

REDUCING SIX BIG LOSSES THROUGH TECHNICAL AND DIGITAL INTEGRATION TO IMPROVE OVERALL EQUIPMENT EFFECTIVENESS (OEE) ON A CARTONER MACHINE IN A PHARMACEUTICAL COMPANY

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Abstrak

Penelitian ini bertujuan untuk meningkatkan Overall Equipment Effectiveness (OEE) pada mesin Cartoner di fasilitas manufaktur farmasi yang berlokasi di Cikarang, Indonesia. Masalah utama yang diidentifikasi adalah rendahnya nilai availability, yang terutama disebabkan oleh seringnya leaflet jammed dan keterlambatan dalam penggantian spare part. Analisis akar masalah menggunakan Diagram Fishbone dan Diagram Pareto menunjukkan bahwa leaflet jammed menyumbang 67% dari total unplanned downtime. Penelitian ini menerapkan kerangka kerja Six Big Losses dengan fokus pada pengurangan downtime. Dua perbaikan diterapkan. Secara teknis, sistem hisap (suction) didesain ulang untuk meningkatkan penanganan leaflet, serta dibuat formulir keluhan untuk pemasok. Secara digital, dikembangkan sistem manajemen inventaris sparepart menggunakan Microsoft Power Apps yang memungkinkan pemantauan stok secara real-time, notifikasi otomatis, dan permintaan spare part yang lebih cepat. Setelah implementasi, nilai OEE meningkat dari 75,36% menjadi 81,90%, dan availability meningkat dari 76,94% menjadi 83,62%. Penelitian ini menunjukkan bahwa penggabungan antara perbaikan teknis dan alat digital dapat secara signifikan mengurangi unplanned downtime dan meningkatkan efisiensi produksi..

Kata kunci: OEE; Six Big Losses; Availability; Diagram Fishbone; Power Apps; Pengendalian Inventaris.

Abstract

Improving Overall Equipment Effectiveness (OEE) On Cartoner Machine Using Six Big Losses In Pharmaceutical Company. This research aims to improve the Overall Equipment Effectiveness (OEE) of the Cartoner machine at a pharmaceutical manufacturing facility in Cikarang, Indonesia. The main problem identified was low availability, primarily caused by frequent leaflet jams and delays in spare part replacement. Root cause analysis using Fishbone Diagrams and Pareto Charts revealed that leaflet jams contributed 67% of unplanned downtime. The study applied the Six Big Losses framework, focusing on downtime reduction. Two improvements were implemented. Technically, the suction system was redesigned to enhance leaflet handling and make a form for complaint to the supplier. Digitally, a Spare Parts Inventory Management System was developed using Microsoft Power Apps, enabling real-time stock monitoring, automated alerts, and faster spare part requests. After implementation, OEE improved from 75.36% to 81.90%, and availability increased from 76.94% to 83.62%. This research demonstrates that combining technical upgrades with digital tools can significantly reduce unplanned downtime and enhance production efficiency.

Keywords: OEE; Six Big Losses; Availability; Fishbone Diagram; Power Apps; Inventory Control.

1. Introduction

Overall Equipment Effectiveness (OEE) is a key performance indicator commonly used in the manufacturing industry to measure the efficiency of

production equipment. OEE consists of three main components: availability, which indicates how often the machine is running when it should be; performance, which reflects how efficiently the machine operates compared to its designed speed; and quality, which measures the proportion of good products produced without defects (Hansen, 2001). Among these, availability plays a crucial role, as frequent machine

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stoppages can lead to lost production time, missed delivery schedules, and increased operational costs, especially in industries such as pharmaceuticals, where reliability and compliance are paramount.

One real example of this issue was found at Pharmacy Company, a multinational pharmaceutical company with a packaging facility in Cikarang, Indonesia. This site handles the repackaging of medicines before exporting to countries such as Taiwan and Malaysia. The production facility investigated in this research operates a single packaging line that consists of three mandatory machines: the Blister machine, the Cartoner machine, and the TEL machine. Based on the six-month downtime Pareto analysis, the Cartoner machine contributed the largest portion of total downtime, making it the most critical focus for improvement. Since these machines are arranged in one continuous and interdependent line, when a single machine, particularly the Cartoner experiences a breakdown or stoppage, the entire line must also stop.

As a result, the OEE measurement in this research reflects the performance of this single integrated line, rather than the performance of the entire plant. This explains why the OEE value in this study (75.36% to 81.90%) appears higher compared to typical pharmaceutical industry averages reported by (McKinsey, 2023), which range between 35% and 45%. Those lower benchmarks represent overall plant performance that includes multiple production lines and frequent cleaning, validation, and documentation activities in compliance with Good Manufacturing Practices (GMP) (Sultana et al., 2015). In contrast, this study focuses on a machine-level OEE analysis of one line to provide a more precise understanding of how targeted technical and digital interventions can improve equipment availability and operational reliability.

To address this problem, this research employs the Six Big Losses framework, a widely used practical method in industry for categorising and analysing the most common causes of lost productivity (Egorova et al., 2016). The method helps focus improvement efforts by categorising losses into specific areas, including equipment failure, adjustments, slow cycles, and defects (Smith, 2021). In this case, the most significant issue was unplanned downtime caused by leaflet jams. As a result, the team made technical improvements to the suction system and created a complaint form to report repeated issues with supplier materials.

Besides technical improvements, the research also focused on digitalising spare part inventory control. A monitoring system was developed using Microsoft PowerApps to assist the engineering team in tracking stock levels, receiving alerts when parts are running low, and requesting items more efficiently (Shrivastava, 2024). It aligns with the goals of Industry 4.0, which promotes the use of smart technologies to improve responsiveness and transparency in manufacturing (Oktareza et al., 2024).

The system was developed using the Rapid Application Development (RAD) approach because it supports quick development cycles, easy modification based on user input, and minimal reliance on complex coding, making it highly suitable for dynamic

production environments where user requirements may evolve during implementation (Campbell, 2025). RAD itself focuses on quick prototyping and continuous user feedback. It follows four phases: planning, design, construction, and deployment (Davis, 2019). In this research, early prototypes were built using Microsoft PowerApps and refined based on feedback from the five-person engineering team. According to Olorunfemi (2024), the system was connected to SharePoint and Excel for real-time updates, allowing for fast development without complex coding, which is ideal for a dynamic production environment like pharmaceutical packaging. The integration of RAD and business process analysis, along with system synchronisation, provides a practical solution to challenges related to real-time material demand (Maukar & Palobo, 2025).

This research uniquely combines the Six Big Losses framework with a real-time digital inventory system built using Microsoft PowerApps to improve OEE, focusing on availability losses. Unlike previous studies that rely on manual tracking or isolated maintenance improvements, this study offers an integrated solution that addresses both machine downtime and spare part availability (Muzaki et al., 2025).

