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Implementation Of Activity Based Costing Strategy To Improve Labor, Energy, And Maintenance Cost Efficiency At Pt Nusira

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Abstract

This study aims to analyze the implementation of the Activity Based Costing (ABC) strategy combined with the lean Muda-Mura-Muri approach in promoting cost efficiency for three main operational cost components at PT Nusira, namely employee costs, energy costs, and maintenance costs. The study employs a descriptive quantitative approach combined with a case study (mixed method), analyzing historical operational cost data in the form of budget versus actual comparisons during the January–June 2026 period, as well as mapping activities and cost drivers for each cost component. The implementation of ABC makes it possible to identify specific cost drivers for each activity, so improvement programs can be designed in a measurable way, including optimizing Value Stream Mapping, automating repetitive processes, digitalizing monitoring, planning integrated preventive maintenance, and substituting biomass fuels. This study provides preliminary evidence that an ABC strategy integrated with the Muda-Mura-Muri principles acts as a driver for achieving cost efficiency in the manufacturing industry, while also serving as a basis for testing hypotheses inferentially through cross-company surveys in further research.

Keywords: Activity Based Costing; Cost Efficiency; Muda-Mura-Muri; Industri Manufaktur; Cost Driver

INTRODUCTION

The manufacturing industry is one of the strategic sectors that supports the national economy through its contribution to Gross Domestic Product, employment

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absorption, and export value. Amid the pressures of global competition, manufacturing companies are required not only to produce quality products but also to manage production costs efficiently in order to remain competitive. One crucial aspect of cost management is the accuracy in determining the cost of goods manufactured, as errors in overhead cost allocation can lead to cost distortion, a condition in which some products are burdened with excessively high costs (overcosting) while others are charged with costs that are too low (undercosting).

At the practical level, operational cost control at PT Nusira generally focuses on three major cost components, namely labor costs (employee cost), energy costs, and repair and maintenance costs (maintenance cost). Effective management of these cost components is essential because they directly influence production efficiency, operational performance, and the company's overall competitiveness (Kaplan & Anderson, 2007; Cooper & Kaplan, 1991). Activity-Based Costing (ABC) offers a more accurate costing approach because it traces costs to the activities and their corresponding cost drivers, enabling organizations to identify non-value-added activities and allocate indirect costs more precisely (Cooper & Kaplan, 1991; Kaplan & Anderson, 2007). As a result, managers are better equipped to detect sources of inefficiency and implement appropriate cost reduction strategies.

This ABC approach becomes even more effective when integrated with the Lean Manufacturing philosophy through the identification of the three primary sources of operational inefficiency, namely Muda (non-value-added activities), Mura (workload imbalance), and Muri (overburden or excessive workload). According to Ohno (1988), these three forms of waste are interrelated, where uneven workloads (Mura) and excessive burdens (Muri) often generate various forms of waste (Muda), leading to higher operational costs and lower process efficiency. Furthermore, empirical studies have demonstrated that integrating Activity-Based Costing with Lean Manufacturing enables organizations not only to measure costs more accurately but also to identify the root causes of waste and improve decision-making for continuous operational improvement (Maskell & Baggaley, 2004; Bhamu & Sangwan, 2014). Therefore, the combination of ABC and Lean Manufacturing provides PT Nusira with a comprehensive framework for improving cost transparency, eliminating waste, enhancing maintenance effectiveness, and supporting sustainable operational excellence.

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Table 1. Budget and Realization of Operational Costs January–June 2025 (Million IDR)

Cost Component	Jenis	Jan	Feb	Mar	Apr	Mei	Jun
Employee Cost	Budget	996	983	997	969	992	974
	Actual	1.710	1.534	1.596	1.260	1.196	1.211
Energy Cost	Budget	550	548	558	550	559	549
	Actual	870	992	948	942	973	970
Maintainance Cost	Budget	304	396	352	374	341	312
	Actual	463	467	507	452	416	422

OBJECTIVES

This article intends

1. Analyzing and describing the actual costs of labor, energy, and maintenance compared to the budget at PT Nusira.
2. Identifying dominant activities and cost drivers for each cost component through Activity Based Costing analysis.
3. Analyzing the application of the Muda, Mura, and Muri principles in mapping and eliminating waste in each cost component.
4. Measuring the potential and projected cost efficiency that can be achieved through improvement programs designed based on ABC.
5. Analyzing the impact of implementing the Activity Based Costing strategy on cost efficiency at PT Nusira

DISCUSSION

Historical data on budget and actual operational costs for the three main components, namely employee costs, energy costs, and maintenance costs, for the period from January to June 2026 are presented in Table 2. All values are expressed in million Rupiah.

