OPERATIONS MANAGEMENT ANALYSIS FOR OPTIMIZATION OF SMITH & WESSON 17 PISTOL PRODUCTION

**E.S. ALIM[1] , I NENGAH PUTRA[2], G.R. DEKSINO[3],
K. GUNAWAN[4], A.K. SUSILO[5]**

[1]Indonesia Defense University, Bogor, 16810 Indonesia
[2]Indonesia Defense University, Bogor, 16810 Indonesia
[3]Indonesia Defense University, Bogor, 16810 Indonesia
[4]Jakarta State University, Jakarta, 13220 Indonesia
[5]Indonesia Naval Technology College, Surabaya, 60178 Indonesia

This study aims to analyze operations management strategies that include production lot selection, safety stock and reorder point calculations, production sequencing, and material requirements planning in the production of the Smith & Wesson 17 Pistol. Data were processed using quantitative methods based on EOQ theory, safety stock management, the Critical Ratio, and Material Requirement Planning (MRP). The results show that a production lot of 40 units yields the lowest annual inventory cycle cost, with an optimal safety stock of 6 units and a reorder point of 38 units. A safety stock of 6 units and a reorder point of 38 units were calculated, considering a 90% cycle service level and a 4-week lead time. The priority order is A → B → C → E → D, with task A having the highest priority because it has the lowest CR. In Problem D, a leveling process is used to even out the workload in production, particularly for components such as Frames, Magazines, and Complete Triggers. In Problem E, Netting, Lotting, and Offsetting calculations are performed to ensure the availability of raw materials and components according to production needs. Production sequencing based on Critical Ratio and MRP tables ensures efficient production schedules and supply chain sustainability.

Key words: *Operations Management, Safety Stock, Reorder Point, Critical Ratio, Material Requirement Planning.*

---

[1] ORCID ID: 0000-0002-4436-6982, e-mail: ekasalim@gmail.com

[2] ORCID ID: 0000-0002-6799-691X, e-mail: nengahputra35@gmail.com

[3] ORCID ID: 0000-0002-7991-5283, e-mail: georgeroykedeksino@gmail.com

[4] ORCID ID: 0000-0002-4124-9334, e-mail: kazangunawan@yahoo.com

[5] ORCID ID: 0000-0002-7012-7520, e-mail: aprilkukuh53@gmail.com

1.INTRODUCTION

The rapid development of industry has created increasingly fierce competition worldwide (Tri, Hoang, and Dung 2021). PT. SWX is one company facing this challenge (Costanzo and Spotts 2015). As part of Smith & Wesson International (Matoso et al. 2014), this company plays a strategic role in providing the primary weapons systems (alutsista) needed by the Indonesian National Armed Forces (TNI). Located in Batam, this company is expected to be the spearhead in supporting the independence of the national defense industry. However, this task is not easy because it involves complex management across various aspects, from production to distribution.

One of the biggest challenges facing PT. SWX is ensuring efficient production. This involves various strategic decisions, such as selecting the optimal production lot size, implementing effective inventory management, and structuring production planning (Silver, Pyke, and Thomas 2016). Furthermore, inventory management is crucial, especially when dealing with fluctuating demand (Mohamed 2024). In the defense industry, product requirements can fluctuate depending on military operational needs. Therefore, companies need to maintain a certain level of inventory, known as safety stock, to anticipate unexpected demand (Siraj et al. 2024). Mistakes in determining safety stock or reorder points can lead to significant losses, both due to stock shortages and excessive storage costs.

Another challenge is effective production planning. PT. SWX, which produces modular products like the Smith & Wesson 17 pistol, requires a well-organized production system. By using approaches such as the Critical Ratio for production sequencing, the company can appropriately prioritize work and ensure all components are available on schedule. This planning also involves netting, lotting, and offsetting processes to ensure a smooth material supply and support the overall assembly process.

In facing these challenges, innovation and technology are key factors. By utilizing data-driven systems such as Enterprise Resource Planning (ERP) (Costanzo and Spotts 2015), PT. SWX can integrate all operational processes, from raw material management to final product delivery. This step not only increases efficiency but also provides greater flexibility in adapting to dynamic market needs. This research aims to provide strategic solutions for the company's operations management to enable continued growth and support the grand vision of the national defense industry.

The urgency of this research arises from PT. SWX's increasingly strategic position within the national defense industry ecosystem, where operational inefficiencies can directly impact defense readiness, supply continuity, and national independence. Without a well-structured operational system, PT. SWX risks experiencing decreased competitiveness, delayed production cycles, and dependence on external suppliers, all of which can weaken the overall national defense posture. Furthermore, there is a need to formulate concrete and applicable strategies that enable PT. SWX to optimize its operational processes while aligning the company's performance with national defense objectives. This study is motivated by a broader vision to strengthen the domestic defense industry as a pillar of national sovereignty, where companies like PT. SWX play a dual role: achieving sustainable business growth and serving as a strategic asset for national defense independence and long-term security.

This research is supported by the Economic Order Quantity (EOQ), Safety Stock and Reorder Point, Material Requirement Planning (MRP) theoretical approach. This research is also supported by descriptive quantitative methods. This quantitative model ensures that decisions are based on measurable and accountable analysis. This research was conducted at PT. SWX, located in Indonesia, with data collection aimed at determining optimal solutions based on existing numerical data, such as inventory costs, order quantities, and production time.

