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Procurement Management Strategy for Zinc Ingots Based on LME Price Volatility: Achieving Cost Reduction Targets and Optimizing Operational Performance in the Hot-Dip Galvanizing Industry

Suherman[1], Nurhidayah [2], Abdullah Syakur Novianto[3]
[1]Magister Manajemen, Universitas Islam Malang, Malang
[2,3]Universitas Islam Malang, Malang
Email: herman.mang81@gmail.com

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Abstract

This study aims to analyze the effect of London Metal Exchange (LME) Zinc price volatility and Zinc Ingot procurement management strategies on the company's operational performance through procurement cost efficiency at the participating EPC company. High volatility in global Zinc prices can influence raw material procurement costs and consequently affect the effectiveness of operational performance. Therefore, appropriate procurement strategies are required to control costs and maintain operational efficiency. This study employed a quantitative approach using a survey method, with data collected through questionnaires distributed to 32 respondents involved in the company's procurement, production, and operational activities. The data were analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM) with SmartPLS 4 software. The results indicate that LME Zinc price volatility significantly affects procurement cost efficiency and the company's operational performance. Zinc Ingot procurement management strategies also have a significant effect on procurement cost efficiency and operational performance. Furthermore, procurement cost efficiency significantly influences operational performance. The mediation analysis reveals that procurement cost efficiency successfully mediates the effects of both LME Zinc price volatility and Zinc Ingot procurement management strategies on operational performance. These findings suggest that effective commodity price risk management and procurement strategies are essential for improving cost efficiency and supporting the achievement of sustainable operational performance.

INTRODUCTION

The steel construction and fabrication industry is a strategic sector that supports infrastructure development, transportation, energy, and mining activities in Indonesia. Globally, the construction sector contributes approximately 6% to the world's Gross Domestic Product (GDP) and is projected to increase to 14.7% by 2030, making operational efficiency a critical factor in sustaining industrial growth and competitiveness (Прадото et al., 2023). In this context, Engineering, Procurement, and Construction (EPC) companies play a central role as they are responsible for integrating project planning, material procurement, manufacturing, and project execution. Therefore, the effectiveness of procurement management has become one of the key determinants of a company's operational performance.

In the steel construction industry, corrosion protection is essential for ensuring the long-term durability of steel structures. One of the most widely adopted methods is hot-dip galvanizing,

a process in which steel is coated with molten zinc to form a protective layer against corrosion. In this process, zinc ingots serve as the primary raw material and contribute significantly to production costs. For EPC companies such as the participating EPC company, which operates in the infrastructure, energy, transportation, and mining sectors, the availability and effective management of zinc ingots are strategic factors in maintaining product quality while achieving operational cost efficiency.

A major challenge in zinc ingot procurement is the high volatility of zinc prices in the global market, which are primarily benchmarked against the London Metal Exchange (LME). Price fluctuations are influenced by global economic conditions, changes in industrial demand, disruptions in international supply chains, and geopolitical uncertainties, all of which can increase procurement costs and reduce corporate profitability (Gaudenzi et al., 2020; Królikowska et al., 2021). Previous studies have shown that rising raw material prices, when not accompanied by corresponding revenue growth, may trigger financial distress and negatively affect the performance of manufacturing firms (Sari & Yunita, 2019). Furthermore, increasing production costs resulting from raw material price fluctuations can potentially disrupt financial stability and operational effectiveness (Siswanto, 2024).

From a Supply Chain Management perspective, effective procurement decision-making—including purchasing timing, contract strategies, inventory management, and price risk mitigation—is crucial for controlling the impact of commodity price volatility. Procurement strategies that are adaptive to market price changes can improve cost efficiency while maintaining operational stability (Saleheen & Habib, 2024; Veli & Bahari, 2024). The Resource-Based View (RBV) suggests that a firm's capability to manage market information, price risks, and procurement processes effectively constitutes a valuable, rare, inimitable, and non-substitutable strategic resource that can generate sustainable competitive advantage (Aisyah et al., 2022; Hanfan, 2021; Wahyudhi et al., 2024). Meanwhile, Contingency Theory emphasizes that the effectiveness of procurement strategies depends on their alignment with dynamic external environmental conditions and specific organizational characteristics (Özmay, 2025; Siburian et al., 2022).

Although studies on commodity price volatility and procurement management have expanded considerably, research integrating LME zinc price volatility, procurement management strategies, procurement cost efficiency, and operational performance within EPC companies remains limited, particularly in emerging economies such as Indonesia (Dinata & Suharjito, 2024; Ichsan, 2021). Existing studies have predominantly focused either on commodity price analysis, supply chain risk management, or the technical aspects of galvanizing processes in isolation. Consequently, limited empirical evidence is available regarding how external market uncertainties, such as zinc price volatility, interact with internal procurement capabilities to influence operational performance outcomes (Dasuki, 2021; Hautala-Kankaanpää, 2023).

This study addresses this gap by developing an integrated framework that links LME zinc price volatility, procurement management strategy, procurement cost efficiency, and operational performance in an EPC environment. Unlike previous studies that examine these variables separately, this research investigates procurement cost efficiency as a mediating mechanism through which procurement strategies and market price volatility affect operational performance. By examining the case of the participating EPC company, this study contributes to the strategic procurement management literature by extending the application of Resource-Based View (RBV) and Contingency Theory in the context of commodity-based procurement decisions. Furthermore, the findings are expected to provide practical insights for managers in designing adaptive

procurement strategies to mitigate commodity price risks, achieve cost-reduction targets, and enhance operational performance in the EPC industry (Nnaji et al., 2024; Siregar et al., 2022).

THEORETICAL REVIEW

LME Zinc Price Volatility and Procurement Cost Efficiency

Commodity price volatility represents one of the primary sources of uncertainty in supply chain management within manufacturing and construction industries. In the context of zinc ingots, prices benchmarked against the London Metal Exchange (LME) are influenced by various factors, including global economic conditions, changes in industrial demand, supply chain disruptions, and geopolitical dynamics, all of which contribute to significant price fluctuations (Gaudenzi et al., 2020; Królikowska et al., 2021). Such price instability increases the risk of material cost deviations and complicates the development of effective procurement planning.

