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Advanced Analysis and Problem-Solving in the Industry: A Strategic Approach to Assisting PT. XYZ in Overcoming Operational Challenges

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ABSTRAK

Penelitian ini bertujuan untuk menyelesaikan tantangan operasional di PT. XYZ menggunakan metodologi canggih dan pendekatan strategis, dengan fokus khusus pada meningkatkan Overall Equipment Effectiveness (OEE) dan Total Productive Maintenance (TPM). OEE berfungsi sebagai metrik kinerja penting yang mencakup ketersediaan, kinerja, dan kualitas untuk memberikan pandangan komprehensif tentang efisiensi peralatan. Integrasi TPM, yang menekankan pemeliharaan proaktif dan preventif, lebih lanjut mendukung tujuan ini dengan melibatkan semua karyawan dalam menjaga dan meningkatkan kinerja peralatan. Penelitian ini memprioritaskan perbaikan mesin tingkat pertama seperti optimalisasi area gripper, sistem pneumatik, klem penahan tali, kawat hidung, conveyor transfer, dan area pemotongan. Selain itu, peningkatan tingkat kedua dalam sistem produksi melibatkan penyempurnaan proses penjadwalan untuk mencegah kekurangan operator, memberikan pelatihan berkelanjutan untuk menjaga keterampilan operator, dan memastikan kesiapan dalam semua kebutuhan produksi. Langkah-langkah ini bertujuan untuk secara sistematis mengatasi akar penyebab ketidak-efisiensian, dengan tujuan akhir meningkatkan efektivitas operasional secara keseluruhan sesuai dengan tujuan dan standar organisasi, sehingga mendorong lingkungan manufaktur yang lebih efisien dan produktif.

ABSTRACT

This research aims to solve operational challenges at PT. XYZ using advanced methodologies and strategic approaches, with a specific focus on enhancing Overall Equipment Effectiveness (OEE) and Total Productive Maintenance (TPM). OEE serves as a critical performance metric encompassing availability, performance, and quality to provide a comprehensive view of equipment efficiency. The integration of TPM, emphasizing proactive and preventive maintenance, further supports these goals by engaging all employees in maintaining and improving equipment performance. The research prioritizes first-tier machine improvements such as optimizing the gripper area, pneumatic systems, strap holding clamps area, nose wire, transfer conveyor, and cutting area. Additionally, second-tier enhancements in production systems involve refining scheduling processes to prevent operator shortages, providing ongoing training to maintain operator proficiency, and ensuring readiness across all production needs. These measures aim to systematically address the root causes of inefficiencies, ultimately enhancing overall operational effectiveness in alignment with organizational objectives and standards, thereby fostering a more streamlined and productive manufacturing environment.

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I. INTRODUCTION

In the quest for operational excellence, PT. XYZ must prioritize the enhancement of Overall Equipment Effectiveness (OEE) and the implementation of Total Productive Maintenance (TPM). OEE is a critical performance metric that quantifies the efficiency and effectiveness of manufacturing operations by measuring the percentage of planned production time that is truly productive. By focusing on improving OEE, PT. XYZ can identify and eliminate inefficiencies, thus maximizing the performance of its equipment and processes [1], [2]. This comprehensive analysis and problem-solving approach enables the organization to maintain a competitive edge in a highly dynamic industrial landscape.

To accurately measure and enhance OEE, PT. XYZ must delve into its three core components: availability, performance, and quality. Availability assesses the uptime of equipment by accounting for unplanned downtime and maintenance activities [3]. Performance measures the speed at which equipment operates compared to its maximum potential, identifying losses due to slow cycles and minor stops. Quality evaluates the proportion of good units produced versus the total output, highlighting defects and rework. By systematically analyzing these factors, PT. XYZ can uncover the root causes of inefficiencies and devise targeted strategies to mitigate them, thereby boosting overall productivity [4].

Integral to improving OEE is the adoption of Total Productive Maintenance (TPM), a holistic approach that aims to maximize the productivity of equipment through proactive and preventive maintenance. TPM emphasizes the involvement of all employees, from operators to top management, in maintaining and improving equipment performance [5]. For PT. XYZ, implementing TPM means fostering a culture of continuous improvement where operators are empowered to conduct routine maintenance and inspections, thus preventing equipment failures and extending the lifespan of machinery. This not only reduces downtime but also enhances the reliability and performance of the production process [6], [7].