This research has several contributions. First, it contributes to the development of operations management theory by contextualizing it within the defense industry, which has unique characteristics such as high reliability requirements, strict regulatory controls, and strategic national interests. Second, it theoretically bridges the gap between firm-level competitiveness and macro-level national defense readiness. Third, the findings offer practical insights for reducing dependence on foreign suppliers by strengthening internal operational capabilities and integrating the local supply chain. Fourth, it provides practical value to defense industry policymakers and regulators by highlighting critical operational factors that influence defense readiness. Fifth, this studies vary in their objectives and scope in assessing and measuring the sustainability of systems based on actual statistical distributions. Thus, it is possible to use statistical or stochastic models in their structure and, as will be presented, to implement optimization and probability calculations.

2. LITERATURE REVIEW

2.1. Operational Management

Operational management is a series of activities that generate value in the form of goods and services by processing inputs into outputs. Inputs are everything needed to initiate the production process, such as raw materials, auxiliary materials, labor, machinery, energy, information, methods, capital, space, and management. Outputs are the outcomes or results of the production process, in the form of goods or services. Simply put, operational management is defined as the activity of managing management resources by converting inputs into outputs in order to increase the utility value of goods effectively and efficiently (Mustofa and Waluyowati 2024).

2.2. Economic Order Quantity (EOQ).

Economic Order Quantity (EOQ) is one of the most widely used concepts in inventory management and logistics. EOQ was first introduced by Ford W. Harris in 1913 and has since become a fundamental decision-making model for inventory management (Rabta 2020). The multi-item EOQ model can be used for a wide range of commodities in retail stores. The computation of safety stock, reorder points, and maximum capacity is another way to support inventory control, helping keep costs even lower than the EOQ model (Mubasysyir, Supian, and Hertini 2024).

The EOQ model assumes a balance between two main components of inventory costs (Setyadi, Al Amin, and Widodo 2024):

a. Ordering Cost: Fixed costs incurred each time a company places an order, such as administrative costs, transportation, and communication. The more frequently a company orders small quantities, the higher the total ordering cost.

b. Holding Cost: Costs associated with storing goods in the warehouse, including space, insurance, damage, and depreciation. These costs increase with the quantity of goods stored.

EOQ provides an optimal solution by mitigating the conflict between high ordering costs (from low order frequency) and high holding costs (from large order quantities).

The basic EOQ formula is as follows:

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Description:

- Annual demand (units per year).
- Ordering cost per order.
- Annual holding cost per unit.

EOQ is very useful in various industries, such as manufacturing, retail, and pharmaceuticals (Poornima et al. 2024). In manufacturing, for example, EOQ is used to ensure raw materials are always available without incurring excess holding costs (Sutejo, Suprayitno, and Latunreng 2023). In the retail sector, this model helps determine the quantity of merchandise to order to maintain optimal stock rotation. However, the successful implementation of EOQ is highly dependent on accurate data, such as demand for goods and operational costs, so companies need to ensure proper data collection (Kurniawan et al. 2024).

2.3.Safety Stock and Reorder Point

Safety stock and reorder points are two crucial elements in inventory management that serve to ensure smooth operations, particularly in the face of uncertain demand and delivery times (Mubasysyir, Supian, and Hertini 2024). Safety stock is additional inventory that serves as a buffer to absorb demand imbalances. Safety stock is useful for overcoming delays in the arrival of raw materials when frequent orders arrive late beyond the lead time (for example, delayed in transit due to floods, bridge collapses, pirates, or other disasters). Safety stock aims to minimize stockouts and reduce additional storage costs and total stockout costs. Storage costs here will increase with the addition of reorder points, driven by safety stock. The advantage of having safety stock is that when demand spikes, it can be used to cover the increase (Mustofa and Waluyowati 2024).

Safety stock is an additional reserve of stock held to anticipate fluctuations in demand fluctuations in delivery delays (Setiawan 2024). The average value and variability of replenishment lead times are two things that affect how much safety stock is needed. They thought that the random lead times followed Weibull distributions. This enabled the creation of analytical expressions that reduced the expected value and variability of overall demand until the first significant delivery from a vendor. The study formulates an expression for the reorder point that guarantees a specified probability of avoiding a stockout prior to the initial delivery, while establishing lower limits on the order size to ensure that the likelihood of a stockout before subsequent deliveries (second, third, etc.) remains minimal (Demiray Kırmızı, Ceylan, and Bulkan 2024). Mathematically, safety stock can be calculated using the formula:

$$Safety\ Stock = z.\sigma$$

Where :

z: Z-score based on desired service level

σ : Standard deviation of demand or lead time.

The reorder point, on the other hand, is the minimum stock level that indicates when a company should reorder to avoid stockouts. The reorder point is calculated based on the average demand rate during the reorder period (lead time) and safety stock. A reorder point is the inventory level that triggers a reorder, taking into account the lead time between when the order is placed and when it is received. Several factors determine the reorder point, including inventory during the delivery period and the desired level of security, material usage during the lead time for receiving the goods, and the amount of safety stock (Putri, Mutiara, and Erni 2025).

Based on the opinions of the two experts above, the factors that influence the reorder point are lead time, the time required between the goods being ordered and their arrival at the company, the level of goods orders per unit of time, and safety stock, the minimum amount of inventory a company must have to guard against the possibility of delays in the arrival of raw materials (Mubasysyir, Supian, and Hertini 2024).

The mathematical formula is:

$$\begin{aligned}&Reorder\ Point\\&= (Demand\ Rate\ x\ Lead\ Time)\\&+ Safety\ Stock\end{aligned}$$

Where:

- Demand Rate: Average demand per period (e.g., per week).
- Lead Time: The time required to receive goods after an order is placed (in weeks, days, or months).
- Safety stock provides a buffer to address demand fluctuations or delivery delays, while the reorder point ensures the company reorders goods at the right time.

