

Application of Activity-Based Costing in Rice Mills to Enhance Efficiency and Competitiveness in Pinrang Regency

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Abstract

This study aims to analyze production cost structures and the application of Activity-Based Costing (ABC) as a basis for determining the cost of goods manufactured in rice milling businesses in Pinrang Regency. A descriptive approach was employed, utilizing primary data obtained through observation, interviews, documentation, and production cost reconstruction. The data covered 65 production batches across three research subjects – PB Aura, UD Ras Tani, and CV Cahaya 277 – during March 2026. Analysis involved activity identification, cost pool grouping, cost driver determination, and the calculation of production costs and initial cost of goods manufactured. Results indicate that raw unhusked rice constitutes the largest cost component, accounting for 97.62% at PB Aura, 97.54% at UD Ras Tani, and 96.82% at CV Cahaya 277. The cost of goods manufactured (after accounting for by-product credits) was Rp10,479/kg, Rp10,222/kg, and Rp10,347/kg, respectively. Activity mapping revealed differences in resource consumption, notably the polishing activity at PB Aura, which was absent in the other two mills. Drying, milling, sorting, polishing, and packaging activities served as the basis for establishing cost pools and cost drivers. Preliminary findings suggest that ABC has the potential to yield more accurate cost allocations and support cost control and pricing decisions. Final ABC calculations and the analysis of differences compared to conventional methods are currently being finalized.

Keywords: *Activity-Based Costing; Production Costs; Cost of Goods Manufactured; Rice Milling; Cost Efficiency*

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INTRODUCTION

The processing of unhusked rice (paddy) into milled rice is a strategic stage in the food agro-industry because it connects agricultural production with the supply of food ready for consumption. Rice milling performance affects processing costs, product quality, resource utilisation, and the continuity of rice distribution. This context is particularly relevant to Pinrang Regency, one of the main rice-producing areas in South Sulawesi. Statistics Indonesia (BPS) reported that rice production in Pinrang reached 563.55 thousand tonnes of milled dry grain (GKG) in 2024, up from 454.77 thousand tonnes in 2023 (BPS-Statistics of Pinrang Regency, 2024, 2025). This production volume indicates the importance of rice processing in the region; however, it does not necessarily mean that every rice mill operates efficiently or has accurate cost information.

Rice milling businesses must manage several cost components, including raw materials, labour, energy, machinery maintenance, depreciation, material handling, transportation, storage, and packaging. Studies of rice milling businesses in other parts of Indonesia show that costs, revenue, business feasibility, and value added are closely related to the sustainability of these businesses (Fatmawaty, 2023). Research on the black rice supply chain in Sleman also found that the largest cost share may occur in different activities for different supply chain actors. Material handling accounted for the largest cost share for farmers, farmer groups, and distributors, whereas inventory accounted for the largest share for retailers (Putriasih et al., 2021). These findings suggest that resource consumption does not always correspond directly to production volume.

Cost measurement problems may arise when overhead costs are allocated using only one measure, such as production volume or the weight of paddy processed. A single allocation basis may conceal differences in resource consumption across activities, particularly when production involves receiving, drying, milling, sorting, polishing, storage, and packaging. Comparative studies in Indonesian production settings have reported differences between conventional costing and Activity-Based Costing (ABC). Hasanah and Saleh (2022), for example, noted that allocating overhead using a single cost driver may distort product costs, whereas ABC uses multiple cost drivers to link costs to the activities that consume resources. Differences between conventional and ABC calculations have also been reported in food and manufacturing businesses (Sugiarsono et al., 2021; Tahang & Hakim, 2023).

ABC traces costs from resources to activities and then assigns them to products based on cost drivers that reflect activity consumption. In rice milling, relevant cost drivers may include the tonnage of paddy handled, machine operating hours, the number of drying cycles, production volume, storage time, and the number of packages. The selection of cost drivers should reflect the production process and the availability of reliable data; it cannot be assumed to be identical across all businesses. A bibliographic study of ABC research in Indonesia found that many studies focus on determining product costs, with descriptive and case study methods commonly used (Febriani et al., 2022). A systematic review of Time-Driven Activity-Based Costing (TDABC) also documented the development of an activity-based approach that uses time to measure capacity and cost (Diehl Cabral et al., 2022).

