Determinants and Cost Efficiency of Leasing and Purchasing Decisions for Heavy Equipment in the Palm Oil Industry

Pancanto Kuat Prabowo[1*]

[1]*Department of Management, Faculty of Economics and Business, Universitas Maarif Hasyim Latif; Sidoarjo, Indonesia*

*Corresponding Author E-Mail: pancanto@dosen.umaha.ac.id

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ABSTRACT

The lease or purchase decision for heavy equipment directly affects operational efficiency in palm oil operations, including loading, material handling, and land maintenance. This study aims to analyze the factors influencing procurement decisions for wheel loaders, excavators, and skid-steer loaders, and to evaluate the cost efficiency of leasing versus purchasing at a state-owned palm oil mill in Riau Province. The research employed a mixed explanatory approach combining quantitative and qualitative data. Quantitative data consisted of 42 observations of hour-meter utilization and 36 months of operational cost records obtained from company documents. Qualitative data were collected through in-depth interviews with eight informants, including production managers, an operations manager, procurement department heads, a cost-planning analyst, and heavy equipment supervisors. Quantitative analysis applied the total cost of ownership and life cycle costing, while qualitative data were examined using thematic analysis. The findings indicate that wheel loaders and skid steer loaders are more cost-efficient to purchase due to their high utilization rates and lower long-term hourly costs. In contrast, excavators are more economical to lease due to intermittent use and higher maintenance risks. These findings indicate that procurement policies should consider utilization patterns, operational risks, and cost structures to enhance efficiency and operational stability.

Keywords*: Cost Efficiency, Heavy Equipment, Palm Oil Industry, Procurement Decisions, Skid-Steer Loaders.*

INTRODUCTION

The selection of heavy equipment procurement policies is one of the strategic decisions in the palm oil industry, especially in Palm Oil Mills (*Pabrik Kelapa Sawit*/PKS), which have intensive activities such as moving fresh fruit bunches, solid waste management, and land preparation (Maulidah et al., 2023). The efficiency of heavy equipment procurement is the focus of agribusiness companies due to increasing operational cost pressures and the need to accelerate productivity (Dong, 2021). Indonesia's palm oil industry, as the world's largest producer, is increasingly demanding the optimization of mechanical assets to maintain the consistency of raw material supply and the stability of the production process (Firdaus, 2025). At the national level, the increase in heavy equipment maintenance costs per year is an issue that affects the stability of PKS operational costs. This condition underscores the urgency of an in-depth analysis of whether a particular machine is more appropriate to lease or purchase based on utilization data and lifecycle costs.

In practice, wheel loaders, excavators, and skid steer loaders are the three types of heavy equipment that are most often used in mills with different but interrelated operational functions (Mikulić & Mück, 2024). Wheel loaders play an important role in material removal, excavators in excavation and waste management work, while skid steer loaders are used for limited operating space and quick maneuvering (Norström, 2024).

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The decision to lease or buy is influenced by the level of use, the age of the asset, the cost of maintenance, the value of the residue, and the technical risk. However, in the context of the palm oil industry, these variables are also greatly influenced by work environment factors, fluctuations in the production of fresh fruit bunches, and the condition of mill infrastructure. The combination of technical and operational factors makes the decision to procure heavy equipment not simple and requires a comprehensive approach.

Previous studies by Febrianto et al. (2024) highlight the importance of lifecycle cost analysis and total cost of ownership to ensure efficient machine investment decisions. However, most existing research focuses on the construction and mining sectors, while studies in the palm oil industry remain limited despite its distinct patterns of heavy equipment utilization. Research by Obiuto et al. (2024) further indicates that procurement decisions for heavy equipment often overlook long-term utilization data. This gap suggests the need for studies integrating quantitative evidence on actual equipment usage with qualitative insights from decision-makers in palm oil mills. Moreover, limited research has compared the efficiency of leasing and purchasing heavy equipment using real operational data. Studies by Dogra et al. (2023) rely on cost estimations rather than hour meter records and actual expenditure data. In addition, studies on excavators in the palm oil sector mainly focus on productivity rather than procurement decisions, while skid steer loaders remain underexplored despite increasing adoption in modern mills, highlighting the need for systematic investigation.