According to Contingency Theory, dynamic changes in the external environment require organizations to adapt their resource management mechanisms to maintain operational efficiency (Özmay, 2025). When zinc price volatility increases, companies may face unexpected procurement cost increases, thereby reducing their ability to control material expenditures effectively. Previous studies have demonstrated that raw material price volatility contributes to higher production costs and decreases cost management efficiency within organizations (Dinata & Suharjito, 2024; Sari & Yunita, 2019). Therefore, LME zinc price volatility is expected to influence procurement cost efficiency.

H1: LME zinc price volatility has a significant effect on zinc ingot procurement cost efficiency.

Procurement Management Strategy and Procurement Cost Efficiency

Procurement management strategy refers to a series of decisions related to supplier selection, purchasing timing, contract arrangements, inventory management, and price risk mitigation aimed at acquiring materials effectively and efficiently (Dinata & Suharjito, 2024; Ichsan, 2021). In manufacturing industries, approximately 60–65% of production costs originate from the procurement of materials and services; therefore, the effectiveness of procurement strategies directly affects corporate cost efficiency ("Contemporary Research on Business and Management," 2020; Shah & Hasan, 2016).

From the Resource-Based View (RBV) perspective, a company's ability to manage procurement processes strategically constitutes a valuable capability that can generate competitive advantage through cost control and resource optimization (Hautala-Kankaanpää, 2023; Ichsan, 2021). In the hot-dip galvanizing industry, zinc ingots may account for approximately 55–65% of total production costs. Consequently, effective procurement strategies such as centralized purchasing, long-term contracts, and forward buying can significantly improve cost efficiency (Adda, 2024; Nnaji et al., 2024). Therefore, procurement management strategy is expected to influence procurement cost efficiency.

H2: Zinc ingot procurement management strategy has a significant effect on procurement cost efficiency.

LME Zinc Price Volatility and Corporate Operational Performance

Operational performance reflects a company's ability to achieve production targets, maintain material supply stability, control operational costs, and ensure manufacturing process reliability (Heizer et al., 2018). In EPC companies, operational success is highly dependent on the availability of strategic materials and the firm's ability to manage supply chain risks effectively.

LME zinc price volatility affects not only procurement costs but also has the potential to disrupt business operations. High price fluctuations may result in changes in purchasing schedules, project budget uncertainties, and material supply delays, ultimately affecting operational effectiveness (Gaudenzi et al., 2020; Królikowska et al., 2021). Previous studies have indicated that commodity price instability can reduce profitability and hinder the achievement of operational targets in manufacturing firms (Sari & Yunita, 2019). Therefore, LME zinc price volatility is expected to influence corporate operational performance.

H3: LME zinc price volatility has a significant effect on corporate operational performance.

Procurement Management Strategy and Corporate Operational Performance

An effective procurement management strategy enables companies to acquire materials at competitive costs, appropriate quality standards, and reliable supply continuity. According to Monczka et al., strategic procurement that is integrated with corporate strategy can create added value and improve operational performance (Nnaji et al., 2024).

From the RBV perspective, a firm's capability to manage supplier relationships, implement long-term contracts, and control price-related risks constitutes a strategic capability that enhances competitive advantage (Hautala-Kankaanpää, 2023). Furthermore, strong supplier partnerships can reduce supply uncertainty, accelerate production processes, and improve operational reliability (Belo et al., 2020; Suardhika, 2018). Therefore, procurement management strategy is expected to influence corporate operational performance.

H4: Zinc ingot procurement management strategy has a significant effect on corporate operational performance.

Cost Efficiency and Corporate Operational Performance

Cost efficiency refers to a company's ability to optimize resource utilization without compromising operational quality and effectiveness (Adda, 2024; Slack & Johnston, 2010). In manufacturing industries, material cost control is particularly important because a substantial proportion of production costs arises from material and service procurement activities ("Contemporary Research on Business and Management," 2020; Shah & Hasan, 2016).

Companies that achieve higher levels of cost efficiency are better positioned to allocate resources optimally, maintain production stability, and improve operational productivity. Previous studies have shown that cost efficiency positively contributes to corporate performance through enhanced supply chain management effectiveness and reduced operational expenses (Siahaya, 2017; Siburian et al., 2022). Therefore, cost efficiency is expected to influence corporate operational performance.

H5: Cost efficiency has a significant effect on corporate operational performance.

The Mediating Role of Cost Efficiency in the Relationship between LME Zinc Price Volatility and Corporate Operational Performance

LME zinc price volatility increases uncertainty in material costs, which ultimately affects a company's ability to control procurement expenditures. When firms are unable to manage the impact of price fluctuations effectively, production costs increase and may negatively affect operational performance (Gaudenzi et al., 2020; Dinata & Suharjito, 2024).

Cost efficiency serves as a mechanism through which the effects of price volatility are transmitted to corporate operational performance. The greater a company's ability to control procurement costs amid price fluctuations, the lower the negative impact of volatility on its operations. Therefore, cost efficiency is expected to mediate the relationship between LME zinc price volatility and corporate operational performance (Siburian et al., 2022).

H6: Cost efficiency mediates the effect of LME zinc price volatility on corporate operational performance.

The Mediating Role of Cost Efficiency in the Relationship between Procurement Management Strategy and Corporate Operational Performance

An effective procurement management strategy enables firms to optimize material purchasing costs through appropriate supplier selection, contract management, and price risk mitigation practices (Ichsan, 2021; Nnaji et al., 2024). These capabilities contribute to enhanced cost efficiency, which ultimately supports the achievement of operational objectives.

Cost efficiency functions as the mechanism through which procurement strategies generate improvements in operational performance. When firms successfully reduce procurement costs without compromising product quality and supply continuity, operational effectiveness improves. Therefore, cost efficiency is expected to act as a mediating variable that strengthens the influence of procurement management strategy on corporate operational performance (Siburian et al., 2022; Slack & Johnston, 2010).