Previous studies support the potential of ABC to clarify cost structures, while also indicating that its application and results depend on context. Sánchez-Rebull et al. (2023) mapped the development of ABC research across different sectors, showing the range of contexts and objectives addressed in the literature. Another review concluded that ABC can support production cost measurement and operational efficiency by addressing limitations in volume-based costing (Febriani et al., 2024). Studies in the crude palm oil industry have applied ABC to evaluate production costs and improve the accuracy of cost calculations, while research on cassava farming has examined its relationship with production cost efficiency and profitability (Abdillah et al., 2024; [author to be verified], 2025). These findings provide a relevant conceptual basis, but they do not establish that the same effects will occur in rice milling businesses in Pinrang.

The research phenomenon addressed in this study is the gap between Pinrang's substantial rice production and rice mills' need for production cost calculations that reflect resource consumption at each processing stage. Regional production data demonstrate the importance of the sector, while studies of rice processing and supply chains show that costs may be concentrated in different activities (BPS-Statistics of Pinrang Regency, 2025; Putriasih et al., 2021; [author to be verified], 2024). If these differences are not reflected in overhead allocation, cost information may be insufficient for evaluating cost performance, setting selling prices, or identifying activities that could be improved.

The relevance of this study lies in synthesising three strands of literature: ABC applications in product costing, cost structures and activities in rice processing and agro-industry, and the implications of cost information for efficiency and managerial decisions. The review identifies activities commonly examined in ABC studies, groups costs into cost pools, reviews the cost drivers used, and synthesises reported differences between conventional costing and ABC. The study does not claim to measure actual costs or efficiency at rice mills in Pinrang. Instead, Pinrang provides a local context that demonstrates the practical relevance of the literature synthesis.

The research gap is the lack of an integrated synthesis of activity-based costing in rice milling that brings together processing activities, cost pool identification, cost driver selection, differences from conventional costing, and managerial implications for the Pinrang context. Previous reviews have mapped ABC research in Indonesia and its general focus on product costing (Febriani et al., 2022), while studies of rice supply chains and milling businesses have typically examined costs, feasibility, or efficiency within particular cases (Putriasih et al., 2021). Because these studies differ in scope and unit of analysis, their findings need to be synthesised before they can inform a contextually relevant basis for applying ABC to rice milling.

The novelty of this study lies in its contextual synthesis of rice processing activities, cost pools, cost drivers, and comparisons between ABC and conventional costing, organised around the rice milling agro-industry in Pinrang Regency. This novelty concerns the focus and organisation of the literature; it does not imply that ABC or rice milling cost studies have never been conducted. Accordingly, this study aims to review production cost structures reported in previous research, identify relevant activities, cost pools, and cost drivers, and compare findings on product costing under conventional and ABC methods. The review is expected to provide a conceptual basis for future empirical research and practical insights for rice milling managers concerning cost information, cost control, and pricing decisions.

RESEARCH METHODS

This study employed a quantitative comparative design to examine differences between conventional costing and Activity-Based Costing (ABC) in three rice milling plants in Pinrang Regency, South Sulawesi: PB Aura, UD Ras Tani, and CV Cahaya 277. The comparison focused on the cost of production (COP), cost of goods sold (COGS), and operational cost-efficiency indicators for rice products, by-products, and production batches. Each comparable production batch was evaluated using both costing methods. This paired comparison provided a basis for assessing how the allocation of overhead costs affected the calculated costs of each product.

capacity, and product range. PB Aura had the largest production volume and processing capacity and produced premium- and medium-grade rice. UD Ras Tani and CV Cahaya 277 had smaller capacities and produced medium-grade rice only; neither plant had polishing equipment. The units of analysis were rice products by grade, by-products, and production batches. The sampling period, number of batches observed at each plant, and criteria for selecting batches should be reported in the final manuscript to enable replication. Primary data were collected through direct observation of production activities and structured interviews with plant managers and operators. The observed activities included paddy intake, drying, milling, sorting and grading, packaging, storage, and distribution. Secondary data were obtained from the plants' cost and production records, including cash

books, invoices, payroll records, electricity and fuel bills, machine-use and maintenance logs, production logs, milling yields, and recorded losses. Data were included when they could be linked to a specific plant, activity, product, or production batch and were sufficiently complete to support both costing methods.