According to Maukar et al. (2025), the RAD approach enables fast development, user-driven customisation, and real-time data synchronisation through SharePoint. It makes the system highly adaptable to dynamic production environments. The dual focus on technical root-cause analysis and digital inventory control aligns with Industry 4.0 goals, setting this research apart from existing literature (Wolniak et al., 2023).

This research serves as a reference for future studies, particularly those related to calculating Overall Equipment Effectiveness to reduce Six Big Losses. Additionally, the findings can be used as an evaluation material for the company's existing policies.

Literature Review

a). Overall Equipment Effectiveness (OEE)

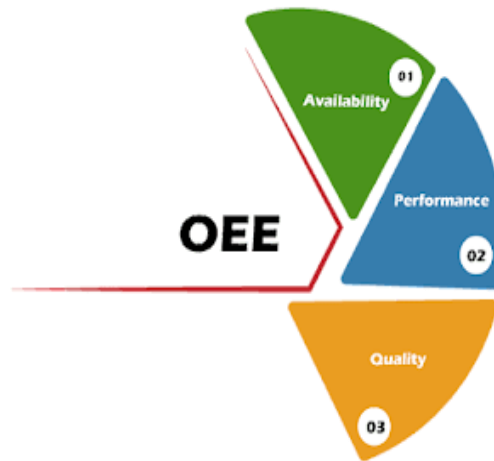
Overall Equipment Effectiveness (OEE) is a key metric for measuring equipment efficiency in pharmaceutical production, where strict quality and compliance standards are critical (Hamed & Soliman, 2020). High OEE is crucial for meeting production targets and GMP standards, as equipment such as granulators, tablet presses, and cartoners must operate efficiently and optimally. A low OEE indicates significant operational and financial losses that must be addressed (Chikwendu et al., 2020). **Figure 1** presents the Components of OEE.

The OEE can be calculated using **Equation (1)**.

$$OEE = Availability \times Performance \times Quality \quad (1)$$

OEE consists of three main components:

Availability measures the actual operating time of the machine compared to the planned production time (Tobe et al., 2018). It can be computed using **Equation (2)**.



Source: <https://www.pharmacalculations.com/2023/12/estimation-of-overall-equipment-effectiveness.html>

Figure 1. The Components of OEE



Source: <https://evocon.com/articles/the-six-big-losses-in-manufacturing/>

Figure 2. Six Big Losses Category

$$\text{Availability} = \frac{\text{Net Operating Time}}{\text{Availability Time}} \quad (2)$$

Performance measures the actual production speed compared to the ideal speed. Performance must be 95% or higher, reflecting consistent, productive machine speed (Andersson & Bellgran, 2015). To calculate the Performance, **Equation (3)** is employed.

$$\text{Performance} = \frac{\text{Produced Product} + \text{Reject Product}}{\text{Target Output}} \quad (3)$$

Lastly, quality measures the number of good products compared to the total production output, which can be expressed in **Equation (4)**. Quality must reach 99% or more, as even minor defects can result in rejected batches (Wolniak et al., 2023).

$$\text{Quality} = \frac{\text{Produced Product}}{\text{Reject Product}} \quad (4)$$

b). Six Big Losses

The Six Big Losses are a primary classification of efficiency losses in production processes, developed from the concept of Total Productive Maintenance (TPM) (Sutoni et al., 2019). The purpose of identifying

the Six Big Losses is to help companies understand and measure the types of losses that affect machine and equipment productivity, and to serve as a foundation for continuous improvement aimed at increasing Overall Equipment Effectiveness (OEE) (Nurprihatin et al., 2019). **Figure 2** depicts the six big losses.

Availability loss refers to the time when machines are scheduled to run but are not operating (Yang et al., 2020). It includes both planned and unplanned stops. Managing this loss is crucial for maintaining a smooth production flow and preventing delays or overtime due to downtime.

According to Stamatis (2010), Performance loss occurs when machines operate at a speed slower than their ideal speed due to small interruptions (micro-stops) or reduced speed (slow cycles). Quality loss occurs when non-conforming products are produced, either during normal operation or during initial startup, resulting in waste and rework (Nurprihatin et al., 2019).

c). Rapid Application Development (RAD)

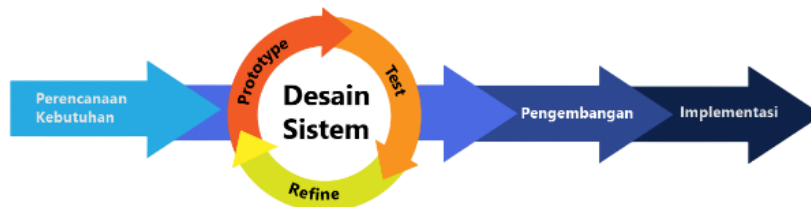
Rapid Application Development (RAD) is a software development methodology introduced by Martin (1991) as a response to the need for faster, more

flexible, and user-driven application development. RAD emphasizes **quick development cycles**, frequent iterations, and direct involvement of end-users throughout the process ((Singgalen & Mantik, 2024). This methodology is particularly well-suited for

research that requires rapid delivery and iterative prototyping (Cofer & Harding, 2006). **Figure 3** presents the RAD stages.

As shown in **Figure 3**, RAD includes four stages: Requirements Planning, User Design,