H7: Cost efficiency mediates the effect of zinc ingot procurement management strategy on corporate operational performance.

CONCEPTUAL FRAMEWORK

This study develops a conceptual framework to explain the relationships among London Metal Exchange (LME) zinc price volatility, zinc ingot procurement management strategy, procurement cost efficiency, and corporate operational performance. The framework is grounded in the Resource-Based View (RBV) and Contingency Theory, which emphasize the importance of strategic procurement capabilities and a firm's ability to respond effectively to dynamic external environmental conditions characterized by commodity price fluctuations.

In this research model, procurement cost efficiency is positioned as a mediating variable that explains the mechanism through which LME zinc price volatility and procurement management strategy influence corporate operational performance. The proposed relationships among the variables are illustrated in **Figure 1**.

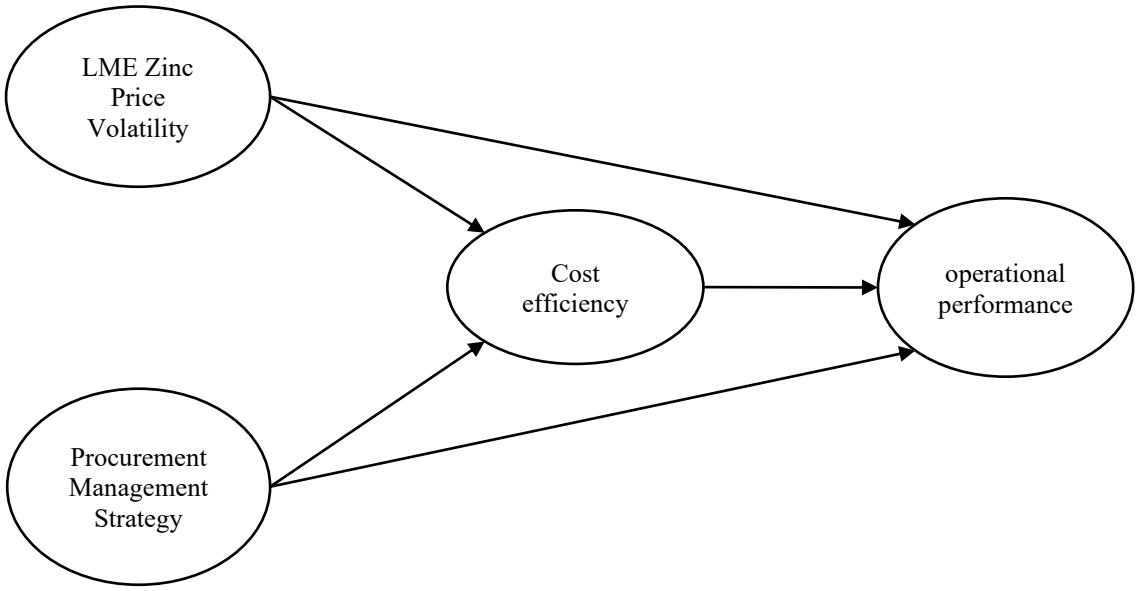

Figure 1. Conceptual Framwork

METHODS

Study population consisted of all personnel from the Purchasing, Supply Chain, Production, and Finance departments who were directly involved in zinc ingot procurement, inventory management, cost control, and production operations. Given the relatively small and homogeneous population, a census sampling technique (saturated sampling) was employed, resulting in a total sample of 32 respondents (Gunawan & Nasir, 2023). Primary data were collected through a structured questionnaire, while secondary data were obtained from company reports and historical zinc price data referenced from the London Metal Exchange (LME).

Data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) with the assistance of SmartPLS 4 software. This method was selected because it is capable of analyzing complex structural models, accommodating relatively small sample sizes, and does not require normally distributed data (Darmaileny et al., 2022; Kurniawati & Surya, 2022). The analysis involved the assessment of both the measurement model and the structural model. The measurement model was evaluated using outer loadings, Average Variance Extracted (AVE), cross-loadings, and Composite Reliability to establish construct validity and reliability, while the structural model was assessed using the coefficient of determination (R^2), path coefficients, t-statistics, and p-values to test the proposed hypotheses. Furthermore, the mediating role of procurement cost efficiency was examined through a bootstrapping procedure to evaluate the specific indirect effects among the study variables.

RESULTS

This study involved 32 respondents from the Purchasing, Supply Chain, Production, and Finance departments within the galvanizing business unit of the participating EPC company. Based on respondent characteristics, the majority were male, accounting for 27 respondents (84.4%), while female respondents totaled 5 individuals (15.6%). In terms of job position, most respondents were from the Quality Control section (53.1%), followed by Department Heads/HODs/Supervisors (12.5%), Warehouse personnel and Warehouse Inventory Controllers (WIC) (9.4%), and PPIC, HSE, and Maintenance personnel, each representing 6.3% of the sample. This composition indicates that the respondents were directly involved in zinc ingot procurement activities, inventory management, quality control, cost management, and production operations, enabling them to provide relevant information regarding the variables examined in this study.

The descriptive analysis results indicate that all research variables received very high ratings from respondents. The LME zinc price volatility variable achieved a mean score of 4.30, suggesting that respondents perceive zinc price fluctuations as an external factor that substantially affects procurement costs and company operations. The procurement management strategy variable obtained a mean score of 4.25, indicating that procurement practices such as inventory management, supplier partnerships, and price risk mitigation have been implemented effectively. Furthermore, procurement cost efficiency recorded a mean score of 4.28, while corporate operational performance achieved a mean score of 4.24. These findings suggest that respondents perceive the company as being capable of managing procurement costs efficiently while maintaining optimal operational performance. Following the descriptive analysis, the measurement model was evaluated.

The measurement model evaluation was conducted to assess the adequacy of the indicators in representing the constructs of LME zinc price volatility, procurement management strategy,

procurement cost efficiency, and corporate operational performance. The results indicate that all indicators demonstrated satisfactory ability to explain their respective constructs. The outer loading values for each indicator are presented in **Table 1**.

