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Analysis of Maintenance for The Model 317 Tray Unloader Using The Preventive Maintenance Method at PT. Madukoro Engineering

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Abstract

This study analyzes the implementation of preventive maintenance on the Model 317 Tray Unloader at PT. Madukoro Engineering, Semarang. The machine performs an essential material transfer function by moving cigarettes from trays toward the packaging process, making equipment reliability important for production continuity. A qualitative descriptive method was applied through direct observation, interviews with the Head of the Primary Division and electrical technicians, and examination of internal maintenance documents. The analysis focused on maintenance schedules, machine components, recurring failures, maintenance practices, and operational problems. The results indicate that preventive maintenance is implemented through daily, weekly, monthly, and annual activities involving inspection, cleaning, lubrication, electrical checking, and component replacement. Several problems were identified, including sensor malfunction caused by cigarette dust, gripper obstruction due to inadequate lubrication, excessive conveyor motor temperature, and tray frame deformation caused by improper loading. Maintenance effectiveness is also constrained by inconsistent documentation, delayed spare-part availability, and limited technical resources. Improvements are recommended through digital maintenance records, routine technical training, critical spare-part control, sensor monitoring, and stronger operational supervision to reduce unexpected downtime and improve machine reliability.

Keywords : *Preventive Maintenance, Tray Unloader, Machine Maintenance, Manufacturing, Downtime Reduction.*

INTRODUCTION

Lestari et al. (2020) explain that maintenance is an important activity within manufacturing production systems because machine conditions directly affect production continuity. Production equipment experiencing performance degradation may cause operational disturbances, increased idle time, and additional repair costs. In industries with high dependence on automated equipment, machine stability becomes an important factor in achieving production targets. Maintenance activities need to be positioned as planned, measurable, and continuity-oriented operational activities.

Suharto (2022) states that modern production processes require resource management capable of maintaining efficiency, quality, and operational continuity. Machines operating at high frequencies are exposed to potential wear, accuracy deterioration, and failures involving mechanical and electrical components. Such conditions can affect production flow when a machine serves as an interconnection between production stages. An appropriate maintenance system is required to maintain machine readiness while controlling potential downtime during production activities.

Situmorang and Wibowo (2021) demonstrate that preventive maintenance can be applied as a strategy for reducing machine downtime in manufacturing environments. Preventive maintenance is implemented through inspections and maintenance actions determined according to specific time intervals or machine operating conditions. This approach allows potential failures to be identified before they develop into breakdowns that interrupt production. Maintenance scheduling is an important component because the effectiveness of maintenance is influenced by the accuracy of inspection timing and technical actions.

Yusuf and Handayani (2020) emphasize that maintenance strategies in automated industries need to consider the interrelationship between mechanical components, electrical systems, sensors, and control systems. A failure in one component may cause the system to operate outside its programmed sequence. In automated machinery, sensors perform important functions in detecting position, material presence, and operating conditions at each stage of the process. Regular maintenance of control systems and supporting components is required to preserve machine reliability.

Widiyanto (2019) explains that the cigarette manufacturing industry has production characteristics that require consistent process stability and quality control. Material transfer systems within cigarette production lines constitute an important component supporting continuity before the packaging stage. The Model 317 Tray Unloader is used to automatically transfer cigarettes from trays toward the packaging process. This function makes the machine an important piece of equipment requiring systematic maintenance attention.

Hadi et al. (2021) demonstrate that maintenance planning for material-handling equipment needs to consider component conditions, operating patterns, and potential failures that may interrupt operations. These characteristics are also relevant to the Model 317 Tray Unloader, which consists of mechanical and control systems for automatically transferring trays. Components such as conveyors, grippers, sensors, motors, bearings, and electrical systems require inspection at intervals appropriate to their operating intensity. Identification of failure-prone components can assist technicians in determining inspection priorities and maintenance actions.

Mohammed et al. (2020) developed a reliability-based preventive maintenance approach for unloading systems and demonstrated the importance of maintenance strategies in maintaining equipment availability. Unloading systems have operational characteristics that require coordination among components to ensure safe and continuous material transfer. This principle can be applied to the evaluation of the Model 317 Tray Unloader, particularly for components exposed to frequent movement and high operating loads. Preventive maintenance analysis needs to consider failure causes, inspection intervals, spare-part requirements, and technician responses to early indications of malfunction.

