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Using Lean to Optimize Processes in Paint Manufacturing to Meet Demand Deadlines

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Abstract

AkzoNobel, a leading manufacturer of paints and protective coatings, has faced challenges in meeting customer demands due to a declining adherence to plan (ATP), resulting in dissatisfied customers, increased costs, and a damaged reputation. To address this issue, a mixed-method research study was conducted, combining quantitative data to assess operational performance with qualitative data to understand operator challenges. Focusing on the PVA product line, the study revealed an average batch cycle time (BCT) of 44.3 hours, serving as a baseline for improvement measurement. Notably, the final quality control testing and extending stages were major contributors to BCT and ATP. Identified issues included resource allocation, communication, standardization, and process inefficiencies. The study recommends strategies for senior management to enhance operational efficiency, reduce BCT, and improve ATP. By implementing these improvements, AkzoNobel aims to optimize manufacturing processes, meet production deadlines, and regain its competitive edge, ensuring high-quality product delivery to Sub-Saharan African consumers and maintaining its status as a world-class manufacturer in the global marketplace.

Keywords

Adherence to Plan (ATP), Operational Efficiency, Batch Cycle Time (BCT) and Manufacturing Process Optimization.

1. Introduction

The paint manufacturing industry serves critical roles in the automotive, construction, shipping, and aerospace sectors, with its success hinging on product quality and meeting deadlines. As construction and manufacturing industries expand, the demand for paint and protective coatings has surged. However, a specific paint manufacturer has struggled with meeting the rising demands within stipulated deadlines, leading to customer dissatisfaction and business losses. This study investigates the company's predicament by collecting and analyzing relevant data, employing tools and techniques from existing literature, and utilizing a research methodology to tackle the issue. Set within a corporate context, the study, based on current performance data, required authorization from the author's manager.

AkzoNobel, a Dutch multinational specializing in paints and coatings, faces a critical challenge as it struggles to meet increasing customer demands due to outdated equipment and inefficient processes. While the company's production capacity has remained largely unchanged over five years, the demand for paint products has surged by approximately 50%. This misalignment has resulted in a significant decline in adherence to plan (ATP), dropping from 94% in 2018 to 54% in 2022.

The consequences of this decline are significant, including increased costs, dissatisfied customers, and damaged reputation. To address this issue, the study aims to investigate industrial engineering principles and tools that can optimize processes and enhance ATP. By applying these tools and techniques, the company seeks to streamline operations, reduce overtime, and minimize resource utilization, leading to cost savings and improved performance. The ultimate goal is to meet demand deadlines efficiently.

In manufacturing, failing to meet deadlines leads to additional expenses related to expedited shipping, overtime wages, and high inventory carrying costs (Christopher & Holweg 2019). Customer dissatisfaction can result in a loss of future business and negative word-of-mouth, while a damaged reputation negatively affects existing customer relationships (Ferdows et al. 2004). To sustain business growth and success, it's imperative to prioritize customer satisfaction by delivering high-quality products on time.

1.1 Problem Statement

This research is focused on investigating the underlying factors contributing to the declining adherence to plan (ATP) observed in AkzoNobel over the past five years. During this period, ATP has dropped from 94% in 2018 to a concerning 54% in 2022 (as depicted in Figure 1). This decline in ATP has had adverse effects, particularly in the company's ability to meet demand deadlines, resulting in customer dissatisfaction and business losses. The study's primary objective is to identify and analyze the root causes behind this low ATP by employing industrial engineering tools and techniques. By doing so, it aims to pinpoint opportunities for enhancing the paint manufacturing process, ultimately enabling the formulation of recommendations for senior management. These recommendations, if implemented, have the potential to significantly improve ATP and the company's capacity to meet demand deadlines effectively.

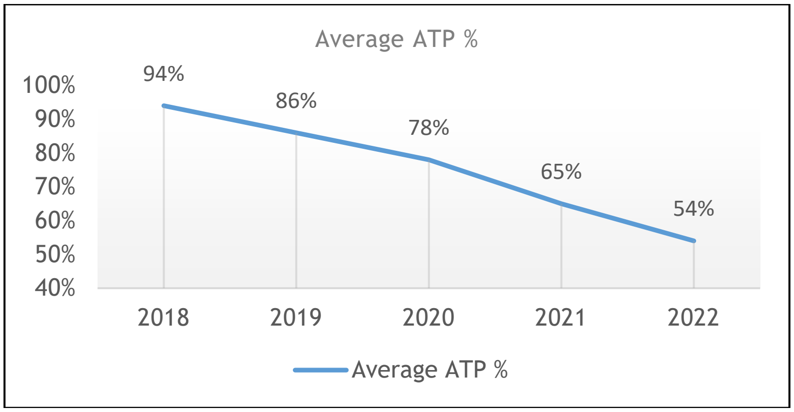

Figure 1. Average ATP% 2018 – 2022

1.2 Significance of the Study

AkzoNobel has faced challenges meeting demand deadlines, leading to dissatisfied customers and business losses. This research aims to identify bottlenecks within the paint manufacturing process that contribute significantly to the declining adherence to plan (ATP) metric, causing delays. The primary focus of this study is to employ relevant tools and techniques to enhance the efficiency and productivity of the manufacturing process. The research intends to offer valuable insights and recommendations for improving the paint manufacturing process, ultimately guiding AkzoNobel in meeting the growing demand for paint products. By addressing these issues, the company can not only maintain positive customer relations but also enhance its competitiveness in the global market.