Tahapan Rapid Application Development



Source: <https://images.app.goo.gl/sxVnaie4S1xtWbvJ6>

Figure 3. RAD Stages

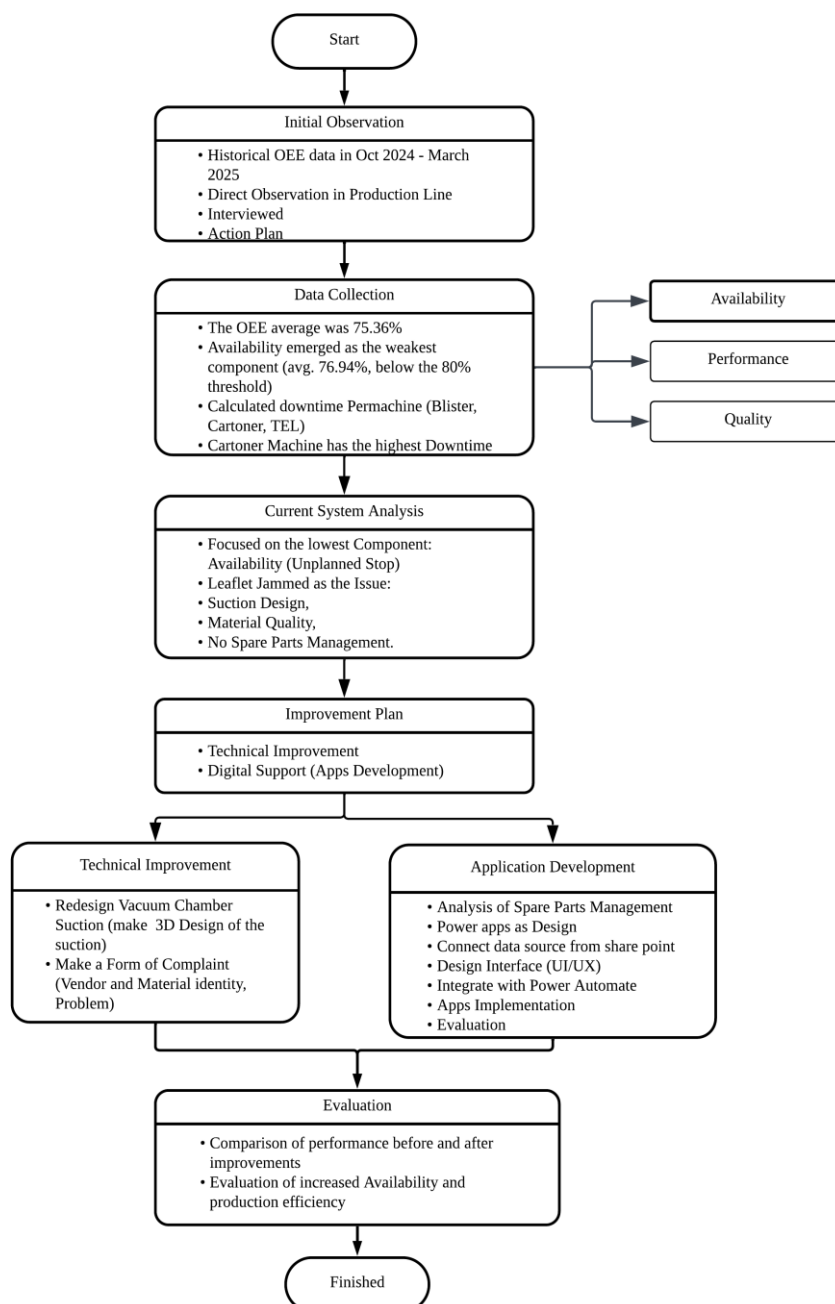


Figure 4. Research Framework

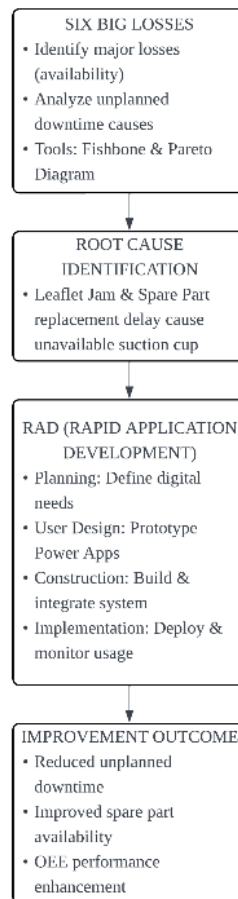


Figure 5. The Integration of Six Big Losses and RAD

Construction, and Implementation (Dennis et al., 2015). Each stage supports continuous feedback and rapid adjustments. In this research, RAD allowed the system to be developed quickly with input from the engineering team, ensuring the final tool aligned with actual operational needs (Saprudin & Pratama, 2025).

Previous research on OEE improvement has largely focused on implementing Total Productive Maintenance (TPM), preventive maintenance scheduling, and downtime tracking using manual or semi-digital systems. However, few research has integrated digital solutions that enable real-time monitoring, automated notifications, and spare part control to directly address availability-related losses. This study fills that gap by combining the Six Big Losses framework with the Rapid Application Development (RAD) methodology to design a Power Apps based spare part management system that enhances machine availability and aligns with Industry 4.0 principles.

2. Method

The research framework for this study is presented in **Figure 4**. The research begins with an Initial Observation phase, during which the researcher conducts direct field observations of several machines within the production line, with a particular focus on mandatory machines, including the Blister, Cartoner, TEL, and Checkweigher.

The project began with an initial observation to identify the root cause of low production effectiveness on the Cartoner machine in a pharmaceutical setting,

utilising historical OEE data (October 2024–March 2025), direct line observations, and staff interviews. Data collection revealed an average OEE of 75.36%, with availability as the weakest factor at 76.94%, highlighting the Cartoner machine's significant downtime. Further analysis identified frequent leaflet jamming as the primary issue, caused by poor suction system design, low material quality, and a lack of structured spare parts management.

The improvement plan addressed this issue through the redesign of the vacuum chamber and the implementation of a standardised complaint form for vendor-related problems. Simultaneously, a digital spare parts management system was developed using Microsoft Power Apps, integrated with SharePoint and Power Automate, offering real-time alerts and a user-friendly interface. Final evaluations showed notable improvements in machine availability, reduced unplanned stops, and enhanced spare parts readiness, resulting in a more efficient and reliable production process.

This study shows how the Six Big Losses framework and the Rapid Application Development (RAD) methodology interact. The Six Big Losses analysis identifies key sources of availability loss, focusing on unplanned downtime caused by leaflet jams and the unavailability of suction cups. The academic contribution of this research is both methodological and technological. Methodologically, it integrates the Six Big Losses framework with the Rapid Application Development (RAD) approach, as illustrated in **Figure 5**, which shows how analytical