Prasadesta and Bastaman (2026) explain that maintenance activities for operational equipment require clear distribution of responsibilities between technical personnel and those supervising operational activities. A similar condition is found in the maintenance of the Model 317 Tray Unloader at PT. Madukoro Engineering, where operators conduct basic inspections while technicians perform more complex inspections and repairs. Field observations identified several maintenance issues, including inconsistent documentation, delayed spare-part availability, dust accumulation on sensors, and inadequate lubrication of mechanical components. This study aims to analyze the implementation of preventive maintenance on the Model 317 Tray Unloader and identify maintenance problems that may affect machine reliability and production continuity.

RESEARCH METHODS

The study employed a qualitative descriptive approach to analyze the implementation of preventive maintenance on the Model 317 Tray Unloader at PT. Madukoro Engineering, Semarang. Primary data were obtained through direct observation of machine operation and maintenance activities, as well as interviews with the Head of the Primary Division and electrical technicians responsible for machine maintenance. Secondary data were collected from internal maintenance documents, including daily and monthly checksheets, maintenance schedules, standard operating procedures, and machine failure records. The observation focused on the operating condition of major components, including the tray infeed, transfer unit, tray carriage, tray tipper, tray lowerator, conveyor, gripper, sensors, motors, bearings, and electrical control panels.

Data analysis was conducted descriptively by comparing the observed maintenance practices with the preventive maintenance schedule implemented by the company. The analysis covered daily, weekly, monthly, and annual maintenance activities, including cleaning, lubrication, inspection, component tightening, sensor checking, electrical inspection, and replacement of damaged components. Machine failure data were classified according to the affected component and the identified cause, such as dust accumulation on sensors, insufficient lubrication of the gripper, excessive motor temperature, and mechanical deformation caused by improper tray loading. The analysis was used to identify weaknesses in the existing maintenance system and formulate improvement measures related to maintenance documentation, spare-part availability, technician competence, inspection consistency, and operational supervision.

RESULTS AND DISCUSSION

Implementation of Preventive Maintenance on the Model 317 Tray Unloader

The maintenance system applied to the Model 317 Tray Unloader at PT. Madukoro Engineering consists of daily, weekly, monthly, and annual activities. Daily maintenance is conducted by operators before production to inspect machine conditions, clean accumulated cigarette dust, and verify the basic operating functions of the equipment. Weekly inspections are performed by technicians with greater attention to the gripper, sensors, electrical panels, and mechanical movement, while monthly maintenance includes lubrication, bolt tightening, and control-system inspection. Hadi et al. (2021) indicate that maintenance planning for continuous unloading equipment requires systematic inspection and repair activities to maintain operational readiness.

Table 1. Preventive Maintenance Schedule of Model 317 Tray Unloader

Maintenance Period	Responsible Personnel	Main Maintenance Activities	Primary Objective
Daily	Operator	Visual inspection, cleaning, electrical checking	Detect early abnormalities
Weekly	Technician	Sensor, gripper, panel, and mechanical inspection	Prevent component failure
Monthly	Technician	Lubrication, bolt tightening, control inspection	Maintain component reliability
Annual	Technician/Workshop	Major inspection and component renewal	Restore machine condition

The maintenance schedule indicates that preventive actions are distributed according to the operational frequency and technical complexity of the machine components. Components exposed to continuous movement, friction, dust, and electrical loading require more frequent inspection than components with lower operational exposure. The division of responsibilities between operators and technicians also creates a basic control structure for maintenance execution and reporting. Hadi et al. (2021) emphasize that maintenance planning should consider equipment operating characteristics and the potential consequences of component failure.

Table 2. Preventive Maintenance Activities by Machine Component

Machine Component	Inspection Activity	Maintenance Action	Maintenance Frequency
Sensor/Photocell	Check response and cleanliness	Cleaning and functional inspection	Daily/Weekly
Gripper	Check movement and lubrication	Lubrication and adjustment	Weekly/Monthly
Conveyor	Check movement and load condition	Inspection and adjustment	Daily/Weekly
Motor	Check temperature and vibration	Inspection and lubrication	Monthly
Gearbox	Check mechanical condition	Oil inspection and replacement	Quarterly/Annual
Electrical Panel	Check cables, MCB, and contactor	Cleaning and component replacement	Weekly/Monthly

The component-level maintenance pattern shows that the company has implemented a preventive approach rather than relying exclusively on corrective repair. The sensor and photocell receive frequent attention because cigarette dust can interfere with detection accuracy, while the gripper requires lubrication to maintain smooth mechanical movement. Motor and gearbox maintenance is performed at longer intervals because the inspection is associated with mechanical condition, temperature, lubrication, and operating stability. Situmorang and Wibowo (2021) state that preventive maintenance can reduce the probability of unexpected machine failure when inspection intervals are established according to equipment requirements.

