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# Maintenance of Meat Grinding Machines at CV. Solo Indah in Palu City

**Musfara Kaharuddin[1*], Asngadi[2], Sulaeman Miru[3], Kadek Agus Dwiwijaya[4]**
Universitas Tadulako, Palu, Indonesia[1,2,3,4]
musfarahfr@gmail.com[1]* , asngadyfeutd@gmail.com[2], sulaemanmiru@untad.ac.id[3], kadekagus@untad.ac.id[4]

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**Abstract**
**Purpose**: This study analyzes the maintenance practices of meat grinding machines at CV Solo Indah in Palu City, focusing on preventive and corrective strategies, and provides recommendations to improve efficiency and reduce breakdowns.
**Methodology/Approach**: Conducted over three months using a descriptive quantitative approach, the study employed direct observation, structured interviews, and documentation. Machine components were evaluated using fishbone diagrams, cost analysis, and efficiency calculations with the formula TC = (F × RI) / (RO × P). Tools included maintenance records, interview guides, and Microsoft Excel.
**Results/Findings**: All major components experienced at least one failure in 2024. The gearbox, machine frame, and feeder had the highest repair costs. The total maintenance cost was Rp13,674,500, with preventive maintenance accounting for 53.68% and corrective for 46.32%. This indicates a balanced and efficient maintenance system categorized as "very efficient" under industry benchmarks.
**Conclusions**: CV Solo Indah implements both preventive and corrective maintenance effectively, though corrective costs remain relatively high. Prioritizing preventive actions for costly components like the gearbox can reduce overall expenses. Fishbone analysis identified root causes in manpower, machine, method, material, environment, and measurement aspects.
**Limitations**: The study focuses on one company and a short 3-month period, limiting generalization to broader industry trends.
**Contribution**: This research enriches industrial engineering and operations management literature, especially for SME-scale meat processing, by providing practical insights to enhance maintenance systems, lower costs, and increase productivity.

**Keywords:** *Corrective Maintenance, Efficiency, Machine Maintenance, Meat Grinder, Preventive Maintenance*

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## 1. Introduction

In a competitive business landscape, consumer satisfaction with purchasing decisions plays a crucial role in maintaining market share and achieving a competitive advantage (Bachri *et al*., 2023: Syamsuddin *et al*., 2024). Machine and equipment maintenance has become increasingly important, especially with technological advancements that continue to replace human labor (Widat *et al.* 2021). Transparency and operational efficiency are essential for effective maintenance (Ilsya *et al.* 2025 ; Likty & Singagerda 2025). The use of appropriate technological approaches and operational management can enhance trust and improve production efficiency, particularly in the SME sector. Machine breakdowns often hinder production, disrupt workflows, reduce product quality, and negatively impact customer satisfaction (Siregar et al., 2022).

Innovations in maintenance practices can boost competitiveness through improvements in manufacturing techniques and product quality (Ibrahim *et al*., 2024). Many companies fail to survive because they cannot overcome obstacles such as machine failures or equipment that are not operationally feasible. Strategic management that reduces costs and maximizes profits is considered a key solution for gaining competitive advantage (Pasaribu *et al*., 2021). Good service quality and superior products increase the likelihood of a company sustaining itself in a competitive market (Wahyuningsih *et al*., 2022).

In the implementation of maintenance activities, manufacturing companies generally apply two types of maintenance: preventive and corrective. Preventive maintenance refers to actions taken to prevent potential issues or equipment failures, whereas corrective maintenance involves steps taken to repair problems that have already occurred. Both are essential components of risk management for maintaining efficiency and ensuring the sustainability of operational systems. Therefore, companies strive to improve customer satisfaction through various strategies (Wahyuningsih *et al*., 2022). By implementing effective maintenance practices, machines and equipment can function optimally for longer periods, allowing the production process to operate smoothly with minimal disruption. According to Nurfatimah *et al*. (2024), an efficient production process occurs when all stages run well without significant obstacles.

Meat is one of the most important food ingredients for fulfilling the nutritional needs of society and is an economic commodity with high strategic value. Globally, average per-capita meat consumption and total meat intake continue to increase, driven by population growth, rising incomes, and socio-cultural traditions that place a high value on meat consumption (Stewart *et al*., 2021). Meat can be cooked, fried, grilled, or processed into various appealing products, such as patties, sausages, nuggets, and meatballs (Gumilar *et al*., 2021). Food processing increases the added value, extends the shelf life, improves product acceptance, and diversifies the processed food products. Meat also serves as a catalyst for the growth of upstream industries and as a driver of downstream industrial development in agribusiness systems. As meat consumption continues to increase each year, various businesses involved in meat processing have emerged, including meat grinding enterprises.

