

Optimizing Production Efficiency Through Total Productive Maintenance: a Case Study of a Vegetable Oil Production Company

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Abstract– This paper aims to present an approach for optimizing production efficiency through Total Productive Maintenance (TPM), using a case study of a vegetable oil production company in Thailand. This study employed both qualitative and quantitative research methods. Data were collected using questionnaires distributed to 200 randomly selected employees from the production and maintenance departments. Prior to the implementation of TPM, the vegetable oil production system operated in a continuous series without backup systems at certain critical points. As a result, the average total equipment effectiveness (OEE) was 83.8%, which fell below the industry standard. After six months of implementing TPM focusing on Pillar 1: Focused Improvement, Pillar 2: Autonomous Maintenance, Pillar 3: Planned Maintenance, and Pillar 4: Education and Training the average total equipment effectiveness increased by 3.92%. This empirical study demonstrates the effectiveness of applying TPM to improve production efficiency in the cooking oil manufacturing sector. The findings suggest that company executives should consider extending TPM implementation across all departments for broader organizational benefits.

Keywords: Production Efficiency Optimization, Total Productive Maintenance, Vegetable Oil Production, Thailand

1. INTRODUCTION

The Thai cooking oil market is highly competitive and consistently experiences strong demand. Many vegetable oil production companies strive to maintain their market share by continuously distributing products at low production costs while efficiently processing vegetable oil from crude palm oil. The company examined in this study specializes in the production and processing of vegetable oil from crude palm oil for distribution in the Thai market. However, the production system has been in use for over a decade, leading to frequent shutdowns for repairs. These interruptions have resulted in production volumes falling short of targets and increasing maintenance costs. In some cases, delayed repairs have caused residual crude palm oil in the system to spoil, rendering it unusable and resulting in production waste. Upgrading or replacing the entire production system would require a significant capital investment. Given the current economic volatility, maintaining the existing system through improved maintenance practices is considered the most viable option.

To address these challenges and reduce both maintenance time and production costs, the researchers applied the principles of Total Productive Maintenance (TPM) to the company's production system over a six-month period. The results were then evaluated and presented to the company for consideration.

Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) is a comprehensive approach to equipment maintenance that aims to maximize the overall effectiveness of production systems by involving all employees in proactive and preventive maintenance activities. The core objectives of TPM are to eliminate equipment breakdowns, defects, and workplace accidents, ultimately enhancing productivity, quality, and operational efficiency.

Key Concepts of Total Productive Maintenance

1. **Employee involvement** – TPM shifts the responsibility of equipment care from solely the maintenance department to all employees, including machine operators and management, fostering a culture of shared responsibility.
2. **Proactive and preventive maintenance** – TPM emphasizes anticipating and addressing potential equipment issues before failures occur, rather than relying solely on reactive repairs.
3. **Continuous improvement** – The approach encourages regular efforts to improve equipment performance and reduce inefficiencies.
4. **Improved equipment effectiveness** – TPM seeks to minimize equipment downtime, defects, and other losses that hinder operational efficiency.
5. **Shared responsibility** – TPM promotes cooperation between production and maintenance teams to ensure equipment reliability and performance.
6. **Breakdown and defect elimination** – Through proactive maintenance, TPM aims to prevent unexpected failures and reduce production errors.

7. **Waste reduction** – TPM contributes to minimizing material waste, energy consumption, and other inefficiencies related to equipment malfunctions.
8. **Workplace safety enhancement** – By encouraging cleanliness and proper maintenance, TPM helps create a safer work environment and reduces the risk of accidents.
9. **Productivity improvement** – By optimizing equipment uptime and performance, TPM supports increased output and operational efficiency.
10. **Employee engagement** – Involving employees in TPM activities fosters ownership, accountability, and motivation, contributing to stronger teamwork and better results.
11. **Four Pillars:** Supporting activities that address different aspects of TPM, such as
 - a. **Autonomous Maintenance** – This pillar empowers operators to perform basic maintenance tasks such as cleaning, inspecting, and minor adjustments. This involvement fosters early detection of issues and a stronger sense of ownership.
 - b. **Planned Maintenance** – This pillar involves scheduling maintenance activities based on usage patterns and equipment condition to prevent unexpected breakdowns and extend equipment life through preventive and predictive maintenance.
 - c. **Focused Improvement** – Small, cross-functional teams are formed to identify and eliminate the root causes of inefficiencies. These teams analyze performance data and implement targeted solutions to enhance equipment effectiveness.
 - d. **Training and Skills Development** – TPM emphasizes building employee capabilities by providing training in maintenance procedures, equipment handling, problem-solving techniques, and the core principles of TPM to ensure effective participation across all levels.

Palm Oil Processing for Cooking

Palm oil processing for culinary use involves refining crude palm oil (CPO) to remove impurities and enhance its quality, making it suitable for human consumption. This process typically consists of four main stages: degumming, neutralization, bleaching, and deodorization. The outcome is refined, bleached, and deodorized (RBD) palm oil, which is widely used in cooking, food processing, and various industrial applications.

