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Application of FMEA and EOQ Methods in Risk Management Assessment

Galuh Citra Sukma Dwika[1], **Isnaini Harahap**[1], **Nurlaila**[1]
[1]Universitas Islam Negeri Sumatera Utara, Indonesia
galuhcitra110503@gmail.com*

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Abstract

This study aims to optimize the control of agroinput inventory at a company in Indonesia through the integration of Failure Mode and Effects Analysis and Economic Order Quantity, supplemented by safety stock and reorder points. The research design is quantitative-operational, utilizing historical demand data, ordering costs, storage costs per unit per year, unit prices, and supplier lead times. Failure Mode and Effects Analysis is used to identify and rank failure modes in the warehouse based on severity, probability of occurrence, and detectability to form a Risk Priority Number. The risk findings are then mapped to inventory policy parameters: determining the service level that forms the basis for the safety stock level, setting the reorder point, and evaluating the order frequency through Economic Order Quantity. The results show that integrating the two approaches produces more efficient order sizes, reduces unnecessary ordering frequency, and reduces the potential for stockouts on items with high risk Priority Numbers by adjusting safety stock and reorder points based on service levels. A before-and-after comparison also confirms that ordering and carrying costs can be reduced without compromising the availability of critical materials. Managerial implications include establishing standard ordering procedures per item (economic lot size, reorder point, and review period), periodically reviewing ordering and carrying cost parameters, and integrating the Risk Priority Number metric into the inventory control system. This study provides practical contributions to strengthening inventory management in the agro-industry sector.

INTRODUCTION

Warehouse management plays a strategic role in ensuring that the flow of materials is timely, reliable, and cost-effective. In contemporary practice, warehouses are no longer seen merely as storage spaces, but as control centers for material flows that affect service quality, the accuracy of process requirements fulfillment, and the overall cost structure of the organization (Putri & Sunarso, 2024; Vinet & Zhedanov, 2011). Various field reports indicate recurring problems in this function, including disorderly space arrangement, inconsistent grouping of goods, and weak recording discipline, resulting in outdated inventory data (Triana & Kartika, 2023).

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This situation prolongs picking and sorting times, increases the risk of items being mixed up or overlooked, and reduces labor productivity. At the same time, many organizations still set inventory policies without adequate cost analysis and data support, making it easy to fall into two equally detrimental extremes: running out of inventory, which hinders the process, and excess inventory, which wastes space and storage costs (Roghib & Naser Daulay, 2023; Nawawi et al., 2023).

A risk management framework is needed to systematically reorganize warehouse processes, starting from identifying sources of risk, assessing the severity and likelihood of occurrence, to determining measurable mitigation measures (Geofanny & Tanaamah, 2022; Sari et al., 2022). Organizations with clear risk management strategies tend to be more adaptive to supply disruptions, able to maintain the reliability of internal services, and at the same time reduce unnecessary costs (Prianto et al., 2024). In this context, two analytical tools are widely used and complement each other. First, Failure Mode and Effects Analysis, which maps and prioritizes process risks based on a combination of severity, probability of occurrence, and detectability, then produces a priority measure known as the Risk Priority Number (Susanti et al., 2023; Syamsiah et al., 2023). Second, Economic Order Quantity, which offers a quantitative approach to determining the optimal order size by balancing ordering costs and storage costs so that the total relevant costs are at a minimum (Jan & Tumewu, 2019; Laoli et al., 2022).

Both have strong scientific rationale. Failure Mode and Effects Analysis helps organizations focus resources on the most critical failure modes so that improvements are not scattered and superficial. Its application has proven to be widespread, from manufacturing to logistics, to reduce defects, eliminate obstacles, and improve reliability (Elvina et al., 2022; Rayoga, 2024; Ridwan et al., 2019). Economic Order Quantity, on the other hand, has long been a pillar of decision-making in ordering policies. Assuming that cost and demand parameters can be estimated, this framework reduces the frequency of excessive orders while preventing the accumulation of unproductive inventory. In modern practice, policy designs based on Economic Order Quantity are almost always accompanied by safety stock and reorder points, both derived from the desired service level and the variability of demand and supplier lead time, so that cost efficiency does not compromise the availability of important goods (Adi et al., 2023; Prihasti & Nugraha, 2021).

