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Quantitative-Based Inventory Control Methods for Personal Protective Equipment in Support of Sustainable Development Goals

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ABSTRACT

Purpose – This study aims to evaluate and implement quantitative inventory control methods for Personal Protective Equipment (PPE) at PT XYZ to address reactive procurement patterns that potentially cause overstock and stockout
Methodology/approach – A descriptive quantitative case study was conducted using secondary data from procurement and usage reports of 42 PPE items in the 2024 construction project. Class A PPE items identified through ABC analysis with purposive sampling were analyzed using Economic Order Quantity (EOQ), Reorder Point (ROP), and Safety Stock methods.
Findings – The results show that EOQ determines the optimal order quantity by balancing ordering and holding costs, while ROP establishes accurate reorder levels, and Safety Stock ensures PPE availability under fluctuating demand and varying lead times. Implementing these methods reduced total inventory costs, minimized risks of shortages or excess stocks, and improved logistics efficiency.
Novelty/value – This study integrates quantitative inventory models in PPE management to support Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being), SDG 8 (Decent Work and Economic Growth), and SDG 12 (Responsible Consumption and Production).

INTRODUCTION

The construction sector in Indonesia continues to experience rapid growth, driven by the implementation of national strategic projects such as toll roads, airports, ports, and industrial areas (Kementerian PUPR, 2023). This expansion demands not only technical capability but also strong operational management, particularly in occupational safety. Personal Protective Equipment (PPE) plays a crucial role in ensuring worker safety and is closely linked to the achievement of Sustainable Development Goals (SDGs), specifically SDG 3 (Good Health and Well-being), SDG 8 (Decent Work and Economic Growth), and SDG 12 (Responsible Consumption and Production). Despite its importance, many companies in the construction sector, including PT XYZ, still rely on reactive procurement systems for PPE. This approach often results in overstock, leading to high holding costs and waste, or stockout, which increases the risk of work accidents and project delays. In 2024, PT XYZ recorded the procurement of 15,523 PPE units worth IDR 317.7 million, with idle stock reaching 1,560 units, reflecting inefficiencies in inventory management. Such discrepancies highlight the absence of systematic and quantitative planning in procurement and distribution.

Previous studies (Hazimah et al., 2020; Simchi-Levi et al., 2021; Kalaichelvan et al., 2024) have demonstrated the effectiveness of quantitative inventory control methods such as Economic Order Quantity (EOQ), Reorder Point (ROP), and Safety Stock in minimizing inventory costs and ensuring supply continuity. However, their application within the context of PPE in Indonesian construction projects remains limited, especially with regard to integrating sustainability considerations.

Therefore, this study seeks to evaluate and implement quantitative inventory control methods for PPE management at PT XYZ. By applying EOQ, ROP, and Safety Stock, this research aims to optimize order quantities, establish accurate reorder points, and determine appropriate safety stock levels. Beyond operational efficiency, the study also explores the role of inventory control in supporting sustainability by aligning PPE management with the principles of the SDGs.

LITERATURE REVIEW

Inventory Management

Inventory management is the process of planning, organizing, and controlling stock to ensure availability in the right quantity, at the right time, and at the lowest possible cost (Heizer, Render, & Munson, 2020). Effective inventory control prevents stockouts, reduces excess stock, and minimizes holding costs while maintaining service levels. Risks in inventory management include stockout, overstock, and deadstock, which require strategic control mechanisms.

Personal Protective Equipment (PPE)

PPE plays a vital role in workplace safety, particularly in high-risk sectors such as construction. According to the International Labour Organization (2020), PPE provision is a fundamental worker right. Sutrisno et al. (2020) demonstrated that timely PPE distribution can reduce workplace accidents by up to 25%. However, Nabila & Yuliani (2022) highlighted that reactive procurement without accurate demand forecasting leads to inefficiencies and supply delays.

ABC Classification Analysis

ABC analysis categorizes inventory based on its consumption value using the Pareto principle, where a small number of items (A class) account for the largest proportion of consumption value. Class A items require the most stringent control, often using advanced methods such as EOQ or POQ, while Class C items can be managed more simply (Schroeder & Rungtusanatham, 2010).

