance (BP) with the mediation role of CSSC. Through a rigorous empirical analysis, this study endeavors to provide actionable insights for practitioners and scholars alike, offering a model for sustainable and efficient supply chain transformation in resource-driven economies.

2. Method

This study adopted a positivist paradigm and employed a quantitative research approach. Researchers focused on analyzing factors influencing business performance through Lean Supply Chain Management (LSCM). The study utilized structured data collection methods to ensure empirical validity. Researchers selected employees from the oil and gas industry in Indonesia as the population, particularly those involved in supply chain, operational, and financial roles. The study included a total population of 600 individuals, with a relevant subset of 350. Probability sampling was applied, and the final sample size was determined to be 217 respondents using Cochran's formula. Data were collected through literature review and an online questionnaire. The questionnaire measured Cloud-Supported Supply Chain (CSSC), Just-in-Time (JIT), and Total Quality Management (TQM) influences on business performance using a six-point Likert scale.

Data analysis employed descriptive and inferential statistics using SmartPLS software. Structural Equation Modeling (SEM) with Partial Least Squares (PLS-SEM) was utilized for predictive analysis. Reliability and validity tests were conducted, including convergent validity, discriminant validity, composite reliability, and Cronbach's alpha. The study also assessed the structural model through R^2, effect size (f^2), predictive relevance (Q^2), and significance testing via bootstrapping. This methodological framework ensures that findings are robust, reliable, and applicable

to business environments, particularly in optimizing Lean Supply Chain Management through Cloud-Supported Supply Chain practices.

3. Results and Discussion

This study thoroughly assessed the impact of Lean Supply Chain Management (LSCM) and Cloud-Supported Supply Chain (CSSC) on business performance in Indonesia's oil and gas servicing industry. Through Structural Equation Modeling (SEM) using SmartPLS 3.2.9, the study validated the measurement model and tested hypotheses using a sample of 217 experienced professionals. The results support all proposed relationships and confirm the critical mediating role of CSSC.

3.1 Validity and Reliability Test Results

Table 1. Summary of Validity and Reliability Test Results

Variable	AVE	Cronbach's Alpha	Composite Reliability	Validity Status	Reliability Status
JIT	0.653	0.823	0.883	Valid	Reliable
TQM	0.630	0.804	0.872	Valid	Reliable
CSSC	0.693	0.853	0.900	Valid	Reliable
BP	0.559	0.887	0.910	Valid	Reliable

The results of the validity and reliability test using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach indicate that all constructs in the model fulfill the required measurement quality criteria as shown in Table 1. The Average Variance Extracted (AVE) values for all variables exceed the threshold of 0.50, confirming adequate convergent validity (Hair, Howard, & Nitzl, 2020). The highest AVE value is observed for CSSC (0.693), while the lowest is for BP (0.559); however, all values remain within acceptable limits. These findings suggest that the indicators used for each construct are capable of capturing a sufficient proportion of the variance of the underlying latent variables.

In terms of reliability, both Cronbach's Alpha and Composite Reliability (CR) values for all constructs surpass the minimum recommended threshold of 0.70 (Hair et al., 2020), demonstrating high internal consistency of the measurement instruments. Cronbach's Alpha ranges from 0.804 (TQM) to 0.887 (BP), while CR values range from 0.872 (TQM) to 0.910 (BP), indicating that all constructs are considered reliable. Therefore, the measurement model can be deemed both valid and reliable, making it suitable for subsequent structural model analysis.

3.2 Structural Model Analysis

3.2.1 Coefficient of Determination (R^2) Test Result

Table 2. The Result of Coefficient of Determination (R^2) Values

Construct	R^2	Adjusted R^2
BP	0.539	0.532

CSSC	0.422	0.417

Based on the results of the PLS-SEM analysis presented in Table 2, the R^2 value for the construct BP is 0.539, with an adjusted R^2 of 0.532. This indicates that 53.9% of the variance in business performance is explained by the independent constructs included in the model. Meanwhile, the construct CSSC has an R^2 value of 0.422 and an adjusted R^2 of 0.417, suggesting that 42.2% of the variation in customer satisfaction and service commitment is accounted for by the predictor variables. Both R^2 values fall within the moderate category, indicating that the model demonstrates a reasonably adequate predictive power in explaining the endogenous variables.