For the conventional-costing baseline, each plant's existing procedure for calculating COP and COGS was documented, including the overhead allocation basis used. For the ABC calculation, production activities were identified and grouped into cost pools. Cost drivers were then selected for each pool based on the relationship between the activity and the costs incurred, as well as the availability and reliability of plant records. The cost drivers considered included paddy tonnage, number of batches, machine hours, electricity consumption in kilowatt-hours (kWh), fuel consumption in litres, number of sacks, indirect labour hours, and storage duration measured in ton-days. For each activity, the activity rate was calculated by dividing the total cost in its cost pool by the total volume of the relevant cost driver. The cost assigned to each product or batch was calculated by multiplying the activity rate by its recorded consumption of that cost driver.

The conventional and ABC results were compared for each product and production batch to identify differences in COP, COGS, and cost structure. Products were classified as undercosted or overcosted under the conventional method when its cost estimate was lower or higher, respectively, than the corresponding ABC estimate. The analysis also examined the contribution of individual activities to total production costs and reviewed activities associated with energy use, waiting time, material handling, rework, and losses as potential areas for process improvement. These activities were assessed using the operational records and observation evidence available at each plant; classification as value-added or non-value-added was based on their contribution to the production process and the information collected.

Differences between the two costing methods were analysed using a paired-samples *t* test when the paired differences met the normality assumption. If that assumption was not met, the Wilcoxon signed-rank test was used. Where the batch-level data supported it, regression analysis or analysis of covariance (ANCOVA) was considered to account for variation in production volume and product type. The statistical unit of analysis and number of independent observations should be specified clearly. Because the study involved three plants, plant-level results should be presented separately; statistical tests should use the paired batch- or product-level observations and should not treat repeated measurements from the same plant as independent observations.

Operational efficiency was assessed using cost per unit, resource utilisation, and the proportion of activity costs in total production costs. Competitiveness was considered in operational terms by comparing the resulting cost structures and production costs. Since the study does not directly measure market share, consumer demand, or selling-price responses, competitiveness findings should be interpreted as cost-based implications rather than as evidence of an observed change in market competitiveness.

As a final step, the study developed an ABC model for rice milling plants. The model included an activity map, cost pools, cost drivers, activity rates, and calculation formats for COP and COGS. Its purpose was to provide a practical costing framework that rice mills could adapt for ongoing cost monitoring and production decision-making.

RESULTS AND DISCUSSION

Primary data reveal differences in operational scale among the mills. PB Aura possesses the largest production volume and processing capacity, whereas CV Cahaya 277 has the smallest processing capacity. UD Ras Tani and CV Cahaya 277 produce only one type of rice medium-grade due to the absence of polishing machinery, while PB Aura produces both premium and medium-grade rice. Production records indicate the following milling yield benchmarks across the three mills: rice yield of 60%, bran 8%, husk 20%, broken rice 5% (Ras Tani and Cahaya 277) or 2% (PB Aura), and processing loss of 7% (Ras Tani and Cahaya 277) or 10% (PB Aura). In the rice milling agro-industry, distinguishing between main products, by-products, and losses is crucial, as these factors influence product costing and the evaluation of process efficiency.

Table 1. Production profiles of three factories in March 2026

Indicator		PB Aura	UD Ras Tani	CV Cahaya 277
Batch quantity (Production)		20	22	23
Paddy input (tonnes)		1.207	715	425
Number of input sacks		9.295	5.511	3.277
Processing capacity (tonnes/hour)		6,5	3,5	2,0
Rice output (tonnes)		724,2	429,0	255,0
Rice milling recovery		60,00%	60,00%	60,00%
Types of rice		Premium and medium	Medium	Medium
Raw material transport characteristics		Company-owned truck	Company-owned truck	Rental truck

Source : Primary Data, 2026

Validation note: The tonnage recorded in the field notes represents rounded production figures, while raw material transactions are calculated based on the number of sacks multiplied by 130 kg. Therefore, the cost of purchasing unhusked rice (gabah) is calculated based on the actual number of sacks recorded and a price of IDR 845,000 per sack.