1. **Crude Palm Oil (CPO)** – The process begins with crude palm oil, which is extracted from the fruit of oil palm trees. CPO contains impurities such as gums, free fatty acids, pigments, and odor-causing compounds, which must be removed through refining.
2. **Refining Process** – The refining of CPO into RBD palm oil involves the following stages:
 - a. **Degumming** – This step removes phospholipids and other impurities by mixing the oil with water or using a dry degumming method.
 - b. **Neutralization** – Free fatty acids are neutralized using an alkaline solution, typically sodium hydroxide, resulting in the formation of soapstock which is subsequently separated from the oil.
 - c. **Bleaching** – Bleaching earth or activated carbon is used to adsorb pigments, trace metals, and residual soap, producing a clearer and more stable oil.
 - d. **Deodorization** – Volatile compounds and unpleasant odors are removed by subjecting the oil to high-temperature steam under vacuum conditions, yielding a neutral-flavored final product.
3. **RBD Palm Oil (Refined, Bleached, and Deodorized)** – The final product is a high-quality, purified oil suitable for direct consumption or further industrial use. RBD palm oil is characterized by its clarity, neutral taste, and resistance to oxidation.
4. **Fractionation (Optional)** – In some cases, RBD palm oil undergoes an additional process called fractionation, which separates the oil into liquid and solid components. The liquid portion, known as palm olein, is widely used as a cooking oil, especially in tropical climates due to its stability at high temperatures.

In summary, the palm oil refining process transforms crude palm oil into a stable, edible product with enhanced characteristics such as improved color, flavor, and oxidative stability, making it suitable for a wide range of culinary applications.

2. METHODOLOGY

This study employed both qualitative and quantitative research methods. Data were collected through a structured questionnaire distributed to 200 randomly selected employees from the production and maintenance departments

3. FINDING

The results of the study on Production Efficiency Optimization by Total Productive Maintenance: A Case of The Vegetable Oil Production Company are presented as follows:

1. The results of the study on the overall efficiency of the vegetable oil production system machinery before using the integrated maintenance with everyone involved found that the overall efficiency of the vegetable oil production system machinery was 83.8% on average. The deodorization and bleaching system had the lowest overall efficiency of the machinery in the vegetable oil production system with an average of 72.6%. The next highest ranking was the heating system with an overall efficiency of the machinery in the vegetable oil production system with an average of 80.3%. Both systems had an average overall efficiency of the machinery lower than the average of the production system.
2. The results of the study on losses in the vegetable oil production system before the integrated maintenance with everyone involved found that the damage or malfunction of machinery and equipment in the vegetable oil production system before the integrated maintenance with everyone involved was caused by the most damage from damaged valves with 35 damages, followed by the cause of blocked pipes with 17 damages, the cause of damaged motors and control systems with 15 damages, and the cause of damaged oil pumps with 10 damages.
3. The results of the implementation of the main pillar activities of integrated maintenance with everyone involved in the vegetable oil production system found that there were causes, obstacles, and problems in understanding and motivation of employees in the production department. and maintenance department, the researcher proposed to adjust the work activities and responsibilities of the employees in the production department and maintenance department to be consistent with the main pillar activities of maintenance with participation of all parties.
4. The results of the study of the overall efficiency of the vegetable oil production system machinery after using maintenance with participation of all parties found that after implementing the main pillar activities of maintenance with participation of all parties in the vegetable oil production system This resulted in an overall efficiency of the vegetable oil production system machines at an average of 87.7%, with the deodorization and bleaching system having the lowest overall efficiency of the machines in the vegetable oil production system at an average of 81.6%, followed by the heat production system with an overall efficiency of the machines in the vegetable oil production system at an average of 84.6%. Both systems had an average overall efficiency of the machines higher than the average of the production system.
5. The results of the study of losses in the vegetable oil production system after using the integrated maintenance with everyone involved found that the number of machine failures or malfunctions decreased to 32 times, classified as follows: valve failures had the highest number of failures at 11 times, pipe blockages at 10 times, oil pump failures at 5 times, motor failures at 4 times, and control system failures at 2 times.
6. The results of the study comparing the overall efficiency of the machines in the oil production system before and after using the integrated maintenance with everyone involved found that:
 - 1) After using the integrated maintenance with everyone involved, the overall efficiency of the vegetable oil production system tended to increase, with the efficiency of the entire production system increasing on average. 3.92%
 - 2) After using the multi-product maintenance system with everyone's participation, the loss of resources in the vegetable oil production system tends to decrease.
 - 3) After using the multi-product maintenance system with everyone's participation, the loss or malfunction of machinery in the vegetable oil production system tends to decrease.

4. CONCLUSION

Following a six-month trial of the Total Productive Maintenance (TPM) system, the company successfully reduced maintenance time and production costs, while improving overall production efficiency by more than 3%. Based on these positive outcomes, the company's management decided to continue

implementing the TPM system within the production department and plans to expand its application to other departments in the future.

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