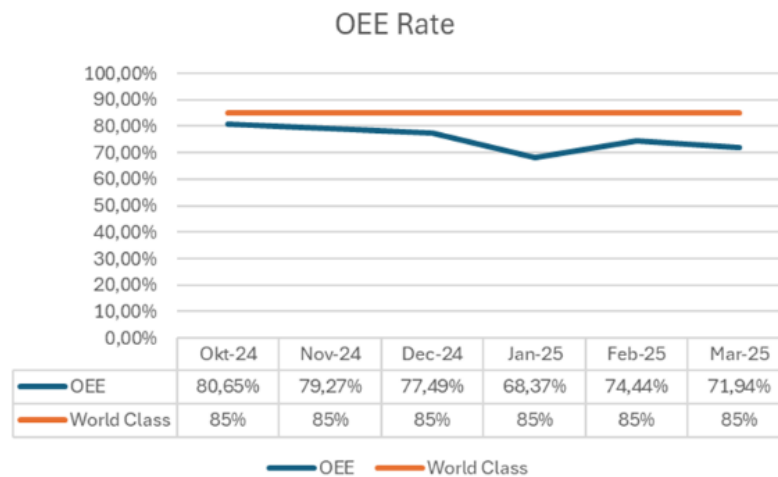


Figure 6. The Line Chart of OEE Rate of Oct 2024 - March 2025

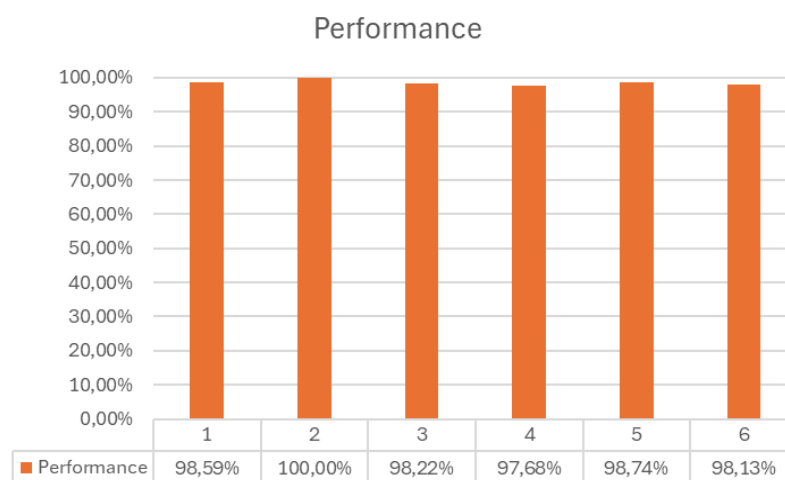


Figure 7. Histogram of Performance Rate October 2024 - March 2025

findings on unplanned downtime directly inform the development of a Power Apps-based spare part management system. Technologically, this integration translates root cause analysis into a digital solution that reduces downtime, improves machine availability, and enhances Overall Equipment Effectiveness (OEE) in line with Industry 4.0 practices.

The Power Apps-based Spare Part Management System represents a step toward digital transformation by enabling real-time data visibility and faster maintenance responses. It supports the principles of cyber-physical systems, where digital tools interact with physical equipment to monitor and control performance.

3. Results and Discussion

3.1 Current OEE Condition

The analysis was conducted on three main machines in the production line: Blister, Cartoner, and TEL. The OEE measurement focused on the Performance Rate (P) and Quality Rate (Q) components, as the Availability aspect remained stable with no significant fluctuations. The initial baseline results for OEE are shown in **Figure 6**.

Based on **Equation (1)**, OEE declined steadily from October 2024 to January 2025, reaching its lowest

at 68.37%, indicating persistent inefficiencies likely due to unplanned downtime. A brief improvement occurred in February (74.44%), but it dropped again in March (71.94%), indicating that root issues remained unresolved. Since OEE stayed below the 85% benchmark, it confirms a clear need for improvement through redesign, preventive maintenance, and operational enhancements. So, the researcher breaks down the components of OEE as follows:

a). Performance

The performance rate compares actual output to the standard output. It is calculated using the machine's total production over the past six months, as shown in **Figure 7**. Using **Equation (3)**, the performance rate from October 2024 to March 2025 remained high, ranging from 97.68% to 100%, showing strong machine output. Although nearly optimal, slight variations suggest that regular speed checks and parameter tuning are still needed to maintain peak efficiency.

b). Quality

Using **Equation (4)**, the Quality rate is based on daily production, and the histogram shows monthly averages over six months, as seen in **Figure 8**.



Figure 8. Histogram of Quality Rate of Oct 2024 - Mar 2025

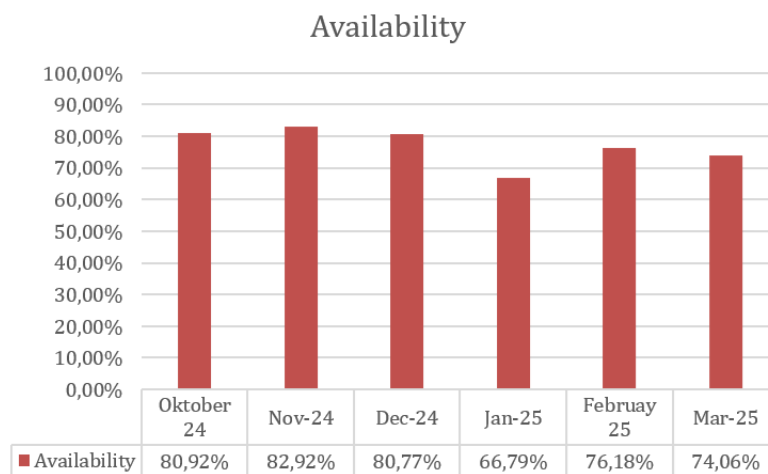


Figure 9. The Histogram of Availability October 2024 - March 2025

According to **Equation (2-4)**, the quality rate remained consistently high, ranging from 99.62% to 99.77% over six months, with November 2024 marking the peak. Despite a slight dip in January, the results reflect strong quality control and no urgent need for improvement.

c). Availability

The availability rate, calculated using **Equation (2)**, is based on operating time minus downtime. Over the six months, the Cartoner's availability ranged from 79.82% (November 2024) to 66.41% (January 2025). Although stable from October to December, it remained below the 85% benchmark. The histogram of availability October 2024 - March 2025 can be seen in **Figure 9**.

Improving the availability is essential, as it impacts machine uptime during planned production. Low availability leads to more stoppages, lowering efficiency. To boost OEE, efforts should focus on reducing unplanned downtime and implementing real-time monitoring. These actions can help reach or surpass the 80% benchmark, enhancing overall productivity.

3.2 Six Big Losses

The OEE analysis identifies six major losses, categorised under availability, performance, and

quality. In this research, availability had the lowest contribution to OEE. Thus, the Six Big Losses focus is on availability-related issues, particularly unplanned stops such as breakdowns. Since planned stops aren't counted as production downtime, they were excluded. Addressing these losses is crucial to enhancing OEE and machine efficiency. Major losses of machine can be seen in **Figure 10**.

This research targets availability, currently at 76%, below the 85% goal. Key issues include weak suction, poor spare parts control, and material untidy, causing frequent jams. Improving inventory control, redesigning the suction system, and creating a form for complaints to suppliers are essential to reduce unplanned downtime and enhance machine efficiency.

a). Availability Analysis

Unplanned stops are unexpected interruptions in machine or line operations caused by issues such as equipment failures, material jams, or delays in changing the suction cup. Unlike planned maintenance or cleaning, these stops reduce availability and disrupt production flow. Minimizing unplanned stops is crucial to maintaining efficiency and improving Overall Equipment Effectiveness (OEE). **Figure 11** shows the Pareto chart of Cartoner machine downtime.