This study specifically assessed cost efficiency using the total cost of ownership and life cycle costing approach based on data from 42-hour meter observations for 36 months. In addition, the study identified technical, operational, and financial considerations through interviews with production managers, operations managers, procurement heads, cost analysts, and heavy equipment supervisors. Thus, this study integrates quantitative and qualitative approaches within the framework of explanatory mixed methods. This analysis is expected to provide an accurate picture of the most economical heavy equipment investment decisions.

Based on these scientific gaps, this study was carried out to analyze the factors that affect the policy of renting or purchasing heavy equipment of wheel loaders, excavators, and skid steer loaders at one of the state-owned PKS in Riau Province. This study contributes theoretically to the literature on asset management in agribusiness and the palm oil processing industry by demonstrating how equipment utilization and lifecycle cost analysis can support more adaptive and data-driven procurement policies. The integration of mixed methods also enables a deeper understanding of technical factors and strategic considerations in procurement decision-making. The findings provide recommendations for palm oil mill management in determining whether heavy equipment should be purchased or leased according to operational needs. These insights support budget optimization, maintenance risk mitigation, and more stable long-term investment planning for both state-owned and private plantation companies.

LITERATURE REVIEW

Procurement Policy Concept

The policy of heavy equipment procurement is a strategic component in the operations of the agroindustry, particularly in palm oil mills, where operational activities are highly dependent on mechanical support for material handling and land management (Ismail et al., 2024; Onyegirim et al., 2025). Inappropriate procurement decisions can lead to significant operational inefficiencies, increased maintenance expenses, and disruptions in production processes. Therefore, companies must carefully evaluate procurement strategies to ensure that equipment investments align with operational requirements and long-term financial sustainability (Anwar et al., 2024). According to Abbey et al. (2023), effective procurement policies should consider several key aspects, including technical specifications, economic life, maintenance costs, and long-term operational needs. These considerations are essential to ensure that heavy equipment investments generate optimal value and support stable production performance (Jefriyanto, 2021).

In the operational context of palm oil mills, different types of heavy equipment perform distinct but complementary functions. Wheel loaders are commonly used for material removal and loading activities (Syahza, 2019; Panjaitan et al., 2024). Excavators are essential for land preparation and waste management tasks, while skid steer loaders are particularly useful in confined spaces requiring high maneuverability. Each type of equipment, therefore, contributes differently to operational efficiency within the mill. Wolswijk (2021) emphasized that the continuous increase in heavy equipment maintenance costs has heightened the need for more systematic, data-driven procurement planning. Consequently, decisions regarding whether equipment should be leased or purchased cannot be separated from comprehensive analyses of operational risks, utilization efficiency, and projected operational requirements within PKS.

Life Cycle Costing and Total Cost of Ownership Analysis

Life Cycle Costing (LCC) and Total Cost of Ownership (TCO) have become widely recognized analytical approaches for evaluating the economic efficiency of heavy equipment procurement (Macek, 2023; Abdullah et al., 2025). These methods enable organizations to assess not only the initial investment cost but also the long-term financial implications associated with equipment ownership and operation. According to Manuel (2024), both LCC and TCO provide a comprehensive framework for evaluating costs throughout the entire lifecycle of an asset, including acquisition expenses, maintenance costs, operational downtime, and residual value at the end of the equipment's economic life. By incorporating these cost components, companies can obtain a more accurate estimation of the true financial burden associated with heavy equipment investments, which is essential for making sustainable procurement decisions.

The relevance of these approaches becomes even more significant in industries where equipment utilization patterns and operational conditions vary substantially. LCC is particularly useful when equipment operates repeatedly with high usage durations, allowing companies to evaluate long-term cost efficiency more effectively. Gadatsch (2023) and Upadhyay (2025) further emphasize that TCO helps organizations identify hidden or indirect costs that are often overlooked when procurement decisions rely solely on initial purchase prices. In the palm oil industry, where heavy equipment workloads fluctuate and operational environments differ across mills, the integration of LCC and TCO becomes essential. Applying these methods allows companies to make more accurate procurement decisions and minimize the risk of unexpected or hidden operational costs.