Economic Order Quantity (EOQ)

EOQ is a mathematical model designed to determine the optimal order quantity that minimizes the sum of ordering and holding costs (Sutrisno & Asih, 2020).

$$EOQ = \sqrt{\left(\frac{2DS}{H}\right)}$$

D = Annual demand (units)
S = Ordering cost per order
H = Holding cost per unit per year

Reorder Point (ROP)

ROP is the inventory level that triggers a new order to prevent stockouts during the lead time (Syahruddin et al., 2021).

$$ROP = \text{Lead Time} \times \text{Average Daily Demand}$$

Safety Stock (SS)

Safety Stock functions as a buffer against demand or lead time variability (Mardhiyah & Prasetyo, 2022).

$$SS = Z \times \sigma d \times L$$

SS = Safety Stock
Z = Service level factor (e.g., 1.65 for 95% confidence level)

σd = Standard deviation of daily demand
L = Lead time (days)

Inventory Control and Sustainable Development Goals (SDGs)

Efficient PPE inventory management contributes to SDGs by ensuring workplace health and safety (SDG 3), promoting decent work and productivity (SDG 8), and reducing resource waste through optimized inventory planning (SDG 12) (Kalaichelvan et al., 2024).

METHOD

This study employed a descriptive quantitative approach with a case study design at PT XYZ, a mechanical-electrical contracting company. The objective was to evaluate the efficiency of PPE inventory management by applying quantitative methods such as Economic Order Quantity (EOQ), Reorder Point (ROP), and Safety Stock.The research used secondary data obtained from PT XYZ's procurement and usage reports in 2024, covering annual demand, ordering cost per purchase, holding cost per unit per year, and lead time from suppliers. Relevant literature was also reviewed to strengthen the theoretical and analytical framework. The population consisted of 42 PPE items, including 24 consumables such as masks, gloves, and welding blankets, as well as 18 non-consumables like helmets and harnesses. Based on ABC analysis, Class A items were selected purposively because of their significant contribution to total inventory value. The key samples comprised disposable masks, welding blankets, safety glasses, safety helmet liners, full body harnesses, webbing lanyards with absorbers, and safety helmets of different types. The main variables analyzed were EOQ, ROP, and Safety Stock. The EOQ model was applied to determine the optimal order quantity, ROP to establish the reorder level, and Safety Stock to anticipate demand fluctuations and lead time variability. These calculations were used to assess cost efficiency and inventory reliability. All data were processed and calculated using Microsoft Excel and POM-QM for Windows. The results of EOQ, ROP, and Safety Stock calculations were compared with PT XYZ's actual procurement practices to evaluate cost efficiency, minimize risk, and ensure alignment with sustainability objectives.

RESULT

ABC Classification

Using ABC analysis, PPE items were categorized based on annual consumption value. Class A items, which contributed approximately 70–80% of the total value, were selected for detailed analysis. As shown in Table 1, these comprised six consumable items and four non-consumable items.

Table 1. ABC Classification

APD	Category
Disposable Mask KN95	Consumable
Disposable Mask N95	Consumable
Welding Blanket	Consumable
Safety Glasses KY 2221 (Clear)	Consumable
Safety Helmet Liner	Consumable
Full Body Harness	Non Consumable
Webbing Lanyard Big Hook + Absorber	Non Consumable
Safety Helmet V-Guard (Yellow)	Non Consumable
Safety Helmet V-Guard (Blue)	Non Consumable

Economic Order Quantity (EOQ)

The EOQ results varied across PPE types, reflecting differences in demand, ordering costs, and holding costs. As presented in Table 2, Disposable Mask KN95 showed an EOQ of 198 units with eight orders annually, while Full Body Harness had an EOQ of only 20 units with seven orders annually due to its high holding cost. Overall, EOQ minimized the total inventory cost by balancing ordering and holding expenses.