A meat-grinding business utilizes equipment or machines designed to grind meat by crushing it into a finer form to produce other food products, such as meatballs and sausages. The machine operates using a rotating cylinder driven by a motor and transmission system, making it highly effective for quickly grinding various types of meat while delivering optimal results and reducing maintenance costs (Fibrianie *et al*., 2018). A meat grinder is a machine used to soften and refine meat for food preparation or as an ingredient in food mixtures (Porawati & Kurniawan, 2020). Unground meat typically remains in small chunks that cannot be easily combined with other ingredients in a food mixture, necessitating a grinding process to facilitate uniform mixing with additional components. The meat-grinding process is one of the key stages in producing foods such as meatballs, nuggets, and sausages, alongside other stages such as dough mixing (Romiyadi & Purnama, 2017). Therefore, the quality of the meat-grinding results is crucial in determining the final texture of the food product.

CV. Solo Indah is a company engaged in meat grinding services, as well as the production of meatballs and siomay, and it operates as a distributor in Palu City. The company was founded in 1985 by H.K. Suparmin and is now continued and further developed by his son, H. Bowo Wijaksono. With the slogan "The King of Meat Grinding, Meatballs & Siomay," Solo Indah has become the largest and most comprehensive meat-grinding enterprise in Palu City, consistently prioritizing quality, customer satisfaction, and hygiene. The concept of customer value has increasingly become a central focus for both academics and practitioners (Wahyuningsih 2005). In its business operations, Solo Indah recognizes that consumers expect clear and transparent information regarding product quality and pricing before making a purchase decision (Zahara *et al*., 2023). With thousands of partners distributed across Palu City and its surrounding areas, the company must continue to strengthen its business operations to maintain sustainable relationships with its partners and consumers (Thahir *et al*., 2022).

One effective strategy to support this effort is the use of social media marketing, which not only helps build trust but also enhances consumers' willingness to purchase or reuse services (Zahara *et al*., 2021). As the largest meat-grinding service provider in Palu City, CV Solo Indah is committed not only to service quality and customer satisfaction but also to implementing strict technical and operational standards to ensure the sustainability of its production machinery. One of the strategic policies enforced is the minimum grinding weight requirement of 1 kg per process, adjusted to the type and characteristics of the meat brought in by customers. Grinding extremely small quantities can increase uneven friction and elevate the risk of damage to vital components, such as the screw shaft, chopping blades, grinding plates, and gearbox. Nonetheless, the company can maintain machine performance stability through appropriate technical adjustments.

This operational standard is part of the company's preventive maintenance approach, which aims to reduce repair frequency, minimize operational costs, and ensure that machines continue to operate optimally. Given that CV Solo Indah has thousands of business partners in Palu and the surrounding areas, the estimated volume of meat processed daily ranges between 500 and 1,000 kg, depending on demand and product type. Consequently, these flexible technical policies, supported by substantial operational capacity, not only safeguard the company's asset investment but also ensure the quality of the ground meat and sustain partner and customer satisfaction.

Based on the background outlined above, the maintenance of meat-grinding machines plays a vital role in sustaining the operational continuity of CV Solo Indah in Palu. Machine breakdowns not only disrupt the production process but also reduce product quality and directly affect customer satisfaction (CS). This study aims to identify the maintenance practices implemented, analyze preventive and corrective maintenance efforts, and formulate strategic recommendations to improve maintenance effectiveness and efficiency. The novelty of this research lies in the use of a Fishbone Diagram as a systematic approach to identify the root causes of maintenance-related issues, as well as emphasizing cost efficiency, which is highly relevant to the Small and Medium Industrial (IKM) sector. Through this approach, CV Solo Indah is expected to reduce potential losses caused by downtime and strengthen its operational resilience sustainably. This study is anticipated to provide practical contributions for SMEs in adopting data-driven and risk-based maintenance strategies and encourage the application of structured analytical methods that are adaptable to the needs of small- and medium-scale industries.