1.3 Objectives

The objectives of the study are listed below:

- To explore various industrial engineering tools and techniques which can be used to collect, analyse and consolidate relevant data.
- To determine which stage in the manufacturing process has the largest impact on adherence to plan.
- To identify opportunities for improving current processes which have a high impact on the adherence to plan.
- To make recommendations to senior management on strategies that will increase the adherence to plan.

2. Literature Review

The literature review in this study aims to comprehensively explore the concept of Adherence to Plan (ATP) metric and its significance in achieving business goals and objectives. The review will delve into various aspects related to

ATP, including its impact, influencing factors, and approaches for improvement, particularly in the context of the manufacturing industry, with a focus on AkzoNobel.

2.1 Overview of Adherence to Plan (ATP)

Adherence to Plan (ATP) is a crucial metric used to evaluate a manufacturing system's efficiency in adhering to its production schedule. For AkzoNobel, this metric is calculated over a specific time frame by dividing the actual number of manufactured products within that period by the planned number of products for the same period. This result is then multiplied by 100 to derive a percentage value. In equation form:

$$\text{ATP} = \frac{\text{No. of products manufactured}}{\text{No. of planned products}} \times 100 \qquad (1)$$

An ATP score of 50% signifies that the company is producing only half of the products scheduled in the production plan, indicating a failure to meet demand deadlines effectively. ATP serves as a valuable indicator of the overall manufacturing performance, offering insights into whether production plans are being successfully executed. When ATP drops below a certain predetermined threshold, it prompts the implementation of corrective actions to improve manufacturing operations and ensure that production aligns better with set plans.

2.2 Factors Influencing Adherence to Plan (ATP)

Several factors significantly influence Adherence to Plan (ATP) within a manufacturing company. Effective production planning and scheduling, as highlighted by Smith and Johnson (2018), are crucial for reliable ATP. Accurate forecasting, realistic timelines, and proper resource allocation are key. Forecasting based on customer demand enables precise production plans, while accurate estimation of manufacturing times for diverse products ensures on-time delivery. Poor forecasting or inadequate resource allocation can lead to last-minute plan changes inevitably lowering the ATP due to material and resource unavailability. The efficiency and effectiveness of the supply chain, as discussed by Chen et al. (2020), plays a pivotal role in the level of ATP. Proper coordination of suppliers, logistics, and inventory impacts ATP. Supplier lead times, inventory management, and logistics coordination all contribute. Effective supplier relationships and efficient payment systems foster reliability and even benefits such as occasional discounts. Inventory must be balanced to prevent shortages or excesses, and well-coordinated logistics minimize delays and enable accurate delivery dates. Collaboration and communication across departments, emphasized by Kim and Lee (2019), are vital for high ATP. Sharing real-time information, cross-functional coordination, and teamwork are key. Constant information flow allows prompt issue awareness and adjustments. Cross-functional teamwork integrates diverse expertise for effective issue resolution and operational efficiency. By setting a shared goal of high ATP, departments can work together synergistically.

2.3 Strategies to Increase the Adherence to Plan (ATP)

There are several strategies that can be implemented to enhance the adherence to plan (ATP). The adoption of Lean Manufacturing principles offers a valuable approach. By eliminating waste, reducing variability, and optimizing processes, lean practices like standardized workflows and visual management systems, as discussed by Jones and Smith (2021), have demonstrated the potential to significantly improve ATP. Lean tools and techniques facilitate process analysis and continuous improvement, with the involvement of operators being vital to maintaining improvements and fostering a culture of ongoing improvement. Integration of advanced technologies, such as Manufacturing Execution Systems (MES) and Internet of Things (IoT) devices, can elevate ATP through real-time monitoring, data analysis, and predictive maintenance, as highlighted by Smith and Patel (2017). Despite initial costs, technology integration brings benefits like resource optimization, reduced disruptions, and informed decision-making. This fosters a more efficient manufacturing environment, allowing swift adjustments based on accurate, up-to-date data and enabling global collaboration for problem-solving. Investing in employee training and engagement, as emphasized by Thompson and Brown (2019), is another powerful strategy. Robust training programs and a culture of continuous learning enhance employees' commitment to adhering to production plans. Regular training keeps employees updated on safety measures, technological advancements, and best practices. Additionally, involving employees in decision-making cultivates a sense of ownership, motivation, and teamwork, thereby aligning their efforts with ATP goals.

2.4 Benefits of Process Improvement Strategies

Implementing process improvement strategies offers a range of significant benefits to the company's operations. Improved operational efficiency is a key advantage, achieved by reducing waste, minimizing batch cycle time (BCT), and optimizing resource utilization. Jones and Smith's research (2018) on lean practices illustrates potential efficiency gains, showing a 30% BCT reduction and 20% overall operational efficiency increase through Lean Six Sigma (LSS) methodologies. This optimization results in faster product delivery, efficient resource allocation, and heightened productivity, ultimately reducing manufacturing costs and boosting profits. Process improvement strategies also positively impact quality goals and objectives. Patel et al.'s findings (2019) emphasize that Total Quality Management (TQM) strategies lead to a 40% decrease in defective products and customer complaints, enhancing product quality and fostering customer loyalty. By consistently delivering high-quality products, companies establish strong customer relationships and build a reputation for excellence. Cost reduction and increased profits are positive outcomes of process improvement strategies. Adams and Brown's study (2020) indicates that Business Process Reengineering (BPR) implementation reduced operational costs by 15% and increased profits by 10% within the first year. Through waste elimination and reengineering, companies identify non-value-adding activities, leading to efficient resource utilization, minimized downtime, and reduced manufacturing costs.

