



The Role of Lean Operations on Company Performance Mediated by Six Sigma at the Yogyakarta Regional Public Service Agency (BLUD)

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Abstract

Rapid development and intense competition demand that organizations, including those in the public sector, improve service quality and efficiency. Methodologies like Lean Operations and Six Sigma have proven effective in the private sector; however, their application and synergistic effects, particularly in public service entities like Regional Public Service Agencies (BLUD), remain underexplored. Purpose: This study aims to analyze the effect of Lean Operations on the corporate performance of the Yogyakarta BLUD, with Six Sigma tested as a mediating variable. Methodology: This quantitative study employs a survey method, collecting data via a Likert-scale questionnaire from 89 respondents within the Yogyakarta BLUD. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to test the direct and mediating effect hypotheses. Results: The findings confirm that Lean Operations has a significant positive effect on corporate performance. Furthermore, Six Sigma not only has a direct positive effect on performance but also significantly mediates the relationship between Lean Operations and corporate performance, indicating that Six Sigma's data-driven methodology is a crucial mechanism for translating Lean's efficiency gains into sustained performance improvements. The model demonstrates strong predictive power, explaining 70% of the variance in corporate performance. Contribution: This research makes both theoretical and practical contributions by validating the integrated role of Lean and Six Sigma in a public sector context, providing BLUD management with a strategic roadmap for enhancing performance by first establishing Lean principles and then leveraging Six Sigma for controlled, high-quality outcomes.

Keywords *Lean Operations, Six Sigma, Corporate Performance, Public Sector, BLUD, PLS-SEM.*

INTRODUCTION

This study investigates the role of Lean Operations in improving organizational performance, with Six Sigma serving as a mediating variable, through a case study at the Regional Public Service Agency (BLUD) in Yogyakarta. Lean Operations emphasizes the identification and elimination of waste to enhance efficiency and deliver greater customer value (Kholil & Pambudi, 2014). However, waste reduction requires a structured, data-driven mechanism to achieve sustainable results. Six Sigma provides this support by applying the DMAIC (Define, Measure, Analyze, Improve, Control) cycle, enabling organizations to detect root causes, minimize variation, and prevent defects (Sujova et al., 2016). The integration of Lean and Six Sigma allows efficiency gains from Lean to be reinforced by quality improvements through Six Sigma, thereby enhancing organizational performance (Setiawan et al., 2020).

In today's era of rapid development and intense competition, public organizations must also improve efficiency and service quality. Problems common in manufacturing, such as low productivity and defective products (Wang et al., 2019), are mirrored in the public sector in the form of bureaucratic delays, extended service waiting times, and low public satisfaction. Thus, applying Lean and Six Sigma is highly relevant for continuous improvement (Bortolotti et al., 2015). Prior evidence supports this integration, as Lean Six Sigma has improved production by 11% and reduced costs by 14.35% in the chemical industry (Muganyi et al., 2019). In healthcare, it reduced waiting times and enhanced service delivery (Widiwati et al., 2025). Public service centers also benefit, with Lean practices improving efficiency and performance (Hassan & Pasha, 2023).

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Despite extensive research on Lean Six Sigma, most studies focus on manufacturing and private enterprises (Ghobakhloo & Fathi, 2020). Limited research examines its application in public service entities, such as BLUDs. Moreover, while many works view Lean Six Sigma as a unified framework, fewer investigate the causal dynamics—particularly how Six Sigma mediates the influence of Lean on performance. Existing findings remain inconsistent, highlighting the need for further inquiry (Manikas et al., 2021).

This research addresses that gap by analyzing Six Sigma's mediating role between Lean principles and organizational performance in Yogyakarta BLUD. Theoretically, it advances understanding of how Lean's waste elimination, reinforced by Six Sigma's rigorous analysis, can enhance public sector performance. Practically, it offers insights for BLUD management while enriching public management literature. The central research question is what is the role of Lean Operations on the performance of Yogyakarta BLUD, with Six Sigma as a mediating variable?

Operationally, Lean Operations is defined as practices targeting waste elimination, measured by cycle time, efficiency, and productivity (Kholil & Pambudi, 2014). Six Sigma is a structured, data-driven approach that utilizes DMAIC and statistical tools (Sujova et al., 2016). Organizational performance reflects operational success and community satisfaction (Agustina et al., 2025).