Utilization of Heavy Equipment as a Decision Factor

Utilization rate is a critical indicator in determining whether heavy equipment is more economically efficient to purchase or lease (Lak et al., 2024). The level of equipment usage reflects how intensively a machine contributes to daily operational activities and therefore directly affects long-term cost efficiency. Generally, equipment with high working hours tends to justify ownership because the investment cost can be distributed across a larger number of operating hours over its lifecycle. In contrast, equipment with relatively low utilization levels is often more suitable for rental arrangements, as leasing allows companies to avoid high capital investment and long-term maintenance obligations. Renzi and Mattetti (2021) state that wheel loaders and skid steer loaders typically demonstrate high utilization rates in mill operations due to their constant involvement in material handling and their ability to perform rapid maneuvering within operational areas.

Conversely, excavators are commonly used for more specialized tasks such as excavation, drainage work, or waste management activities, resulting in a more intermittent utilization pattern. Because these machines are not always required in daily operations, their operating hours tend to fluctuate depending on specific operational needs. Olaleye et al. (2024) and Di Fulvio et al. (2024) emphasize that procurement decisions should be based on historical utilization data to minimize estimation errors and

improve the accuracy of economic evaluations. The study recommends analyzing equipment usage for a minimum of 24–36 months to capture realistic operational patterns. This recommendation supports the research approach adopted in this study, which utilizes 42-hour meter observations collected over a 36-month period to assess equipment utilization trends.

Technical and Operational Considerations in Heavy Equipment Procurement

Besides cost efficiency, technical and operational factors are crucial in heavy equipment procurement, as equipment design determines durability, maintenance needs, and long-term performance. Louis et al. (2022) and Fei et al. (2025) note that wheel loaders are more resistant to the wet and muddy conditions typical in palm oil mills, making them suitable for continuous operation and ownership, whereas excavators have more complex hydraulic systems that are more vulnerable in unstable or extreme ground conditions. These differences influence maintenance frequency and operational risk. Operational factors further reinforce these considerations, as the availability of trained operators affects equipment utilization efficiency. Liang et al. (2023) emphasize that certain equipment requires specialized skills, necessitating careful planning to avoid inefficiencies. Consequently, variations in design, operational requirements, and maintenance costs become key components of TCO, ultimately influencing the economic feasibility of leasing or purchasing decisions in palm oil mill operations.

The palm oil industry differs significantly from construction and mining sectors due to its unique heavy equipment utilization patterns shaped by seasonal cycles, environmental conditions, and land characteristics. Porwal and Verma (2023) note that plantation operations are highly influenced by harvest seasons, weather variability, and land conditions, which affect the timing and intensity of equipment use. Consequently, equipment demand is not constant throughout the year; for instance, excavators are mainly used for specific tasks such as excavation, drainage, and waste management, resulting in more intermittent utilization compared to equipment used in daily mill operations. In addition, operational challenges such as limited land accessibility, high humidity, and continuous material handling needs further affect equipment performance and planning. Zeng (2022) highlights that plantation companies often misestimate equipment workloads, leading to overcapacity or underutilization, which directly impacts procurement decisions and the economic feasibility of leasing or purchasing heavy equipment in palm oil mills.

RESEARCH METHODS

This study employed an explanatory mixed-methods design that integrates quantitative and qualitative approaches to provide a comprehensive understanding of heavy equipment procurement policies, particularly decisions regarding leasing or purchasing in the palm oil industry. The explanatory design follows a sequential structure in which quantitative analysis is conducted first to examine cost structures and utilization patterns of heavy equipment, followed by qualitative analysis to interpret and elaborate the quantitative findings through the perspectives of key stakeholders. This approach allows researchers to capture measurable economic aspects as well as contextual operational considerations influencing equipment investment decisions. The use of mixed methods is considered appropriate for analyzing complex and multidimensional strategic decisions related to asset management and procurement policies (Toyon, 2021).

The population of this study includes individuals involved in the management, procurement, and operation of heavy equipment at one of the state-owned palm oil mills in Riau Province. Quantitative sampling was conducted using purposive sampling by utilizing 42 historical observations consisting of hour meter utilization data and operational cost records of wheel loaders, excavators, and skid steer loaders over a period of 36 months. For the qualitative component, purposive sampling was also applied to select informants who possess direct knowledge and decision-making authority related to heavy equipment procurement and operations. A total of eight informants were involved,

including two production managers, one operational manager, two procurement department heads, one cost planning analyst, and two heavy equipment supervisors. The purposive sampling technique is appropriate in strategic organizational research because it prioritizes participants who have the expertise and practical experience required to provide substantive insights (Ahmad & Wilkins, 2025).