Enhanced customer satisfaction is a direct result of process optimization. Chen et al.'s research (2021) shows that customer-focused improvement strategies lead to a 25% increase in customer satisfaction and a 20% rise in customer retention rates. Process optimization ensures consistent product quality, reduces defects, and meets customer expectations, contributing to a positive customer experience and reputation. Employee empowerment and engagement are enriched by process improvement strategies. Lee and Kim's study (2019) reveals those initiatives like Kaizen lead to higher employee satisfaction, motivation, and ownership in improvement efforts. Involving employees in improvement projects creates a sense of purpose, allows insight into operational issues, and fosters a dynamic work environment, ultimately leading to enhanced job satisfaction and skill development. Increased adaptability and agility are consequential benefits. Smith et al.'s research (2022) highlights agile strategies resulting in quicker product launches and improved responsiveness to market demands, critical in a dynamic business environment. Process improvement strategies enable companies to adapt to changing market conditions, develop sustainable products, and stay ahead of competitors, ensuring long-term success and growth.

2.5 Tools and Techniques for Process Optimization

There are a range of industrial engineering tools and techniques that can be used to optimize processes, with a focus on root cause analysis (RCA) and process improvement strategies. The 5 Whys Technique, developed by Sakichi Toyoda (Serrat & Serrat 2017), is an RCA tool that involves repeatedly asking "why" to uncover the root cause of a problem. It encourages cross-functional involvement and countermeasure implementation. The 5 Whys technique is effective in resolving issues, from simple to complex, and can be combined with Lean Manufacturing principles. A Fishbone Diagram, also known as an Ishikawa or cause-and-effect diagram, is an approach that models potential root causes in the shape of a fish to troubleshoot solutions (Botezatu et al. 2019). It's widely used in root cause analysis for quality management and product development, helping to identify factors contributing to problems. The Pareto Analysis technique based on the Pareto Principle, is another RCA tool that prioritizes issues by identifying the vital few causes responsible for most problems (Pyzdek 2021).

It assists in making effective decisions and resource allocation by focusing on high-impact issues first, aligning efforts for productivity improvement. Time & method studies is a process improvement tool that is used to analyse work methods and the time required for tasks, offering insights into efficiency and areas for optimization (Rajiwate et al. 2020). Time studies measure task completion time, aiding in setting realistic goals and resource allocation, while method studies focus on sequence, steps, and techniques used for tasks. Both contribute to process optimization and productivity enhancement. Value Stream Maps (VSM) is a Lean Manufacturing tool that uses flowcharts to capture every step in a process, providing an overview of value flow and identifying waste and inefficiencies (Stadnicka & Litwin 2019). By visualizing the entire process, including value-adding and non-value-adding activities, VSM helps in streamlining processes, reducing manufacturing times, and enhancing quality. It also aids in designing future-state improvements for overall process enhancement.

3. Methods

Research is regarded as a formal and systematic process that entails a thorough application of the scientific method of analysis. It encompasses a methodical approach to investigation, typically culminating in the creation of a structured record detailing the procedures and a comprehensive report presenting the findings or conclusions (Pandey & Pandey 2021). The chapter begins by discussing the rationale for the chosen methodology, explaining the reasoning behind its selection for the study. It also introduces the research design, which provides an overall direction for the methodology used throughout the subsequent sections of the chapter. The research process itself is outlined to illustrate the flow of work during the study. The author delves into the details of Saunders' Research Onion, a conceptual framework for research methodology. Within this framework, they describe and justify the specific methods selected at each layer of the Research Onion, clarifying why these methods are appropriate for the study. Furthermore, the chapter identifies and discusses the various tools and research instruments utilized for data collection and analysis.

3.1 Rationale for the Methodology

This study aims to address low adherence to plan (ATP) by enhancing operational efficiency and productivity while minimizing waste and costs. The research methodology involves assessing the current process to find bottlenecks and inefficiencies. This assessment includes process mapping, data analysis, and observations. Quantitative data (process cycle times) and qualitative data (observations) will be collected through multiple observations and time studies on product batches within the same family. A value stream map (VSM) will visualize the manufacturing process, aiding in bottleneck and inefficiency identification. Operators and foremen will be engaged, and the study's objectives will be explained to gain valuable insights and enhance openness to proposed improvements, ensuring feasibility and sustainability. Proposed improvements will be tested on the VSM to assess their impact before full-scale implementation. Continuous monitoring and measurements post-implementation will track performance, identify further improvement opportunities, and maintain sustained process enhancements over time.

3.2 Research Design

This research design employs a mixed-methods approach, combining quantitative and qualitative methods to comprehensively study the manufacturing process:

Quantitative Phase:

- Define Key Performance Indicators (KPIs), with a focus on Batch Cycle Time (BCT).
- Collect quantitative data through time studies on the manufacturing process.
- Analyse quantitative data using techniques like Value Stream Mapping (VSM) and Pareto analysis to identify bottlenecks and inefficiencies.

Qualitative Phase:

- Utilize process mapping and observations to visually represent the process and uncover challenges faced by operators.
- Collect qualitative data through direct observations of the process.
- Analyse qualitative data to gain a deeper understanding of factors influencing the process and generate actionable recommendations.

Integration and Recommendations:

- Integrate findings from both quantitative and qualitative phases to form a comprehensive understanding of the process, including its strengths, weaknesses, and areas for improvement.
- Generate actionable recommendations aligned with desired performance outcomes, addressing identified bottlenecks.
- Develop an implementation plan outlining necessary resources and timelines for implementing recommended process improvements.

