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ANALYSIS OF *WORK-IN-PROCESS* INVENTORY CONTROL IN OPTIMIZING PRODUCTION PRODUCTIVITY (CASE STUDY: ALCON BATAM MANUFACTURING)

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Abstract

Proper Work-In-Process Inventory Control in Terms of Quantity and Periodicity is a Crucial Variable in Balancing the Production Process in a Manufacturing Company. The right amount of well-controlled Work-In-Process inventory enhances the optimization of production productivity. Unstable Work-In-Process inventory levels in the production line lead to waiting times (downtime), resulting in an unproductive and inefficient production process. The objective of this study is to analyze the implementation and control of Work-In-Process inventory levels about the effectiveness of the production process at Alcon Batam Manufacturing. This research was conducted using a qualitative method through a case study approach, referring to previous research theories to analyze and describe the actual implementation of Work-In-Process inventory control at Alcon Batam Manufacturing, as well as assess its effectiveness in production productivity. The findings of this study recommend the implementation of the Min-Max Stock method as a solution to minimize waiting time in the production flow, thereby optimizing production productivity. The study identifies the optimal Work-In-Process inventory levels for production activities at Alcon Batam Manufacturing for each production process as follows: 871.5 units for Packaging, 1,207.5 units for RFID, 766.5 units for CLTI, 861 units for Buffing, 798 units for Belling and Handpiece, and 1,102.5 units for Coupling.

Keywords: Inventory Control, Productivity, Work-In-Process

Introduction

A manufacturing company is an implementer of complex management activities. The operational activities of a manufacturing company consist of numerous components that require optimal control and regulation. One of the crucial components of a manufacturing company is inventory. Inventory is one of the most valuable assets of a company, and effective inventory control with proper management helps reduce production costs. The purpose of inventory management implementation is to regulate raw material supplies so that they can be utilized efficiently (Nuraeni & Santoso, 2024). Inventory control is the process of planning, organizing, and overseeing a company's assets to ensure their availability according to needs while minimizing costs. Improper inventory management can lead to various issues, such as high storage costs and lost business opportunities due to stock shortages (Pide, 2025).

Inventory management is a series of decisions or policies made by a company to ensure that it can provide high-quality inventory in the right quantity and at the right time (Lase et al., 2022). Inventory consists of three types: raw material inventory, *Work-In-Process* inventory, and finished goods inventory. Raw material inventory refers to components in the production process that will be processed into *Work-In-Process* inventory and eventually become finished goods. *Work-In-Process* inventory refers to inventory that has undergone the production process but has not yet been completed. Finished goods inventory is the final transformation of raw materials and other production components that have completed all stages of production and are ready for distribution (Nuraeni & Santoso, 2024). Every business process must be controlled and executed with efficient principles while adhering to environmentally friendly practices (Sucitra et al., 2020).

The inventory control process aims to prevent stock shortages (*out of stock*) and excess stock (*overstock*). Well-regulated inventory levels help maintain a balance between output and input at each stage of production, allowing manufacturing companies to reduce storage costs and minimize waiting time (*downtime*). Downtime refers to periods when the production process halts during working hours while waiting for raw materials or *Work-In-Process* inventory to become available from the previous stage. Alcon Batam is a manufacturing company that implements a parallel production process, where work on a single lot request can be carried out continuously across three or more processes simultaneously. The parallel method requires precise inventory levels for subsequent processes, and if inventory is unavailable, those processes will cease operations.

This results in an unproductive production process due to ineffective *Work-In-Process* inventory control. Therefore, this study aims to provide recommendations for improving inventory control at Alcon Batam Manufacturing to enhance efficiency and optimize production productivity. The general objective of inventory

control is to ensure that the company maintains an optimal inventory level, both in terms of quantity and timing, to support smooth operations and business efficiency (Pide, 2025). The scope of this study is to analyze the *Work-In-Process* inventory control process in the production line of Alcon Batam Manufacturing for the April 2025 period. This involves collecting data on *Work-In-Process* inventory levels during production, analyzing the data, and determining the optimal inventory levels using the *Min-Max Stock* method to develop solutions for addressing inefficiencies in production for future periods.