The implementation observed during the six-month practical work period also shows that maintenance effectiveness depends on operator discipline and technician availability. Daily checks are intended to identify abnormal conditions before production, but incomplete checksheet entries reduce the reliability of maintenance records. Delays in obtaining lubricants and spare parts can also shift scheduled maintenance toward corrective action after a component has already deteriorated. Raissi et al. (2019) associate preventive maintenance scheduling with production requirements and resource constraints, indicating that maintenance planning needs to account for both technical requirements and resource availability.

Analysis of Machine Failures and Maintenance Problems

The observation of the Model 317 Tray Unloader identified several recurring failures involving the sensor, gripper, conveyor motor, and tray support frame. Sensor malfunction was mainly associated with cigarette dust accumulation, while gripper obstruction was related to insufficient lubrication and mechanical wear. Excessive motor temperature was observed during prolonged operation under high workload, whereas deformation of the tray support frame was associated with improper manual loading. Yusuf and Handayani (2020) emphasize that automated equipment requires integrated attention to mechanical, electrical, and control components because failure in one subsystem can disrupt the overall operating sequence.

Table 3. Identification of Failures on Model 317 Tray Unloader

Affected Component	Observed Failure	Main Cause	Operational Impact
Sensor/Photocell	Sensor does not respond	Cigarette dust accumulation	Tray detection interruption
Gripper	Gripper movement becomes stuck	Insufficient lubrication	Transfer process disturbance
Conveyor Motor	Excessive temperature	High operating load	Risk of motor failure
Tray Support Frame	Frame deformation	Improper manual loading	Tray movement obstruction

The failure distribution demonstrates that machine disturbances are generated by a combination of environmental, mechanical, operational, and workload-related factors. Dust contamination represents an environmental factor, while inadequate lubrication represents a maintenance-related factor that directly affects moving components. Motor overheating reflects the interaction between operating intensity and equipment condition, while frame deformation indicates the influence of operator handling practices. Lestari et al. (2020) identify machine condition and maintenance quality as important factors in maintaining production continuity within manufacturing operations.

Table 4. Failure Factors and Required Maintenance Responses

Failure Factor	Risk Level	Required Response	Preventive Action
Dust accumulation	High	Clean sensor immediately	Scheduled sensor cleaning
Insufficient lubrication	High	Lubricate and inspect gripper	Routine lubrication schedule
Excessive motor temperature	High	Stop and inspect motor	Temperature monitoring
Improper tray loading	Medium	Realign or repair frame	Operator training

Cable or panel deterioration	High	Inspect electrical system	Periodic electrical inspection

The required maintenance responses indicate that several observed failures can be controlled through earlier detection rather than waiting for complete component breakdown. Sensor cleaning should be integrated into routine daily activities because the operating environment contains cigarette dust that can accumulate around detection surfaces. Lubrication control and motor condition monitoring also require clear intervals so that maintenance personnel can identify deterioration before the machine reaches a critical condition. Santos et al. (2015) associate production improvement with systematic elimination of operational losses, making early maintenance intervention relevant to production stability.

The analysis further indicates that maintenance problems are not limited to technical failures but also involve documentation and resource management. Inconsistent completion of daily checksheets reduces the availability of historical information regarding machine condition, while delayed spare-part procurement may extend repair duration when a component fails. Limited technical personnel can also restrict the frequency of specialized activities such as sensor calibration and detailed electrical inspection. Hadi et al. (2021) highlight the importance of structured maintenance planning for equipment with continuous operating functions, particularly when equipment availability is closely related to production performance.

Evaluation and Improvement of Preventive Maintenance Performance

The evaluation indicates that the preventive maintenance system of the Model 317 Tray Unloader has provided a basic framework for controlling machine deterioration, but several operational weaknesses remain. The existing schedule covers routine inspection, cleaning, lubrication, electrical checking, and component replacement, while implementation is still dependent on operator discipline and technician availability. Maintenance activities that are not recorded consistently make it difficult to establish a reliable history of component conditions and recurring failures. Tshuma discusses maintenance practices for bulk material handling equipment as activities that require structured inspection, equipment monitoring, and systematic maintenance management to preserve operational performance.