This mixed-methods approach allows for a thorough evaluation of process performance while also providing insights into the qualitative aspects affecting it. By combining quantitative and qualitative data, the study enhances the validity and reliability of its findings, ultimately leading to practical and effective recommendations for process optimization.

3.3 Research Process

The research process provides an overview of the steps that were followed to achieve the research objectives. First the literature relevant to adherence to plan (ATP) and process optimization was reviewed. The appropriate tools and techniques were the reviewed to determine which ones were relevant to the study. A process flow diagram depicting the manufacturing process was then developed. The sample population was then established by analysing past data and time studies were conducted on the selected population through direct observation of the process. Multiple samples were studied and consolidated using VSM (value stream mapping) and Pareto charts. Challenges faced by the operators were studied to determine possible solutions and improvements. Lastly the proposed improved process flow was drawn to show the impact of the optimization efforts relative to the current process flow.

3.4 Research Onion

The research methodology employed in this study follows the structure of Saunders' Research Onion model, which is a tool used to guide researchers through the decision-making process in developing a suitable and effective research approach (Mardiana 2020). The research onion comprises of six layers, each building upon the previous one, culminating in the selection of tools and data collection methods for the study.

Data Collection and Analysis forms the final layer, outlining the tools and techniques used for data gathering and interpretation. The tools and techniques used during the study were identified during the literature review. A SIPOC (supplier, input, process, output, customer) diagram was drawn to gain a basic understanding of the manufacturing process and the flow of materials between the different stages. The current manufacturing process was then represented on a process flow diagram (PFD) using the SIPOC diagram as a reference. The PFD was used for visualizing the manufacturing stages and for identifying improvement opportunities. Time studies were conducted on the manufacturing processes of the high-volume products chosen to be subjected to the study. Process times were recorded on time study sheets and summarized onto a single table to calculate the average batch cycle time and average time taken to complete each task in the manufacturing process. Observations were made while conducting time studies to identify operational challenges experienced by operators. Value stream mapping (VSM) was used to analyse the time study data and assess the value-added and non-value-added activities in the manufacturing process. The Pareto analysis technique was then used to rank the manufacturing stages by impact on adherence to plan (ATP), aiding in prioritizing improvement efforts. Brainstorming was then used to generate potential solutions and improvement actions based on the observations made and data collected.

4. Results and Discussion

The findings and analysis of the data collected during the research phase of the study are presented below. The analysis is aligned with the research objectives developed prior to conducting the study. The current manufacturing process is explained using diagrams for clarity and understanding and thoroughly analysed using various tools and techniques as stated in the research methodology to determine which stages in the process have the highest impact on adherence to plan (ATP) and where there are opportunities for implementing improvements with the aim of increasing the level of ATP.

4.1 Manufacturing Process Analysis

In this section, the manufacturing process of paint is analysed and outlined, providing a comprehensive understanding of the transformation of raw materials into finished products. The process is divided into various stages, and each stage's contribution to the overall process is examined.

4.1.1 Basic Overview of the Manufacturing Process

The manufacturing process (Figure. 2) begins with an order placed for a specific product, such as Product A. The production foreman receives a batch card from the planning department, detailing the required raw materials. The raw materials are obtained from the raw materials store (RMS) and delivered to the production plant. The plant operator, responsible for the batch, selects the appropriate mixing tank (HSD) and manually adds raw materials, following the instructions on the batch card. After thorough mixing, a sample is taken for a FOG (fineness of grind) test conducted in the quality control (QC) lab. Upon passing the FOG test, the extending process begins in an extending tank (ET), where additives, thickeners, and colorants are mixed for a designated time. QC testing is conducted on samples from the extended batch, ensuring quality standards are met. Once approved, the batch is filled into cans, placed on pallets, and sent to the distribution centre for storage and delivery.

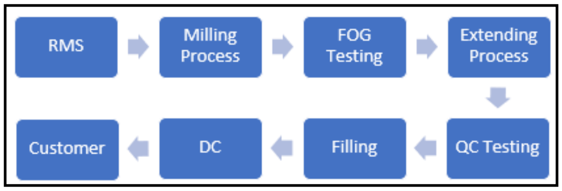

Figure 2. Outline of the Paint Manufacturing Process

4.1.2 SIPOC Analysis

A SIPOC (supplier, input, process, output, customer) diagram (fig. 3) provides a detailed understanding of resource flow and processes within the manufacturing. It outlines the roles of suppliers, input sources, processes, outputs, and customers for each stage of the manufacturing process. For example, the loading of raw materials into the high-speed disperser (HSD) involves input from the RMS and production plant, with the HSD operator controlling the process. Similarly, the extending process involves multiple inputs, processes, and outputs, and the product's journey is traced from raw materials to the distribution center.