A critical aspect of TPM is the establishment of autonomous maintenance, where operators take ownership of their equipment by performing basic maintenance tasks such as cleaning, lubrication, and inspection. This hands-on approach ensures that potential issues are identified and addressed before they escalate into major problems, thereby maintaining optimal equipment conditions. PT. XYZ can benefit from regular training programs to equip operators with the necessary skills and knowledge, fostering a sense of responsibility and pride in their work. Autonomous maintenance also frees up maintenance personnel to focus on more complex tasks, thus improving overall maintenance efficiency [8].

In conjunction with autonomous maintenance, PT. XYZ should implement planned maintenance strategies to schedule preventive maintenance activities based on equipment usage and performance data. By analyzing historical maintenance records and real-time data, the company can predict when maintenance should be performed to prevent unexpected breakdowns. This data-driven approach to maintenance scheduling minimizes disruptions to production, ensuring that equipment operates at peak efficiency [9]. Furthermore, integrating predictive maintenance technologies, such as condition monitoring and IoT sensors, can provide early warnings of potential failures, allowing for timely interventions and reducing unplanned downtime.

Ultimately, the strategic focus on enhancing OEE and implementing TPM at PT. XYZ is instrumental in overcoming operational challenges and driving continuous improvement. By adopting a data-driven approach to analyzing equipment performance and engaging all employees in proactive maintenance activities, PT. XYZ can significantly enhance its operational efficiency and productivity [10]. This comprehensive strategy not only addresses immediate issues but also lays the foundation for sustainable long-term growth, positioning PT. XYZ as a leader in the industry. Through meticulous analysis, strategic problem-solving, and a commitment to continuous improvement, PT. XYZ can achieve operational excellence and maintain a competitive advantage in a rapidly evolving industrial environment [11].

II. METHOD

Overall Equipment Effectiveness (OEE)

This research methodology employs Overall Equipment Effectiveness (OEE) to analyze and improve operational efficiency at PT. XYZ. OEE, defined as the product of Availability, Performance, and Quality, provides a comprehensive measure of how effectively equipment is utilized. The methodology encompasses data collection, OEE calculation, root cause analysis, and the implementation of targeted interventions, ensuring a robust and systematic approach to identifying and addressing operational inefficiencies. Once data is collected, the calculation of OEE proceeds by evaluating:

$$OEE = Availability \times Performance \times Quality$$

Total Productive Maintenance (TPM)

This research methodology centers on the implementation of Total Productive Maintenance (TPM) to enhance operational efficiency and productivity at PT. XYZ. TPM is a comprehensive approach that integrates maintenance activities into the daily operations of a manufacturing facility, emphasizing proactive and preventive measures. Implementation of TPM Activities with the foundation established, TPM activities are systematically implemented across the facility. Autonomous maintenance tasks are integrated into daily routines, and planned maintenance schedules are developed and executed. Focused improvement projects are launched to address specific operational challenges, with cross-functional teams collaborating to identify solutions and implement changes. Quality maintenance practices are incorporated to ensure consistent product quality, and safety measures are reinforced to create a safe working environment.

III. RESULT

Availability, Performance, and Quality are the cornerstone metrics of Overall Equipment Effectiveness (OEE), each playing a critical role in determining operational efficiency. Availability measures the proportion of scheduled time that the equipment is actually operational, reflecting the impact of downtime on productivity. Performance assesses the speed at which equipment operates compared to its maximum potential, highlighting inefficiencies due to reduced operating speeds or minor stops. Quality evaluates the ratio of good output to the total production, ensuring that products meet the required standards without defects or rework. Together, these metrics provide a comprehensive view of how effectively equipment is utilized, offering actionable insights for optimizing manufacturing processes and enhancing overall productivity.

1. Availability

   The observations from the Availability component reveal the following insights:

   - The average result based on Table 2 is 89.93%.
   - Only 12.5% (4 instances) of the machine's operational time achieved the product output target.
   - A significant 87.5% (28 instances) failed to meet the target, with 85.7% of the downtime attributed to machine-related issues.