## 2. Literature Review

### *2.1 Operational Management*

According to Kristanto *et al*. (2022), operational management is a series of production processes that transform inputs into outputs, encompassing the planning, control, and supervision of resources to achieve production objectives, improve quality, and enhance customer satisfaction. Ferdinand and Wahyuningsih (2018) further explain that sales personnel who create a positive environment can attract customers and drive sales. Customer satisfaction, as stated by Adam *et al*. (2023), is a vital factor in the effectiveness of marketing strategies. Widyaningsih *et al.* (2020) emphasized that management strategies integrated with efficient operational systems can enhance competitive advantage. Alansori *et al.* (2021) highlighted the importance of organizational culture and technology adoption in supporting operational efficiency. Modern technologies, including work digitalization, have also been proven to increase effectiveness and efficiency (Oktaria & Hermansyah, 2023). Widyaningsih *et al.* (2020) reaffirmed the importance of integrating strategies and operational efficiency to maintain business sustainability.

### *2.2 Maintenance*

Maintenance is an activity aimed at ensuring that buildings, facilities, and equipment remain in good condition, operate properly, and comply with the existing standards (Rahmawati *et al*., 2024). According to Heizer and Render (2016), maintenance refers to all activities performed to keep equipment systems functioning so that work can be completed according to specifications. Febriyan and Cahyono (2023) described maintenance as a combination of several actions undertaken to preserve and care for a machine and restore it to an acceptable condition. Generally, the more frequently machinery is used within a production system, the more critical the role of maintenance management in that system (Rachman *et al*., 2017).

Therefore, the concept of maintenance in modern operational contexts is no longer limited to the technical condition of machines but encompasses a holistic approach to the entire work ecosystem. Maintenance is not merely defined as an effort to ensure the technical functionality of machines; rather, it includes broader aspects, such as the role of the workforce in sustaining operational continuity. In modern maintenance management, preventive activities are not limited to inspections and component replacements but also involve daily routines, such as unit cleaning and workspace sanitation, performed by trained personnel. These cleaning activities serve a strategic function in preventing the accumulation of dirt, grease, and meat residues, which may trigger corrosion or long-term mechanical disruptions. Administratively, the cost of cleaning activities is classified under labor wages rather than direct maintenance costs. Nevertheless, functionally, such activities remain an integral component of preventive maintenance strategies aimed at reducing corrective costs and maintaining optimal machine performance.

### *2.3 Types of Maintenance*

According to Li *et al*. (2020), various types of maintenance strategies can be implemented. Maintenance strategies can be categorized into two main types. The first is preventive maintenance, which is performed at predetermined intervals or based on specific criteria, such as machine age or operating schedules. The second is corrective maintenance, also known as reactive maintenance, which is performed after a failure occurs during operation to repair or restore operational conditions.

According to Widiasanti and Nugraha (2017), there are three primary approaches to maintenance. The first is breakdown maintenance, in which equipment is allowed to operate continuously until it fails, meaning that the equipment becomes unusable owing to damage. The second is preventive maintenance, in which periodic inspections are conducted on existing equipment. The third is predictive maintenance, which involves monitoring the condition of equipment using specific diagnostic tools at regular intervals. If early signs of deterioration or malfunction are detected, corrective actions are taken before failure occurs.

## 3. Research Methodology

### *3.1 Research Design*

This study employed a descriptive method with a quantitative approach to systematically and factually describe the maintenance practices of meat-grinding machines at CV Solo Indah, Palu City. The primary focus is to analyze the implementation of preventive maintenance, such as routine inspections, lubrication, and component replacement, as well as corrective maintenance, which involves repairs conducted after machine failure. This study examined the frequency of maintenance activities and allocation of maintenance costs over a three-month period. Primary data were collected through direct observation of maintenance activities and interviews with management and technician.

Secondary data were obtained from internal documentation, such as maintenance schedules, damage reports, and detailed cost records. Data collection techniques included systematic observation, structured and unstructured interviews, and document reviews. Analysis was conducted using A Fishbone Diagram was used to identify the underlying causes of inefficiencies across six dimensions: human, machine, method, material, environment, and measurement. In addition, a cost-efficiency analysis was conducted using descriptive-percentage methods, along with monthly evaluations of maintenance expenses based on the probability of failure for each major machine component.