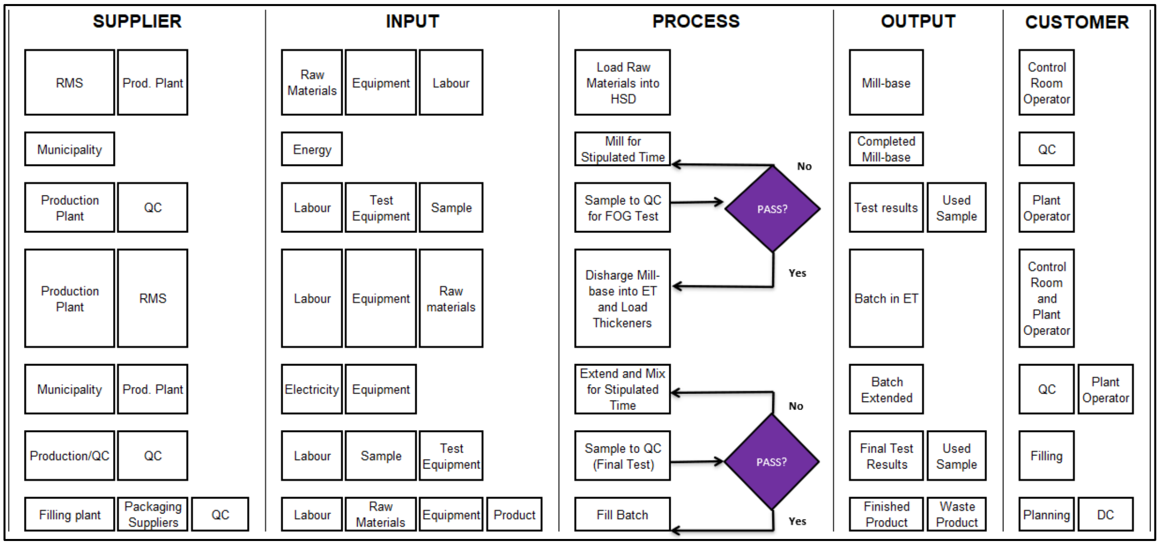

Figure 3. SIPOC Diagram

4.1.3 Process Flow Diagram

The process flow diagram (Fig. 4) is derived from the SIPOC diagram, simplifying the manufacturing process into a more easily comprehensible visual format. It highlights the sequence of stages, starting with raw material addition to the high-speed disperser (HSD), progressing through milling, extending, and testing, leading to the filling of product into cans. The diagram clarifies the flow of activities and transitions between stages, enhancing clarity and understanding.

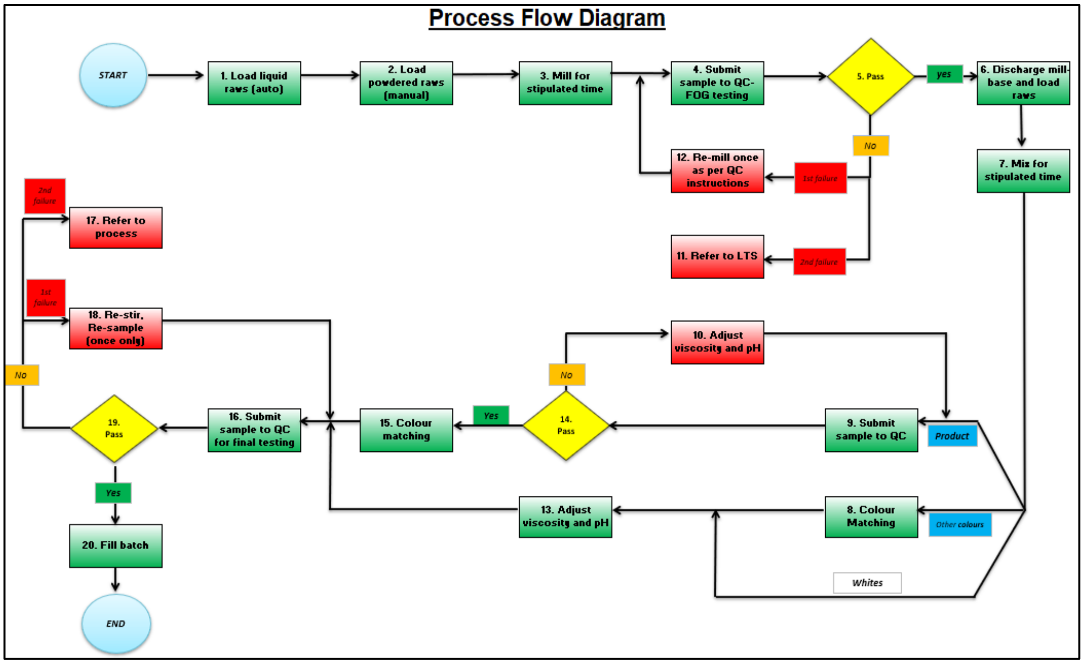

Figure 4. Manufacturing PFD

4.2 High-Volume Product Analysis

In this section, an analysis of high-volume PVA products produced by the company over the years 2020 to 2022 is presented. The analysis employs the Pareto principle (80:20 rule) to identify significant product families for each year, focusing on the "vital few" high-volume products. These products are referred to by their abbreviated names for confidentiality reasons. Here's a summary of the key findings:

4.1.1 High-Volume Products- 2020

Using the Pareto analysis, the following "vital few" high-volume products were identified for 2020: WGR, BM, ACR, TRD, LXSK, RG. Products with lower volumes, referred to as the "trivial many", were not considered for the study.

4.1.2 High-Volume Products- 2021

The same set of high-volume products as in 2020 remained prominent in 2021: WGR, BM, TRD, ACR, LXSK, RG. Similarly, products with lower volumes were excluded from the study.

4.1.3 High-Volume Products- 2022

The high-volume product lineup for 2022 was consistent with the previous two years: WGR, BM, TRD, ACR, RG, LXSK. These products maintained their high volume across all three years, making them ideal candidates for the study. Products with lower volumes were not considered.