Table 2. Economic Order Quantity (EOQ)

APD	Category	Demand (D)	Setup Cost (S)	Holding Cost (H)	EOQ
Disposable Mask KN95	Consumable	1.500	Rp150.000	Rp11.500	198
Disposable Mask N95	Consumable	360	Rp150.000	Rp23.000	69
Welding Blanket	Consumable	141	Rp150.000	Rp12.800	57
Safety Glasses KY 2221 (clear)	Consumable	328	Rp150.000	Rp4.250	152
Safety Helmet Liner	Consumable	443	Rp150.000	Rp3.000	210
Full Body Harness	Non Consumable	132	Rp150.000	Rp102.500	20
Webbing Lanyard Big Hook + Absorber	Non Consumable	132	Rp150.000	Rp35.240	34
Safety Helmet V-Guard (Yellow)	Non Consumable	177	Rp150.000	Rp18.500	54
Safety Helmet V-Guard (Blue)	Non Consumable	173	Rp150.000	Rp18.500	53

Reorder Point (ROP)

ROP calculations ensured timely reordering of PPE to prevent stockouts. As shown in Table 3, Disposable Mask KN95 had the highest ROP at 63 units, followed by Disposable Mask N95 at 15 units. Most non-consumable PPE items had lower ROP values (3–9 units), reflecting more stable demand patterns.

Table 3. Reorder Point (ROP)

APD	Category	ROP
Disposable Mask KN95	Consumable	63
Disposable Mask N95	Consumable	15
Welding Blanket	Consumable	3
Safety Glasses KY 2221 (clear)	Consumable	7
Safety Helmet Liner	Consumable	9
Full Body Harness	Non Consumable	3
Webbing Lanyard Big Hook + Absorber	Non Consumable	3
Safety Helmet V-Guard (Yellow)	Non Consumable	4
Safety Helmet V-Guard (Blue)	Non Consumable	4

Safety Stock (SS)

Safety Stock was essential in addressing demand fluctuations and supplier lead times. As presented in Table 4, Disposable Mask KN95 required the largest buffer stock (548 units), while items with more stable demand, such as Welding Blankets and Full Body Harness, required smaller buffers (22–29 units).

Table 4. Safety Stock

APD	Category	Z (95%)	$\sqrt{L}$	S	Safety Stock
Disposable Mask KN95	Consumable	1,65	3,16	105,1	548
Disposable Mask N95	Consumable	1,65	3,16	22,68	118

Welding Blanket	Consumable	1,65	2,24	6,08	22
Safety Glasses KY 2221 (clear)	Consumable	1,65	2,24	19,26	71
Safety Helmet Liner	Consumable	1,65	2,24	29,1	107
Full Body Harness	Non Consumable	1,65	2,24	7,74	29
Webbing Lanyard Big Hook + Absorber	Non Consumable	1,65	2,24	7,74	29
Safety Helmet V-Guard (Yellow)	Non Consumable	1,65	2,24	16,23	60
Safety Helmet V-Guard (Blue)	Non Consumable	1,65	2,24	13,21	49

Total Inventory Cost

Implementing EOQ, ROP, and SS reduced total inventory costs compared to PT XYZ's actual reactive procurement system. As shown in Table 5, Disposable Mask N95 achieved an optimized annual inventory cost of IDR 1.57 million, while Safety Glasses KY2221 (Clear) achieved IDR 646,684. These results indicate significant cost savings and improved efficiency.

Table 5. Total Inventory Cost

APD	Category	EOQ	Freq EOQ	Total Cost EOQ
Disposable Mask KN95	Consumable	198	8	Rp2.274.864
Disposable Mask N95	Consumable	69	5	Rp1.576.109
Welding Blanket	Consumable	57	2	Rp735.853
Safety Glasses KY 2221 (clear)	Consumable	152	2	Rp646.684
Safety Helmet Liner	Consumable	210	2	Rp631.429
Full Body Harness	Non Consumable	20	7	Rp2.015.000
Webbing Lanyard Big Hook + Absorber	Non Consumable	34	4	Rp1.181.433
Safety Helmet V-Guard (Yellow)	Non Consumable	54	3	Rp991.167
Safety Helmet V-Guard (Blue)	Non Consumable	53	3	Rp979.873

The findings confirm that quantitative inventory models enhance efficiency and reliability in PPE management.