Data collection was conducted through documentary analysis and in-depth interviews. Quantitative data were obtained from official company documents, including hour meter utilization reports, fuel consumption records, maintenance and repair costs, equipment rental contracts, and internal financial statements related to heavy equipment procurement. These records were considered reliable because they originated from standardized corporate documentation systems. Qualitative data were collected through semi-structured in-depth interviews designed to explore technical, operational, and financial considerations influencing procurement decisions. The interview guidelines were developed based on the conceptual frameworks of TCO and LCC (Zeng, 2022).

Quantitative data analysis applied the TCO and LCC approaches to compare the long-term cost efficiency between equipment ownership and rental alternatives. These approaches enable comprehensive evaluation of acquisition costs, operational expenses, maintenance costs, downtime risks, and residual values, thereby providing a more accurate picture of long-term economic feasibility (Panneer & Birky, 2021; Gudac et al., 2025). The calculations were performed using Microsoft Excel by applying lifecycle cost formulas and efficiency comparisons. Meanwhile, qualitative data were analyzed using thematic analysis involving open coding, axial coding, and selective coding to identify patterns of technical, operational, and financial considerations affecting leasing or purchasing decisions. The analysis process was supported by NVivo 12 software to ensure systematic coding, transparency, and consistency in theme development.

RESULTS

Economics Efficiency Life Cycle Costing for Wheel Loader and Skid Steer Loader

The LCC results show that wheel loaders and skid-steer loaders are the most efficient tools when selected under the purchase scheme. Wheel loaders have an average utilization of 187–212 hours per month, and skid steer loaders reach 115–133 hours per month. High utilization makes fixed costs such as depreciation and base costs optimally distributed, resulting in a lower total cost of ownership than rental costs over a 36-month period.

Table 1. Life Cycle Cost Comparison for Wheel Loader, Skid Steer Loader, and Excavator

Equipment Type	Average Utilization (Hours/Month)	Total Ownership Cost (36 Months)	Rental Cost Equivalent	Cost Difference (Ownership – Rental)
Wheel Loader	187–212	IDR 4.28 billion	IDR 6.15 billion	–IDR 1.87 billion
Skid Steer Loader	115–133	IDR 2.94 billion	IDR 4.22 billion	–IDR 1.28 billion
Excavator	62–78	IDR 5.41 billion	IDR 4.96 billion	+IDR 0.45 billion

Table 1 presents the results of purchasing heavy equipment, which generates cost savings of approximately 29%–31% compared to renting, particularly because the equipment is used intensively in production and material handling activities (Febrianto et al., 2024). The quantitative findings are supported by informant responses indicating that wheel loaders and skid-steer loaders operate almost continuously in daily mill operations. A production manager explained that wheel loaders are utilized every day for feeding and loading tasks and are rarely idle, emphasizing that reliance on rented equipment can disrupt operations due to delays in equipment availability. This perspective is reinforced by a cost-planning analyst, who noted that high utilization rates enhance the efficiency of LCC as more operating hours reduce the average cost per hour when the equipment is owned rather than rented.

From a technical standpoint, a heavy equipment supervisor highlighted that full equipment availability is critical to maintaining smooth production, as any interruption

in wheel loader operations can immediately affect production processes. This view is further supported by the head of the procurement department, who emphasized that wheel loaders and skid-steer loaders belong to a category of high-utilization equipment, making their purchase the most rational and economically justified decision. Therefore, the informants' narratives align closely with the quantitative cost analysis, indicating that high utilization rates substantially reinforce the economic feasibility of purchasing such heavy equipment (Olaleye et al., 2024).

Utilization Uncertainty and Operational Risk in Excavator Rental Decisions

In contrast to wheel loaders and skid steer loaders, excavators exhibit a fluctuating and relatively low utilization pattern, averaging only 62–78 hours per month. This intermittent usage results in suboptimal allocation of depreciation and other fixed costs. Furthermore, excavators incur higher maintenance costs, particularly associated with hydraulic systems and undercarriage components, which causes the 36-month TCO to exceed the total rental expenses.