4.1.4 Product Volume Summary

A graphical summary was provided (Fig. 5), indicating the production volumes for the six high-volume product families across the years 2020 to 2022. Among these, the product family "WGR" consistently exhibited the highest production volume. As a result, "WGR" was selected as the subject of the study due to its sustained high-volume production over the three-year period. This choice ensures readily available data for conducting process optimization. While only one product family was studied due to time constraints, the insights and improvement strategies derived from studying "WGR" can be extrapolated to benefit the other product families as well.

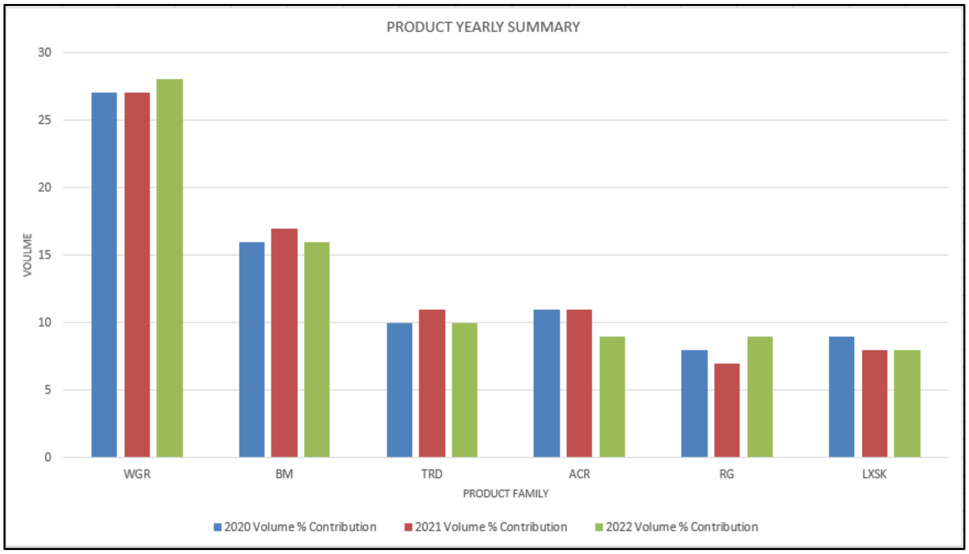

Figure 5. Volume Summary

4.3 Time Study Analysis

A comprehensive time study analysis was conducted on the WGR product family, comprising of multiple products with variations limited to pigments and colorants. The manufacturing process for 20 products was observed and recorded time study sheets.

Data collected from the time study sheets were compiled into a comprehensive summary. In this summary, the average time required to complete each stage of the manufacturing process was computed, serving as the benchmark for each activity. The following average times were determined for each stage:

1. Milling Stage (Step 1 to 12) - 333.8 minutes
2. QC FOG Testing (Step 13 to 14) - 8.1 minutes
3. Extension Stage (Step 15 to 34) - 831.8 minutes
4. QC Testing (Step 35 to 48) - 1144.3 minutes
5. Filling Process (Step 49) - 339.3 minutes

Consequently, the average Batch Cycle Time (BCT) amounted to 2657.3 minutes or equivalently, 44.3 hours. These values have been established as the reference points against which the impacts of the proposed improvement initiatives will be measured once implemented. Future time studies, utilizing the same methodology, will be conducted post-implementation to assess changes in BCT.

4.4 Value Stream Map (VSM) Analysis

The average time taken to complete each activity in the manufacturing process calculated in table 1 was used to populate the VSM (value stream map) shown in Figure 6. In summary the following data was obtained from the VSM:

Table 1. VSM Results

Stages	**Steps**	**Time Taken**	**Idle Time**	**Value Adding**
Stage 1- Milling	11	5.54hrs	1.19hrs	4.35hrs
Stage 2- FOG test	2	0.17hrs	0.02hrs	0.15hrs
Stage 3- Extending	20	13.86hrs	6.64hrs	7.23hrs
Stage 4- QC	14	18.7hrs	12.19hrs	6.51hrs
Stage 5- Filling	1	5.65hrs	2.65hrs	3hrs
Total	48	43.93hrs	22.69hrs	21.24hrs