Table 2. Reconciliation of production inputs and outputs

Factory	Total Unmilled Rice	Rice Milling Yield	Broken rice	Bran	Husk	Shrinkage Loss	Total
Pb Aura	1.207,00	724,20 ton (60%)	24,14 ton (2%)	96,56 ton (8%)	241,40 ton (20%)	120,70 ton (10%)	1.207,00 ton
Ras Tani	715,00	429,00 ton (60%)	35,75 ton (5%)	57,20 ton (8%)	143,00 ton (20%)	50,05 ton (7%)	715,00 ton (100%)

Cahaya 277	425,00	255,00 ton (60%)	21,25 ton (5%)	34,00 ton (8%)	85,00 ton (20%)	29,75 ton (7%)	425,00 ton (100%)
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Source : Primary Data, 2026

Production input-output reconciliation is conducted to ensure alignment between the quantity of unhusked rice (paddy) processed and the total milling output. Based on data from March 2026, the total paddy input across three mills reached 2,347 tons, consisting of 1,207 tons at PB Aura, 715 tons at UD Ras Tani, and 425 tons at CV Cahaya 277. This total input is reconciled into its constituent components milled rice, broken rice, husks, bran, and processing losses based on the specific milling yield percentages for each facility, ensuring the sum accounts for 100% of the input. This reconciliation serves as the foundation for verifying the consistency of production data and supports the analysis of production costs and the calculation of the cost of goods manufactured using the Activity-Based Costing (ABC) approach.

Cost structure analysis reveals that raw unhusked rice constitutes the largest cost component across all the entities studied. Raw material costs account for approximately 97.62% of identified production costs at PB Aura, 97.54% at UD Ras Tani, and 96.82% at CV Cahaya 277. While this dominance makes the control of raw material prices and volumes crucial, accurate overhead allocation remains essential for management to assess activity consumption, compare batch efficiencies, and determine prices more rationally. ABC literature emphasizes that activity-based allocation can mitigate cost distortions when overhead is consumed unevenly.

Table 3. Reconciliation of production inputs and outputs

Cost components	PB Aura	UD Ras Tani	CV Cahaya 277
Paddy rice raw material	Rp7.854.275.000	Rp4.656.795.000	Rp2.769.065.000
Procurement transportation	Rp19.400.000	Rp13.200.000	Rp23.000.000
Direct labor	Rp55.770.000	Rp19.288.500	Rp16.385.000
Indirect labor	-	Rp13.777.500	Rp8.192.500
Product packaging	Rp53.145.000	Rp32.775.900	Rp19.486.000
Electricity	Rp40.105.000	Rp29.510.000	Rp20.100.300
Machine depreciation per month	Rp20.000.000	Rp7.500.000	Rp3.000.000
Machine maintenance	Rp2.000.000	Rp1.000.000	Rp700.000
Sewing thread	Rp800.000	Rp330.000	Rp184.000
TOTAL IDENTIFIED COSTS	Rp8.045.495.000	Rp4.774.176.900	Rp2.860.112.800
Cost per tonne of input	Rp6.665.696	Rp6.677.170	Rp6.729.677
Proportion of raw materials	97,62%	97,54%	96,82%

Source : Primary Data, 2026

Transportation costs for finished products are not included because, based on interviews at the three mills, all shipping costs for rice and by-products are borne by the buyers. The costs mentioned above represent production costs that could be identified from field data; they do not account for administrative or financial expenses, taxes, or other non-production components.

Activity mapping reveals that it is not entirely accurate to allocate overhead costs based on a single volume-based driver. Consequently, an initial Activity Based Costing (ABC) model was developed by tracing costs to the activities that consume resources. PB

Aura performs a polishing activity a process not present at UD Ras Tani or CV Cahaya 277. This distinction is significant because the production of premium rice at PB Aura involves additional activities, which, in theory, should result in a cost allocation that differs from that of medium grade rice.