From October 2024 to March 2025, Cartoner machine downtime was primarily caused by Leaflet Jammed (67%) and Blister stacking (26%), accounting

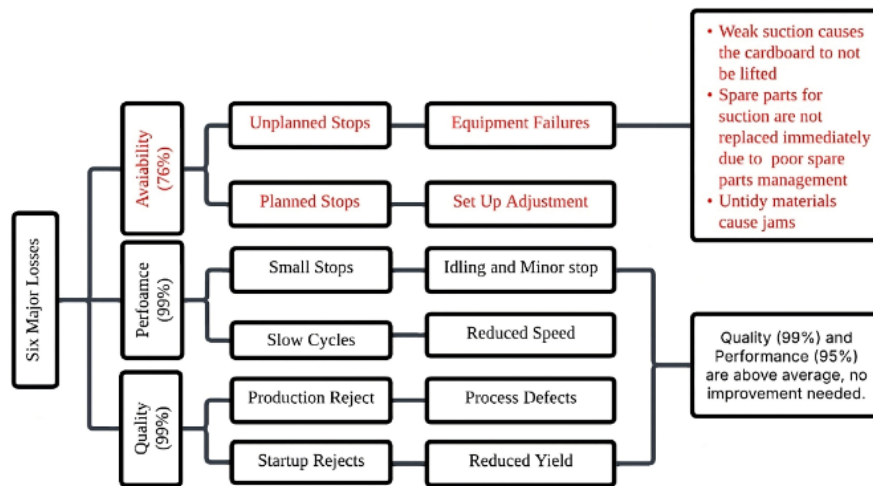


Figure 10. Major Losses of Cartoner Machine

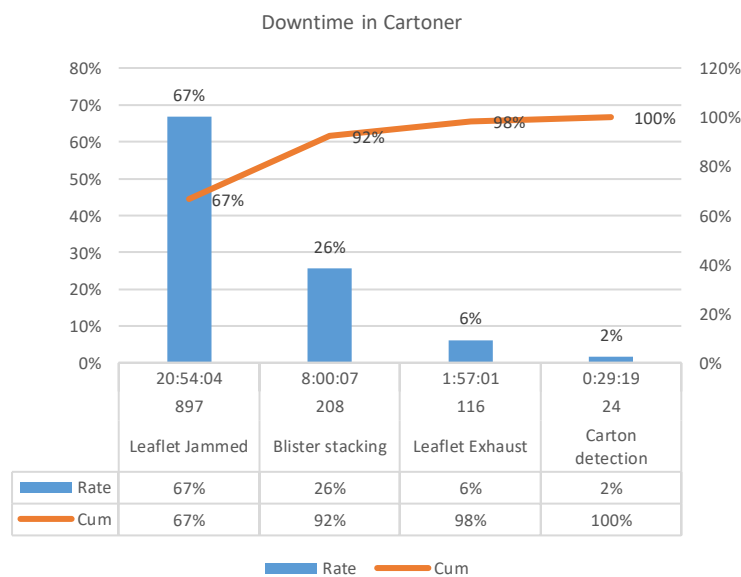


Figure 11. Pareto Downtime in Cartoner

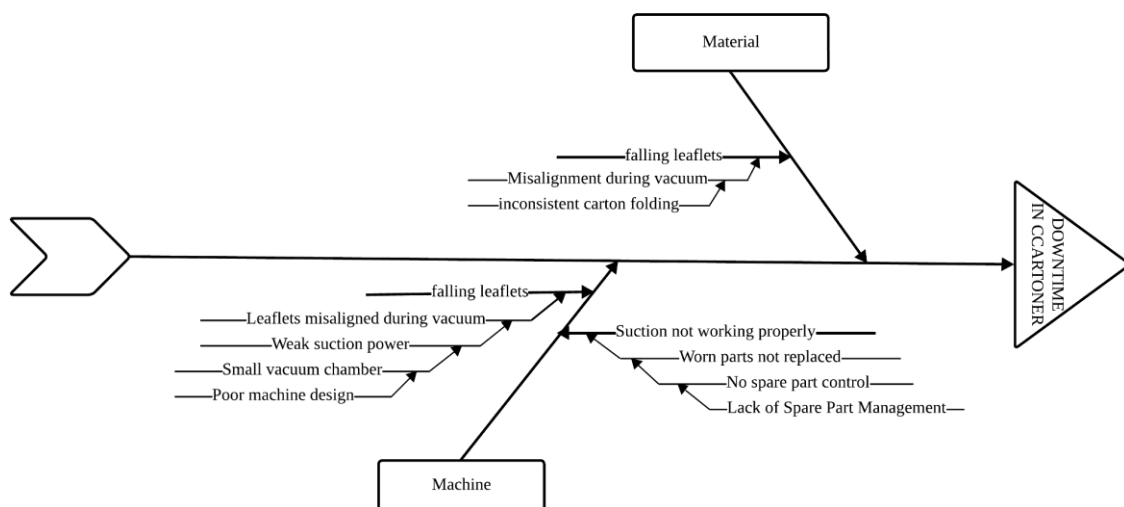


Figure 12. Fishbone Diagram of Downtime

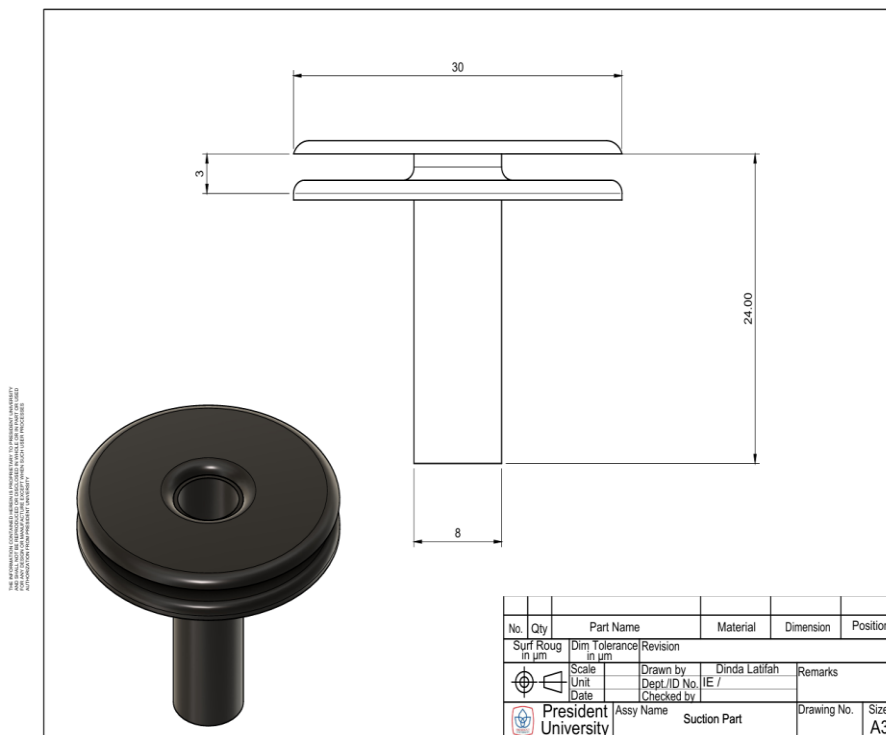
together for 92% of unplanned stops. Leaflet jams stemmed from misalignment, sensor errors, or poor leaflet quality, while Blister stacking resulted from irregular feeding or conveyor issues.