The urgency of strengthening this approach increases in the context of an increasingly volatile supply chain. Surge in demand, shipping disruptions, storage capacity limitations, and uncertainty in product quality require inventory policies that are sensitive to process risks and based on reliable calculations. Empirical experience in many agribusiness organizations shows a similar pattern: over-ordering in certain periods leads to stockpiling and quality deterioration, while under-ordering in other periods triggers stockouts and internal service disruptions. These problems are exacerbated by manual recording, irregular physical checks, and uncertainty about supplier lead times, which in certain conditions can extend to nearly a week. The combination of these factors reduces space utilization, increases storage costs, and weakens the accuracy of inventory replenishment.

The integration of Failure Mode and Effects Analysis with Economic Order Quantity provides a logical and sequential solution path. Failure Mode and Effects Analysis is placed as the initial layer to map failure modes across the entire Warehouse activity chain, such as late receipts, picking errors, incorrect labeling, placement deviating from the slotting design, and uncertainty in supplier lead times. The results of the mapping, especially modes with high Risk Priority Numbers, are then translated into inventory policy parameters with varying levels of strictness. Items with a high impact of failure and difficult to detect can be given a higher service level through larger safety stock and more conservative reorder points, while items with a low level of risk follow standard parameters so that storage costs do not balloon. Thus, decisions on order size and timing are no longer uniform for all items, but explicitly adjust to the risk profile of the process.

Recent literature reinforces this rationale. The latest comprehensive study shows that Economic Order Quantity-based inventory policies need to be combined with uncertainty management and sustainability dimensions. The review maps out eighteen prerequisites that can change the Economic Order Quantity formula, ranging from imperfect quality, minimum order limits, costs and carbon emissions, to supply chain disruptions, and confirms a shift in research towards a more practical, resilient Economic Order Quantity that is in line with technology-based industrial transformation (Alnahhal et al., 2024). Simulations during the global health crisis also indicate that to prevent stockouts during demand surges and supply disruptions, order sizes based on Economic Order Quantity need to be increased by approximately twenty to thirty percent, then when demand stabilizes again, they can be reduced by approximately ten to fifteen percent to reduce storage costs.

In terms of quality, the development of lot size determination models confirms that the assumption of "perfect goods" is unrealistic. Imperfect quality-based models place inspection, defect rates, and waiting times as policy determinants; calculating reorder points becomes an important milestone so that orders are placed at the right time and do not trigger excess or shortage of inventory (Nobil et al., 2020). The integration of reorder point calculations in imperfect quality scenarios provides explicit operational guidance, including options for stochastic waiting times and supplier constraints, so that policy design more closely approximates real-world conditions. From a methodological perspective, beyond the classical formula, the simulation-based regression approach offers a practical way to estimate order sizes and reorder points that are more consistent with varied field data. This approach starts from simulations of processes rich in factors such as warehouse costs, distance, price, demand variability, and fulfillment time, then condenses them into regression models that are easy for managers to implement (Milewski & Wiśniewski, 2022). In line with the risk framework, a map of failure modes with high Risk Priority Numbers can be translated into higher service levels in the design of safety stock and reorder points; thus, decisions on order size and timing become responsive to process risks and demand-supply volatility, which are now increasingly prominent.

In addition to explaining the logic of integration, it is also important to emphasize the basis of cost definitions so that policies can be evaluated fairly. Ordering costs should reflect the actual costs of administration, order issuance, receipt, and inspection, not the purchase value. Storage costs per unit per year need to accommodate capital costs, space, energy, insurance, and the risk of damage or expiration. This clarity ensures that comparisons before and after intervention use the same cost components, so that evaluations are not biased by irrelevant factors (Qanitah et al., 2025; Vinet & Zhedanov, 2011). At the operational level, this means that the calculation of safety stock and reorder points should be based on the desired service level and the variability of demand and lead time, rather than simply practical rules that are insensitive to change.

Governance and operational ethics dimensions are also relevant. Excess inventory that leads to damage or expiration is a form of waste that impacts costs and the environment. Strengthening record keeping, batch or lot tracking, periodic packaging inspections, and implementing "first in, first out" for sensitive materials helps reduce the risk of quality deterioration while increasing accountability. Simple digitalization, such as the use of barcodes or quick response codes, control dashboards, and exception reports, can strengthen detection capabilities in Failure Mode and Effects Analysis and reduce discrepancies between records and the physical condition of inventory (Triana & Kartika, 2023). With this foundation, the integration of Failure Mode and Effects Analysis and Economic Order Quantity not only cuts costs but also fosters a more transparent, adaptive, and sustainable process discipline.