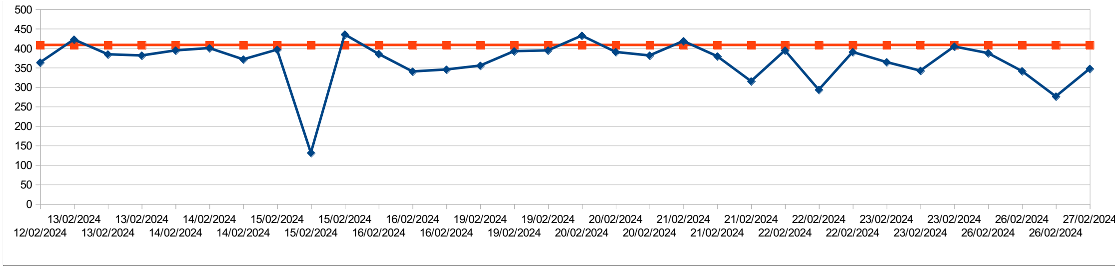

Figure 1. Availability data

2. Performance

   Based on the observations of the performance components, here are the findings:
   - The average result based on Table 2 is 56.99%.
   - 3.12% (1 time) of the machines achieved the target product.
   - A total of 96.87% (31 times) did not achieve the target due to a high rejection rate ranging from 6.45% to 38.92%.

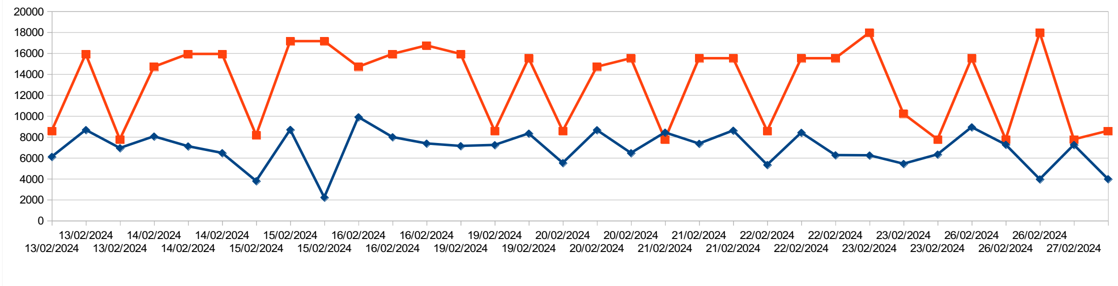

Figure 2. Performance data

3. Quality

   Based on the observations of the quality components, the findings are as follows:
   - The average result based on Table 2 is 86.64%.
   - A total of 21.87% (7 times) had a very high rejection percentage, exceeding 15%, due to machine issues.

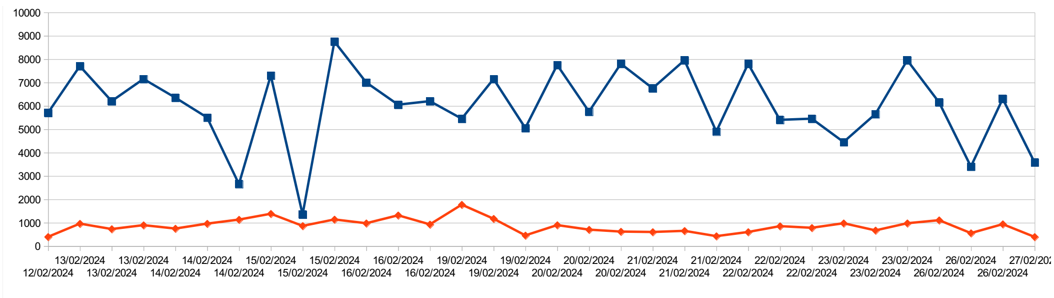

Figure 3. Quality data

Based on the calculations of the availability, performance, and quality values, the OEE (Overall Equipment Effectiveness) results are as follows:

Table 1. Average Score

Availability (%)	Performance (%)	Quality (%)	OEE (%)
89.93	56.99	86.64	45.54

These values indicate the overall efficiency and effectiveness of the equipment in production based on the combined factors of availability, performance, and quality. Here are the observations based on the OEE data:

- The average overall OEE is 45.54%.
- 3.13% (1 time) of the machines exceeded the target OEE of 85%.
- 40.63% (13 times) of the availability component (time) exceeded the target of 95%.
- 3.13% (1 time) of the performance component (machines) exceeded the target of 95%.
- The quality component (products) has never reached the target of 95%.