Table 1. Outer Loading

Item	Cost efficiency (Z)	Operational performance (Y)	Procurement Management Strategy (X2)	LME Zinc Price Volatility (X1)
X1.1				0.876
X1.2				0.764
X1.3				0.709
X1.4				0.847
X2.1			0.911	
X2.2			0.791	
X2.3			0.901	
X2.4			0.730	
Y.1		0.918		
Y.2		0.805		
Y.3		0.845		
Y.4		0.864		
Z.1	0.814			
Z.2	0.828			
Z.3	0.777			
Z.4	0.839			

Source: Processed data from SmartPLS. 4

Based on Table 1, all research indicators exhibit outer loading values above 0.70, thereby satisfying the criterion for convergent validity and demonstrating their ability to adequately represent the constructs being measured (Hair et al., 2022). These results indicate that all indicators associated with the variables of LME Zinc Price Volatility (X1), Procurement Management Strategy (X2), Procurement Cost Efficiency (Z), and Operational Performance (Y) are valid and appropriate for use in subsequent analyses.

More specifically, the highest outer loading value was observed for the Procurement Management Strategy construct (X2.1 = 0.911), indicating that the implementation of hedging strategies represents the strongest indicator of this construct. For the LME Zinc Price Volatility variable, indicator X1.1 recorded the highest loading value (0.876), while indicator Y1 demonstrated the highest loading value (0.918) within the Operational Performance construct. Meanwhile, for the Procurement Cost Efficiency variable, indicator Z4 exhibited the highest loading value at 0.839. Overall, these findings confirm that the measurement model satisfies the requirements of convergent validity and is suitable for proceeding to the next stage of model evaluation.

Table 2 *Construct Reliability and Validity*

Variable	*Cronbach's Alpha*	*Composite Reliability* (rho_a)	*Composite Reliability* (rho_c)	Average variance extracted (AVE)
Cost efficiency (Z)	0.832	0.835	0.888	0.664
Operational performance (Y)	0.881	0.888	0.918	0.738
Procurement Management Strategy (X2)	0.854	0.867	0.903	0.700
LME Zinc Price Volatility (X1)	0.811	0.810	0.877	0.643

Source: Processed data from SmartPLS. 4

Based on Table 2, the results of the construct reliability and validity assessment indicate that all research constructs satisfy the reliability and validity criteria required in PLS-SEM analysis. This is evidenced by the Cronbach's Alpha and Composite Reliability values, all of which exceed the minimum threshold of 0.70, indicating that the indicators within each construct exhibit strong internal consistency in measuring the intended variables (Hair et al., 2022). Among all constructs, Operational Performance demonstrated the highest level of reliability, with a Cronbach's Alpha value of 0.881 and a Composite Reliability value of 0.918. In contrast, LME Zinc Price Volatility exhibited the lowest reliability values; however, these values remained above the recommended threshold, confirming the construct's reliability.

From the perspective of convergent validity, all variables also achieved Average Variance Extracted (AVE) values above 0.50, ranging from 0.643 to 0.738. These results indicate that each construct is capable of explaining more than 50% of the variance in its respective indicators, thereby satisfying the criterion for convergent validity. Operational Performance recorded the highest AVE value of 0.738, suggesting the strongest ability to represent its underlying indicators. Overall, these findings confirm that the measurement model demonstrates satisfactory reliability and validity, indicating that all constructs are suitable for inclusion in the subsequent structural model assessment.

Table 3. Discriminant Validity (Fornell-larcker criterion)

Variable	Cost efficiency (Z)	Operational performance (Y)	Procurement Management Strategy(X2)	LME Zinc Price Volatility(X1)
Cost efficiency (Z)	0.815			
Operational performance (Y)	0.754	0.859		
Procurement Management Strategy(X2)	0.657	0.734	0.837	
LME Zinc Price Volatility(X1)	0.671	0.736	0.645	0.802

Source: Processed data from SmartPLS. 4

Based on Table 3, the results of the discriminant validity assessment using the Fornell–Larcker criterion indicate that all constructs satisfy the required discriminant validity standards. This is evidenced by the square root of the AVE for each construct being greater than its correlations with other constructs in the model (Hair et al., 2022). These findings suggest that each latent variable adequately explains its own indicators and can be clearly distinguished from the other constructs included in the research model.

The highest square root of AVE value was observed for Operational Performance (0.859), followed by Procurement Management Strategy (0.837), Procurement Cost Efficiency (0.815), and LME Zinc Price Volatility (0.802). All of these values exceed the corresponding inter-construct correlations, indicating the absence of overlap among the constructs. Therefore, all constructs in this study demonstrate satisfactory discriminant validity, confirming that the measurement model meets the required quality criteria and is appropriate for subsequent structural model (inner model) evaluation. One of the initial steps in structural model assessment is the examination of the R^2 (coefficient of determination) values, which are used to evaluate the model's explanatory power with respect to the endogenous variables.

Table 4. R-Square (R2)

	R-square	R-square adjusted

Cost efficiency (Z)	0.537	0.505
Operational performance (Y)	0.712	0.681

Source: Processed data from SmartPLS. 4

Based on Table 5, the results of the R-Square (R^2) assessment indicate that the research model demonstrates substantial explanatory power for the endogenous variables. The Procurement Cost Efficiency (Z) variable obtained an R^2 value of 0.537, indicating that LME Zinc Price Volatility (X1) and Procurement Management Strategy (X2) jointly explain 53.7% of the variance in Procurement Cost Efficiency, while the remaining 46.3% is attributable to factors outside the proposed model. According to the criteria suggested by Hair et al. (2022), this value can be classified as moderate. Meanwhile, Operational Performance (Y) achieved an R^2 value of 0.712, indicating that LME Zinc Price Volatility, Procurement Management Strategy, and Procurement Cost Efficiency collectively explain 71.2% of the variance in Operational Performance, while the remaining 28.8% is explained by other variables not included in this study. These findings suggest that the model possesses strong predictive capability, particularly in explaining operational performance, indicating that the proposed structural model adequately captures the relationships among the study variables.