Safety stock and the reorder point work together to maintain inventory availability in the warehouse without experiencing stockouts or excessive buildup (Best et al. 2022). In its implementation, companies need to rely on accurate demand data and consider variability in lead times to ensure this calculation remains relevant and effective.

2.4. Critical Ratio (CR)

Critical Ratio (CR) is a method in production sequencing used to prioritize tasks based on their urgency (Gao, Wang, and Pedrycz 2020). This method helps companies manage processing time and due dates more efficiently (Kim, Kim, and Cho 2020). The Critical Ratio is often applied in the context of operations management, particularly in manufacturing environments and on projects with many tasks and tight schedules.

Mathematically, Critical Ratio is calculated using the formula:

$$CR = \frac{Due\ Date - Current\ Time}{Processing\ Time}$$

Where:

- Due Date: The due date of the task.
- Current Time: The current time in the production schedule.
- Processing Time: The time required to complete the task.

Critical Ratio Interpretation

- CR < 1: he task has high priority because the remaining time is less than the time required to complete it. If not started immediately, the task is at risk of missing its deadline.
- CR = 1: he task must be started immediately to be completed on time.
- CR > 1: The task has more remaining time than processing time, so it has lower priority than other tasks with a smaller CR.

2.5. Material Requirement Planning (MRP)

Material Requirement Planning (MRP) is a system used to manage and plan the need for raw materials and components in the production process. MRP was first developed in the 1960s as a solution to inefficient inventory management and procurement in manufacturing environments (Pramono 2024). This system is designed to ensure that the necessary raw materials are available at the right time and in the right quantities, thereby optimizing the production process and reducing inventory costs.

MRP is a system for planning and controlling inventory that depends on demand and schedules the proper amount. The MRP system can tell you how many raw materials you will need to make a product in the future. The MRP's job is to manage inventory levels, figure out which processes are most important for each item, and plan the production system's capacity (Omair, Stingl, and Wæhrens 2025)the RP available in the market shows high variation in quality, composition, and properties, and often experiences higher variability in lead time. This renders the supply chain of RP and the production systems more vulnerable, making it difficult for material requirement planning (MRP. This includes ordering things in the right amount and at the right time. In the meantime, MRP's main goal is to get the appropriate raw materials to the right place at the right time in order to make customers happier (Cipta, Aprilia, and Kurniawan 2023).

The primary purpose of MRP is to efficiently control and plan the flow of materials in the production process (Saptadi et al. 2023). MRP enables companies to calculate precisely how much material is needed, when it is needed, and when to place orders to meet production needs (Fole et al. 2024). This system aims to reduce inventory buildup, prevent stockouts, and improve the efficiency of storage space and company fund management.

MRP is a popular way for businesses to plan and optimize their procurement of raw materials. It helps them make decisions about things like reordering and capacity planning. MRP has been a key instrument for boosting productivity and gaining a competitive edge in the global economy. It is also very crucial for managing inventory while making complicated industrial items. Most enterprise resource planning (ERP) systems now include MRP as a key aspect. As a result, it is stored in the ERP database (supply, demand, capacity, planned reception, etc.) and runs regularly (daily or weekly) depending on the type of problem (Omair, Stingl, and Wæhrens 2025).

MRP relies on three main components in material planning (Ivanov, Tsipoulanidis, and Schönberger 2021):

a. Bill of Materials (BOM): A list detailing all raw materials and components required to produce a final product. The BOM describes the relationship between a product and its components.
b. Master Production Schedule (MPS): A master production schedule that shows how many products will be produced in a given time period, based on the demand or orders received.
c. Inventory Records: Records that include the amount of stock available, the quantity ordered, and the delivery time for each raw material and component.

3. METHODOLOGY

The research in this study is quantitative, using mathematical calculations to address the company's problems (Tika, Suprianto, and Isron 2022). This research was conducted at PT. SWX, located in Indonesia, with data collection aimed at determining optimal solutions based on existing numerical data, such as inventory costs, order quantities, and production time. This quantitative model ensures that decisions are based on measurable and accountable analysis. The proposed model has been applied to each demand dimension evaluated for the 2023–2024 time period.

Furthermore, the quantitative research applied also allows for simulations and comparisons of various possible decision scenarios. For example, through mathematical calculations, the impact of changes in order quantities or inventory costs on total operating costs can be projected. This allows the company not only to obtain an overview of the most efficient solution but also to understand the risks and consequences of each available decision alternative. This is crucial for PT. SWX in navigating fluctuating market dynamics.

Furthermore, a quantitative approach adds value by providing objective results free of subjective bias in decision-making (Chen et al. 2025). The processed numerical data can serve as the basis for designing long-term strategies, such as production capacity planning, supply chain management, and operational cost control (Yao et al. 2022). In this way, PT. SWX can increase competitiveness through evidence-based decisions, as well as reduce uncertainty in production and distribution processes.

3.1. Production Lot Selection (Economic Order Quantity - EOQ)

In the first problem faced by PT. SWX, namely selecting the ideal production lot size, the Economic Order Quantity (EOQ) model was used to determine the most efficient lot size. EOQ is one of the most commonly used methods in inventory management to minimize the total costs associated with ordering and holding goods. In this case, the company had to choose among three lot sizes (20, 40, and 60 units), considering ordering costs, annual holding costs, and weekly supply quantities. The EOQ formula used to calculate the annual cycle inventory costs for each alternative, selecting the alternative with the lowest cost.