Based on the urgency and theoretical basis above, this study uses Failure Mode and Effects Analysis as a process for identifying and prioritizing risks, and Economic Order Quantity as a framework for determining efficient order sizes. The two are linked through the service level that guides the amount of safety stock and reorder points per item. This study utilizes historical demand data, supplier lead times, ordering cost components, and storage cost components, and conducts pre- and post-intervention readings so that the impact of policies on relevant costs and availability reliability can be evaluated.

Although Failure Mode and Effects Analysis and Economic Order Quantity have been extensively researched, the explicit relationship between process risk priorities represented by Risk Priority Numbers and the determination of service levels, safety stock, and reorder points is still limited to specific operational contexts. Many studies discuss Economic Order Quantity under the assumption of perfect product quality and deterministic lead times, even though empirical evidence shows significant imperfections in quality, fluctuations in demand, and variations in lead times. On the other hand, studies of Failure Mode and Effects Analysis in warehouses often stop at risk lists and general recommendations without translating them into measurable inventory policy parameters.

This study offers novelty by linking process risk priorities from Failure Mode and Effects Analysis directly to inventory policy design based on Economic Order Quantity, through differentiation of service levels per item. Items with high Risk Priority Numbers receive more conservative parameters, while low-risk items follow standard parameters to contain storage cost growth. Another novelty lies in the affirmation of consistent definitions of ordering costs and storage costs as the basis for evaluation, as well as in the integration of recent literature findings on imperfect quality, variable waiting times, and sustainability requirements into the policy design argument (Alnahhal et al., 2024; Milewski & Wiśniewski, 2022; Nobil et al., 2020).

Theoretically, this study strengthens the bridge between process risk management and inventory control theory by showing how the output of Failure Mode and Effects Analysis can be used to set service levels, safety stock, and reorder points. In practical terms, this approach provides a replicable standard procedure for setting order sizes, order frequencies, and replenishment thresholds differently per item, thereby reducing relevant costs without compromising availability. In the current context, these findings are relevant for supply chains facing uncertainty and sustainability demands; in the long term, this approach paves the way for further integration with information systems that enable real-time monitoring and adaptive parameter adjustments.

METHODS

This study uses a quantitative-operational case study design at a company in Indonesia. This design was chosen because it is able to capture the real relationship between demand patterns, supplier lead times, and ordering decisions in a single annual cycle, so that the results can be directly used for operational improvements (Asril et al., 2023; Eriyanti et al., 2020; Maputra et al., 2020; Vinet & Zhedanov, 2011). The unit of analysis included four groups of agricultural inputs with different demand and risk characteristics. The observation period was from January to December 2024 to cover seasonal variations. Primary data were obtained through observation of the processes of receiving, placing, and retrieving goods, as well as structured interviews with three warehouse officers who handled daily operations. Informants were selected purposively based on their key roles and mastery of the process so that the information collected was relevant to the research objectives. Secondary data included monthly usage records, supplier waiting time records, ordering costs, storage costs per unit per year, unit prices, and internal work guidelines (Myint & Kyaw, 2024; Rachmawati & Surya, 2025; Rahma & Azhar, 2024).

The analysis was conducted in two mutually reinforcing layers. The first layer used Failure Mode and Effects Analysis to map warehouse process risks. Three internal assessors assigned severity, probability of occurrence, and detectability scores on a five-point scale after a brief consensus-building session; the scores were multiplied to obtain a Risk Priority Number as the basis for the order of improvement. The use of this method is supported by literature because it effectively prioritizes operations, can be enriched with multi-criteria weighting for uncertainty, and has a more rigorous assessment scheme development (Kırmızı et al., 2024; Du et al., 2023; Tang et al., 2024).

The second layer designs inventory policy using an economic order quantity framework supplemented by safety stock and reorder points. This framework balances ordering costs and holding costs, while two additional parameters maintain service levels when demand and lead times change. The determination of lot size and order thresholds considers recent findings on imperfect goods quality, minimum order limits, and supply chain disruptions; in crisis conditions, lot sizes are adjusted to prevent stockouts and then recalibrated when conditions stabilize. Sensitivity testing refers to simulation-based regression approaches and guidelines for determining safety stock under uncertainty (Barros et al., 2021; Milewski & Wiśniewski, 2022). The outputs of the two layers are synthesized into a policy matrix per item for order size, order frequency, safety stock, and reorder point, taking into account space limitations and material handling capabilities. Practical validation is carried out through periodic reviews and continuous improvement of warehouse operations (Klarić et al., 2025).