Following the confirmation of the model's satisfactory explanatory power, the next stage involved hypothesis testing to evaluate the causal relationships proposed in the conceptual framework. This assessment was conducted through path coefficient analysis using the bootstrapping procedure in SmartPLS 4 to identify the direction, strength, and statistical significance of both direct and indirect effects among the constructs. The results of the hypothesis testing are presented in the following table.

Table 6. Path Coefficients

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Cost efficiency (Z) -> Operational performance (Y)	0.346	0.327	0.116	2.971	0.003
Procurement Management Strategy(X2) -> Cost efficiency (Z)	0.384	0.385	0.141	2.730	0.006
Procurement Management Strategy(X2) -> Operational performance (Y)	0.311	0.334	0.136	2.292	0.022
LME Zinc Price Volatility(X1) -> Cost efficiency (Z)	0.424	0.428	0.141	2.998	0.003
LME Zinc Price Volatility(X1) -> Operational performance (Y)	0.303	0.301	0.136	2.231	0.026

Source: Processed data from SmartPLS. 4

Based on Table 6, the hypothesis testing results indicate that all direct relationships in the research model are positive and statistically significant. LME Zinc Price Volatility has a positive effect on Procurement Cost Efficiency ($\beta = 0.424$; $T = 2.998$; $p = 0.003$), supporting H1, which suggests that the company's ability to manage the impact of zinc price fluctuations contributes to improved cost efficiency. Procurement Management Strategy also has a positive effect on

Procurement Cost Efficiency (β = 0.384; T = 2.730; p = 0.006), supporting H2, indicating that the implementation of effective procurement strategies enhances the company's cost efficiency. Furthermore, LME Zinc Price Volatility was found to have a positive effect on Operational Performance (β = 0.303; T = 2.231; p = 0.026), supporting H3, while Procurement Management Strategy positively affects Operational Performance (β = 0.311; T = 2.292; p = 0.022), thereby supporting H4. In addition, Procurement Cost Efficiency exerts a positive and significant effect on Operational Performance (β = 0.346; T = 2.971; p = 0.003), supporting H5. Overall, these findings demonstrate that both LME zinc price volatility and procurement management strategy play important roles in improving procurement cost efficiency, while LME zinc price volatility, procurement management strategy, and procurement cost efficiency directly contribute to enhanced operational performance. Therefore, all direct-effect hypotheses proposed in this study are supported.

Following the assessment of the direct effects, the analysis proceeded to the examination of indirect effects to evaluate the mediating role of Procurement Cost Efficiency in the relationships between LME Zinc Price Volatility, Procurement Management Strategy, and Operational Performance. The mediation analysis was conducted using the Specific Indirect Effects procedure through bootstrapping in SmartPLS. This analysis was intended to determine whether procurement cost efficiency functions as a mechanism through which the independent variables influence operational performance. The results of the specific indirect effects analysis are presented in the following table.

Table 7. Specific indirect effects

Variable	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Procurement Management Strategy(X2) -> Cost efficiency (Z) -> Operational performance (Y)	0.133	0.127	0.067	1.971	0.049
LME Zinc Price Volatility(X1) -> Cost efficiency (Z) -> Operational performance (Y)	0.147	0.140	0.071	2.067	0.039

Source: Processed data from SmartPLS. 4

Based on the results of the specific indirect effects analysis, Procurement Cost Efficiency (Z) was found to serve as a significant mediating variable in the relationships between Procurement Management Strategy (X2) and LME Zinc Price Volatility (X1) on Operational Performance (Y). The indirect effect of Procurement Management Strategy on Operational Performance through Procurement Cost Efficiency yielded a path coefficient of 0.133, with a T-statistic of 1.971 and a p-value of 0.049, thereby supporting H7. This finding indicates that the implementation of effective procurement strategies enhances procurement cost efficiency, which subsequently contributes to improved operational performance.

Similarly, the indirect effect of LME Zinc Price Volatility on Operational Performance through Procurement Cost Efficiency produced a path coefficient of 0.147, with a T-statistic of 2.067 and a p-value of 0.039, thus supporting H6. This result suggests that the company's ability

to manage the impact of zinc price fluctuations improves procurement cost efficiency, which in turn supports better operational performance. Overall, because both the direct and indirect effects along these pathways are statistically significant, Procurement Cost Efficiency functions as a partial mediator in the relationships between LME Zinc Price Volatility, Procurement Management Strategy, and Operational Performance. These findings confirm that improvements in operational performance are influenced not only directly by external market conditions and procurement strategies but also indirectly through the company's ability to achieve greater procurement cost efficiency.

DISCUSSION

The Effect of LME Zinc Price Volatility on Zinc Ingot Procurement Cost Efficiency

The findings indicate that LME zinc price volatility has a positive and significant effect on zinc ingot procurement cost efficiency at the participating EPC company. This result suggests that fluctuations in global zinc prices constitute a critical factor influencing the company's ability to manage raw material procurement costs effectively. As the primary input in the hot-dip galvanizing process, zinc ingots represent a substantial proportion of total production costs; therefore, changes in zinc prices directly affect procurement budgets and the company's ability to achieve cost-reduction targets.

Empirically, respondents perceived fluctuations in London Metal Exchange (LME) zinc prices as having a considerable impact on procurement budgeting and requiring more rigorous management practices. These findings imply that companies capable of monitoring price trends, identifying optimal purchasing periods, and adjusting procurement policies in response to market dynamics are more likely to achieve higher levels of cost efficiency. Conversely, the inability to anticipate price movements may increase procurement expenditures and reduce the effectiveness of resource utilization.

These findings are consistent with Contingency Theory, which posits that organizational effectiveness depends on the ability to adapt strategies to changes in the external environment. Zinc price volatility represents a form of environmental uncertainty that requires firms to respond through adaptive procurement planning and cost-control mechanisms. Furthermore, the Supply Chain Management perspective emphasizes that raw material price risk management is a critical component of maintaining supply chain efficiency. The present findings support those of Saleheen and Habib (2024) and Hautala-Kankaanpää (2023), who reported that commodity price volatility encourages firms to strengthen cost management practices and procurement strategies to sustain operational efficiency.