The EOQ method is particularly appropriate in this context because it helps companies determine efficient lot sizes based on ordering and holding costs, which are particularly relevant in mass-production operations like those carried out by PT. SWX.

3.2. Calculating Safety Stock and Reorder Point

Regarding the second issue, regarding safety stock and reorder points, companies need to calculate the required reserve stock to anticipate demand fluctuations and lead time disruptions. The methodology used to calculate safety stock and reorder points follows a standard formula that accounts for average demand, standard deviation, lead time, and the desired service level. In this case, the company must ensure there is sufficient stock to meet demand, even in the event of a disruption in the raw material procurement process.

Safety stock calculations are carried out by considering the level of demand and lead time variability, using standard deviation and z-scores to determine the amount of reserve stock needed to maintain a high level of customer service. Next, the reorder point is calculated based on average demand during the lead time and the previously calculated safety stock, to ensure reorders are placed before stock runs out.

3.3. Production Sequencing with Critical Ratio (CR)

For the third problem related to production sequencing, where the company needed to develop an efficient production schedule for Smith & Wesson 17 components, the methodology used was the Critical Ratio (CR). CR is a technique for determining job priority based on the ratio of the remaining time (from the due date) to the time required to complete the job. By calculating the CR for each job, the company can prioritize the most urgent jobs, namely those with the lowest CR.

This method allows the company to manage time more effectively, minimize waiting times, and ensure that the jobs that must be completed first are prioritized, which is crucial in a time-constrained production environment.

3.4. Material Planning with Netting, Lotting, and Offsetting

For the fourth and fifth issues, which relate to production leveling and material requirements planning (netting, lotting, and offsetting), the methodology used is Material Requirements Planning (MRP). In this case, the company must calculate the material requirements for each component based on lead time, required quantity, and production sequence. The company also needs to consider netting, lotting, and offsetting techniques to ensure that raw materials and components are available on time without causing stockpiles or shortages.

Netting is used to calculate raw material requirements based on the number of components required for production. Lotting determines the optimal order size based on material requirements and offsets delivery times so that raw materials arrive on time according to the production schedule. These three techniques are used to plan material requirements more efficiently, reduce waste, and ensure a smooth production process.

4. RESULTS AND DISCUSSION

PT. SWX is a Foreign Direct Investment company located in Indonesia that produces defense equipment for the Indonesian National Armed Forces (TNI). Manufacturing operations face various challenges, including selecting the optimal lot size, managing inventory, and planning production.

4.1. Problem A - Ideal Lot Selection

To determine the most profitable lot size, the researcher will calculate the annual cycle inventory cost (C) using the Economic Order Quantity (EOQ) formula.

Table 1 Smith & Wesson 17 Pistol Sales Quantity

No	Description	Unit	Quantity
1	Price per unit of Smith & Wesson	USD	1500
2	Ordering fee (S)	USD	450
3	Annual loan fee (H)	Unit/pistol	25%
4	Quantity supplied per week	Units	15
5	Number of weeks in a year	Week	52
6	Alternative lot sizes: 20 units, 40 units, 60 units		

Step 1: Calculate the Holding Cost (H) per unit

Holding cost per unit per year (H) = 25% x USD 1,500 = USD 375

Step 2: Calculate the Annual Cycle Inventory Cost (C)

To calculate the annual cycle inventory cost, use the formula:

$$C = \frac{D}{Q} x\, S + \frac{Q}{2} x\, H$$

Where:

- D is the total annual demand (number of supplies per week x number of items per year) = 15 x 52 = 780 units per year
- Q is the selected lot size (20, 40, or 60 units)
- S is the ordering cost per order = USD 450
- H is the holding cost per unit per year = USD 375

For Lot 20 units:

$$C_{20} = \frac{780}{20} x\, 450 + \frac{20}{2} x\, 375$$
$$= 39\, x\, 450$$
$$+ 10\, x\, 375$$
$$= 17.550 + 3.750$$
$$= 21.300 \text{ USD}$$

For Lot 40 units:

$$C_{40} = \frac{780}{40} x\, 450 + \frac{40}{2} x\, 375$$
$$= 19{,}5\, x\, 450$$
$$+ 20\, x\, 375$$
$$= 8.775 + 7.500$$
$$= 16.275 \text{ USD}$$

For Lot 60 units:

$$C_{60} = \frac{780}{60} x\, 450 + \frac{60}{2} x\, 375$$
$$= 13\, x\, 450$$
$$+ 30\, x\, 375$$
$$= 5.850 + 11.250$$
$$= 17.100 \text{ USD}$$

From the calculation above, the lowest annual cycle inventory cost is for a lot of 40 units, which is USD 16,275. Therefore, the most profitable lot size is 40 units. The calculations demonstrate the effectiveness in guiding strategic decision making and resource allocation to achieve business objectives.

4.2. Problem B – Safety Stock and Reorder Point

Table 2 Average Replacement Demand

No	Description	Unit	Quantity
1	Average weekly demand for 30mm	Unit	8
2	Standard deviation of weekly demand	Unit	4
3	Lead time	Week	4%
4	Cycle service level = 90 % (z = 1,28)		

Step 1: Calculating Safety Stock

Safety Stock is calculated using the formula:

$$Safety\ Stock = z.\sigma$$

Where:

z = 1,28 (for a 90% service level). After determining the standard deviation of demand during the lead time, the company's service level needs to be determined. In an effort to satisfy customers, PT SWX sets a service level of 90%, or only allows stockouts to occur 10% out of 100 times.