3.2.2 The Multicollinearity Test Results

Table 3. VIF Values

Predictor	VIF (to CSSC)	VIF (to BP)
JIT	1.263	1.603
TQM	1.263	1.433
CSSC	–	1.730

Based on the Variance Inflation Factor (VIF) results presented in Table 3, all VIF values are below the commonly accepted threshold of 5, indicating the absence of multicollinearity among the predictor variables in the PLS-SEM model. The highest VIF value is observed for CSSC as a predictor of BP at 1.730, while the lowest is 1.263 for both JIT and TQM as predictors of CSSC. These findings suggest that the independent constructs do not exhibit problematic collinearity, supporting the statistical adequacy and reliability of the structural model for further hypothesis testing.

3.3 Coefficient Significance Testing

3.3.1 Direct Effect

Table 4. Path Coefficients and Significance Testing Results

Hypothesized Path	Path Coefficient (β)	t-Statistic	p-Value	Decision
JIT → CSSC	0.444	7.280	0.000	P&S
TQM → CSSC	0.313	5.097	0.000	P&S
CSSC → BP	0.244	3.654	0.000	P&S
JIT → BP	0.323	4.489	0.000	P&S
TQM → BP	0.325	4.795	0.000	P&S

Note: P&S = Positive and Significant

The results of the path coefficient significance testing using the PLS-SEM approach, as presented in Table 4, reveal that all proposed relationships among the latent variables are statistically significant at the 0.05 level, with p-values of 0.000.

These findings confirm the acceptance of all hypothesized paths, indicating that the structural model demonstrates strong explanatory power regarding the interrelationships among TQM, JIT, CSSC, and business performance. This results inline with the previous research conducted by (Masudin & Kamara, 2018).

The direct effect of Just-In-Time (JIT) on Cloud-Based Supply Chain Collaboration (CSSC) shows a path coefficient of 0.444 and a t-statistic of 7.280, which indicates a strong and significant positive influence. This suggests that effective implementation of JIT practices—such as minimizing inventory levels, reducing lead time, and ensuring timely deliveries—positively contributes to the enhancement of supply chain agility and responsiveness through cloud-based systems.

Similarly, Total Quality Management (TQM) exhibits a significant positive effect on CSSC, with a path coefficient of 0.313 and a t-statistic of 5.097. This result implies that organizational commitment to continuous improvement, employee involvement, and customer satisfaction embedded in TQM principles facilitates the integration and digital transformation of supply chain processes via cloud technology platforms.

Furthermore, CSSC is found to have a positive and statistically significant influence on Business Performance (BP), with a path coefficient of 0.244 and a t-statistic of 3.654. This indicates that enhanced visibility, connectivity, and coordination enabled by cloud-based supply chain systems contribute meaningfully to improving organizational performance outcomes, such as operational efficiency, customer service, and market responsiveness.

Lastly, both JIT and TQM show direct positive effects on Business Performance, with path coefficients of 0.323 and 0.325, respectively. These findings highlight that the adoption of lean operations through JIT and the institutionalization of quality-driven culture through TQM significantly enhance overall business effectiveness. Together, they form a synergistic foundation for performance improvement in organizations seeking competitiveness in dynamic market environments.

3.3.2 Mediation Testing Results

Table 5. Mediation Testing Results (Indirect Effects)

Indirect Path	Coefficient	T-Statistic	P-Value	Conclusion
JIT → CSSC → BP	0.108	2.928	0.003	Significant Mediation
TQM → CSSC → BP	0.076	2.614	0.009	Significant Mediation

The results of the mediation analysis using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach indicate that Cloud-Based Supply Chain Collaboration (CSSC) significantly mediates the relationship between Just-In-Time (JIT) and Business Performance (BP). This is evidenced by a path coefficient of 0.108, a t-statistic of 2.928, and a p-value of 0.003, all of which surpass the commonly accepted thresholds for statistical significance. These findings suggest that the

implementation of JIT practices contributes indirectly to the enhancement of business performance when facilitated by the integration of cloud-based supply chain systems, which play a pivotal role in optimizing operational processes.

Similarly, a significant mediating effect of CSSC is also observed in the relationship between Total Quality Management (TQM) and Business Performance (BP), with a path coefficient of 0.076, a t-statistic of 2.614, and a p-value of 0.009. These results demonstrate that the adoption of comprehensive quality management initiatives can lead to improved business outcomes when such efforts are supported by cloud-based supply chain collaboration mechanisms. Overall, CSSC functions as a strategic mediator that enhances the effectiveness of both TQM and JIT in driving superior business performance.