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Table 2. Budget and Realization of Operational Costs January–June 2026 (Million IDR)

Cost Component	Jenis	Jan	Feb	Mar	Apr	Mei	Jun
Employee Cost	Budget	996	983	997	969	992	974
	Actual	872	762	1.596	887	865	744
Energy Cost	Budget	550	548	558	550	559	549
	Actual	419	415	448	442	443	470
Maintainance Cost	Budget	304	396	352	374	341	312
	Actual	280	215	262	270	313	236

Overall, actual expenses were lower than the budget across almost all components and months → operational cost efficiency is quite good. The only significant exception is the spike in Employee Costs in March, which stands out as an outlier and requires special explanation/justification in the journal as it could obscure the efficiency trends present in other components. The consistent underspending pattern in Energy and Maintenance could also serve as a basis for evaluating whether future budget figures need to be adjusted to be more realistic (not always significantly higher than actuals). Based on limited observations and interviews on the production line, five main activities that make up Employee Cost were identified, along with their cost drivers and waste categories, as shown in Table below.

Table 3. Activity and Cost Driver Employee Cost

Activity	Cost Driver	3M Category
Manual machine operation	Operator working hours	Muri
Manual production monitoring	Checking frequency	Muda
Repetitive work on the production line	Number of activity repetitions	Muda
Overtime due to production bottlenecks	Overtime hours	Mura

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Activity	Cost Driver	3M Category
Non-productive movement of operators	Operator travel distance	Muda

Recommended Efficiency Program

Workflow Optimization in the Production Line

Workflow mapping using Value Stream Mapping (VSM) to eliminate Muda activities at each workstation and balance workload between operators to reduce Mura. Impact on ABC: a decrease in the consumption of the cost driver 'non-productive working hours,' which is directly related to the spike in overtime costs in January and March.

Repetitive Process Automation

Automation in repetitive activities that were previously performed manually can reduce the need for direct manpower. Impact on ABC: the cost pool for "direct operator costs" decreases significantly, with success parameters measured by a reduction in the man-hour per production unit ratio.

Digital Monitoring

The implementation of a digital monitoring system based on dashboards or IoT replaces manual inspections, allowing a single operator to monitor more points simultaneously. Impact on ABC: the cost driver 'manual inspection frequency' is eliminated, with the subsequent effect of reducing monitoring headcount without compromising the quality of supervision.

Systematic Application of the Principles of Muda, Mura, and Muri

Eliminating unnecessary movements and wait times between stations (Muda), balancing workload across shifts and lines (Mura), and ensuring each employee's workload matches standard capacity (Muri). The potential result of these four programs is a more efficient redistribution of work, not just cutting manpower, but reallocating it to more value-added functions.

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Activity Based Costing Analysis on Energy Cost Components
Identification of Activities and Cost Driver

Table 4. Activity and Cost Energy Driver

Activity	Cost Driver	3M Category
Electromotor operation	Ampere × hours of operation	Muri
Production area lighting	Watts × hours on	Muda
Boiler biomass consumption	Tons of biomass used	Mura
Heavy equipment movement	Hours of operation + fuel consumption	Muda
Electrical power losses	kWh wasted	Muda

The energy cost realization consistently remained below the budget throughout the observation period, with favorable variances ranging from -6.6 percent to -24.0 percent. This performance reflects the effectiveness of energy efficiency initiatives in reducing operational costs while maintaining stable production activities and operational performance. The consistent achievement of favorable variances indicates that the company's energy consumption has been managed efficiently without compromising production output or process reliability. Furthermore, these favorable results demonstrate that the implemented energy management strategies have delivered tangible financial and operational benefits, contributing to improved cost efficiency and supporting the organization's broader operational objectives. Such achievements are most likely attributable to the successful implementation of the following energy efficiency programs, which have either been fully implemented or are currently in progress.

Recommended Efficiency Program
Using Electric Motors with Joint Coupling

Replacing the conventional transmission system with a direct joint coupling to reduce energy losses due to friction and slip in the transmission. Impact on ABC: the cost driver 'kWh consumption per hour of operation' decreases directly.

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Lighting with Automatic Sensor

Replacement of conventional lamps with motion/light sensor lamps so that they are only active when the area is in use. Impact on ABC: the cost driver "lamp operating hours" is drastically reduced.

Utilization of Solar Panels for Nighttime Lighting

The utilization of solar energy for lighting needs during night shifts to reduce dependence on electricity from the main grid. Impact on ABC: the reallocation of part of the cost pool from "electricity costs" to "capitalized investments".

Installation of Microcontrollers on Electric Motors

Current limitation is applied to each electric motor to ensure that the operating current does not exceed the installed capacity. This control is intended to prevent overload conditions that can result in excessive power consumption, reduced equipment efficiency, accelerated component wear, and potential motor damage. By maintaining operation within the specified capacity, energy utilization becomes more stable and reliable. Impact on ABC: elimination of the cost driver “excessive power consumption due to overload,” leading to more efficient energy use and improved cost control.