Methods

This study began with observations at Alcon Batam Manufacturing to analyze the production process and inventory control carried out during the April 2025 period. Based on a literature review referencing previous research on inventory control, the author identified inefficiencies in *Work-In-Process* inventory management within Alcon Batam's production line. To analyze the inventory control system applied at Alcon Batam Manufacturing, the author collected *Work-In-Process* inventory data from the production period of April 2025. Using the available data, the author then analyzed and described the impact of ineffective *Work-In-Process* inventory control on production output optimization and efficiency. The study applied the *Min-Max Stock* inventory control method to determine the standard *minimum stock* levels of *Work-In-Process* inventory in order to eliminate waiting time (*downtime*) in the production process.

The *Min-Max Stock* method is a control strategy in which, when inventory levels approach the safety stock threshold, a reorder point is triggered. This allows the company to minimize costs associated with the risk of inventory shortages (*out of stock*) (Ismira, 2024). The *Min-Max Stock* method analyzes the condition in which, when inventory levels approach the minimum threshold, a reorder must be initiated (Rahmadhani & Ernawati, 2024). Using the *Min-Max Stock* inventory control concept, the author calculates the appropriate inventory levels for each production process at Alcon Batam Manufacturing to determine the optimal *minimum stock*. The purpose of implementing the *Min-Max Stock* concept is to optimize the production process by preventing waiting time (*downtime*) caused by the unavailability of *Work-In-Process* inventory in the right quantity and at the right time.

Results and Discussions

1. Analysis of Production Scheduling and Inventory Management

The production process is a series of complex and structured activities that require various components to be effectively integrated. In carrying out production, maintaining balance among components such as the availability of raw materials, *Work-In-Process* inventory, and finished goods, as well as scheduling and production planning is crucial (Nuraeni & Santoso, 2024). At Alcon Batam Manufacturing, the production activities involve processing raw materials by adding components at each stage to enhance the functionality and value of the product, transforming it into *Work-In-Process* inventory and eventually into finished goods. The distinguishing factors in each production cycle are the processes performed, the equipment used, and the capability of resources to produce a certain quantity of products within a given period (*productivity*).

The production process cycle at Alcon Batam Manufacturing, which transforms *Work-In-Process* inventory into finished goods, is illustrated in the following diagram:

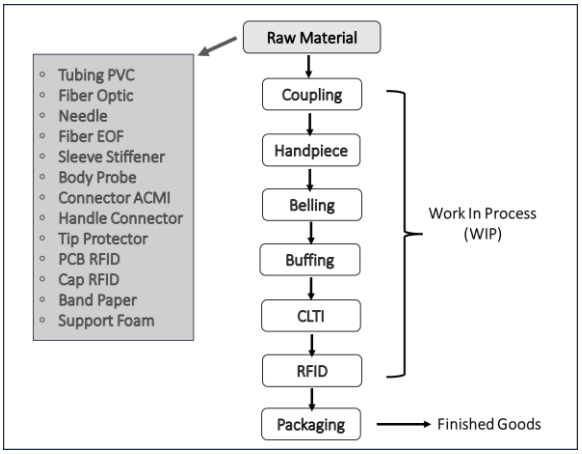

Figure 1
Alcon Batam Manufacturing Production Cycle

Production scheduling is an essential tool to help companies achieve their production goals optimally. With effective scheduling, businesses can enhance efficiency, productivity, and product quality while also

increasing profitability and customer satisfaction (Nuraeni & Santoso, 2024). To ensure an optimal production process, an adequate supply of *Work-In-Process* inventory from the previous stage is required in the right quantity and at the right time. *If Work-In-Process* inventory is unavailable in the correct quantity and timing, the subsequent process will cease operations, reflecting ineffective control in inventory management within the production line. According to (Sakti et al., 2023), effective production scheduling can optimize production time and reduce queuing or waiting time.

During the observation period, the author identified unproductive activities in the form of downtime caused by the unavailability of *Work-In-Process* inventory when the next production stage required supplies. Effective inventory control ensures that a company can avoid shortages of raw materials or *Work-In-Process* inventory that could halt production (Pide, 2025). The unavailability of *Work-In-Process* inventory for continuation in the next stage reflects an ineffective inventory control system within the production line. If *Work-In-Process* inventory is unavailable for production, the process of producing finished goods will be disrupted. The primary cause of this issue is an imbalance in the production cycle, resulting from ineffective production scheduling and inventory management. Therefore, improvements in inventory management methods or systems must be applied to the Alcon Batam Manufacturing production line to optimize production processes. Inventory management plays a crucial role in regulating and maintaining the company's inventory levels. Inventory management activities include acquiring and storing inventory, estimating inventory levels, and addressing uncertainties in demand and ordering time (Sanni El Randi & Meirini, 2021).