### *3.2 Corrective Maintenance*

Maintenance is an activity aimed at ensuring that buildings, facilities, and equipment remain in good condition, operate properly, and meet the established standards (Rahmawati *et al*., 2024). According to Heizer and Render (2016), maintenance refers to all activities carried out to keep equipment systems functioning so that work can be completed as required. Similarly, Febriyan and Cahyono (2023) defined maintenance as a combination of actions performed to preserve and repair machinery to ensure that it operates within acceptable conditions. Rozi *et al* (2024), emphasize that production performance is significantly influenced by three main factors: demand volume, smoothness of raw material supply, and management of working hours. As machines operate more frequently and under higher workloads within a production system, the role of maintenance management becomes increasingly critical (Rachman *et al.*, 2017). Therefore, corrective maintenance is essential because it restores equipment to its optimal condition after failure, ensuring the continuity of production operations. The monthly maintenance cost can be calculated using the following equation:

$$TC = \frac{(F).(RI)}{RO\ .\ P}$$

Where:
TC = Monthly Maintenance Cost
F = Number of Facilities
RI = Repair Cost
RO = Repair Interval (Time Between Failures)
P = Probability of Damage
Source: Handoko (2000)

### *3.3 Fishbone Diagrams*

According to Li *et al*. (2020), various maintenance strategies can be implemented depending on the operational needs of an organization. Generally, maintenance strategies are classified into two main categories. The first is preventive maintenance, which is performed at predetermined intervals or based on specific criteria, such as machine age or operating schedules. The second is corrective maintenance, also known as reactive maintenance, which is performed after a failure occurs during operation to repair or restore equipment to normal operational conditions. Widiasanti and Nugraha (2017) identified three types of maintenance methods. Breakdown maintenance is a method in which equipment is allowed to operate continuously until failure.

In other words, the equipment can no longer be used because it has already been broken down. Preventive maintenance involves periodic inspections of existing equipment. The third method is predictive maintenance, which involves examining the condition of equipment using specific diagnostic tools regularly. When early signs of deterioration are detected, corrective actions are implemented immediately. This approach incorporates the Six-M technique: materials, machines/equipment, manpower, management, methods/processes, and natural/environmental factors (Luca 2015).

These primary causes can be categorized into several groups, namely methods or systems, machines or equipment, manpower or personnel, materials, environmental factors, and measurement systems (Ardianto *et al*., 2020). Therefore, most potential causes can be traced back to identify the root problems, often using the Six-M technique, which consists of material, machines/equipment, manpower, management, methods/processes, and natural/environmental conditions (Luca, 2015). By using a Fishbone Diagram, researchers can comprehensively identify the root causes of maintenance issues in the meat grinding machines at CV Solo Indah. This information can be used to formulate effective improvement recommendations.

### *3.4 Efficiency*

Efficiency was measured using a descriptive percentage approach. The formula is as follows.
Efficiency = (Maintenance Costs Obtained/Target Revenue) × 100% (Angwarmase & Ardhiyanto, 2024)

$$Efficiency = \frac{Actual\ Maintenance\ Costs}{Total\ Maintenance\ Budget} \times 100\%$$

Based on the formula above, the efficiency assessment is considered very efficient when the calculation result is less than 60%, as efficiency is evaluated by comparing the output and input.

Table 1. Efficiency Criteria

| Performance Percentage | Criteria |
|---|---|
| >100% | Not Efficient |
| 90% – 100% | Less Efficient |
| 80% – 90% | Fairly Efficient |
| 60% – 80% | Efficient |
| <60% | Very Efficient |

Source: Mahmudi (2016)

## 4. Results and Discussion

### *4.1 Results*

#### *4.1.1 Fishbone Analysis*

V Solo Indah faces several challenges in maintaining the effectiveness of its meat-grinding machines, which directly impacts product quality, operational efficiency, and financial losses. These issues stem from several interconnected factors. To systematically identify the root causes, the fishbone diagram approach was employed as an effective and comprehensive tool.