RESULT AND DISCUSSION

Data profile, demand patterns, and operational context

The study was conducted at a warehouse belonging to a company in Indonesia that handles four groups of agricultural inputs: nitrogen-phosphorus-potassium fertilizers, dolomite fertilizers, glyphosate-based weed control chemicals, and paraquat-based weed control chemicals. The observation period from January to December 2024 was chosen to cover one full seasonal cycle. The annual usage recapitulation shows the following total requirements: 545,276.5 kilograms of nitrogen-phosphorus-potassium fertilizer, 385,432 kilograms of dolomite fertilizer, 26,066.3 liters of glyphosate, and 1,783.6 liters of paraquat. The monthly averages are 45,439.7 kilograms; 59,297.2 kilograms; 2,172.2 liters; and 148.6 liters, respectively.

Table 1. 2024 Demand Summary

Item	Total	Average/month
Nitrogen, phosphorus, potassium fertilizer	545.276.5 kg	45.439.7 kg
Dolomite fertilizer	385.432 kg	59.297.2 kg
Glyphosate	26.066.3 L	2.172.2 L
Paraquat	1.783.6 L	148.6 L

Observation of the process revealed three main problems. First, there were periods of over-ordering, resulting in goods piling up and taking up space. Second, limited space slowed down the receiving, placement, and retrieval processes. Third, in certain cases, supplier lead times were close to one week. The combination of these three issues has given rise to two equally detrimental situations: excess inventory, which increases storage costs and reduces quality, and stockouts, which disrupt the smooth running of internal services.

To reorganize decisions, this study combines Failure Mode and Effects Analysis to map and prioritize process risks, as well as Economic Order Quantity to determine economical order sizes. The policy is supplemented with safety stock and reorder points based on the desired service level, so that cost efficiency goes hand in hand with availability reliability. Recent evidence supports this direction: order size and reorder point settings need to be adjusted for imperfect quality, minimum order limits, and supply chain disruptions; even in times of crisis, it is advisable to temporarily increase order sizes to prevent stockouts, then reduce them again when the situation stabilizes (Alnahhal et al., 2024; Nobil et al., 2020). In addition to analytical approaches, practical estimates can be reinforced with regression models formulated from simulations of various combinations of costs, demand variability, and fulfillment times, making them more suitable for changing field conditions (Barros et al., 2021; Milewski & Wiśniewski, 2022).

With this framework, future ordering requirements are no longer determined solely by habit, but rather by the risk profile of the process and annual demand patterns. This principle then becomes the basis for calculating order size, order scheduling, safety stock levels, and reorder points for each item.

Results of failure mode and effects analysis and risk prioritization

Risk assessment was conducted by three experienced officers using the Failure Mode and Effects Analysis framework. Each failure mode was assessed on three dimensions: severity of consequences, probability of occurrence, and the system's ability to detect it before it has an impact. A scale of 1 to 5 was used. The risk priority value was calculated as the product of the three dimensions, so that the higher the value, the more urgent it was to address. This approach was chosen because it proved effective in providing a clear sequence of actions in the context of warehousing and was easy to combine with multi-criteria decision-making techniques when uncertainty was high.

Mapping covers four process blocks: ordering, storage, expenditure, and maintenance and security. A summary of the results is presented in table 2. The highest risk priority value appears in the failure mode “excessive ordering causing accumulation and risk of damage/expiration” in the ordering block, with a value of 45. Other high values are seen in “order quantity exceeding space capacity” (30), “capacity limitations triggering excess or shortage of supplies” (24), and “physical-administrative stock differences” due to unreliable recording (20). This pattern is consistent with literature findings that ordering decisions that do not consider capacity, demand variation, and lead time will trigger excess inventory, increased storage costs, and decreased physical quality.