Substitution of Alternative Biomass Sources

A comparative analysis of the cost per calorie unit of various biomass types (palm shells, wood pellets, palm fiber, candlenut shells, and corn cobs) was conducted to identify the most cost-effective biomass blending strategy capable of maintaining a stable calorific value while optimizing fuel expenditure and enhancing overall operational efficiency.

Application of Muda, Mura, Muri in Heavy Equipment Operation

Elimination of non-productive heavy equipment movements (Muda), scheduling operations evenly to avoid activity accumulation (Mura), and ensuring that heavy equipment loads do not exceed capacity to prevent excessive fuel consumption (Muri).

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Analysis of Activity Based Costing on Repair and Maintenance Cost Components Identification of Activities and Cost Drivers

Table 6. Activities and Cost Drivers of Repair and Maintenance Costs

Activity	Cost Driver	3M Category
Sudden breakdown repair (corrective)	Frequency of malfunctions	Muda
Emergency spare parts procurement	Number of emergency purchase orders	Mura
Production machine downtime	Downtime hours	Muri
Scheduled preventive maintenance	Frequency of scheduled PM	Normal
Routine spare parts replacement	Number of units replaced	Normal

The realization of maintenance costs remained below the allocated budget in five of the six observed months, indicating that maintenance expenditures were generally well controlled throughout the observation period. The largest cost savings were recorded in February (-41.3 percent) and June (-35.8 percent), reflecting relatively efficient maintenance activities and the absence of major unexpected equipment failures during those months. In contrast, May experienced a maintenance cost increase of 29.9 percent above the planned budget, suggesting the occurrence of an unanticipated equipment breakdown, particularly of the Muda and Muri nature, which required immediate corrective actions and additional maintenance resources.

This fluctuation demonstrates that although maintenance costs can often be managed within budget, unexpected failures still have the potential to significantly increase operational expenses. Therefore, the observed pattern highlights the importance of transitioning from a predominantly corrective maintenance approach toward a more structured preventive and predictive maintenance strategy. Such an approach would help reduce the frequency of unexpected breakdowns, improve equipment reliability, optimize maintenance planning, and ultimately enhance cost efficiency and operational performance.

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Recommended Efficiency Program

Integrated Maintenance Planning

The development of a comprehensive maintenance planning system, which includes scheduling preventive maintenance based on production machine operating hours, servicing heavy equipment according to hour meters, as well as periodic maintenance of the electrical system, generators, and boiler in the power house, with a gradual approach from corrective to preventive and predictive maintenance. Impact on ABC: the cost pool "emergency repair costs" shifts to the cost pool "planned maintenance costs," which is empirically much lower, as demonstrated by the efficiency achievement of -15.9 percent in Table 3, making the maintenance budget more predictable and controllable.

Data-Based Equivalent Spare Part Substitution

The decision to substitute spare parts is carried out through stages of identifying high-value components, analyzing technical specifications, benchmarking local and imported alternatives, conducting comparative lifespan tests, and calculating the total cost of ownership, rather than merely the purchase price. As an illustration, if spare part A costs Rp2,000,000 per unit and can last 1,000 hours of operation, while spare part B costs Rp1,200,000 per unit but only lasts 700 hours of operation, then the cost per hour of use for spare part A is Rp2,000 per hour, whereas for spare part B it is Rp1,714 per hour, making spare part B more efficient according to ABC analysis despite its shorter lifespan. The relevant ABC parameter in this decision-making is cost per hour of use, not merely the unit purchase price.

CONCLUSION

Based on the data presentation and analysis above, the following conclusions can be drawn:

1. The realization of operational costs for the period January–June 2026 shows different patterns among components: Energy Costs and Repair/Maintenance Costs were realized at 13.2 percent and 15.9 percent below budget, respectively, while Employee Costs were realized 2.9 percent above budget with sharp monthly fluctuations.
2. Activity-Based Costing analysis successfully identified specific activities and cost drivers in each cost component, which were previously hidden within conventional cost allocations, allowing waste to be traced back to the root causing activities.

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3. The application of the principles of Muda, Mura, and Muri strengthens ABC analysis in categorizing types of waste, and shows that the spikes in labor costs in January and March are dominated by Mura-type waste, while the surge in maintenance costs in May stems from unscheduled Muda and Muri-type events.
4. The designed efficiency programs are measurable and cross-departmental, encompassing optimization of Value Stream Mapping, automation of repetitive processes, digitization of monitoring, biomass energy substitution, as well as integrated preventive maintenance planning, with potential impacts that can be traced directly to the cost drivers of each activity.
5. The findings of this study descriptively support the hypothesis direction that Activity Based Costing serves as a driving strategy for achieving cost efficiency at PT Nusira, although inferential-statistical validation still requires further testing with a broader scope.

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