Tabel 4. Initial design of cost pools and cost drivers

Cost pool/activity	Major cost components	Initial cost driver
Procurement/Transportation of Unhulled Rice	Truck costs, fuel/driver, or rental fees	Number of vehicles/trips per Batch
Material handling/unloading	Indirect labor/labor Transport	Number of sacks or tonnage
Drying	Electric dryer, shrinkage dryer, rice husk fuel	Machine hours/tonnage; rice husk consumption
Hulling/milling	Electricity and machinery depreciation	Machine hours/tonnage
Sorting/separation	Electricity and machinery depreciation	Machine hours/tonnag
Polishing (PB Aura)	Electricity and depreciation of polishing machines	Machine hours/tonnage of polished rice
Packaging	Packaging and packaging machine activities	Number of product sacks
Sewing notions	Sewing thread	Number of batches/number of sacks
Maintenance	Machine maintenance costs	Machine hours or maintenance events
Penyimpanan	Room/handling fees, if applicable	Ton-day

Source : Primary Data, 2026

Electricity bills for the three factories are available as monthly figures, while usage metering per machine or per batch is not yet available. For progress reporting, electricity loads are provisionally allocated based on process hours, which are derived from batch tonnage and production capacity. The interim formula is: electricity cost per batch = batch tonnage × electricity rate per ton, where the electricity rate per ton = monthly electricity bill / total production tonnage. This approach will be refined in the final Activity-Based Costing (ABC) calculation once information regarding machine time or consumption per activity can be verified.

Tabel 5. Initial electricity tariff rates

Factory	Electricity bills	Estimated processing time	Hourly rate	Cost per tonne
PB Aura	Rp40.105.000	185,69	Rp215.976	Rp33.227
UD Ras Tani	Rp29.510.000	204,29	Rp144.455	Rp41.273
CV Cahaya 277	Rp20.100.300	212,50	Rp94.590	Rp47.295

Source : Primary Data, 2026

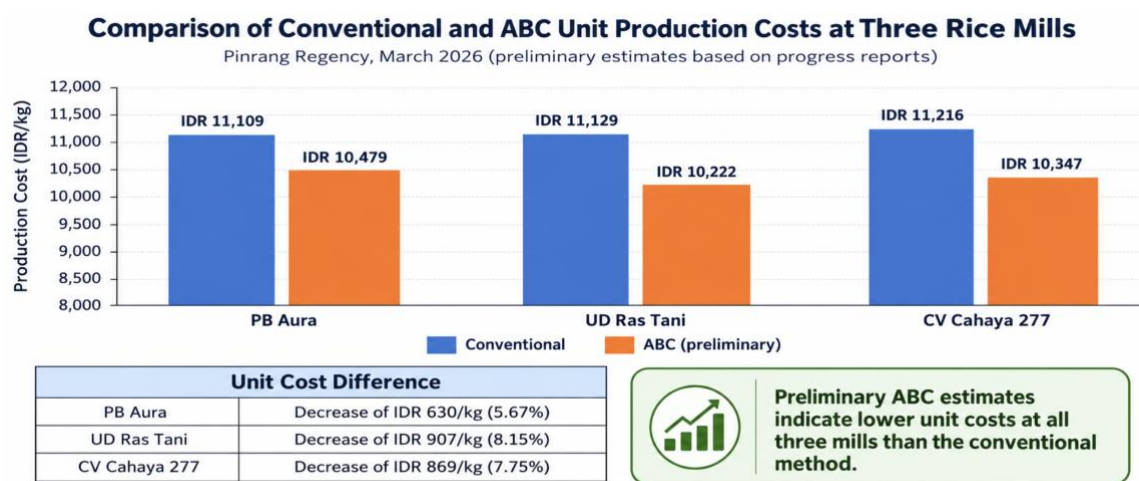
Descriptively, the electricity cost per ton is approximately IDR 33,227 for PB Aura, IDR 41,273 for UD Ras Tani, and IDR 47,295 for CV Cahaya 277. This pattern aligns with differences in scale and machine capacity; however, at this stage, it cannot be concluded that a direct cause-and-effect relationship exists, as electricity bills may encompass the power consumption of other facilities, variations in idle time, power factor, and the specific operational characteristics of the machinery.