σ = 4 (Standard deviation of weekly demand)

$$\begin{aligned} Safety\ Stock &= 1{,}28\ x\ 4 \\ &= 5{,}12\ unit \\ &= 6\ unit \end{aligned}$$

Step 2: Calculating the Reorder Point

The reorder point is calculated using the formula:

$$\begin{aligned} &Reorder\ Point \\ &= (Demant\ Rate\ x\ Lead\ Time) \\ &+ Safety\ Stock \end{aligned}$$

Where:

- Demand Rate = 8 units per week
- Lead Time = 4 weeks
- Safety Stock = 6 units

$$\begin{aligned} Reorder\ Point &= (8\ x\ 4) + 6 \\ &= 32 + 6 \\ &= 38\ unit \end{aligned}$$

By holding 6 units as safety stock, the company can anticipate demand fluctuations or delays during the lead time, ensuring that customer needs are met. A sufficiently large safety stock size (6 units) reflects the high demand uncertainty (standard deviation of 4 units) during the lead time. A reorder point of 38 units ensures that new orders are placed with enough time to arrive before stock runs out, given the average demand of 8 units/week and a lead time of 4 weeks. This combination of ROP and SS provides a sufficient buffer to prevent stockouts without creating excessive inventory. Hence, it is necessary to research the implementation of inventory control. Analysis needs to be done to find out whether the method or method in the process of implementing inventory control (Nasution, Asthariq, and Girsang 2022).

☐ Work A

$$CR_A = \frac{8-0}{6} = 1.33$$

☐ Work B

$$CR_B = \frac{12-0}{8} = 1.50$$

☐ Work C

$$CR_C = \frac{15-0}{10} = 1.50$$

☐ Work D

$$CR_D = \frac{5-0}{2} = 2.50$$

☐ Work E

$$CR_E = \frac{10-0}{5} = 2.0$$

4.3.Problem C – Operation Sequencing with Critical Ratio

Table 3 Job Time and Due Time Data

Work	**Working Time**	**Due Time**
A	6	8
B	8	12
C	10	15
D	2	5
E	5	10

The Critical Ratio, according to EOQ can be determined using the formula:

$$CR = \frac{Due\ Date - Current\ Time}{Processing\ Time}$$

Where Current Time is assumed to be 0 (zero). Starting from zero point, so it can be used to simplify mathematical calculations and facilitate inventory planning analysis.

Step 1: Calculate the Critical Ratio for each job:

Step 2: Prioritization based on sequence

- A (CR = 1.33): This job has the lowest CR and is closest to critical. Therefore, it must be completed first to avoid delays.
- B (CR = 1.50) and C (CR = 1.50): These two jobs are in a balanced situation, but must still be done after A because of its subsequent priority.
- E (CR = 2.00): There is still enough time to complete this job without significant risk of delay.

- D (CR = 2.50): This job has the highest CR, making it the safest and can be done last

The CR method provides an effective approach to prioritizing jobs in a production system based on the remaining time relative to the required time. The sequence A → B → C → E → D reflects optimal resource allocation while minimizing the risk of delays on critical jobs.

4.4. Problem D – Leveling

Leveling is the process of adjusting production or material requirements to ensure a more even workload. In the context of Material Requirement Planning (MRP), leveling helps reduce fluctuations in production requirements and ensures optimal capacity utilization.

4.5. Problem E - Netting, Lotting, and Offsetting

The gross requirement for a Smith & Wesson 17 Pistol for five weeks is as follows:

Table 4. Gross Pistol Requirement Data

Gross Requirement Pistol				
1	2	3	4	5
100	120	150	180	200

Using the lead time and existing project minimums for each component, we can calculate the required netting, lotting, and offsetting for each component. The following component data and relevant information are available:

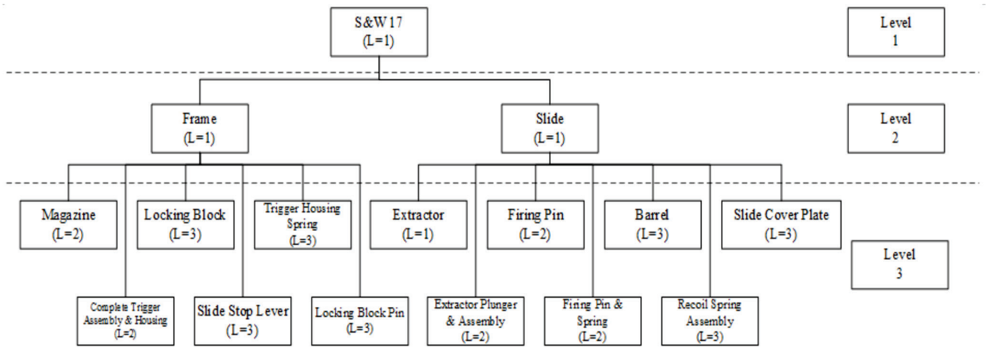

Fig. 1. Product Structure Based on the Manufacturing Hierarchy of the S&W 17 Pistol

Table 5 Lead Time, Project in Hand, Minimum Project in Hand data

Component	**Code**	**Lead Time Week**	**Project in Hand**	**Minimum Project in Hand**
PISTOL Smoth & Wesson 17	Pi	1	10	50
Frame	Fr	1	10	30
Magazine	Ma	2	10	30
Complete Trigger	Co	2	10	30
Assembly and Housing	As	2	10	30
Locking Block	Lo	3	10	30
Slide Stop Lever	Sl	3	10	30
Trigger Housing Spring	Tr	3	10	30
Locking Block Pin	LoB	3	10	30
SLIDE	Sd	1	10	30
Extractor	Ex	1	10	30
Extractor Plunger and Assy	EXP	2	10	30
Firing Pin	Fi	2	10	30
Firing Pin Safety and Spring	FiP	2	10	30
Barrel	Ba	3	10	30
Recoil Spring Assy	Re	3	10	30
Slide Cover Plate	SlC	3	10	30

In Material Requirement Planning (MRP), the Netting, Lotting, and Offsetting processes are essential steps to ensure raw materials and components are available on time and in the required quantities to efficiently meet production needs.

a. Netting.