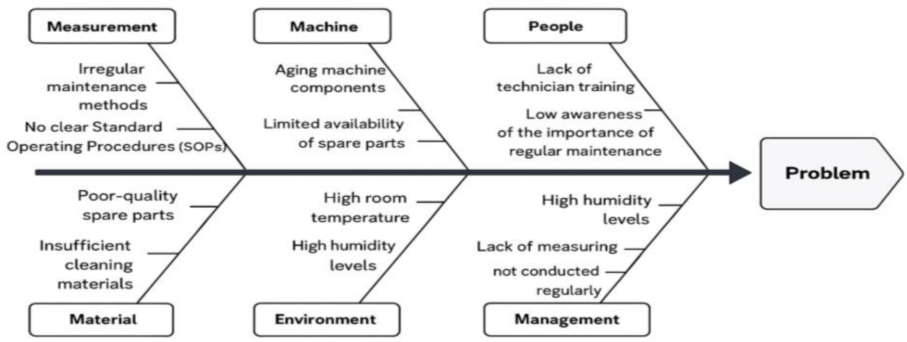


Figure 1. Fishbone Diagram
Source: Processed Data, 2025

Based on fishbone diagram analysis, the maintenance problems affecting the meat-grinding machines at CV Solo Indah originate from six main categories: people, machines, methods, materials, environment, and measurement. The human factor includes limited technician training and low awareness of the importance of routine maintenance. In the machine category, the old age of the equipment and limited availability of spare parts frequently trigger recurring technical failures. From a methodological perspective, the absence of standardized SOPs and inconsistent implementation of procedures further reduce the effectiveness of maintenance activities.

The material aspect also poses challenges, particularly because of the poor quality of spare parts and insufficient availability of supporting materials. The work environment, characterized by high temperatures and uncontrolled humidity, accelerates the wear and damage of components. Meanwhile, the measurement factor indicates poor availability of measurement tools and low inspection frequency, resulting in early signs of machine failure going undetected. These findings serve as a basis for formulating more efficient and sustainable maintenance-improvement strategies. Table 2 presents comprehensive data on the types of machine components that frequently experience damage, descriptions of the problematic components, frequency of failures throughout 2024, and estimated repair or replacement costs for each component.

Table 2. Machine Damage Data for 2024

| No. | Machine Component Type | Frequently Damaged Parts | Failure Frequency (Times/Selected Period) | Estimated Repair/Replacement Cost (Rp) | Total |
|---|---|---|---|---|---|
| 1 | Motor Drive | Motor bearings and burnt motor coils | 1 | 1,050,000 | 1,050,000 |
| 2 | Gearbox | Worn/broken gear teeth and leaking seals | 1 | 2,434,000 | 2,434,000 |
| 3 | Screw Shaft (Auger) | Wear due to continuous friction; bent/broken due to hard objects | 1 | 195,000 | 195,000 |
| 4 | Cutting Blade | Blunt and chipped/broken edges | 1 | 180,000 | 180,000 |
| 5 | Grinding Plate (Die Plate) | Clogged/damaged holes; bent/broken plate | 1 | 145,000 | 145,000 |
| 6 | Feeder Section | Damage caused by impact | 1 | 520,000 | 520,000 |
| 7 | Machine Frame | Corrosion/cracks | 1 | 1,710,000 | 1,710,000 |
| 8 | Other Electrical Components | Broken/loose cables, damaged contactor/relay, and faulty switch | 1 | 100,000 | 100,000 |
| **TOTAL** | | | | | **6,334,000** |

Source: Processed Data, 2025

Based on Table 2, throughout 2024, all major components of the meat grinding machine at CV Solo Indah experienced damage once, with varying types of failure. The gearbox recorded the highest repair cost of Rp2,434,000, indicating severe damage and highlighting the need to prioritize preventive maintenance for this component. The total annual corrective maintenance cost reached Rp6,334,000, a significant amount that could disrupt operations if not supported by consistent preventive maintenance practices. The machine frame and feeder section also contributed substantially to the total cost, suggesting the need for preventive measures, such as anti-corrosion coating and impact protection. Although electrical components incur relatively low repair costs, their role remains critical, as failures in this area have the potential to cause system-wide breakdowns. These findings underscore the importance of a comprehensive maintenance strategy, emphasizing the prevention of recurring failures and the protection of vital components

*4.1.2 Maintenance System Analysis*

The following data present the breakdown frequency of the meat grinding machine components at CV Solo Indah in 2024, measured based on the probability of failure:

Table 3. Machine Breakdown Period in 2024

| No. | Machine Component | Probability (%) | Cumulative Probability (%) | Number of Months in a Year | Total |
|---|---|---|---|---|---|
| 1 | Motor Drive | 16.58 | 16.58 | 12 | 1 |
| 2 | Gearbox | 38.43 | 33.15 | 12 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| 3 | Screw Shaft (Auger) | 3.08 | 71.58 | 12 | 1 |
| 4 | Cutting Blade | 2.84 | 74.66 | 12 | 1 |
| 5 | Grinding Plate (Die Plate) | 2.29 | 77.50 | 12 | 1 |
| 6 | Feeder Section | 8.21 | 79.79 | 12 | 1 |
| 7 | Machine Frame | 27.00 | 88.00 | 12 | 1 |
| 8 | Other Electrical Components | 1.58 | 115.00 | 12 | 1 |

Source: Processed Data, 2025

Table 3 illustrates the variation in the damage probability levels for each component of the meat grinder at CV Solo Indah. The gearbox recorded the highest risk at 38.43%, followed by the machine frame (27.00%) and drive motor (16.58%), indicating that these three components are the most vulnerable and have the greatest impact on operational performance. In contrast, electrical components had the lowest risk level at 1.58%. These differences reflect the actual wear conditions and can be used as a basis for establishing maintenance priority scales in the future. The use of cumulative probability data enables a company to design more structured risk-mitigation strategies, particularly for components with high damage consequences. Thus, even though all components experience one failure during the year, the varying probability values serve as an essential foundation for making more efficient and preventive maintenance decisions.

The calculation of the corrective maintenance costs per month for the meat grinder at CV Solo Indah showed significant variation in the expenses required for each machine component. The calculation method uses the formula TC = (F × RI) / (RO × P), where TC is the total maintenance cost, F is the number of facilities (1 machine unit), RI is the repair cost per failure, RO is the interval between failures ( assumed to be once per year), and P is the failure probability. The following section presents an interpretation of the Total Corrective Maintenance Cost per month.

1. Total Corrective Maintenance Cost per Month for the Meat Grinder Components (Drive Motor)
   $TC = \frac{(F).(RI)}{RO\ .\ P} = \frac{1\ X\ Rp.1.050.000}{1x12}$ = Rp.87.500/month
2. Total Corrective Maintenance Cost per Month for the Meat Grinder Components (gearbox)
   $TC = \frac{(F).(RI)}{RO\ .\ P} = \frac{1\ X\ Rp.2.434.000}{1x12}$ = Rp202.833/month
3. Total Corrective Maintenance Cost per Month for Meat Grinder Components (Auger Shaft):
   $TC = \frac{(F).(RI)}{RO\ .\ P} = \frac{1\ X\ Rp.195.000}{1x12}$ = Rp16.250/month
4. Total Corrective Maintenance Cost per Month for the Meat Grinder Components (Chopping Blade)
   $TC = \frac{(F).(RI)}{RO\ .\ P} = \frac{1\ X\ Rp.180,000}{1x12}$ = Rp15.000/month
5. Total Corrective Maintenance Cost per Month for the Meat Grinder Components (Filter Plate (mold)):
   $TC = \frac{(F).(RI)}{RO\ .\ P} = \frac{1\ X\ Rp.145,000}{1x12}$ = Rp12.083/month
6. Total Corrective Maintenance Cost per Month for Meat Grinder Components (Feeder Section)
   $TC = \frac{(F).(RI)}{RO\ .\ P} = \frac{1\ X\ Rp.520.000}{1x12}$ = Rp43.333/month
7. Total Corrective Maintenance Cost per Month for Meat Grinder Components (Machine Frame):
   $TC = \frac{(F).(RI)}{RO\ .\ P} = \frac{1\ X\ Rp.1.710.000}{1x12}$ = Rp142.500/month
8. Total Corrective Maintenance Cost per Month for Meat Grinder Components (Other Electrical Components):
   $TC = \frac{(F).(RI)}{RO\ .\ P} = \frac{1\ X\ Rp.100.000}{1x12}$ = Rp8.333/month

The calculation results showed that the gearbox generated the highest monthly corrective maintenance cost at Rp202,833, making it the most financially critical component. The drive motor and machine frame also incur substantial costs of Rp87,500 and Rp142,500 per month, respectively, indicating their vital roles in ensuring smooth operational performance. Meanwhile, other components, such as the filter plate, chopping blade, and electrical system, incur relatively low maintenance costs; however, they still require periodic monitoring to prevent potential systemic disruptions. With the total annual corrective maintenance cost reaching Rp6,334,000, the monthly average cost of Rp527,833 highlights the need for a strategic shift toward a more structured preventive maintenance approach. This strategy aims to reduce unexpected expenditures and ensure optimal continuity of production processes.