Table 2. Summary of risk priorities based on failure mode and effects analysis

Process Block	Primary Failure Mode	Severity	Occurrence	Detection	Risk Priority Number
Ordering	Order quantity does not match actual needs	4	3	2	24
Ordering	Order quantity exceeds storage capacity	5	2	3	30
Ordering	Delayed arrival of goods	4	3	1	12
Ordering	Over-ordering causes stockpile and damage risk	5	3	3	45
Ordering	Misalignment between order data and receipt records	5	2	2	20
Storage	Stockpile disrupts workflow	5	2	2	20
Storage	Mixed items/damaged packaging due to inconsistent standards	5	2	2	20
Storage	Quality degradation/expiration due to time or environment	4	1	3	12
Storage	Limited capacity causes surplus or shortage	5	2	2	20
Storage	Discrepancy between physical and administrative stock	4	3	2	24
Distribution	Inaccurate recording of outgoing goods	3	3	2	18
Distribution	Slow distribution process	3	2	1	6
Maintenance/Security	Loose access control and weak record-keeping	5	2	2	20

The interpretation of findings confirms that the primary source of inefficiency lies not only in lot sizing, but also in the discipline of ordering policies and capacity management. Accordingly, improvement efforts are directed toward: establishing ordering policies that account for space limitations (e.g., splitting lots and arranging staggered deliveries), adjusting reorder points and safety stock based on demand variability and lead time, and enhancing detection capabilities through scannable labeling, periodic inventory checks, and firm visual controls (Sari et al., 2022; Triana & Kartika, 2023). Recent literature supports this focus: during supply disruptions or demand surges, order sizes often need to be temporarily increased to prevent stockouts, then recalibrated once conditions stabilize; reorder points must be explicitly calculated, especially in scenarios involving imperfect product quality (Alnahhal et al., 2024; Nobil et al., 2020). Beyond analytical approaches, simulation-based regression models can help determine more field-appropriate ordering thresholds (Milewski & Wiśniewski, 2022), while guidelines for setting safety stock under uncertainty offer practical references for balancing risk and cost (Barros et al., 2021). Overall, the results of the Failure Mode and Effects Analysis provide a concrete priority map linking process risks to decisions on order size and timing, enabling subsequent improvements to target the most impactful root causes.

Design and outcomes of economic order quantity, safety stock, and reorder point policies

Inventory policy design is carried out using the Economic Order Quantity framework to determine the order size that minimizes the combined costs of ordering and storage. To maintain service levels when demand and supplier lead times change, this framework is supplemented with safety stock and reorder points. In integration with the results of Failure Mode and Effects Analysis, items with higher risk priority are given higher service level targets so that safety stock and reorder points are more conservative; low-risk items follow standard parameters to keep storage costs under control.

The calculation inputs are sourced from annual demand, one-time costs covering administrative activities to acceptance inspections, and ideal storage costs per unit per year, which include capital, space, energy, insurance, and quality deterioration risks. Emphasizing this cost definition is important so that the before-and-after evaluation compares the same components. Table 3 summarizes the parameters used.

Table 3. Cost parameters as inputs for economic order quantity

Item	Annual Demand	Ordering Cost per Order	Annual Holding Cost per Unit
Nitrogen–Phosphorus–Potassium Fertilizer	545.276.5 kg	Rp 783.306.465	Rp 1.255 per kg
Dolomite Fertilizer	385.432 kg	Rp 106.428.000	Rp 1.775 per kg
Glyphosate	26.066.3 L	Rp 271.457.920	Rp 26.249 per L
Paraquat	1.783.6 L	Rp 38.416.063	Rp 383.616 per L

Based on the above parameters, the Economic Order Quantity for nitrogen-phosphorus-potassium fertilizer is 825,026 kilograms, for dolomite fertilizer is 429,980 kilograms, for glyphosate is 23,219 liters, and for paraquat is

1,793 liters. A comparison with actual ordering practices in 2024 is shown in Table 4.

Table 4. Comparison of actual order size and Economic Order Quantity results

Item	Actual Total Orders in 2024	EOQ-Based Order Size	Operational Implications
Nitrogen–Phosphorus–Potassium Fertilizer	555.536.5 kg	825.026 kg	Ideal lot size is larger; reduce ordering frequency while considering space limitations.
Dolomite Fertilizer	588.000 kg	429.980 kg	Indicates excess inventory; opportunity to reduce holding costs.
Glyphosate	20.920 L	23.219 L	Value aligns with current practice; focus on setting safety stock and reorder point.
Paraquat	1.874 L	1.793 L	Nearly identical; apply fine-tuning via safety stock and early issue principle for expiry.