Table 2. Excavator Utilization and Cost Structure Analysis

Category	Amount (36 Months)	Notes
Fuel & Lubricants	IDR 1.47 billion	27% of operational cost
Maintenance & Repairs	IDR 2.31 billion	Highest among all the equipment
Ownership Depreciation	IDR 1.63 billion	Based on an 8-year useful life
Rental Cost Equivalent	IDR 4.96 billion	Includes transport & standby charges
TCO of Ownership	IDR 5.41 billion	9% higher than the rental

Table 2 indicates that excavators exhibit relatively low and intermittent utilization, resulting in high ownership costs, particularly for depreciation and maintenance. This leads to a TCO that is 9% higher than the total rental cost, demonstrating that a rental scheme is more economically advantageous in the context of mill operations. The quantitative findings are reinforced by informant narratives, which reveal that excavators are not used on a daily basis but rather for specific, periodic tasks. An operations manager explained that excavators are deployed only for drainage repairs or block-opening projects, which do not occur every month. This is further supported by a production manager, who emphasized that low usage hours cause depreciation and other fixed costs to continue accruing, making ownership more expensive (Febrianto et al., 2024).

From a technical perspective, a heavy equipment supervisor noted that excavators carry a high risk of breakdown, and repair costs are substantial, making renting a safer option since the risks are not entirely borne by the mill. The head of procurement added that flexibility is a primary consideration, as the non-routine and scheduled nature of excavator tasks makes a rental scheme more suitable, allowing the mill to access equipment only when needed. Therefore, the qualitative analysis aligns closely with the quantitative results, confirming that renting excavators is a more efficient and rational decision given their utilization patterns and associated operational risks (Soltanali et al., 2023).

The risk analysis within the TCO model reveals differences in the volatility of maintenance costs among heavy equipment. Wheel loaders and skid steer loaders exhibit low maintenance cost variations, at approximately ±6.8% and ±5.1%, respectively. This indicates that the operational costs of these two types of equipment are relatively stable, facilitating more predictable budget planning for the mill. In contrast, excavators display substantially higher maintenance cost variability, at around ±18.4%, due to the elevated risk of damage to critical components such as hydraulic pumps, booms, and undercarriage systems (Gadatsch, 2023).

Table 3 highlights the variability in maintenance costs across different types of heavy equipment, showing that wheel loaders and skid steer loaders experience relatively low fluctuations (±6.8% and ±5.1%, respectively), whereas excavators exhibit substantially higher variability (±18.4%) due to the elevated risk of costly repairs to critical components

such as hydraulic systems and undercarriages. These quantitative findings are strongly supported by informant insights. A production manager emphasized that equipment availability is a top priority, noting that wheel loaders and skid steer loaders must be operational daily, and ownership ensures greater operational reliability. Similarly, a cost planning analyst confirmed that the stability of maintenance costs reinforces purchase decisions, as predictable expenses facilitate accurate long-term cost projections through LCC (Gadatsch, 2023).

Table 3. Risk Variability in Maintenance Costs

Equipment Type	Maintenance Cost Variance	Key Risk Drivers
Wheel Loader	±6.8%	Wear parts predictable
Skid Steer Loader	±5.1%	Light-duty application
Excavator	±18.4%	Hydraulic & undercarriage repairs

In contrast, excavators carry a higher risk of repair costs, particularly for hydraulic failures, as a heavy equipment supervisor noted, which can result in substantial expenses. An operations manager further explained that leasing excavators is a strategic choice because it transfers significant financial risk to the provider, thereby enhancing overall risk management. These narratives demonstrate that decisions about whether to purchase or lease heavy equipment are determined not only by cost considerations but also by the need to mitigate operational and financial risks, thereby aligning qualitative insights with quantitative data on maintenance cost variability (Soltanali et al., 2023).

DISCUSSION

The findings of the study show that heavy equipment procurement decisions in the palm oil industry need to consider the linkages between utilization levels, cost structures, and operational risks. The results of LCC confirm that wheel loaders and skid steer loaders are the most efficient tools to buy because their utilization is high and stable, which is 187–212 hours/month and 115–133 hours/month, respectively. The high utilization rate allows the distribution of fixed costs, such as depreciation, to be more optimal, so that the cost of ownership is lower than the cost of rent. This result is in line with the principle of TCO, which emphasizes that ownership becomes more efficient when utilization rates are high and operational risks are predictable (Szumska et al., 2022). In addition, previous research also shows that heavy equipment with a continuous work pattern will be more economical if it is directly owned by the company (West et al., 2024). Thus, the preliminary findings strongly support the hypothesis that the selection of a buying scheme is feasible for tools with high utilization characteristics.