Table 4. Company Maintenance Budget and Comparison of Annual Corrective and Preventive Maintenance Costs for the Meat Grinder Machine

| **Machine Component** | **Corrective Maintenance Cost/Year (Rp)** | **Estimated Preventive Maintenance Cost/Year (Rp)** | **Total Maintenance Cost/Year (Rp)** | **Failure Probability (%)** | **Cost Probability (%)** |
|---|---|---|---|---|---|
| Motor Drive | 1,050,000 | 1,320,000 | 2,370,000 | 16.58 | 11.53 |
| Gearbox | 2,434,000 | 2,811,500 | 5,245,500 | 38.43 | 59.16 |
| Screw Shaft (Auger) | 195,000 | 533,000 | 728,000 | 3.08 | 0.66 |
| Cutting Blade | 180,000 | 240,000 | 420,000 | 2.84 | 0.35 |
| Grinding Plate (Die Plate) | 145,000 | 215,000 | 360,000 | 2.29 | 0.24 |
| Feeder Section | 520,000 | 550,000 | 1,070,000 | 8.21 | 2.58 |
| Machine Frame | 1,710,000 | 1,490,000 | 3,200,000 | 27.00 | 25.35 |
| Other Electrical Components | 100,000 | 181,000 | 281,000 | 1.58 | 0.13 |
| **TOTAL** | **6,334,000** | **7,340,500** | **13,674,500** | **100** | **100** |

Source: Processed Data, 2025

Table 4 shows that CV Solo Indah allocates its maintenance budget proportionally with a preventive orientation, accounting for 53.7% of the total Rp13,674,500. This reflects a proactive approach to maintaining the performance of machines. The gearbox incurs the highest total maintenance cost (Rp5,245,500), highlighting its urgency as a top maintenance priority. The machine frame and drive motor also incur substantial costs, reinforcing the need for focused attention on these core components. Meanwhile, components such as the filter plate, chopping blade, and electrical system have lower cost burdens; however, they still require periodic monitoring to prevent cumulative impacts. The uneven distribution of cost and failure probability underscores the need for a priority-based maintenance strategy rather than a uniform approach. By understanding the characteristics of each component, companies can optimize their maintenance resources more efficiently and sustainably.

*4.1.3 Machine Maintenance Efficiency*

Based on the calculation of the total maintenance cost for the meat grinder at CV Solo Indah, the total annual budget amounts to Rp13,674,500, consisting of Rp7,340,500 and Rp6, 334, 000 in preventive and corrective maintenance costs, respectively. The following efficiency formula is used to measure maintenance efficiency:

$$Preventive\ Efficiency = \frac{7.340.500}{13.674.500} \times 100\% = 53{,}68$$

The preventive maintenance efficiency of 53.68% falls under the “very efficient” category, according to Mahmudi (2016). This achievement reflects the dominance of preventive budgeting as a proactive strategy for reducing the risk of equipment failure. It serves as a positive indicator of the company’s commitment to continuous production and operational risk control. To maintain and enhance this performance, it is recommended that the company strengthen the periodic inspection systems and implement structured scheduling for component replacement. Furthermore, a risk-based and failure frequency analysis approach should be integrated to ensure more precise cost allocation and support long-term maintenance and sustainability.

$$Corrective\ Efficiency = \frac{6.334.000}{13.674.500} \times 100\% = 46,32$$

The corrective maintenance efficiency of 46.32% is also categorized as "very efficient" by Mahmudi (2016). However, the substantial proportion of the budget used for repairs indicates that equipment damage is still a challenge. This suggests that corrective actions continue to dominate preventive efforts. Therefore, strengthening preventive maintenance should be prioritized to reduce the dependency on corrective measures. Improving this strategy has the potential to minimize unplanned expenses, increase equipment reliability, and maintain the overall operational stability.

### *4.2 Discussion*

#### *4.2.1 Fishbone Diagram Analysis*

The Fishbone Diagram was used as a systematic analytical tool to identify the root causes of maintenance issues in the meat-grinding machine at CV Solo Indah. Based on observations and internal data, several interrelated factors were identified as contributors to the ineffectiveness of the current maintenance system. The diagram groups these factors into six main categories: manpower, machines, methods, materials, environment, and measurement. Problems related to manpower include insufficient technician training and low awareness of the importance of routine maintenance. From a machine perspective, the long operational age and limited availability of spare parts increase the risk of frequent failures.