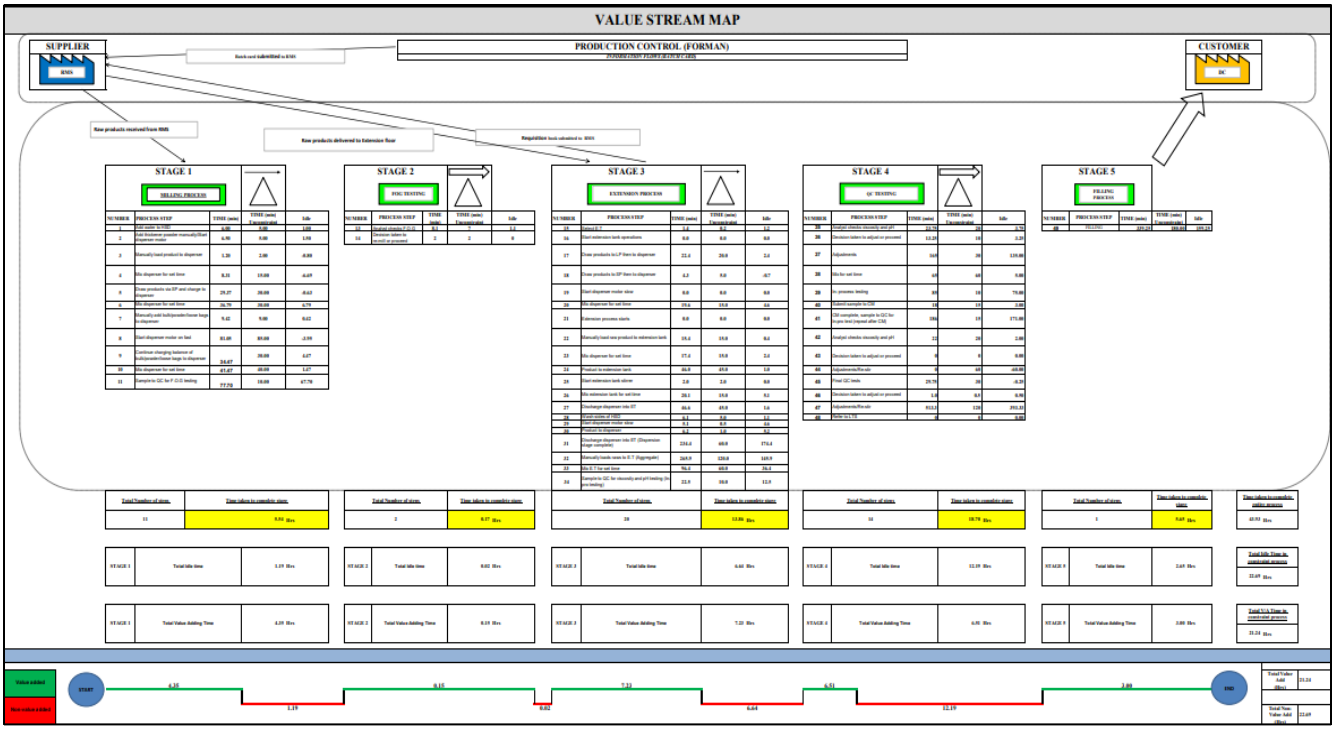

Figure 6. Value Stream Map

4.5 Pareto Chart Analysis

The total time taken to complete each stage in the manufacturing process calculated using the VSM (value stream map) was used to develop a Pareto chart as shown in Figure 7. Using the 80:20 rule it can be concluded that the “vital few” stages in the manufacturing process are:

1. Final Testing (incl. color matching)- 1122 minutes.
2. Extending Stage- 831 minutes.

These stages are the most time-consuming stages in the manufacturing process and contribute largely to the high BCT (batch cycle time) and are therefore the root causes of the low ATP (adherence to plan) as these stages have the largest impact and delay the products from being completed as per the production plan.

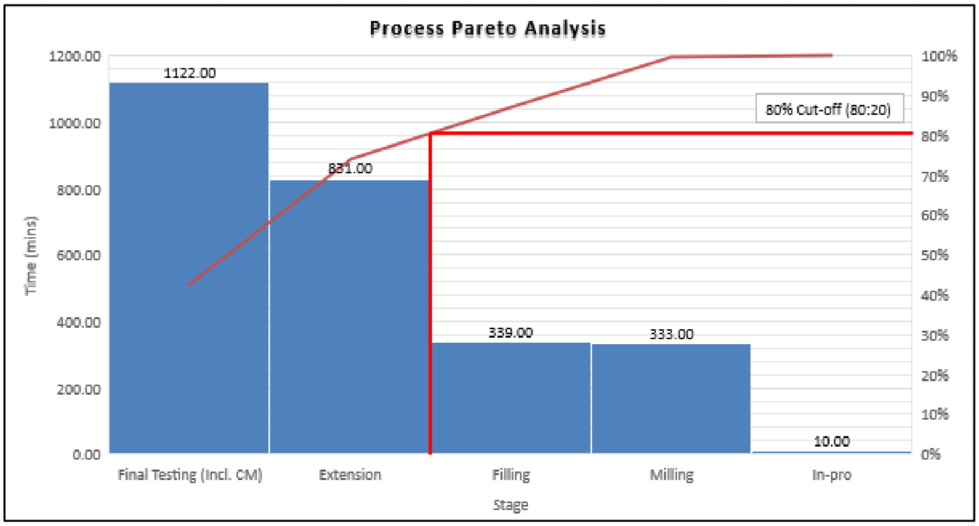

Figure 7. Pareto Chart

4.6 Analysis of the Challenges Observed

The various challenges experienced by operators that were observed during the time studies are listed and analysed below:

1. Only one hoist between HSD (high speed disperser) 6 and 7- the hoist is used to pick up bulk bags that weigh more than 1000kg to load the contents of the bulk bag into the HSD. Only one hoist between both HSD's means that only one HSD can be loaded at a time while the other operator must wait for the hoist to become available which contributes to the idle time and overall BCT (batch cycle time).
2. Only one operator running the entire extending floor- the extending floor contains multiple ET's (extending tanks) and there is only one operator available to attend to the numerous batches within those tanks. This delays products from being completed as the operator can only attend to one batch at a time which involves highly manual activities, so the operator becomes less efficient as each batch is completed due to fatigue and tiredness.
3. Too much walking to QC (quality control) for submitting samples- it is not practical to take a sample from an ET as and when it is ready as it involves the operator walking to and from QC multiple times to submit samples. It would be more efficient for the operator to submit multiple samples to QC at once.
4. Batch card does not stipulate exact times for milling and mixing- this creates confusion for operators as they must guess how long to have the batch mixing for until it is ready. This means that operators can have batches mixing for longer than required.
5. QC does not notify the operator promptly when to proceed to the next stage- the QC analyst testing the batch does not let the operator know as soon as the testing is completed resulting in lost time.
6. Discrepancy between QC analysts when conducting FOG (fineness of grind) testing- this discrepancy results in unnecessary re-milling and re-sampling.
7. Inaccurate viscosity calculation- this inaccuracy results in many additions and adjustments to the batch which impacts the BCT.
8. Single pump system- the milling floor contains one pump which restricts milling operations when chemicals and liquid raw materials are required for multiple HSD's. This delays batches from being completed as the pump can only load raw materials into one HSD at a time.
9. Mixing blade height- there are no graduations or markings on the mixing blade shaft/disperser to show the height of the blade in the tank. This means that batches may not be mixed efficiently if the mixing blade is at the wrong height.
10. Discrepancies between the PLC (programmable logic controller) system, batch card and the operators understanding of the process- this creates confusion during manufacturing and delays products as processes are not standardized.
11. Too many loose bags- a single bulk bag can be used rather than the operator using multiple paper bags and loading each one into the tank which is time consuming.
12. Tank turnaround time is high, and tanks are occupied for too long- this delays new batches from starting production having a cascading effect on the production plan.
13. Time consuming QC test methods- the methods used by QC to test samples are long and time-consuming which results in an extended BCT and can be streamlined using predictive test methods.
14. Practicality of process- the proper sequencing of steps is not followed by operators during the manufacturing process due to practicality.
15. Product formulations- the product formulations have been adjusted many times and the changes implemented may not be correct which results in additions having to be done to match the batch to the standard.

4.7 Proposed Improvements

The improvement strategy recommended to AkzoNobel as a plan to enhance operational efficiency and increase the adherence to plan (ATP) was developed. Brainstorming was used to formulate solutions and take advantage of improvement opportunities. Action steps were developed for each brainstorming output and prioritized according to the level of difficulty of carrying out the action.

An improved process flow that is recommended to reduce the BCT (batch cycle time) is shown in figure 8. The improved process flow stipulates the exact mixing times for product WGR and creates a direct interface between the operator responsible for the batch and the QC analyst testing the batch to reduce the amount of waiting time spent by the operator and avoid unnecessary channels of communication.

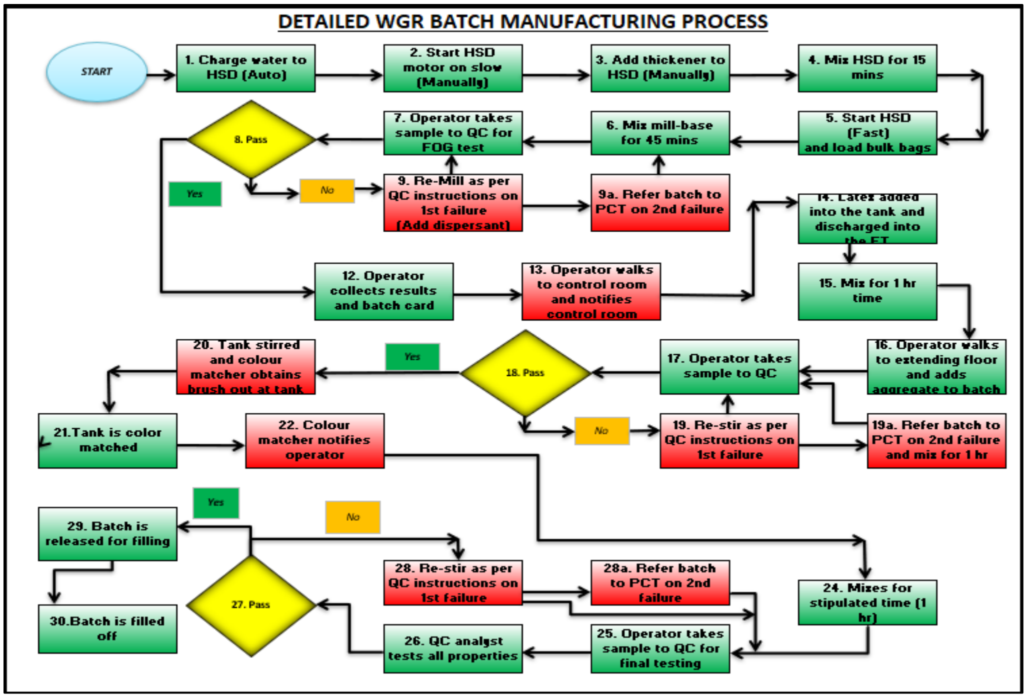

Figure 8. Proposed Improved Manufacturing Process

5. Conclusion

In conclusion, this study aimed to investigate the causes of low adherence to plan (ATP) experienced by AkzoNobel and recommend improvement strategies to optimize manufacturing processes and meet demand deadlines efficiently. The findings revealed several underlying factors contributing to low ATP which includes poor resource allocation, communication gaps between departments, lack of standardization, teamwork issues, inefficient QC (quality control) testing methods, manual task fatigue, and impractical manufacturing sequences. Primary research using industrial engineering tools and techniques further identified the final QC testing stage and the extending stage as having the largest impact on ATP. Opportunities for improvement were identified through value stream mapping, leading to the formulation of process improvement strategies. As a result, the study proposes recommendations for senior management to enhance operational efficiency and increase the adherence to plan. By addressing these findings and implementing the improvement strategies, AkzoNobel can optimize its manufacturing processes, reduce batch cycle times (BCT), and better meet production deadlines ultimately achieving higher levels of ATP and improving overall performance in the market.

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