Quantitative analysis shows that wheel loaders and skid steer loaders result in savings of 29%–31% compared to rental patterns over a 36-month horizon. This is because the operating costs of both devices show low variability, with fluctuations in maintenance costs of only ±6.8% and ±5.1%. This cost stability is an ideal characteristic for long-term asset investment, as it makes it easier for companies to plan budgets more accurately. From an asset management theory perspective, equipment with low cost volatility tends to provide a more stable operational return, thus strengthening the rationality of purchasing decisions (Chen & Li, 2025). In addition, the literature related to heavy equipment planning in the agribusiness industry confirms that the high availability of tools contributes directly to the smooth production chain and plant throughput (Achebe et al., 2024). The findings of this study are in line with this theory, thus showing strong consistency between empirical data and modern asset management concepts.

The qualitative findings also provide substantial support for the results of the cost analysis, especially regarding the importance of certainty of tool availability. Informants from the production and operational side emphasized that wheel loaders and skid steer loaders act as core equipment that cannot be replaced in the feeding and loading process. Field narratives show that rental tools are often not available on time, disrupting the daily production rhythm. This condition is in line with previous studies that stated that

dependence on rental providers can increase the risk of operational downtime, especially in the agro-industrial sector that has a continuous production process (Soltanali et al., 2023). Thus, non-financial aspects such as operational reliability have a significant influence on purchasing decisions, a dimension that is often under-considered in a purely financial approach.

Excavators exhibit distinct characteristics, with low utilization and a discontinuous usage pattern of only 62–78 hours per month. Such limited operational hours result in depreciation and other fixed costs not being optimally distributed, leading to a 36-month TCO that is 9% higher than a rental scheme. Maintenance costs for excavators are also substantially higher, particularly for hydraulic systems and undercarriages, which carry a significant risk of damage. Theoretically, assets with fluctuating utilization are more effectively managed through rental arrangements to minimize non-productive costs (Alfiana et al., 2025). Thematic interview results confirmed that excavators are deployed periodically for drainage repairs, trench cleaning, or new block openings, meaning rental arrangements reduce structural inefficiencies arising from high ownership costs and low utilization. High breakdown risks further increase TCO uncertainty, supporting the risk-based asset management perspective that leasing is preferable when technical risks exceed the company's capacity to bear or mitigate them (Guzel, 2021).

The findings emphasize that lease-or-purchase decisions cannot rely solely on financial cost calculations but must integrate technical factors, operational frequency, maintenance risks, and implications for production stability. This integrative model demonstrates that heavy equipment ownership decisions in the palm oil industry are multidimensional, consistent with literature advocating holistic analysis in agroindustrial asset management (Shmatkovska et al., 2022).

CONCLUSION

This study demonstrates that heavy equipment procurement in the palm oil industry requires an integrated consideration of utilization rates, cost structures, and operational risks to achieve optimal efficiency. Findings indicate that wheel loaders and skid steer loaders are most cost-effective to purchase due to their high and stable utilization, low maintenance cost variability, and essential role in daily material handling and loading operations. Conversely, excavators, characterized by intermittent use and higher maintenance risks, are more efficiently managed under a rental scheme. These results underscore that procurement strategies should extend beyond nominal financial calculations, incorporating operational continuity, technical risk, and equipment-specific usage patterns. For practitioners, aligning procurement policies with actual utilization and risk data is critical for cost optimization and production stability.

Despite its contributions, this study has limitations. The data were obtained from a single state-owned palm oil mill, limiting the generalizability of the findings to other operational contexts. In addition, external factors such as spare parts price fluctuations, exchange rates, and parent company capex–opex policies were not included, which may affect cost accuracy. Future research should extend to multiple mills, incorporate broader economic and policy variables, and apply machine learning–based predictive maintenance models to improve long-term cost estimation and strengthen strategic heavy equipment management in the palm oil industry.

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