The method category highlights the absence of standard procedures and inconsistencies in the execution of maintenance. Meanwhile, poor material quality and a lack of supporting resources accelerate component wear. The working environment, characterized by high temperatures and humidity, further deteriorates machine conditions. In terms of measurements, limited tools and inadequate inspection frequencies hinder the early detection of potential failures. These findings provide a strong foundation for CV Solo Indah to design a more comprehensive and targeted maintenance strategy, ranging from improving technician skills and developing SOPs to optimizing environmental conditions and implementing regular evaluations, supported by proper measuring instruments.

#### *4.2.2 Comparison of Corrective and Preventive Maintenance Costs*

The comparison between corrective and preventive costs serves as a key indicator of maintenance policy effectiveness. At CV Solo Indah, the 2024 budget allocation shows a dominance of preventive maintenance, accounting for 53.68% of the total Rp13,674,500. This proportion reflects a strategic shift toward more structured and well-planned preventive action. This approach is more adaptive than the findings of Siregar *et al.* (2022), who reported corrective dominance due to the absence of preventive schedules. Prioritizing critical components, such as the gearbox and machine frame, illustrates a data- and risk-based maintenance strategy. This indicates that the company is not merely responding to failures but proactively manages potential disruptions before they occur. Practices such as periodic inspections, failure-history recording, and performance-based evaluations position CV Solo Indah on the path toward implementing Reliability-Centered Maintenance (RCM). To ensure the continuity of this strategy, expanding inspection coverage and improving preventive execution standards are essential to maintain cost efficiency and operational stability in the long term..

#### *4.2.3 Maintenance Cost Efficiency of the Meat-Grinding Machine*

Maintenance cost efficiency serves as an important benchmark in asset management, especially for the meat-grinding machine that plays a central role in CV Solo Indah's production process. The preventive budget proportion of 53.68% from the total Rp13,674,500 demonstrates the company's orientation toward preventive actions, aligned with effective risk management principles. According to the standard of Mahmudi (2016), this achievement is categorized as "very efficient," as it remains below the 60% threshold. Nevertheless, attention to components with high corrective cost contributions, such as the gearbox, machine frame, and feeder, must remain a priority in future maintenance strategies. Comparisons with the study of Kalua and Syamsuddin (2022) reinforce the superiority of CV Solo Indah's approach, which has applied the principles of Reliability-Centered Maintenance (RCM).

Beyond financial aspects, efficiency is also reflected in improved technician effectiveness, more structured maintenance scheduling, and enhanced operational stability of the wind farm. Maintenance system optimization can be strengthened using technologies such as condition monitoring and digitized maintenance history documentation. Combined with enhanced human resource technical capacity, these efforts will bolster operational resilience, increase company competitiveness, and enable more adaptive responses to market dynamics.

## 5. Conclusion

This study concludes that CV Solo Indah has implemented a systematic maintenance strategy for its meat-grinding machines through both preventive and corrective approaches. The total maintenance cost in 2024 amounted to Rp13,674,500, dominated by preventive maintenance (53.68%), indicating the company's proactive approach. However, components such as the gearbox, machine frame, and feeder section remain the highest contributors to corrective costs and should be prioritized in future plans. The Fishbone Diagram analysis identified six main factors contributing to inefficiency: manpower, machine, method, material, environment, and measurement. The practical implications of these findings include the need to improve technician training, develop standardized SOPs, conduct routine inspections, and digitize maintenance data to enhance efficiency, reduce unexpected costs, and maintain operational stability.

Recommended improvement steps include enhancing technician training, developing structured maintenance SOPs, scheduling regular inspections, and digitizing maintenance records to ensure sustainable efficiency and minimize potential operational disruptions.

## Limitations and Future Research

This study is limited to a single research object, CV Solo Indah in Palu City; thus, the findings cannot be fully generalized to the broader meat-grinding industry. Furthermore, the three-month data collection period may not adequately capture long-term failure patterns. The research focus, which emphasizes cost and failure frequency, does not explore the technical aspects or user experience of the machine. Future research should involve multiple companies, extend the observation period, and combine quantitative and qualitative approaches. The integration of technologies such as the Internet of Things and sensor-based monitoring systems is also suggested to develop more effective and adaptive predictive maintenance strategies.

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