- Netting is the process of calculating the net requirement for a component after accounting for the Gross Requirement, Project on Hand, and Minimum on Hand.
- Gross Requirement is the number of units needed to meet production demand.
- Project on Hand is the number of units already on hand or in production.
- Minimum on Hand is the minimum amount of stock required to ensure production continuity.

The formula for Netting is:

Net Requirement=Gross Requirement−(Project on Hand+Minimum on Hand)

Table 6 Netting Data

Week	Pi	Fr	Ma	Co	As	Lo	Sl	Tr	LoB	Sd	Ex	EXP	FiP	Ba	Re	SlC
1	40	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2	60	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
3	90	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
4	120	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
5	140	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160

b. Lotting (Lot Size Determination)

Lotting is the process of determining the lot size to be ordered or produced. Lot size can be determined using various methods, such as Fixed Lot Size or Lot-for-Lot (LFL), where each production lot is adjusted to the calculated net requirement. In this case, we assume we are using a flexible lot size based on our needs.

After calculating the Net Requirement, we determine the lot size required for each component. In this case, we assume we are using the Lot-for-Lot (LFL) method, meaning the quantity produced is in accordance with the weekly net requirement. The lotting method that can be proposed to the company is the LFL method because it has the minimum inventory cost and can minimize the accumulation of raw material stock because the number of orders is adjusted to the production needs of the related period (Bakhtiar and Sinaga 2020)

Table 7 Lotting Data

Week	Pi	Fr	Ma	Co	As	Lo	Sl	Tr	LoB	Sd	Ex	EXP	FiP	Ba	Re	SlC
1	40	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
2	60	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
3	90	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
4	120	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
5	140	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160

Offsetting

By calculating lead time, we determine when orders or production must be placed so that components are available in the right week.

Table 8 Data Offsetting

Component	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**
PISTOL Smooth & Wesson 17	40	60	90	120	140
FRAME	60	80	90	120	140
Magazine	60	80	90	120	140
Complete Trigger	60	80	90	120	140
Assembly and Housing	60	80	90	120	140
Locking Block	60	80	90	120	140
Slide Stop Lever	60	80	90	120	140
Trigger Housing Spring	60	80	90	120	140
Locking Block Pin	60	80	90	120	140
SLIDE	60	80	90	120	140
Extractor	60	80	90	120	140
Extractor Plunger and Assy	60	80	90	120	140
Firing Pin	60	80	90	120	140
Firing Pin Safety and Spring	60	80	90	120	140
Barrel	60	80	90	120	140
Recoil Spring Assy	60	80	90	120	140
Slide Cover Plate	60	80	90	120	140

5. CONCLUSION

In Problem A, we used the Economic Order Quantity (EOQ) approach to determine the most efficient order lot size. Based on calculations, a lot size of 40 units provides the lowest annual inventory cost compared to 20 and 60 units. This indicates that optimal lot sizes can reduce ordering and holding costs, which are crucial in manufacturing and logistics operations. Larger lot sizes are not always more profitable because they increase holding costs, while too small a lot size increases the frequency of orders, which can be more expensive. The appropriate lot size (40 units) helps optimize operational costs.

Safety stock and a reorder point (ROP) are used to ensure smooth production processes and uninterrupted demand fulfillment. Based on calculations, a safety stock of 6 units and a reorder point of 38 units were calculated, considering a 90% cycle service level and a 4-week lead time. Safety stock serves to anticipate unexpected fluctuations in demand, while the reorder point ensures that reorders are placed before stock runs out. With accurate calculations, the company can minimize the risk of stockouts and maintain smooth production.

We used the Critical Ratio (CR) method to prioritize tasks based on the remaining time and the time required to complete them. By calculating the CR for each task, we can rank tasks according to their urgency. In this case, the priority order is A → B → C → E → D, with task A having the highest priority because it has the lowest CR. The Critical Ratio method helps manage production schedules by prioritizing tasks closest to their deadlines. This technique is essential for optimizing time and resource allocation in complex production processes and avoiding delays.

In Problem D, a leveling process is used to even out the workload in production, particularly for components such as Frames, Magazines, and Complete Triggers. Using weekly demand data, leveling ensures consistent production each week, reducing fluctuations that can disrupt production flow. Leveling helps ensure production runs more steadily and is not disrupted by large fluctuations in demand or capacity. This improves resource efficiency and minimizes the need for sudden adjustments, such as overtime or excess storage.

In Problem E, Netting, Lotting, and Offsetting calculations are performed to ensure the availability of raw materials and components according to production needs. Netting calculates net requirements after accounting for existing stock; Lotting determines the lot size to be produced; and Offsetting ensures orders are placed on time by considering lead times. Netting, Lotting, and Offsetting are very important processes in material planning and inventory management. By performing careful calculations, companies can ensure the timely availability of raw materials, minimize storage costs, and avoid disruptions in the production process.