b). Cause and Failure Effect Diagram (Fishbone Diagram)

The Fishbone Diagram, as seen in **Figure 12**, identifies and categorises the root causes contributing

Table 1. The Improvement Action Plan

✂ Technical Development	
Action Plan	Implementation Checklist
Weak/ small suction power	- Redesign suction chamber - Trial tested
Leaflets often fall due to material	- Complaint form template created - Include vendor and material name
💻 Digital Development	
Action Plan	Implementation Checklist
Inventory Control of Spare Parts	- Spare part database structure built - Spare part data entry - Design UI/UX - Notification active

**Figure 13.** 3D Drawing of Suction

to equipment inefficiencies. It helps visualize how various factors such as machine condition, materials, methods, and manpower interact to create production problems. This analysis guides focused improvement efforts to minimize downtime and enhance overall equipment performance.

As seen in **Figure 12**, the Fishbone Diagram shows the root causes of equipment failure, one of the Six Big Losses. The primary issue is leaflet misalignment, which causes jams during the vacuum process, driven by two key factors: Machine and Material. Machine-related causes include poor spare part management, delayed replacement of worn parts, inadequate suction due to a small vacuum design, and insufficient suction power. Material-related issues involve inconsistent carton folding and leaflet quality, both of which worsen misalignment and downtime.

3.3 Improvement Plan

As part of the improvement efforts, technical upgrades are being made to boost machine efficiency. In parallel, a digital spare parts management system

will be deployed across production areas. **Table 1** outlines the whole improvement plan

The first improvement involves enlarging the vacuum chamber to increase suction power and reduce jamming. Second, a supplier complaint form is introduced to track carton folding quality, ensuring consistent, symmetrical folds for smoother packaging. Digitally, a spare parts management system will be implemented to track stock levels, usage, and notify users of stockouts. This system enhances transparency, accuracy, and traceability, supporting smoother production operations.

3.3.1 Technical Development

a. Modification of Suction Components

The redesign was carried out using CAD software, specifically Fusion 360, to develop a 3D model. The initial design was based on actual measurements and functional needs provided by the Engineering team on the production floor. **Figure 13** shows the 3D of the suction.

Figure 14. Form Complaint to Supplier

The illustration shows a side and 3D view of a vacuum suction cup with key dimensions: 30 mm top diameter, 24 mm height, and 8 mm base. The 3 mm flexible lip enhances sealing and suction, ideal for lifting smooth surfaces in automated systems.

b. Form Complaint to Supplier

The Material Issue Tracker form is used to record and manage vendor-related material defects. **Figure 14** shows the complaint form used for this purpose. The supplier complaint form starts with “Vendor and Material” to identify the source of the defect. It requires a clear description of the issue under “Problem and Defect” and emphasises preserving samples under “Material Identity.” Fields like “Total Defect” and “Priority” help assess impact and urgency. Overall, the form ensures the structured and traceable handling of material complaints, supporting supplier accountability and quality improvement.

3.3.2 Digital Development

The spare part management app developed in Microsoft Power Apps helps digitise and streamline inventory processes. It tracks stock levels, usage, and triggers low-stock alerts through real-time sync with data sources like SharePoint or Excel. Built using the Rapid Application Development (RAD) method, the app improves visibility, speeds up decision-making, and reduces downtime ideal for manufacturing and pharmaceutical settings.

a). Required Planning

The core features Add Item, Stock Out, and Search Item List streamline spare part management.

Users can add new parts with key details, track withdrawals with low stock alerts, and quickly access item data. Together, these functions support real-time visibility and efficient inventory control.

The homepage of the InStock Sparepart Engineering app, as shown in **Figure 15**, features a user-friendly interface tailored for engineering and maintenance staff. It includes company branding, a clear title, and three main function buttons in Bahasa Indonesia: “Cari Item dari List,” “Buat Item Baru,” and “Butuh Order Baru.” These features enable users to search for inventory, add new items, and request orders addressing issues such as stock-outs and delays. The interface uses the company’s color scheme and includes a cartoon engineer mascot to reinforce its purpose. The layout supports efficient navigation and aligns with the goal of improving spare part management.

b). User Design (Iteration Cycle 1 – Prototype A)

The initial low-fidelity prototype emphasised item entry and display features. User feedback led to the addition of photo upload and minimum/maximum stock fields. When an engineer selects an item on the second page, detailed information about the spare part appears. **Figure 16** shows the spare parts item list and **Figure 17** shows detail the spare part.

When an engineer selects a spare part from the list, they are directed to a detailed view that shows key information, such as the item name, location, specifications, stock levels, and status (e.g., “STOCK ADA”). Each item has a unique ID, and users can add or withdraw stock by entering values. A dropdown allows users to select their name for accountability, and