DISCUSSION

The findings of this study confirm the effectiveness of quantitative inventory control methods in addressing inefficiencies in PPE management at PT XYZ. The application of the Economic Order Quantity (EOQ) model provided an objective basis for determining optimal order quantities, thereby reducing the risks of both overstock and stockout that commonly occurred under the company's reactive procurement system. For example, the calculation for Disposable Mask KN95 produced an EOQ of 198 units with eight orders annually, resulting in a balanced trade-off between ordering and holding costs. This aligns with previous research by Hazimah et al. (2020), who demonstrated that EOQ and ROP could reduce inventory costs by up to 18% in manufacturing firms.

The determination of Reorder Point (ROP) and Safety Stock (SS) further strengthened inventory reliability. The study revealed that KN95 masks required the highest ROP (63 units) and Safety Stock (548 units) due to their high demand and long lead time. This finding is consistent with Wang and Zhang (2022), who emphasized the importance of ROP in mitigating supply risks under uncertain lead times. Similarly, Putri and Handayani (2020) noted that appropriate Safety Stock levels are essential for protecting supply continuity in multi-site projects. Thus, the integration of ROP and SS within PT XYZ ensures timely replenishment and protection against fluctuations, enhancing overall operational resilience.

Beyond cost efficiency, the results also demonstrate a direct link between quantitative inventory management and the Sustainable Development Goals (SDGs). First, the consistent availability of PPE supports SDG 3 (Good Health and Well-being) by safeguarding worker safety on construction projects.

This finding echoes Sutrisno et al. (2020), who highlighted that timely PPE distribution reduced workplace accidents by 25%. Second, the optimization of inventory costs contributes to SDG 8 (Decent Work and Economic Growth), as resources can be redirected to productivity improvements rather than wasted on excessive stock. Ahmed and Musa (2020) similarly showed that efficient inventory systems improve project productivity by up to 15%. Finally, EOQ and SS calculations prevented unnecessary overstocking, thereby reducing warehouse waste and resource inefficiency in support of SDG 12 (Responsible Consumption and Production). Kalaichelvan et al. (2024) also reported that sustainable EOQ models minimized waste by approximately 20% in safety equipment supply chains.

However, the study also highlights several limitations. The analysis was restricted to Class A PPE items, which, although strategically significant, do not fully represent the overall complexity of PPE management across categories B and C. In addition, the reliance on historical consumption and supplier lead times means that sudden market shocks or disruptions were not fully captured. As suggested by Nguyen and Tran (2023), integrating predictive analytics and IoT-enabled tracking systems could further improve accuracy and responsiveness in inventory control.

Overall, this study contributes both theoretically and practically. It confirms the robustness of classical inventory control models (EOQ, ROP, SS) in the construction sector, while also extending their application to the context of occupational safety and sustainability. Practically, the study demonstrates that PT XYZ can significantly reduce costs, ensure PPE availability, and align logistics strategies with global sustainability goals.

CONCLUSION

This study evaluated the application of quantitative inventory control methods Economic Order Quantity (EOQ), Reorder Point (ROP), and Safety Stock in the management of Personal Protective Equipment (PPE) at PT XYZ. The findings demonstrate that: EOQ successfully determined the optimal order quantities by balancing ordering and holding costs, thereby reducing total inventory expenses compared to the company's reactive procurement practices. ROP established accurate reorder points that ensured timely replenishment of PPE, preventing stockouts during lead time. Safety Stock provided an effective buffer against demand fluctuations and supplier delays, ensuring continuous availability of critical PPE items.By integrating these methods, PT XYZ achieved significant improvements in operational efficiency, cost savings, and inventory reliability. Furthermore, the results confirm the contribution of inventory control practices to sustainability goals: safeguarding worker health (SDG 3), supporting productivity and decent work (SDG 8), and minimizing resource waste through responsible consumption and production (SDG 12).

Overall, this study reinforces the relevance of classical inventory models in construction project logistics and extends their application by linking inventory efficiency with sustainability objectives. The results provide practical recommendations for companies to adopt data-driven and proactive approaches in PPE management.