Furthermore, this study offers several avenues for future research. First, future research could expand the analysis of EOQ and safety stock by incorporating probabilistic demand and lead time variability models. Second, future research could compare CR with other scheduling and prioritization rules—such as Earliest Due Date (EDD), Shortest Processing Time (SPT), or Free Time Remaining—in multi-machine or multi-product environments. Third, future research could improve netting, lotting, and offsetting processes by integrating capacity constraints, supplier reliability, and risk-based lead time variability. This would support the development of more robust MRP systems that can better handle disruptions and improve material availability.

ACKNOWLEDGEMENT

This work was supported in part by a grant from Indonesia Defense

University. We would like to express our gratitude to all parties who supported the completion of this research.

DATA AVAILABILITY STATEMENT

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

AI DISCLOSURE

The authors confirm that no generative AI tools were used in the preparation of this manuscript. All content is solely the product of original human intellectual effort and authorship.

REFERENCES

[1] Am, Jordan Bar, Laura Furstenthal, Felicitas Jorge, and Erik Roth. 2020. "Innovation in a Crisis: Why It Is More Critical than Ever." *McKinsey & Company* 11.

[2] Bakhtiar, Arfan &, and Erry Phoni Sinaga. 2020. "International Journal of Applied Science and Engineering Review." *International Journal of Applied Science and Engineering Review* 1 (6): 1–5.

[3] Best, Julian, Christoph H Glock, Eric H Grosse, Yacine Rekik, and Aris Syntetos. 2022. "On the Causes of Positive Inventory Discrepancies in Retail Stores." *International Journal of Physical Distribution & Logistics Management* 52 (5/6): 414–30.

[4] Budianto, Eka Wahyu Hestya, and Nindi Dwi Tetria Dewi. 2024. "The Role of Integrated Marketing Communications to Improving The Islamic Social Economy." *International Journal of Global Modern Research (IJGMR)* 1 (1): 1–18.

[5] Chen, Yang, Samuel N Kirshner, Anton Ovchinnikov, Meena Andiappan, and Tracy Jenkin. 2025. "A Manager and an AI Walk into a Bar: Does ChatGPT Make Biased Decisions like We Do?" *Manufacturing & Service Operations Management* 27 (2): 354–68.

[6] Cipta, Hendra, Rima Aprilia, and Hari Kurniawan. 2023. "Material Requirements Planning Method for Controlling Inventory of Raw Materials." *Jurnal Teknik Informatika C.I.T Medicom* 15 (1): 1–8. https://doi.org/10.35335/cit.vol15.2023.358.pp1-8.

[7] Costanzo, Paul J, and Harlan Spotts. 2015. "Re-Energizing The Brand: Smith & Wesson Holding Corporation." *Journal of the International Academy for Case Studies* 21 (3): 29.

[8] Demiray Kırmızı, Sema, Zeynep Ceylan, and Serol Bulkan. 2024. "Enhancing Inventory Management through Safety-Stock Strategies—A Case Study." *Systems* 12 (7):

1–17. https://doi.org/10.3390/systems12070260.

[9] Fole, Asrul, Nur Ihwan Safutra, Takdir Alisyahbana, Yamin Almuhajirin, and Khoerun Nisa Safitri. 2024. "Peningkatkan Efisiensi Rantai Pasok Melalui Material Requirement Planning Untuk Bahan Baku Dalam Produksi Lemari: Studi Kasus CV. Indo Mebel." *Jurnal Teknik Ibnu Sina (JT-IBSI)* 9 (01): 11–21.

[10] Gao, Da, Gai-Ge Wang, and Witold Pedrycz. 2020. "Solving Fuzzy Job-Shop Scheduling Problem Using DE Algorithm Improved by a Selection Mechanism." *IEEE Transactions on Fuzzy Systems* 28 (12): 3265–75.

[11] Ivanov, Dmitry, Alexander Tsipoulanidis, and Jörn Schönberger. 2021. "Production and Material Requirements Planning." In *Global Supply Chain and Operations Management: A Decision-Oriented Introduction to the Creation of Value*, 359–83. Springer.

[12] Javaid, Mohd, Abid Haleem, Ravi Pratap Singh, Rajiv Suman, and Ernesto Santibañez Gonzalez. 2022. "Understanding the Adoption of Industry 4.0 Technologies in Improving Environmental Sustainability." *Sustainable Operations and Computers* 3:203–17.

[13] Kim, Taehoon, Yong-woo Kim, and Hunhee Cho. 2020. "Dynamic Production Scheduling Model under Due Date Uncertainty in Precast Concrete Construction." *Journal of Cleaner Production* 257:120527.

[14] Kurniawan, Michael Radius, Hadiyanto Hadiyanto, Joe Daniansyah Pahlevi Zulkarnaen, and Christian Harito. 2024. "Use Case Diagram for Enhancing Warehouse Performance at PT. MDA Through the Implementation of 5S, Economic Order Quantity, Safety Stock, and Warehouse Management System." *Engineering, MAthematics and Computer Science Journal (EMACS)* 6 (1): 69–78.

[15] Matoso, Rodrigo Ivo, Alexandre Rodrigues Freire, Leonardo Soriano de Mello Santos, Eduardo Daruge Junior, Ana Claudia Rossi, and Felippe Bevilacqua Prado. 2014. "Comparison of Gunshot Entrance Morphologies Caused by. 40-Caliber Smith & Wesson,. 380-Caliber, and 9-Mm Luger Bullets: A Finite Element Analysis Study." *PloS One* 9 (10): e111192.

[16] Mohamed, Ahmed Esmail. 2024. "Inventory Management." In *Operations Management-Recent Advances and New Perspectives*. IntechOpen.