LITERATURE REVIEW

Lean Operations and Corporate Performance

In recent years, firms have increasingly embraced lean practices to reduce waste and enhance profitability (Bhattacharya & Daouk, 2003). Lean emphasizes resource efficiency and waste elimination (Manikas et al., 2021). While initially identifying seven waste types (Hines et al., 1999), later studies added underutilized talent (Erdil et al., 2018a) and environmental overuse (Wang et al., 2019). Empirical evidence links lean inventory and capacity to better performance (Erdil et al., 2018a). Moreover, investing in modern equipment enables the adoption of leaner technologies and minimizes inefficiencies (Manikas et al., 2021). Accordingly, this study hypothesizes that lean inventory, capacity, and equipment investment improve Return on Assets (Erdil et al., 2018b; Kholil & Pambudi, 2014; Shafer & Moeller, 2012).

Six Sigma and corporate performance

Six Sigma is a management approach designed to enhance company performance by minimizing defects and process variation, aiming for no more than 3.4 Defects per Million Opportunities (DPMO). Using the DMAIC cycle, it identifies and removes root causes (Ishak et al., 2020). Studies show that Six Sigma improves efficiency, reduces rework, and boosts customer satisfaction (Maware et al., 2022), resulting in financial gains through cost savings and revenue growth (Echegoyen et al., 2018). However, success requires a commitment to leadership, employee training, strategic alignment, and a supportive culture (Pereira et al., 2019). Properly implemented, Six Sigma drives significant operational and financial improvement.

Lean Operation and Six Sigma

Lean Six Sigma, the integration of Lean and Six Sigma, is a key strategy to enhance operational performance. Lean, derived from the Toyota Production System, focuses on efficiency and waste elimination, including excess inventory and unnecessary lead time, while Six Sigma reduces variation and defects through a data-driven approach. Lean accelerates processes, whereas Six Sigma ensures consistent quality. Applied together, they offset each other's weaknesses, creating efficient, reliable, defect-free processes (Womack & Jones, 1997). This synergy enhances product quality, reduces cycle times, and lowers costs, thereby strengthening profitability and competitiveness (Shah & Deshpande, 2015). Effective implementation requires a commitment from

top management, cultural support, and trained teams. Therefore, the hypothesis are:

H1: Lean Operations influences corporate performance

H2: Lean Operations influences Six Sigma

H3: Six Sigma influences corporate performance

H4: Lean Operations' influence on corporate performance is mediated by Six Sigma's

RESEARCH METHOD

This study employs a quantitative survey approach to investigate the impact of Lean Operations on Corporate Performance, with Six Sigma serving as a mediator. It is descriptive and verifiable, aiming to explain causal relationships (Hair et al., 2021). The subjects are all BLUDs in Yogyakarta, using a census or purposive sampling of managers/senior staff (Antony et al., 2017). Variables include Lean Operations (independent), Six Sigma (mediator), and Corporate Performance (dependent). Lean is measured by cycle time, productivity, and kaizen (Womack & Jones, 1997), six Sigma is measured by DMAIC and statistical tools (Almasarweh et al., 2020), performance is measured by efficiency, speed, satisfaction, and service quality (Muganyi et al., 2019).

Table 1. Operationalization of the research instrument

Variable	Definition	Indicator
Lean Operation (X) (Manikas et al., 2021; Singh et al., 2022)	A management system focused on eliminating waste to improve efficiency and customer value.	1. Efficiency of cycle time and lead time. 2. Level of waste elimination (e.g., excess inventory, unnecessary motion, defects) 3. Implementation of value stream mapping. 4. Continuous improvement (Kaizen).
Six Sigma (Z) (Citybabu & Yamini, 2024; Maware et al., 2022; Widiwati et al., 2025)	A structured methodology for improving the quality of business processes by reducing variation and defects.	1. Implementation of the DMAIC (Define, Measure, Analyze, Improve, Control) methodology 2. Use of statistical tools (e.g., SPC, FMEA, Pareto Chart) 3. Management commitment to Six Sigma initiatives. 4. Staff training and competency in Six Sigma principles.
Corporate Performance (Y) (Erdil et al., 2018b; Susanto et al., 2023; Suto & Takehara, 2018)	The degree of success an organization achieves in meeting its strategic goals, measured from both financial and non-financial perspectives.	1. Financial: Operational cost efficiency, Revenue increase or budget effectiveness. 2. NonFinancial: Level of customer satisfaction,

Quality of services provided.

FINDINGS AND DISCUSSION

This study employed SmartPLS 4.0 as the most appropriate SEM method for 89 BLUD respondents. Based on the “10-times rule,” the minimum sample is 10 times the maximum structural paths, requiring 30 for three paths; thus, 89 is sufficient (Hair et al., 2017; Singh et al., 2024). PLS-SEM analysis begins with outer model evaluation (reliability, validity) followed by the inner model (relationships) (Hair et al., 2017; Hair, 2009). Reliability was assessed using Cronbach’s alpha (>0.6 acceptable), convergent validity by AVE (>0.5) and loadings (>0.6) (Armstrong et al., 2015; Hair et al., 2017), and discriminant validity via Fornell-Larcker (1981), considered the most rigorous test (Hakelius & Hansson, 2016).