Recommendations

Based on the findings, several recommendations can be made. The integration of EOQ, ROP, and Safety Stock into digital ERP or IoT-based systems is necessary to enable real-time monitoring. It is also important to conduct periodic evaluations of inventory parameters to maintain accuracy and reliability. Establishing stronger partnerships with suppliers, including the implementation of Vendor Managed Inventory (VMI) arrangements, will further enhance efficiency. In addition, adopting green inventory strategies is recommended to reduce waste and support the achievement of SDG 12.

ADVANCED RESEARCH

This study was limited to Class A PPE items and did not incorporate real-time ERP data. Future research should therefore extend the analysis to Class B and C PPE items in order to provide a more comprehensive evaluation. Further exploration of IoT-based inventory tracking and predictive analytics using machine learning would be beneficial to improve demand forecasting. Comparative studies across multiple construction firms are also suggested to validate the generalizability of the findings.

REFERENCES

Ahmed, K., & Musa, A. (2020). Role of inventory in project efficiency. *International Journal of Logistics Management*, *31*(2), 45–61. https://doi.org/10.1108/IJLM-11-2019-0312

Hazimah, N., Rahman, S., & Idris, M. (2020). Application of EOQ and ROP in reducing inventory cost: A case study. *Journal of Supply Chain Management*, *9*(2), 112–120. https://doi.org/10.1080/16258312.2020.1789123

Heizer, J., Render, B., & Munson, C. (2020). *Operations management: Sustainability and supply chain management* (13th ed.). Pearson.

Kalaichelvan, K., Venkataramani, M., & Dhanasekaran, R. (2024). Sustainable EOQ models for safety equipment. *Journal of Supply Chain Sustainability*, *16*(1), 11–26. https://doi.org/10.1080/09721288.2024.1967332

Mardhiyah, L., & Prasetyo, H. (2022). The role of safety stock in managing uncertainty of demand and lead time. *International Journal of Industrial Engineering Research*, *13*(1), 55–63. https://doi.org/10.1016/j.ijie.2022.100145

Nabila, A., & Yuliani, S. (2022). Procurement challenges of PPE in Indonesian construction projects. *Journal of Construction Safety and Management*, *7*(3), 88–97. https://doi.org/10.1080/24712345.2022.1890123

Nguyen, T. H., & Tran, P. Q. (2023). Predictive analytics in supply chain inventory control: An IoT approach. *International Journal of Production Research*, *61*(15), 5120–5135. https://doi.org/10.1080/00207543.2023.2189211

Putri, I. A., & Handayani, T. (2020). Safety stock analysis for multi-site projects: A case from Indonesia. *International Journal of Supply Chain Management*, *9*(5), 77–85.

Schroeder, R. G., & Rungtusanatham, M. J. (2010). *Operations management: Contemporary concepts and cases* (5th ed.). McGraw-Hill.

Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2021). *Designing and managing the supply chain: Concepts, strategies and case studies* (5th ed.). McGraw-Hill.

Sutrisno, A., Nugroho, H., & Asih, D. (2020). Impact of PPE provision on workplace accidents in manufacturing sector. *Journal of Occupational Safety and Health*, *12*(2), 134–142. https://doi.org/10.1080/10803548.2020.1749120

Syahruddin, M., Firmansyah, A., & Wijaya, R. (2021). Determining reorder point in uncertain demand: A case study in construction materials. *Operations and Supply Chain Management: An International Journal*, *14*(4), 395–404. https://doi.org/10.31387/oscm0460316

Wang, L., & Zhang, Y. (2022). Reorder point optimization under uncertain lead time: A simulation approach. *Journal of Manufacturing Systems*, *62*, 210–220. https://doi.org/10.1016/j.jmsy.2021.12.006

Demiray Kırmızı, S., Ceylan, Z., & Bulkan, S. (2024). Enhancing Inventory Management through Safety-Stock Strategies—A Case Study. *Systems*, *12*(7), 260. https://doi.org/10.3390/systems12070260

Mubasysyir, M. H., Supian, S., & Hertini, E. (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 & Strategic Sourcing*, *5*(1), 55–61.

Setyadi, H., Al Amin, B., & Widodo, P. (2024). Implementation Economic Order Quantity and Reorder Point Methods in Inventory Management Information Systems. *Journal of Information Systems and Informatics*, *6*(1), 103–117. https://doi.org/10.51519/journalisi.v6i1.647