Based on the collected data on *Work-In-Process* inventory in the Alcon Batam Manufacturing production line, it was found that the inventory levels of *Work-In-Process* designated for final processing into finished goods were in an unstable and unbalanced condition. The *Work-In-Process* Packaging inventory levels for the April 2025 period are illustrated in the following graph:

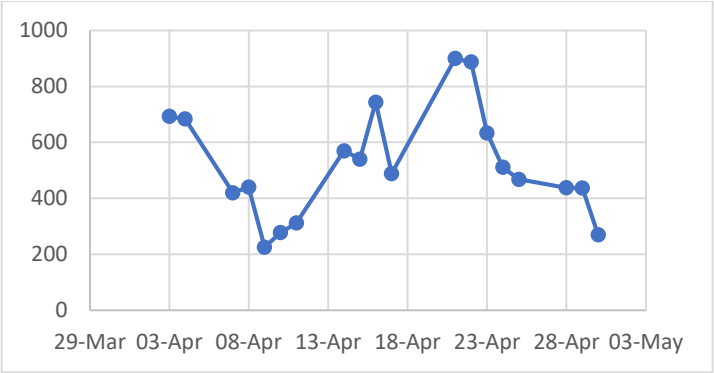

Figure 2
***Work-In-Process* Packaging Inventory Graph – April 2025**

The unstable finished goods inventory levels within the production line indicate that production scheduling and inventory management are not well-controlled. During the observation period at the Alcon Batam Manufacturing production line, the author found that the final production stage (Packaging) faced instability in fulfilling *Work-In-Process* inventory requirements from previous processes. As a result, the availability of finished goods to meet customer demand was not optimal. The unavailability of finished goods in quantities that match customer demand reflects the ineffectiveness of the production scheduling and inventory control system. Therefore, improvements in the implementation of production scheduling and inventory management methods are needed to optimize productivity in the Alcon Batam Manufacturing production line and better meet customer needs and demands.

2. Implementation of *Work-In-Process* Control Using the *Minimum Stock* Method

Inventory is a crucial asset for a company, essential in determining the sustainability of a manufacturing business. Inventory control is a system used by a company to provide reports to management, serving as a performance measurement tool for inventory and assisting in the development of inventory policies (Wahyudi, 2022). Inventory control helps a company minimize the risk of disruptions in production schedules while ensuring that capital investment in inventory is not excessive (Soeltanong & Sasongko, 2021).

Work-In-Process inventory control can be managed using the *Min-Max Stock* method, which sets *minimum* and *maximum* stock standards for each production process to ensure smooth operations. This approach prevents stock shortages (*out of stock*) that can halt production and overstocking, which increases

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storage costs. In parallel production processes, the *minimum stock* level serves as a reference for determining the required workforce and production machines needed to convert *Work-In-Process* inventory into finished goods based on received customer demand. To establish the *minimum stock* level, a calculation is performed by multiplying the production capacity of each process by the production period.

Minimum Stock = Average Demand × Lead Time

Explanation:
- *Minimum stock* is the lowest inventory level that must be maintained for a particular type of inventory.
- Average demand refers to the average quantity of products required by the next process over a specific period.
- Lead time is the duration needed to complete a process.

Minimum stock refers to the amount of usage during the purchase order period. It is calculated by multiplying the ordering time per period by the average usage within a month/week/day, plus safety stock (Ismira, 2024). Therefore, it is necessary to calculate the average demand of the next process along with the required production period to ensure that the production process operates optimally within its timeframe. Having the right inventory levels will enhance production efficiency by eliminating downtime in subsequent processes. Based on the *Min-Max Stock* concept, the minimum inventory level is the minimum quantity of products that a company must maintain to ensure that the product can meet customer demand (Rahmadhani & Ernawati, 2024).