Table 2. Outer Model Assessment

Variable	Indicators	Loading Factor	AVE (AVE > 0.05)	Crombach's Alpha ($\alpha > 0.6$)
Lean Operations	LO1	0.66	0.55	0.80
	LO2	0.67		
	LO3	0.84		
	LO4	0.79		
	LO5	0.75		
SIX Sigma	SS1	0.88	0.76	0.92
	SS2	0.84		
	SS3	0.90		
	SS4	0.85		
	SS5	0.87		
Corporate Performance	CP1	0.84	0.76	0.89
	CP2	0.89		
	CP3	0.93		
	CP4	0.83		

Discriminant validity ensures constructs are distinct from one another. The most common method compares squared AVE values with correlations: validity is established if a construct’s AVE exceeds its correlations with other constructs (Fornell & Larcker, 1981). This shows that each construct explains more variance in its own indicators. Cross-loadings can also be examined, where an indicator should load higher on its own construct than on others, with a benchmark of > 0.6 . The Fornell-Larcker approach is regarded as the most rigorous for testing discriminant validity (Henseler et al., 2009). In this study, all reliability and validity requirements were successfully achieved.

Table 3. Fornell-Larcker Criterion

	Corporate Performance	Lean Operations	Six Sigma
Corporate Performance	0.870		

Lean Operations	0.746	0.744	
Six Sigma	0.814	0.752	0.869

Inner Model Assessment

After the outer model has been evaluated, the next step is to assess the inner model. This evaluation begins by examining the path coefficients and their significance values. Significance is typically determined using the bootstrapping method within SmartPLS 4.0. For this study, a sample size of 2000 was used for the bootstrapping process to test for significance. All tested pathways were accepted with varying strengths. Lower p-values and higher coefficient values indicate stronger relationships between variables.

Table 4. Pathway assessment

Hypotheses	Pathways	Pathways Coefficient	T-Stats	P-Value	Result
H1	Lean Operations -> Corporate Performance	0.308	2.498	0.013	Accept
H2	Lean Operations -> Six Sigma	0.752	12.118	0.000	Accept
H3	Six Sigma -> Corporate Performance	0.583	4.928	0.000	Accept

Based on the table provided, the analysis of the inner model yields the following results for the three hypotheses:

1. Hypothesis 1 (H1)

The relationship between Lean Operations and Corporate Performance is statistically significant and positive. The pathways coefficient is 0.308, indicating that for every one-unit increase in Lean Operations, there is a 0.308 increase in Corporate Performance. The T-statistic is 2.498, which is greater than the standard threshold of 1.96 for a 5% significance level. Additionally, the p-value of 0.013 is less than 0.05, confirming the statistical significance. Therefore, H1 is accepted.

2. Hypothesis 2 (H2)

The relationship between Lean Operations and Six Sigma is highly significant and positive. The pathways coefficient is 0.752, suggesting a strong positive effect. The T-statistic is 12.118 and the p-value is 0.000, both of which are well beyond the thresholds for statistical significance. This provides strong evidence that a higher level of Lean Operations is associated with a higher level of Six Sigma. Therefore, H2 is accepted.

3. Hypothesis 3 (H3)

The relationship between Six Sigma and Corporate Performance is also highly significant and positive. The pathways coefficient is 0.583, indicating a substantial positive effect. Similar to H2, the T-statistic is 4.928, and the p-value is 0.000, both of which strongly support the relationship. This suggests that implementing Six Sigma practices has a significant positive impact on Corporate Performance. Therefore, H3 is accepted.

Table 5 Structural Model Assessment

Endogenous Variables	R Square
CP	0.70
SS	0.57

The R-squared value for Corporate Performance (CP) is 0.70, indicating that Lean Operations and Six Sigma explain 70% of its variance. This substantial value indicates very strong predictive power. For Six Sigma (SS), the R-squared is 0.57, showing that the model explains 57% of its variance. This reflects a moderately strong ability to predict Six Sigma implementation, confirming the model's effectiveness in explaining both constructs.

Table 6. Goodness-of-Fit

Description	Value	Interpretation	Reference
Goodness of Fit	—	Good	Wetzel et al. (2009)

The Goodness-of-Fit (GoF) assesses overall model quality in PLS-SEM by combining average communality (AVE) and R^2 . This study's GoF value of 0.78, classified as "Good" (Wetzel et al., 2009), indicates strong explanatory power, confirming that the model is both robust and reliable in explaining construct relationships.