The Effect of Procurement Management Strategy on Procurement Cost Efficiency

The results demonstrate that procurement management strategy has a positive and significant effect on procurement cost efficiency. This finding suggests that the effectiveness of procurement management directly contributes to the company's ability to achieve cost-efficiency objectives. Strategies such as hedging, inventory management based on price trends, long-term supplier partnerships, and vendor evaluation have proven effective in enhancing procurement cost control.

From an operational perspective, effective procurement strategies enable firms to obtain materials at more competitive prices, reduce the risk of cost escalation resulting from market fluctuations, and ensure supply continuity. Consequently, companies can minimize additional costs arising from supply disruptions and inventory inefficiencies. These findings indicate that

procurement cost efficiency is influenced not only by market conditions but also by managerial capabilities in strategically managing procurement activities.

This result can be explained through the Resource-Based View (RBV), which considers procurement strategy as an organizational capability capable of generating competitive advantage through effective resource management and supplier relationship management. In addition, Supply Chain Management theory highlights procurement as a critical activity for improving supply chain efficiency. These findings are consistent with those reported by Gaudenzi et al. (2020), Dinata and Suharjito (2024), and Siburian et al. (2022), who found that integrated procurement strategies enhance cost efficiency while strengthening supply chain resilience.

The Effect of LME Zinc Price Volatility on Operational Performance

The findings reveal that LME zinc price volatility has a positive and significant effect on operational performance. This result suggests that the company's ability to respond effectively to fluctuations in global zinc prices contributes to improved operational outcomes. Although price volatility is an external factor beyond managerial control, the ability to manage its consequences represents an important determinant of operational continuity and effectiveness.

In practical terms, zinc price fluctuations affect procurement planning, production costs, and material availability within the galvanizing process. Therefore, firms capable of anticipating price changes through effective planning are better positioned to maintain production continuity, meet project deadlines, and minimize operational disruptions. These findings indicate that organizational responsiveness to market volatility is more important than the volatility itself.

This result supports Contingency Theory, which emphasizes the alignment between organizational strategies and external environmental conditions. Moreover, the Supply Chain Management perspective suggests that raw material price risk management is an integral component of maintaining operational stability. The findings are consistent with those of Saleheen and Habib (2024), Hautala-Kankaanpää (2023), and Ichsan (2021), who concluded that effective management of raw material price uncertainty contributes to improved operational effectiveness and performance.

The Effect of Procurement Management Strategy on Operational Performance

The results indicate that procurement management strategy has a positive and significant effect on operational performance. This finding suggests that procurement strategy functions not merely as a mechanism for acquiring raw materials but also as a strategic instrument that supports overall operational success.

Effective procurement strategies enable firms to secure materials in the right quantity, quality, timing, and cost. Such conditions reduce the risk of production delays, support project execution, and enhance resource utilization efficiency. Consequently, the more effective the procurement strategy implemented by the company, the greater its ability to achieve operational objectives.

From the Resource-Based View perspective, procurement strategy constitutes a strategic capability that creates value and competitive advantage through supplier management and risk-control practices. Furthermore, Supply Chain Management theory emphasizes that integrating procurement activities with broader supply chain processes enhances operational reliability and organizational performance. These findings are consistent with previous studies by Gaudenzi et al. (2020), Dinata and Suharjito (2024), and Siburian et al. (2022), which reported that effective procurement practices contribute significantly to operational performance improvement.

The Effect of Cost Efficiency on Operational Performance

The findings demonstrate that cost efficiency has a positive and significant effect on operational performance. This result confirms that the ability to manage costs effectively is a crucial factor in achieving superior operational outcomes. Within the hot-dip galvanizing industry, cost efficiency extends beyond expenditure reduction and encompasses the optimization of resource utilization to support uninterrupted production processes.

Descriptive results indicate that cost efficiency is reflected in well-planned material availability, stable raw material supply, consistent quality control, and effective utilization of production capacity. These conditions enable firms to enhance productivity, reduce waste, and maintain stable operational cash flows. Consequently, higher levels of cost efficiency lead to improved operational performance.

This finding is consistent with the Resource-Based View, which argues that efficient resource management constitutes a source of sustainable competitive advantage. Additionally, Supply Chain Management theory identifies cost efficiency as one of the primary objectives of supply chain management because of its direct contribution to operational effectiveness. The results support the findings of Dasuki (2021), Dinata and Suharjito (2024), and Siburian et al. (2022), who concluded that cost efficiency plays a critical role in improving productivity, business process effectiveness, and overall operational performance.

The Mediating Role of Cost Efficiency in the Relationship Between LME Zinc Price Volatility and Operational Performance

The findings indicate that procurement cost efficiency significantly mediates the relationship between LME zinc price volatility and operational performance at the participating EPC company. This result suggests that the impact of global zinc price fluctuations on operational performance occurs not only directly but also indirectly through the company's ability to control procurement costs. Firms capable of mitigating the effects of price volatility through cost-efficient procurement practices are better positioned to maintain operational stability and achieve performance targets.

Empirically, zinc price fluctuations resulting from global market conditions, geopolitical uncertainties, and supply chain disruptions increase procurement cost risks. However, these adverse effects can be mitigated through effective purchasing planning, inventory control, and optimized material utilization. Improved cost efficiency subsequently contributes to smoother production processes, timely project completion, and enhanced operational effectiveness.

These findings support Contingency Theory, which emphasizes organizational adaptation to external environmental changes. In this context, cost efficiency serves as an adaptive mechanism that enables firms to respond effectively to commodity price uncertainty. Furthermore, Supply Chain Management theory highlights cost control as a critical instrument for mitigating supply chain risks associated with raw material price volatility. The findings are consistent with those of Saleheen and Habib (2024), Hautala-Kankaanpää (2023), and Dasuki (2021), who emphasized that cost efficiency serves as a strategic mechanism for maintaining operational stability under uncertain market conditions. Therefore, procurement cost efficiency functions as a partial mediator in the relationship between LME zinc price volatility and operational performance.