These observations highlight the performance metrics and deviations from the targets set for each component of OEE.

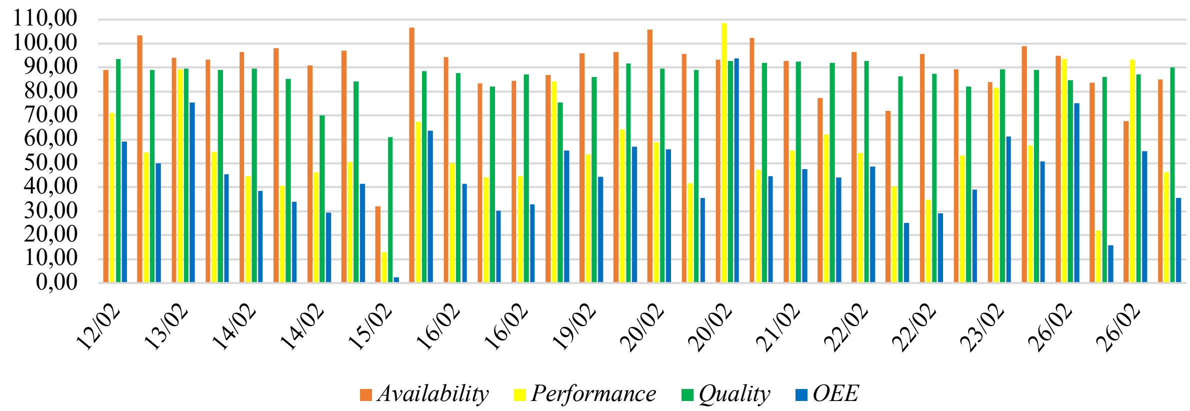

Figure 4. Comparison of Component Value Achievement and OEE

Based on the calculation of maximum machine speed, the machine should be capable of producing 21,000 masks per hour if operated at 80% of its capacity. However, the current average production is only 6,878 masks per hour, which accounts for 32.75% of the machine's specified capacity. This indicates significant potential for productivity improvement. To enhance productivity, steps can be taken based on an analysis of issues causing losses according to the "six big losses" concept. These steps may include identifying and reducing machine downtime, improving machine performance, and enhancing product quality, all aimed at achieving the desired productivity targets.

Based on the data, the losses can be categorized into three types: downtime losses, speed losses, and quality losses. The analysis shows that the component with the lowest average OEE percentage is performance, primarily due to machine-related factors.

Table 2. Six Big Losses Analysis

No	Component	Big Losses	Total Loss Time (minutes)	Percentage (%)
1	Availability	Breakdown Losses	866	37.30
		Setup & Adjustment	520	22.39
2	Performance	Small Stop	4	0.17
		Speed Losses	0	0.00
3	Quality	Start-up Defect	0	0.00
		Production Defect	932	40.14

This analysis reveals that:

- Availability losses are primarily due to breakdowns and setup adjustments, contributing to 37.30% and 22.39% of total loss time respectively.
- Performance losses are minimal, with small stops accounting for 0.17% of total loss time, indicating potential for improvement in this area.
- Quality losses mainly stem from production defects, amounting to 40.14% of total loss time.

Addressing these specific areas through targeted improvements in machine reliability, downtime reduction, and quality enhancement processes can effectively raise overall OEE and productivity levels.

Production Defects

The mask production results do not meet standards, such as incorrect strap positions, detachment issues, or incorrect folding of the mask body. The primary cause is instability in the ultrasonic welding holder.