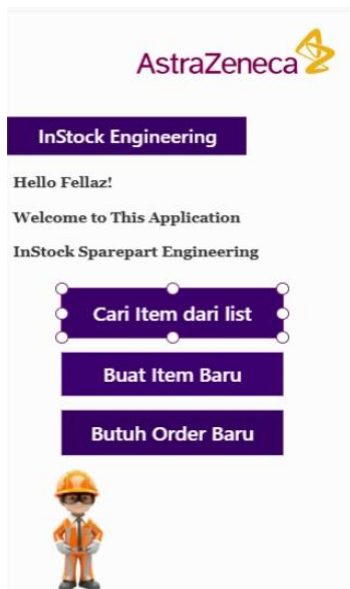


Figure 15. Homepage of Apps

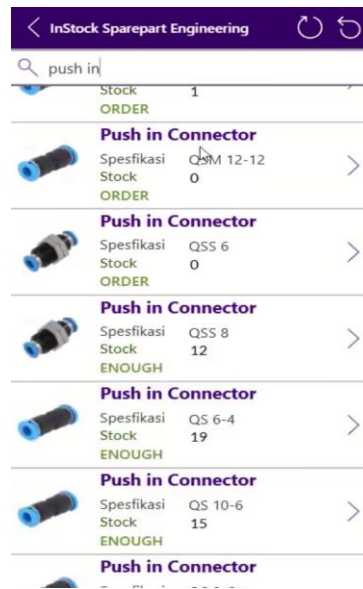


Figure 16. List of Spare Parts

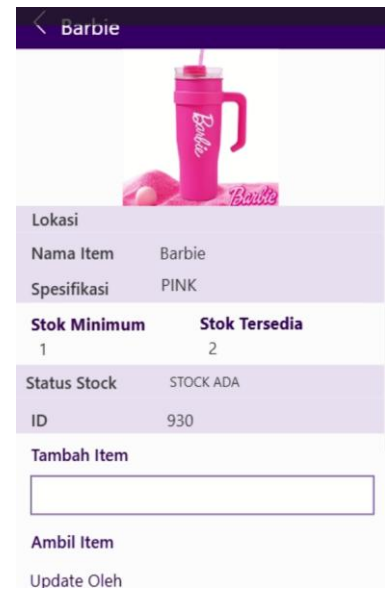


Figure 17. Detail Spare Parts Screen

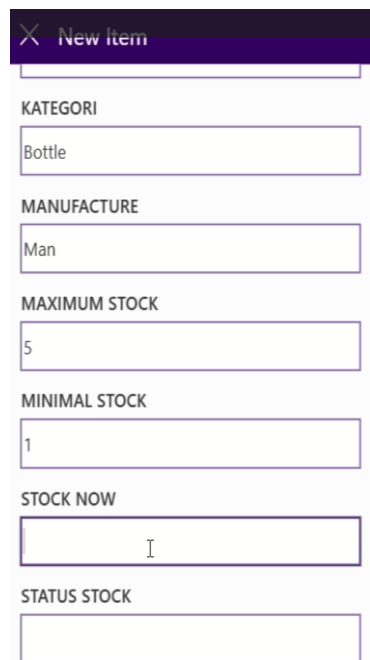


Figure 18. Input New Item Screen

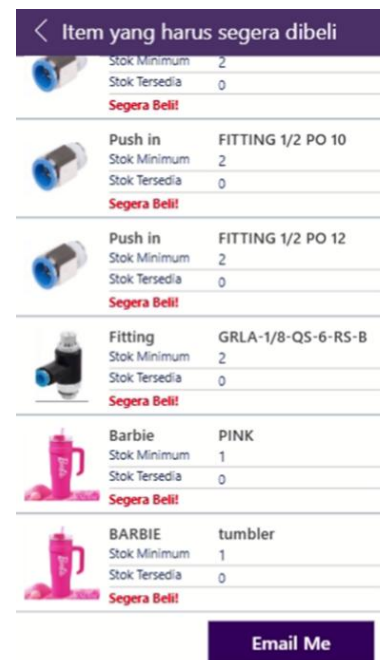


Figure 19 Home Page of Item Stock out

changes are saved using the Update button. This real-time system ensures accurate inventory tracking and efficient management of spare parts. Future improvements could include timestamps, usage history, and low-stock alerts.

c). User Design (Iteration Cycle 2 – Prototype B)

In the second design iteration, the New Item screen was enhanced with photo upload, minimum and maximum stock fields, and a dynamic stock status display. These updates improved clarity, accuracy, and usability for real-time spare part tracking. The input form is shown in Figure 18.

Figure 18 shows the "New Item" input form in the InStock Sparepart Engineering app, used to register new spare parts. It includes fields like Category, Manufacturer, Maximum Stock, Minimum Stock, and Current Stock, ensuring accurate inventory setup. The

Stock Status field updates based on current stock levels to indicate availability. The form is simple, structured, and supports real-time data entry. Figure 19 then presents the homepage for stock-out actions.

The homepage displays a list of out-of-stock items marked with a red "Segera Beli!" alert, signaling urgent restocking needs. It highlights both technical and general items, ensuring timely replenishment. The "Email Me" button likely enables quick notifications, supporting efficient inventory management and preventing delays.

d). Construction (Final Build)

The finalised app integrates with SharePoint as the backend, triggering automated alerts when stock hits zero or the reorder point. It also logs usage history and the responsible personnel. Testing confirmed smooth navigation and functioning alerts, powered by

LOCATION	NAMA BARANG	SPESIFIKASI	KATEGORI	MANUFACTURE	MINIMAL STO...	MAXIMUM
D1.1A.1	ENGSEL PLASTIK	#0	MEKANIK		1	
D1.2A.1	SILINDER FESTO MAGAZINE CARBONER	ADNT-12-10-A-P	PNEUMATIK	FESTO	1	
D1.2A.1	Silinder transport	15039 P108	PNEUMATIK	Festo	1	
D1.2A.2	Cylinder Festo	ADNU-20-10-P-A	Pneumatic	Festo	1	
D1.2A.3	Cylinder Festo	ADNUL-32-10-P-A	Pneumatic	Festo	1	
D1.2A.3	Cylinder FESTO	AND-32-5-4-P-A	Pneumatic	FESTO	1	

Figure 20. SharePoint Database

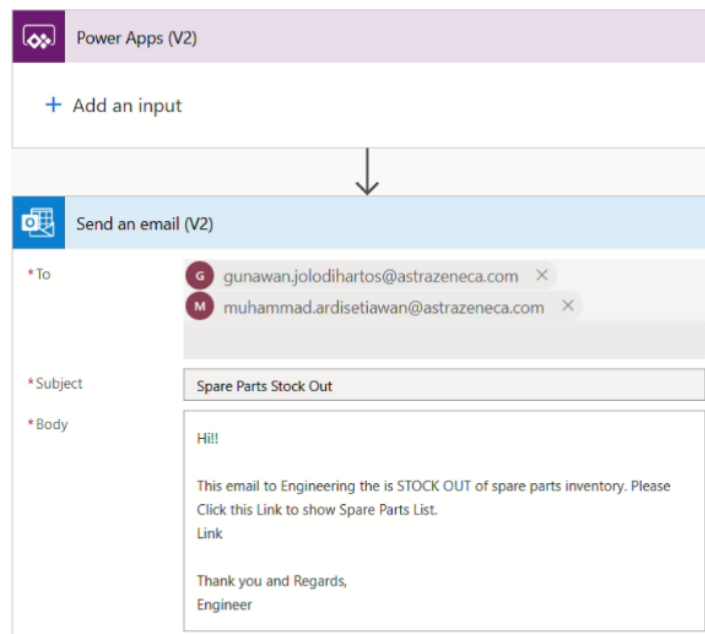


Figure 21. Notification Alerts

a Power Automate logic flow. **Figure 20** displays the SharePoint database page, while **Figure 21** shows the Power Automate flow for Outlook notifications.