Table 5. Evaluation of Existing Preventive Maintenance Practices

Evaluation Aspect	Existing Condition	Identified Problem	Improvement Required
Maintenance schedule	Daily, weekly, monthly, and annual activities	Some activities are not consistently documented	Schedule monitoring
Daily inspection	Conducted by operators	Checksheet completion is inconsistent	Operator supervision
Lubrication	Conducted periodically	Lubricant availability may be delayed	Spare lubricant control
Sensor maintenance	Cleaning is performed	Calibration is not conducted frequently	Periodic calibration
Electrical maintenance	Panel and cables are inspected	Component deterioration may remain undetected	Detailed electrical inspection
Spare parts	Available according to requirements	Procurement may take excessive time	Minimum stock level

The evaluation table shows that the principal weakness is not the absence of a maintenance system but the limited consistency of its implementation. Preventive maintenance requires synchronization between schedules, human resources, spare parts, inspection records, and machine operating conditions. Raissi et al. (2019) demonstrate that preventive maintenance scheduling can be affected by production requirements and resource constraints, which is relevant to the need for controlled maintenance intervals at PT. Madukoro Engineering. A maintenance schedule that is technically appropriate but poorly documented may reduce the effectiveness of subsequent maintenance decisions.

Table 6. Proposed Preventive Maintenance Improvement Program

Improvement Program	Implementation Method	Responsible Personnel	Expected Result
Digital maintenance record	Record inspection results electronically	Operator/Technician	Accurate maintenance history
Sensor cleaning control	Add sensor cleaning to daily checklist	Operator	Reduced detection failure
Lubrication monitoring	Establish lubricant inventory and schedule	Technician/Purchasing	Reduced gripper failure
Motor condition monitoring	Record temperature during operation	Technician	Early detection of overheating
Operator training	Training on tray loading and machine operation	Production Supervisor	Reduced mechanical damage
Spare-part control	Set minimum stock for critical components	Purchasing/Technician	Faster repair response
Technical inspection	Periodic detailed inspection	Technician	Improved equipment reliability

The proposed program focuses on preventive actions that directly correspond to the failures identified during field observation. Digital maintenance records can improve traceability, while minimum stock levels for critical components can reduce waiting time during corrective intervention. Sensor cleaning, motor temperature monitoring, and lubrication control can also provide early indications of deterioration before a major breakdown occurs. Hadi et al. (2021) support structured maintenance planning for unloading equipment because systematic inspection and repair are closely related to equipment availability.

The operational improvement program also requires stronger control of the physical and technical environment surrounding the machine. Cleaning procedures should be maintained because contamination can interfere with sensor performance, while mechanical components require adequate lubrication and inspection to limit friction-related deterioration. Satmoko et al. (2013) demonstrate that mechanical loading and unloading systems require careful consideration of component movement, mechanical configuration, and operational reliability, while Bahri emphasizes the importance of appropriate equipment operation and maintenance practices in mechanical systems. A combination of scheduled inspection, operator training, spare-part readiness, and accurate maintenance documentation provides a practical basis for improving the reliability of the Model 317 Tray Unloader.

CONCLUSION

The analysis of the Model 317 Tray Unloader at PT. Madukoro Engineering shows that preventive maintenance has been implemented through daily, weekly, monthly, and annual maintenance activities. The maintenance system covers inspection, cleaning, lubrication, electrical checking, component adjustment, and replacement of damaged components. Several recurring problems were identified, including sensor failure caused by cigarette dust, gripper obstruction due to insufficient lubrication, excessive conveyor motor temperature, and deformation of the tray support frame caused by improper loading. These conditions indicate that the existing maintenance system provides a basic preventive framework, but its effectiveness remains affected by inconsistent documentation, limited spare-part availability, and variations in operator and technician performance.

Improvement of the maintenance system should focus on strengthening maintenance documentation, technical competence, spare-part management, and operational supervision. Digital maintenance records can provide more accurate information regarding inspection history, component conditions, and recurring failures, while routine training can improve operator compliance and technician capability. Preventive monitoring of sensors, grippers, motors, and electrical components should also be integrated with clearly defined maintenance intervals and response procedures. These measures can support higher machine reliability, reduce the probability of unexpected downtime, and maintain the continuity of the cigarette packaging process.

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