Breakdown Losses:

Some common machine issues include: Electrical failures and Mechanical breakdowns

Table 3. Analysis of Losses due to Breakdown Issues

No	Issue Description	Frequency (times)	Percentage (%)
1	Earloop Long Area – gripper	7	41.18
2	Earloop Long Area – pneumatic	2	11.76
3	Earloop Long Area – holding clamp	1	5.88
4	Earloop Long Area – transfer conv.	1	5.88
5	Earloop Long Area – cutting	1	5.88
6	Earloop Short Area – gripper	1	5.88
7	Earloop Short Area – holding clamp	2	11.76
8	Body Area – nose wire	2	11.76
	TOTAL	17	100

Analysis:

a. The breakdown issues primarily affect various components related to the earloop and body areas of the mask production process.
b. The most frequent issues involve the gripper in the earloop long area, accounting for 41.18% of the total breakdown occurrences.

c. Addressing these specific breakdowns through targeted maintenance and improvement measures can help reduce downtime and enhance overall production efficiency.

Setup & Adjustment

Table 4. Analysis of Losses due to Setup & Adjustment Issues

No	Issue Description	Frequency (times)	Percentage (%)
1	Initial setup	1	10.00
2	Insufficient operators	4	40.00
3	Inexperienced operators	2	20.00
4	Unprepared production equipment (gloves)	1	10.00
5	Unprepared raw materials (earloop)	1	10.00
6	Batch completion	1	10.00
	TOTAL	10	100

Analysis:

a. The setup and adjustment issues impact the production system in several ways.
b. Most frequently, problems arise from insufficient or inexperienced operators, accounting for 60% of the setup and adjustment issues.
c. Other issues include initial setup challenges, unprepared production equipment and raw materials, and batch completion issues.
d. Addressing these setup and adjustment challenges can streamline operations and improve overall efficiency in production.

Small Stop

This issue occurred only once during the observation period, where the machine stopped briefly (less than 5 minutes) due to the need for re-setting in the Earloop Long area's cutting section.

Start-up Defect

There were no losses due to initial setup errors resulting in product damage during the observation period.

IV. DISCUSSION

In the observation and data processing conducted, problems and their general sources observed in the field were grouped and categorized. The findings from this categorization were then applied in a fishbone diagram, also known as an Ishikawa or cause-and-effect diagram, encompassing four main categories 1). Method: Factors related to the methods or procedures used in the production process, such as machine setup procedures or operational steps that may not be optimal; 2). Man: The role of and skills possessed by operators in operating machines and overseeing the production process. This includes aspects such as the number of operators, training, and experience levels; 3). Measurement: Quality measurement and control during the production process, including product inspection and machine performance measurement to identify deviations from targets; 4). Machine: The condition and performance of the machines used in the production process, encompassing aspects like reliability, capacity, and maintenance requirements [12].

Based on the observation and data processing regarding the losses that have prevented the achievement of machine operational targets, the most significant time-based losses are as follows: production defects at 40.14%, breakdown losses at 37.30%, setup & adjustment at 22.39%, and small stops at 0.17%. Given this data, a systematic and continuous improvement plan is essential to achieve production results that align with machine specifications and standards [13], [14].

First-tier machine improvements are Long area-gripper, Long area-pneumatic, Short area-holding clamp, Body area-nose wire, Long area-holding clamp, Long area-transfer conveyor, Long area-cutting, Short area-gripper. Second-tier production system improvements use Revising planning to establish better schedules to prevent operator shortage issues, Providing periodic training for machine operators to maintain peak performance and skill levels, Ensuring readiness of all production process requirements, from raw materials to work aids, to minimize downtime due to these issues [15], [16]. By implementing these structured improvements, the aim is to systematically address root causes of inefficiencies and enhance overall operational effectiveness in line with organizational goals and standards [17].

V. CONCLUSION

In conclusion, prioritizing first-tier machine improvements including the long area gripper, pneumatic systems, holding clamps in both short and long areas, nose wire in the body area, transfer conveyor, and cutting operations, alongside second-tier production system enhancements such as refining scheduling processes to prevent operator shortages, providing regular training to uphold operator proficiency, and ensuring comprehensive readiness across all production needs, aims to systematically tackle the root causes of inefficiencies. These measures are designed to enhance overall operational effectiveness in alignment with organizational objectives and standards, fostering a more streamlined and productive manufacturing environment.

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