SharePoint functions as the backend database, enabling real-time updates and centralised access to spare part data. Power Automate supports this by monitoring stock levels and sending automated Outlook email alerts when items reach the reorder point, ensuring timely restocking and avoiding stock-outs.

3.4 Comparison

The comparison analysis evaluates data before and after improvement actions conducted from April to May 2025. These results are measured against initial observations to assess the effectiveness of the changes across multiple data categories. Following efforts to address the Six Big Losses, a notable reduction in

machine downtime due to leaflet jams was achieved. This improvement is illustrated in detail in **Figure 22**.

Figure 22 shows an increase in OEE from 75.36% to 81.90% after the intervention, representing a 6.54% improvement. This reflects better equipment utilisation and reduced downtime. The rise in the Availability factor suggests more consistent machine operation during scheduled time, contributing to higher productivity and process stability. The Availability chart shows an increase from 76.94% to 83.90%, surpassing the 80% target and indicating reduced downtime and more stable machine use. This improvement reflects the success of actions such as improved maintenance, effective spare parts control, and optimised material handling. This improvement can be seen in **Figure 23**.

Despite the progress, leaflet jams remain the main cause of downtime at 71.84%, showing ongoing

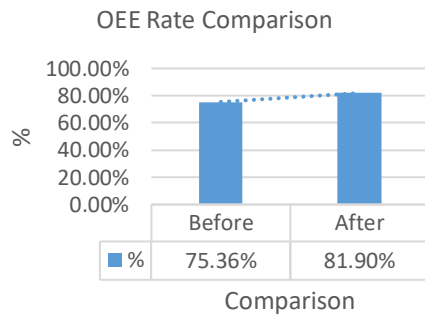


Figure 22. Comparison of OEE Rate

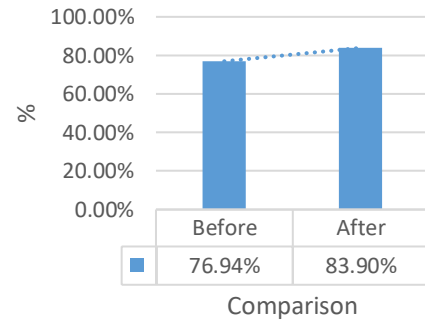


Figure 23. Availability Rate After Improvement

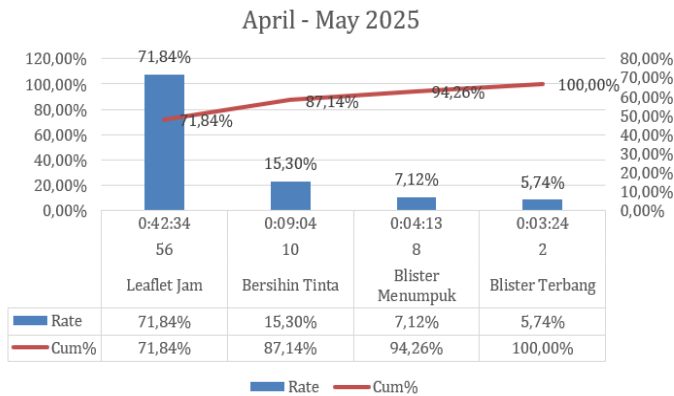


Figure 24. Cartoner Downtime after Improvement April-May 2025



Figure 25. Vacuum Gauge Setup of Cartoner Machine

Table 2. Inventory Control Improvement

Aspect	Before (Excel)	(After) Microsoft Power Apps
Update Method	Manual input in Excel	Real-time update via app
Stock Alerts	No automatic alerts when stock is low	Automatic reminders when stock reaches minimum
Accessibility	Only accessible on specific devices (e.g., local PC)	Accessible via mobile devices anytime, anywhere
Item Lookup	Manual search in spreadsheet	Quick search with user-friendly mobile interface
Data Accuracy	Prone to human error due to manual entry	More accurate with form-based input and validations
New Item Entry	Manually added into Excel sheet	Can be added directly into app and synced to the database
Stock Status Monitoring	Must check each row in Excel to know status	Auto-display of stock status (e.g., "Stok Ada", "Order")
User Experience	Static and time-consuming	Interactive and efficient UI tailored for operations

suction issues. Other causes, such as ink cleaning and blister handling, are minor and under control. **Figure 24** details the post-improvement downtime of the Cartoner machine.

To further reduce leaflet-related downtime, the next improvement focus should include structured spare part control, supplier feedback on material quality, and potential redesign of the vacuum system for better suction. Using tools like Microsoft Power Apps can enhance real-time tracking and visibility of part usage and machine status. As a second strategy, **Figure 25** illustrates the use of a manometer to optimize suction at the vacuum pick-up section. The Piab manometer, installed in the pneumatic system,

shows a vacuum pressure of around -60 kPa, indicating effective suction performance for handling leaflets.

With a vacuum pressure of around -60 kPa, the system improves leaflet transfer by reducing sticking or pick-up failures, which are common causes of jams. It complements earlier strategies, such as adjusting the stacker position or adding sensors.

A key improvement in this research is the shift from manual Excel tracking to real-time spare part management using Microsoft Power Apps. The system now provides automated alerts for zero stock and updates inventory directly, enhancing accuracy, reducing downtime risk, and improving maintenance planning. **Table 2** illustrates this enhanced inventory control.

The improvements occurred due to the redesigned suction system, which enhanced vacuum stability and reduced leaflet jams, and the Power Apps based spare part system, which minimized replacement suction cup delays. The discussion now compares these findings with previous research, highlighting how this research uniquely integrates technical modification and digitalisation. The outcomes are connected to TPM pillars Focused and Planned Maintenance and Lean principles of waste and downtime reduction, reinforcing the research's theoretical and practical contribution.

4. Conclusions

This research aimed to improve the Overall Equipment Effectiveness (OEE) of the Cartoner machine at a pharmaceutical company in Cikarang. The main problems were low availability due to frequent leaflet jams (67% of downtime) and slow repairs caused by poor spare part management.

The packaging line is limited to one, comprising three interconnected machines (Blister, Cartoner, and TEL). As the production line operates as a single system, any downtime in one machine halts the entire line. Therefore, the OEE findings represent machine-level performance and cannot be generalised to the whole plant. Future research should include multiple lines, explore predictive maintenance integration, and expand analysis to company-wide OEE performance.

Two key solutions were implemented: a technical upgrade that involved redesigning the suction component to enhance vacuum strength, and a digital improvement achieved through a Power Apps-based inventory system integrated with SharePoint and Power Automate. These changes resulted in a rise in OEE from 75.36% to 81.90% and availability from 76.94% to 83.90%, indicating a significant reduction in downtime and progress toward achieving the 85% world-class OEE benchmark.

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