The Mediating Role of Cost Efficiency in the Relationship Between Procurement Management Strategy and Operational Performance

The results reveal that procurement cost efficiency significantly mediates the relationship between procurement management strategy and operational performance at the participating EPC company. This finding indicates that procurement strategy influences operational performance not

only directly but also indirectly through its contribution to cost efficiency. In other words, the effectiveness of procurement strategies in improving operational performance is partially achieved through their ability to optimize procurement costs.

Empirically, procurement practices such as adaptive inventory policies, strategic supplier partnerships, and regular vendor evaluations contribute to sustainable material availability while reducing procurement costs. These strategies also support supply continuity, timely project completion, and improved production quality. The findings demonstrate a strong interrelationship among procurement strategy, cost efficiency, and operational performance in supporting organizational effectiveness.

In practice, effective procurement strategies enable firms to acquire raw materials at controlled costs, reduce the risk of unfavorable purchasing decisions, and minimize waste within procurement processes. Appropriate inventory management also helps prevent excessive holding costs and material shortages that could disrupt production activities. Once cost efficiency is achieved, firms gain greater flexibility to allocate resources toward value-adding activities, thereby enhancing operational performance.

These findings can be explained through the Resource-Based View (RBV), which argues that competitive advantage originates from an organization's ability to manage resources effectively. Procurement management strategy represents a strategic capability that creates value through supplier management, risk control, and effective purchasing decisions. Furthermore, the Supply Chain Management perspective emphasizes procurement as a critical component of the supply chain that directly influences operational efficiency and effectiveness. The findings support previous studies by Gaudenzi et al. (2020), Dinata and Suharjito (2024), and Siburian et al. (2022), which demonstrated that effective procurement strategies improve cost efficiency while enhancing operational performance. Therefore, procurement cost efficiency acts as a partial mediator that strengthens the relationship between procurement management strategy and operational performance, indicating that more effective procurement strategies lead to higher and more sustainable operational performance.

CONCLUSION

Based on the findings of this study, it can be concluded that LME zinc price volatility and zinc ingot procurement management strategy have significant effects on both procurement cost efficiency and operational performance at the participating EPC company, either directly or indirectly through procurement cost efficiency as a mediating variable. The results indicate that fluctuations in global zinc prices play a crucial role in determining the effectiveness of cost control, while effective procurement strategies contribute to improved cost efficiency and enhanced operational performance. Furthermore, procurement cost efficiency was found to play a strategic role in improving operational performance and in mediating the effects of price volatility and procurement strategy on organizational performance. Overall, these findings highlight that a company's ability to manage price-related risks, optimize procurement strategies, and achieve cost efficiency represents a critical factor in sustaining and enhancing operational performance. The study also contributes to the literature on strategic procurement management by demonstrating the mediating role of procurement cost efficiency in the relationship between external market uncertainty and operational performance within the EPC industry.

Future studies are encouraged to expand the research framework by incorporating additional variables that may influence operational performance, such as inventory management,

supplier quality, production capacity, supply chain digitalization, technological capabilities, and production process efficiency. Further research may also employ mixed-methods or longitudinal approaches to provide deeper insights into the dynamic relationship between commodity price fluctuations and operational performance over time. In addition, extending the scope of investigation across multiple companies or industries would enhance the generalizability of the findings and provide a more comprehensive understanding of supply chain management and cost-efficiency practices in different organizational contexts.

REFERENCE

Adda, G. (2024). Examining the relationship between procurement strategies and organizational performance of Ghanaian firms: How does strategic procurement drive organizational success? *Economics Management and Sustainability, 9*(2), 20. https://doi.org/10.14254/jems.2024.9-2.2

Aisyah, H., Puspita, S., & Elizamiharti, E. (2022). Resource-based view: Strategi UMKM di Sumatera Barat untuk mencapai keunggulan kompetitif. *JMD Jurnal Riset Manajemen & Bisnis Dewantara, 5*(2), 109. https://doi.org/10.26533/jmd.v5i2.1029

Belo, I. F. de J. M., Belo, T. F., & Amaral, A. M. (2020). The mediation effects of purchasing strategy and supplier integration on the relations between purchasing skills and corporate performance. *Timor Leste Journal of Business and Management, 2*, 1. https://doi.org/10.51703/bm.v2i2.17

Dasuki, R. E. (2021). Manajemen strategi: Kajian teori resource based view. *Coopetition Jurnal Ilmiah Manajemen, 12*(3), 447. https://doi.org/10.32670/coopetition.v12i3.710

Dinata, M. C., & Suharjito, S. (2024). Materials inventory optimization using various forecasting techniques and purchasing quantity in packaging industry. *Journal of Industrial Engineering and Management, 17*(2), 321. https://doi.org/10.3926/jiem.7032

Gaudenzi, B., Zsidisin, G. A., & Pellegrino, R. (2020). Measuring the financial effects of mitigating commodity price volatility in supply chains. *Supply Chain Management: An International Journal, 26*(1), 17. https://doi.org/10.1108/scm-02-2020-0047

Hanfan, A. (2021). Product configuration capability for improving marketing performance of small and medium metal industry in Central Java - Indonesia. *Jurnal Manajemen dan Kewirausahaan, 23*(2), 138. https://doi.org/10.9744/jmk.23.2.138-147

Hautala-Kankaanpää, T. (2023). Complementary and contingent value of SMEs' data capability and supply chain capability in the competitive environment. *Industrial Management & Data Systems, 123*(8), 2128. https://doi.org/10.1108/imds-01-2023-0013

Heizer, J., Render, B., & Munson, C. (2018). *Operations management: Sustainability and supply chain management*.