Before the final Activity-Based Costing (ABC) rates are calculated, a baseline cost of goods sold (COGS) is established to assess the cost position. A basic COGS is determined by dividing the total identified production costs by the quantity of rice produced (in kilograms). Subsequently, a by-product credit approach is applied, wherein the economic value of sellable items—such as broken rice, rice bran, and rice husks—is deducted from the costs allocated to the rice. At PB Aura and UD Ras Tani, rice husks used as fuel for dryers are not credited as sellable by-products, thereby avoiding the double-counting of the benefits derived from the husks. At CV Cahaya 277, there are no records regarding the use of rice husks as fuel; therefore, for the purpose of this preliminary analysis, all rice husks are treated as potential sellable by-products. This approach is a provisional analytical policy and will be subject to confirmation during the final calculation.

Tabel 6. Provisional baseline cost of goods sold (COGS)

Indicator	PB Aura	UD Ras Tani	CV Cahaya 277
Total identified costs	Rp8.045.495.000	Rp4.774.176.900	Rp2.860.112.800
Simple cost of goods sold (COGS) for rice per kg	Rp11.109	Rp11.129	Rp11.216
By-product credit	Rp456.571.500	Rp389.122.600	Rp221.550.000
Cost of Goods Sold (COGS) after product creditssamping/kg	Rp10.479	Rp10.222	Rp10.347
Reference selling price of rice per kg	Rp13.640	Rp13.300	Rp13.300
Price spread - COGS/kg	Rp3.161	Rp3.078	Rp2.953

Source : Primary Data, 2026



Note: ABC values are preliminary estimates based on progress reports; final ABC unit costs may change after activity and cost-driver validation.

Source: Preliminary primary data, 2026.

The graph shows that the cost of goods manufactured (COGM) calculated using the Activity-Based Costing (ABC) approach is lower than that obtained via conventional

methods across all three manufacturing facilities. The most significant reduction is observed at UD Ras Tani (8.15%), followed by CV Cahaya 277 (7.75%) and PB Aura (5.67%). These preliminary findings suggest that the ABC approach has the potential to yield lower and more targeted production cost allocations, based on the specific activities that consume resources. However, these results do not yet constitute a final conclusion, as the ABC-based COGM calculations are still undergoing verification, refinement of cost drivers, and further analysis, prior to statistical testing for significant differences.

Activities that directly alter the condition of a product such as drying, husking/milling, sorting, polishing, and packaging are classified as value added activities, or those necessary to produce the final product. Material handling, waiting times, repetitive movement, rework, and abnormal losses are potential non value added activities that must be evaluated through process observation. Activity Based Management (ABM) research indicates that mapping non-value-added activities can facilitate a more targeted approach to waste reduction [20]. Recorded losses stand at approximately 10.07% for PB Aura, 6.92% for UD Ras Tani, and 6.75% for CV Cahaya 277. These figures cannot be automatically categorized as waste, as some losses may stem from reductions in moisture content, the removal of husks, or the technical characteristics of the milling process. The final stage involves distinguishing between normal and abnormal losses based on process verification. Immediate opportunities for further efficiency analysis include energy optimization, the utilization of husks as fuel, the management of material handling, and ensuring that polishing costs are accurately allocated only to the products that actually undergo that specific process.

CONCLUSION

Research conducted at PB Aura, UD Ras Tani, and CV Cahaya 277 indicates that the production costs for rice milling are dominated by raw materials, accounting for 96.82%–97.62% of the total. Activity mapping demonstrates that the implementation of ActivityBased Costing (ABC) allows for the allocation of overhead costs that more accurately reflect the specific activities and cost drivers involved.

The findings show that the cost of goods sold (COGS) calculated using the ABC approach is potentially lower than the baseline COGS specifically by 5.67% for PB Aura, 8.15% for UD Ras Tani, and 7.75% for CV Cahaya 277. Furthermore, ABC helps identify activities that may lead to inefficiencies, such as material handling, waiting times, energy consumption, and losses. Consequently, ABC has the potential to improve the accuracy of COGS data and support cost efficiency within the rice milling industry.

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