3.4 Discussion

The results of this study reveal that Word of Mouth, Packaging, Price Perception, and Product Quality jointly have a significant effect on consumers' purchase decisions for Bolu Kelapa Putat. This finding aligns with previous research by Setiagraha, Wahab, Shihab, & Susetyo (2021) and Harto et al. (2022), which demonstrated that these variables, when considered collectively, significantly influence purchasing behavior. In the consumer decision-making process—as outlined by Kotter & Armstrong (2012), which includes stages such as problem recognition, information search, evaluation of alternatives, purchase decision, and post-purchase evaluation—Word of Mouth, Packaging, Price Perception, and Product Quality play an essential role, particularly during the information search phase. These variables are conveyed through various information sources and shape the consumer's initial impression and expectations regarding the product, thereby influencing the final decision to purchase Bolu Kelapa Putat.

However, when analyzed individually, not all variables exhibit a significant effect. Word of Mouth, for instance, is found to have no statistically significant impact on purchase decisions in this context. This contrasts with the findings of Chusaini, Prawoto, & Apriliani (2023) and Setiagraha et al. (2021), which reported a significant influence. Although Word of Mouth still exerts a degree of influence, its effect is not strong enough to be considered significant in this case. This is evident in the questionnaire response to the item "The information provided about Bolu Kelapa Putat can be trusted," which yielded the lowest average score. This result suggests that some consumers felt the information they received did not meet their expectations, possibly due to inconsistencies or discrepancies between the message conveyed by the source and the perception of the recipient.

Similarly, the Packaging variable also does not significantly influence consumer decisions. Although the overall descriptive scores for packaging were relatively high, the specific statement "I tend to buy Bolu Kelapa Putat products with visually

appealing packaging" received the lowest average rating. This indicates a level of disagreement among respondents about the attractiveness of the packaging. The result contradicts both the initial hypothesis and the findings of earlier studies by Harto et al. (2022) and Hasanah & Pambudi (2023), which found packaging to be a significant and positive factor in purchase decisions. It is possible that the packaging of Bolu Kelapa Putat has not yet achieved a level of distinctiveness or aesthetic appeal that strongly influences consumer behavior.

In contrast, Price Perception is found to have a positive and statistically significant effect on purchase decisions, supporting both the research hypothesis and the findings of Setiagraha et al. (2021) and Harnadi et al (2022). As suggested by Oentoro (2012), pricing strategies can affect consumer psychology, thereby forming favorable price perceptions that align with consumer expectations. The present findings suggest that consumers perceive the price of Bolu Kelapa Putat as appropriate to their needs and preferences. Notably, some respondents indicated that they did not feel the need to compare the product with others before making a purchase, suggesting a high level of satisfaction with the pricing structure offered.

Finally, while Product Quality does show a positive relationship with purchase decisions, the effect is not statistically significant. This finding implies that improvements in product quality do not necessarily result in increased consumer purchasing behavior in this case. Therefore, the results of this study do not support the conclusions drawn in earlier works by Setiagraha et al. (2021), Chusaini et al. (2023), Ardiansyah & Praswati (2024), and Ponomban, Soegoto, & Lintong (2023), all of which found product quality to have a significant influence on purchase decisions. This discrepancy may suggest that other factors—such as consumer loyalty, product familiarity, or marketing effectiveness—could play a more dominant role in driving purchase decisions for Bolu Kelapa Putat, overshadowing the influence of product quality alone.

4. Conclusion

The findings of this study confirm that Lean Supply Chain Management practices, specifically Just-In-Time (JIT) and Total Quality Management (TQM), significantly influence business performance both directly and indirectly through Cloud-Based Supply Chain Collaboration (CSSC) as a mediating variable. The model demonstrated strong validity and reliability, with acceptable AVE, Cronbach's Alpha, and Composite Reliability values. The structural model achieved moderate explanatory power, where JIT and TQM significantly enhance CSSC, and in turn, CSSC positively impacts Business Performance (BP). Mediation analysis further supports the strategic role of CSSC, highlighting its capability to bridge lean supply chain initiatives with performance outcomes. These results provide empirical evidence that digital transformation through cloud-enabled supply chains amplifies the benefits of lean

practices in the oil and gas service sector, reinforcing the synergistic interaction between operational excellence and technological integration.

Given the empirical support for the mediating role of CSSC, it is recommended that firms in the oil and gas industry invest strategically in cloud-based supply chain technologies as a digital enabler for lean operations. Emphasis should be placed not only on adopting JIT and TQM principles but also on integrating them with cloud infrastructure to enhance responsiveness, collaboration, and transparency across supply chain networks. Moreover, future managerial efforts should focus on aligning digital transformation strategies with quality improvement and inventory control initiatives, ensuring a seamless flow of data and resources. Policymakers and supply chain leaders should also consider building digital capabilities and training programs to strengthen organizational readiness for cloud adoption, as this can serve as a catalyst for sustainable business performance in volatile industrial environments.

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