Ichsan, M., et al. (2021). The mediating effect of strategic purchasing in pre-stressed concrete based construction project: A case study of construction contractor in Indonesia. *Türk Bilgisayar ve Matematik Eğitimi Dergisi, 12*(10). https://doi.org/10.17762/turcomat.v12i10.5539

Królikowska, E., Sierpińska-Sawicz, A., & Królikowski, M. (2021). Volatility in the raw materials market and risk mitigation methods. *Inżynieria Mineralna, 1*(1). https://doi.org/10.29227/im-2019-01-43

Lestari, S. P., & Sutrisna, A. (2022). Operational performance of small and medium enterprises in pandemic era. *Advances in Economics, Business and Management Research*. https://doi.org/10.2991/aebmr.k.220701.026

Muharram, M., Hariyati, D., & Simanjuntak, L. R. (2025). Efisiensi dan efektivitas pengadaan barang/jasa (E-procurement) pada LPSE dan E-katalog di Dinas Lingkungan Hidup Provinsi DKI Jakarta. *Journal of Accounting and Finance Management, 6*(3), 1547. https://doi.org/10.38035/jafm.v6i3.2277

Nnaji, U. O., Benjamin, L. B., Eyo-Udo, N. L., & Etukudoh, E. A. (2024). Effective cost management strategies in global supply chains. *International Journal of Applied Research in Social Sciences, 6*(5), 945. https://doi.org/10.51594/ijarss.v6i5.1146

Özmay, H. (2025). Palm yağı fiyatlarını etkileyen parametreler ve fiyat tahmin modeli. *DergiPark*.

Rohmasari, I. D., & Fakhroni, Z. (2023). Pengaruh supply chain management terhadap pertumbuhan laba dengan keunggulan kompetitif sebagai pemediasi. *Journal of Applied Managerial Accounting, 7*(2), 208. https://doi.org/10.30871/jama.v7i2.5742

Roshan, V. (2024). Enhancing operational efficiency and cash flow through supply chain optimization in the oil and gas sector. *International Journal of Business and Management, 19*(3), 91. https://doi.org/10.5539/ijbm.v19n3p91

Saleheen, F., & Habib, M. M. (2024). Evaluating supply chain performance through financial metrics: A study in a manufacturing industry. *International Journal of Supply Chain Management, 13*(2), 35. https://doi.org/10.59160/ijscm.v13i2.6240

Sari, M. P., & Yunita, I. (2019). Analisis prediksi kebangkrutan dan tingkat akurasi model Springate, Zmijewski, dan Grover. *JIM UPB, 7*(1), 69. https://doi.org/10.33884/jimupb.v7i1.907

Shah, S., & Hasan, S. M. (2016). Procurement practices in project-based manufacturing environments. *MATEC Web of Conferences, 76*, 2007. https://doi.org/10.1051/matecconf/20167602007

Siahaya, W. (2017). *Manajemen pengadaan: Procurement management*.

Siburian, D. S. M., Hidayati, S. A., & Pituringsih, E. (2022). Efektivitas penerapan supply chain management, Cost efficiency operasional pada kinerja perusahaan di moderasi keunggulan kompetitif. *E-Jurnal Akuntansi, 32*(5), 1332. https://doi.org/10.24843/eja.2022.v32.i05.p16

Siregar, H., Suroso, A. I., & Djohar, S. (2022). Development of efficient strategies to optimize production efficiency: Evidence from pine chemical industry. *Decision Science Letters, 11*(4), 419. https://doi.org/10.5267/j.dsl.2022.7.003

Siswanto, S. (2024). Influence of financial ratios on financial distress in manufacturing companies. *Jurnal Ekonomi Bisnis & Entrepreneurship, 18*(1), 205. https://doi.org/10.55208/jebe.v18i1.543

Slack, N., & Johnston, R. E. (2010). *Operations management*.

Soebandrija, K. E. N., & Kartowisastro, R. H. (2015). Analisis kinerja perusahaan ekspedisi dalam perspektif supply chain dan ANP. *ComTech, 6*(2), 248. https://doi.org/10.21512/comtech.v6i2.2269

Suardhika, I. N. (2018). Model integrasi dalam resource-based view untuk penerapan strategi bersaing dan pencapaian kinerja usaha. *EKUITAS, 16*(1). https://doi.org/10.24034/j25485024.y2012.v16.i1.144

Sukma, A. (2018). Perspektif resource based view (RBV) dalam membangun competitive advantage. *Ad Deenar Jurnal Ekonomi dan Bisnis Islam, 1*(1), 75. https://doi.org/10.30868/ad.v1i01.229

Susilawati, E., & Mulyana, A. (2018). Pengaruh penjualan dan biaya operasional terhadap laba bersih. *Organum, 1*(2), 74. https://doi.org/10.35138/organum.v1i2.33

Syahrani, R., & Habibullah, H. (2024). Peran teknologi informasi komunikasi dalam manajemen rantai pasok: Systematic literature review. *Journal of Business Management, 2*(1), 1. https://doi.org/10.47134/jobm.v2i1.19

Tarigan, Z. J. H., Siagian, H., Basana, S. R., & Jie, F. (2019). Effect of key user empowerment, purchasing strategy, process integration, production system to operational performance. *E3S Web of Conferences, 130*, 1042. https://doi.org/10.1051/e3sconf/201913001042

Veli, R., & Bahari, A. (2024). Perbandingan metode harga pokok produksi dalam penentuan harga jual. *Monex Journal Research Accounting, 13*(1), 1. https://doi.org/10.30591/monex.v13i01.5351

Wahyudhi, W. S., Sanny, L., Simatupang, B., & Furinto, A. (2024). The influences of sustainability practices and IT capability on project operational performance. *Uncertain Supply Chain Management, 12*(4), 2167. https://doi.org/10.5267/j.uscm.2024.6.013

Wijaya, A. S. G. (2024). Strategi manajerial dalam meningkatkan daya saing bisnis lokal. *Dinamika, 2*(2), 122. https://doi.org/10.56457/dinamika.v2i2.670

Winata, I. G. K. A. (2019). Menciptakan keunggulan bersaing berkelanjutan melalui budaya organisasi, strategi dan kinerja operasi. *Matrik, 13*(1). https://doi.org/10.24843/matrik:jmbk.2019.v13.i01.p05

Прадото, P., Soemardi, B. W., Gazali, A., Sunarjo, H. N., Putri, A. T., Purba, R. P., & Mahardika, I. (2023). An overview of technology landscape in construction materials for the Indonesian construction industry. *Jurnal Teknik Sipil, 30*(3). https://doi.org/10.5614/jts.2023.30.3.3