The implementation of the *Min-Max Stock* method at Alcon Batam Manufacturing is carried out by determining the optimal *minimum stock* level for each production process. This ensures that every stage operates productively, without downtime caused by the unavailability of the *Work-In-Process* inventory needed for the next process. Production productivity is an assessment of a company's productivity in terms of its production performance. It is calculated by dividing net sales by the cost of production (Marinus Ronal, 2022). Therefore, to reduce the cost of goods, productivity in the production process must be enhanced by eliminating downtime. Based on productivity data for each production process at Alcon Batam Manufacturing and referring to the *Min-Max Stock* method concept, the effective *minimum stock* calculations for each production process are as follows:

Table 1 Minimum *Work-In-Process* Stock Quantity

Process	Productivity/hour	*Minimum Stock* (Unit)
Coupling	105	1.102,5
Handpiece	76	798
Belling	76	798
Buffing	82	861
CLTI	73	766,5
RFID	115	1.207,5
Packaging	83	871,5

Source: Data Processing Result, 2025

By implementing *Work-In-Process* inventory control using the *Min-Max Stock* concept, production management can regulate production scheduling according to customer demand and business needs. When *Work-In-Process* inventory decreases, production management can analyze previous processes to identify any discrepancies that may have occurred. In a parallel production system, a critical condition arises when inventory falls below the minimum threshold, requiring reordering of raw materials or *Work-In-Process* inventory. Based on *minimum stock* calculations using the *Min-Max Stock* method, inventory control at Alcon Batam Manufacturing is implemented by monitoring the determined *minimum stock* levels. The control mechanism is supported by Microsoft Excel, designed to record predefined *minimum stock* standards using the *Min-Max Stock* method for each process.

It also incorporates customer demand targets for each production period. In the inventory control process, an automatic formula in Excel is used to calculate available *Work-In-Process* inventory by adding the finished goods produced by the previous process plus the *minimum stock* required for the next process and subtracting the finished goods produced by each process. If the *Work-In-Process* inventory of any process drops below the *minimum stock* level, the Excel spreadsheet will automatically highlight the affected cell in red. This allows production management to analyze any shifts or inefficiencies impacting inventory

optimization and production effectiveness. By applying this approach, the analysis and resolution of obstacles in the production cycle become more precise and efficient, ensuring a smooth and optimized workflow.

Based on further observations of the production process implementation with the application of *Work-In-Process* inventory levels using the *minimum stock* concept, as outlined in Table 1, it was found that the process flow in the Alcon Batam Manufacturing production line became more effective and efficient. This improvement is reflected in the reduction of *downtime* during production, as *Work-In-Process* inventory was available in the work area in the right quantities, aligning with the requirements of each production stage. As a result, the production process could continue seamlessly without interruptions caused by waiting for *Work-In-Process* inventory from the previous stage.

The results of implementing *minimum stock* using the *Min-Max Stock* concept at Alcon Batam Manufacturing show a 19% reduction in downtime duration, as presented in the following table:

Table 2 Optimization Data of *Min-Max Stock* Implementation in Production

Indicator	**Before the Implementation of *Minimum Stock***	**After the Implementation of *Minimum Stock***
Quantity of *Work-In-Process*	226	871
Working Hours	10.5	10.5
Downtime Duration (hours)	2.5	0.5
Downtime Percentage	24%	5%

Source: Data Processing Result, 2025

Conclusion

Based on the results of this study, the author concludes:

1. Inventory management control is a critical factor in supporting productivity within manufacturing companies. Effective inventory management creates an efficient production cycle.
2. In controlling *Work-In-Process* inventory within a parallel production system, the implementation of the *Min-Max Stock* concept can serve as a solution to mitigate the risk of stock shortages (*out-of-stock issues*) that disrupt optimal production flow.
3. In practice, based on observations and collected data from the study, Alcon Batam Manufacturing has successfully reduced downtime in the production process by 19%, minimizing non-productive activities caused by the unavailability of *Work-In-Process* inventory.

Suggestions

Based on this study, the author suggests:

1. Alcon Batam Manufacturing should conduct periodic reviews, analyzing downtime reduction consistency in production. These insights can be leveraged to optimize workforce productivity and other available resources.
2. For future research, the *Min-Max Stock* method can be implemented alongside *Just-In-Time* to ensure inventory availability precisely when needed, with an efficient production layout that optimizes the cycle and process flow. Implementing *Just-In-Time* inventory control can serve as a production flow system, while *Min-Max Stock* acts as a measurement tool for inventory management.

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