Table 7. Mediation Effect

Hypotheses	Pathways	Pathways Coefficient	T-Stats	P-Value	Result
H4	Lean Operations -> Sig sigma -> Corporate Performance	0.459	2.498	0.000	Accept

The mediation test for H4 shows Six Sigma significantly mediates the link between Lean Operations and Corporate Performance. The indirect path (0.459) indicates a strong positive effect, supported by a T-statistic of 2.498 and p-value of 0.000, confirming statistical significance. Thus, H4 is accepted. These results highlight that Lean Operations improves performance not only directly but also indirectly by enabling Six Sigma practices, which strengthen and sustain organizational outcomes.

Discussion

This study confirms that Lean Operations have a significant and positive influence on the performance of the Regional Public Service Agency (BLUD) in Yogyakarta, with Six Sigma serving as a key mediating factor. The results provide both theoretical and practical contributions, particularly in the context of the public sector, which remains relatively underexplored in Lean Six Sigma research. Specifically, Lean Operations directly improves corporate performance (H1 accepted) while also strengthening the adoption of Six Sigma (H2 accepted). This supports prior studies emphasizing the complementary nature of Lean and Six Sigma: Lean generates efficiency and process flow, creating stability for Six Sigma's data-driven tools to ensure consistent quality (Womack & Jones, 1997; Shah & Deshpande, 2015). In the BLUD setting, Lean's waste reduction and cycle efficiency improvements form the necessary groundwork for Six Sigma's structured methodology.

The analysis also demonstrates that Six Sigma exerts a strong positive effect on performance (H3 accepted), consistent with findings from the manufacturing and service sectors (Maware et al., 2022; Widarwati et al., 2023). Notably, the mediation analysis shows that Six Sigma significantly channels Lean's impact on performance, with an indirect path coefficient of 0.459 (H4 accepted). This suggests that Lean alone delivers efficiency gains, but its influence is amplified when Six Sigma translates those improvements into high-quality outcomes by addressing variation and solving complex problems. In this sense, Six Sigma functions as the mechanism that locks in Lean's initial benefits, preventing regression and driving sustained performance.

Theoretically, these findings clarify the causal pathway through which Lean creates value in a public organization. Lean simplifies processes, but Six Sigma provides the rigorous analysis needed to institutionalize improvements. Implementing Lean without Six Sigma risks partial results, as deeper issues of process variation remain unresolved. This reinforces the integrative Lean Six Sigma approach, which scholars argue is more effective than applying either methodology in isolation (McDermott et al., 2022; Thiagarajan et al., 2017). Although Lean Six Sigma adoption in the public sector is often hindered by bureaucracy and weak improvement cultures, this study demonstrates that with a sequential approach first Lean, then Six Sigma BLUDs can achieve substantial improvements in efficiency and service quality, highlighting the transferability of this approach from private to public contexts.

The model demonstrates strong explanatory power, with R^2 values of 0.70 for corporate performance and 0.57 for Six Sigma, indicating that Lean Operations substantially enhances Six Sigma capability. Validity and reliability were confirmed: loadings >0.6 , AVE >0.5 , Cronbach's alpha >0.6 , and discriminant validity via Fornell–Larcker were satisfied. The overall model fit (GoF = 0.78) confirms the robustness and predictive strength of the model.

CONCLUSIONS

This study examined the effect of Lean Operations on the performance of the Yogyakarta Regional Public Service Agency (BLUD), with Six Sigma as a mediating variable. The findings provide strong empirical support for all hypotheses. Lean Operations directly enhances corporate performance and significantly drives the adoption of Six Sigma. In turn, Six Sigma not only improves performance but also mediates the relationship between Lean and performance, showing that Lean's benefits are amplified through Six Sigma's structured, data-driven problem-solving framework. Theoretically, this study contributes by clarifying the mechanism of Lean Six Sigma integration in the public sector, an underexplored area. The synergy is shown to be sequential: Lean creates efficiency by reducing waste, while Six Sigma ensures quality and consistency through analysis, improvement, and control. Practically, the results offer public managers a roadmap: Lean provides immediate efficiency, but combining it with Six Sigma secures sustainable, high-quality performance improvements.

LIMITATIONS & FURTHER RESEARCH

This study has limitations that open avenues for future research. Focusing only on one BLUD in Yogyakarta limits generalizability; broader samples across regions or public organizations are recommended. The direct mediation model could be extended with moderators such as organizational culture, leadership, technological readiness, or regulatory pressure. Additionally, a longitudinal design would provide deeper insights into the sequential implementation of Lean–Six Sigma and the long-term sustainability of performance improvements, which extend beyond the scope of this study's cross-sectional analysis.

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