[17] Mubasysyir, Muhammad Hanif, Sudradjat Supian, and Elis Hertini. 2024. "Multi-Item Inventory Control Using Economic Order Quantity (EOQ) Model with Safety Stock, Reorder Point, and Maximum Capacity in Retail Business." *International Journal of Global Operations Research* 5 (1): 55–61.

[18] Mustofa, Assyfatul Qolbi, and Nur Prima Waluyowati. 2024. “Penerapan Analisis ABC, Safety Stock, Dan Reorder Point Bahan Baku Impor.” *Jurnal Kewirausahaan Dan Inovasi* 3 (2): 333–48.

[19] Nasution, Sri Lestari Ramadhani, Miftah Asthariq, and Ermi Girsang. 2022. “Analysis of the Implementation of Drug Inventory Control with the Always Better Control-Economic Order Quantity-Reorder Point-Safety Stock Method.” *Open Access Macedonian Journal of Medical Sciences* 10 (A): 1397–1401. https://doi.org/10.3889/oamjms.2022.10383.

[20] Omair, Muhammad, Verena Stingl, and Brian Vejrum Wæhrens. 2025. “Circular Economy of Plastic: Revisiting Material Requirements Planning Practices for Managing Uncertain Supply.” *Sustainability (Switzerland)* 17 (1). https://doi.org/10.3390/su17010112.

[21] Poornima, Galiveeti, J Vinay, P Karthikeyan, and V N Jinesh. 2024. “Inventory Tracking via IoT in the Pharmaceutical Industry.” In *Intelligent Wireless Sensor Networks and the Internet of Things*, 147–204. CRC Press.

[22] Pramono, Owen Denpas. 2024. “Perencanaan Persediaan Bahan Baku Menggunakan Metode Material Requirements Planning (MRP) Di Nugraha Group.” *Jurnal Ilmiah Penelitian Mahasiswa* 2 (4): 239–50.

[23] Putri, Suci Triana, Rina Mutiara, and Nofi Erni. 2025. “Efisiensi Perencanaan Persediaan Obat Fast Moving Dengan Kombinasi ABC-VEN, Safety Stock Dan Reorder Point Di Instalasi Farmasi Rumah Sakit Ibu Dan Anak Viola.” *QISTINA: Jurnal Multidisiplin Indonesia* 4 (1): 41–58. https://doi.org/10.57235/qistina.v4i1.5783.

[24] Rabta, Boualem. 2020. “An Economic Order Quantity Inventory Model for a Product with a Circular Economy Indicator.” *Computers & Industrial Engineering* 140:106215.

[25] Saptadi, Singgih, Helvina Aulia Zahra, Ary Arvianto, Purnawan Adi Wicaksono, and Wiwik Budiawan. 2023. “Inventory Planning and Control Method for Cement Raw Material with Material Requirement Planning (MRP).” *International Journal of Applied Science and Engineering Review (IJASER)* 4 (3): 18–31.

[26] Schiuma, Giovanni, Eva Schettini, Francesco Santarsiero, and Daniela Carlucci. 2022. “The Transformative Leadership Compass: Six Competencies for Digital Transformation Entrepreneurship.” *International Journal of Entrepreneurial Behavior & Research* 28 (5): 1273–91.

[27] Setiawan, Fery. 2024. “Perancangan Aplikasi Pengendalian Persediaan Barang Dengan Metode Safety Stock

Dan Reorder Point (Studi Kasus: PT. Airlangga Jaya Mandiri).” *LOGIC: Jurnal Ilmu Komputer Dan Pendidikan* 2 (2): 401–8.

[28] Setyadi, Heribertus Ary, Budi Al Amin, and Pudji Widodo. 2024. “Implementation Economic Order Quantity and Reorder Point Methods in Inventory Management Information Systems.” *Journal of Information Systems and Informatics* 6 (1): 103–17.

[29] Silver, Edward A, David F Pyke, and Douglas J Thomas. 2016. *Inventory and Production Management in Supply Chains*. CRC press.

[30] Siraj, Mahrukh, Asad Naseem, Muttahira Maryam, and Javeria Asad. 2024. “Optimizing Inventory Management: A Comprehensive Analysis of Economic Order Quantity, Lot Size, Safety Stock, and Reordering Quantity Strategies.” *Journal of Business Administration and Management Sciences (JOBAMS)* 6 (1): 8–16.

[31] Sutejo, Mohamad Bambang, Degdo Suprayitno, and Wahyuddin Latunreng. 2023. “Controlling Raw Material Inventory Using the Economic Order Quantity (EOQ) Method at PT. ICI Paints Indonesia.” *Sinergi International Journal of Logistics* 1 (3): 108–22.

[32] Tika, Etika Sabariah, Agung Suprianto, and Isron Isron. 2022. “Development of Business Mathematics Counting Integration Methods in the Big Data Era in Food Barn Management.” *Jurnal Ekonomi* 11 (03): 1554–64.

[33] Tri, Nguyen Minh, Pham Duy Hoang, and Nguyen Trung Dung. 2021. “Impact of the Industrial Revolution 4.0 on Higher Education in Vietnam: Challenges and Opportunities.” *Linguistics and Culture Review* 5 (S3): 1–15.

[34] Wolniak, Radosław, Adam Wyszomirski, Marcin Olkiewicz, and Anna Olkiewicz. 2021. “Environmental Corporate Social Responsibility Activities in Heating Industry—Case Study.” *Energies* 14 (7): 1930.

[35] Yao, Xufeng, Nourah Almatooq, Ronald G Askin, and Greg Gruber. 2022. “Capacity Planning and Production Scheduling Integration: Improving Operational Efficiency via Detailed Modelling.” *International Journal of Production Research* 60 (24): 7239–61.