Safety stock levels are determined in two ways. First, a practical approach based on the difference between maximum and minimum daily usage over seven days as an initial comparison. Second, a statistical approach based on service levels that incorporates daily demand variations and supplier lead times as a reference for operational policy (Vinet & Zhedanov, 2011). A summary of the initial values is shown in table 5.

Table 5. Safety Stock Summary

Item	Safety Stock
Nitrogen–Phosphorus–Potassium Fertilizer	43.978.41 kg
Dolomite Fertilizer	24.551.59 kg
Glyphosate	1.696.10 L
Paraquat	112.70 L

These results provide clear implementation directions. For items with order sizes greater than the economic order quantity, the frequency of orders can be reduced by phased deliveries to prevent stockpiling. For items with order sizes smaller than the economic order quantity, order control is necessary to reduce storage costs. For all items, the reorder point should reflect actual demand variations and lead times (Ratningsih, 2021). Recent evidence confirms that Economic Order Quantity policies and reorder points need to be adjusted when item quality is imperfect, there are minimum order limits, or supply disruptions occur; even during crisis periods, temporary adjustments to order sizes are recommended to prevent stockouts (Alnahhal et al., 2024; Nobil et al., 2020). For variable environments, reorder point estimates can be strengthened with simulation-based regression models and guidelines for determining safety stock under uncertainty (Barros et al., 2021; Miles et al., 2014). Thus, the resulting policies are measurable, adaptive, and ready for evaluation in the next cycle.

Integrated discussion: validation of findings, managerial implications, and improvement agenda

The calculation results show a pattern consistent with the operations management literature. For bulk materials such as nitrogen-phosphorus-potassium fertilizer, the Economic Order Quantity is higher than the company's current practice. Increasing the lot size reasonably reduces the ordering cost component because the number of orders per year decreases. However, this change needs to be accompanied by phased delivery arrangements and loading and unloading scheduling so that storage space is not temporarily filled to capacity. These findings are in line with the basic principles of Economic Order Quantity and applied evidence in industries with high logistics costs (Kusuma Ningrat & Gunawan, 2023; Vinet & Zhedanov, 2011).

For dolomite fertilizer, the Economic Order Quantity is lower than actual practice, indicating a tendency toward excess inventory. Adjusting the lot size to the calculated value has the potential to significantly reduce storage costs without reducing supply continuity (Fachrezy & Setiafindari, 2024). For chemicals containing the active ingredients glyphosate and paraquat, the Economic Order Quantity is relatively close to actual annual demand. Therefore, the key to service reliability is not changing the lot size, but rather setting safety stock and reorder points that reflect demand variability and supplier lead times (Dewi et al., 2025; Vikaliana et al., 2024).

For a fair before-and-after evaluation, the cost components being compared must be the same. Economic Order Quantity minimizes the sum of ordering costs and holding costs; purchasing costs are not included because they do not change when the lot size changes. Therefore, the estimated cost per order must accurately reflect administrative activities, order issuance, receiving processes, and inspection. Meanwhile, storage costs per unit per year must include capital costs, space, energy, insurance, and the risk of quality deterioration or expiration. Consistency in the definition of these costs prevents bias in decisions between items.

The integration of Failure Mode and Effects Analysis with Economic Order Quantity provides a clear path from process risk to decisions on order size and timing. The risk map shows that the main sources of inefficiency are related to undisciplined ordering policies, including a tendency to over-order and weaknesses in detection capabilities, such as inaccurate recording and irregular periodic checks. When risk priority values are translated into service level targets, the amount of safety stock and reorder point thresholds can be differentiated according to the risk level of each item (Ahmad & Sholeh, 2019; Sari et al., 2022). Recent evidence reinforces this approach: effective Economic Order Quantity policies in real-world conditions need to consider imperfect quality, minimum order limits, and supply chain disruptions; even in times of crisis, lot sizes often need to be temporarily increased to prevent stockouts, then reduced again when the situation stabilizes (Alnahhal et al., 2024; Nobil et al., 2020). When variability is high, order threshold estimates can be strengthened with simulation-based regression models that summarize the effects of warehouse costs, distance, price, demand variation, and fulfillment time into a form that is easy for managers to use (Milewski & Wiśniewski, 2022). Guidelines for determining safety stock under uncertainty are also useful for balancing risk and cost in a practical manner (Barros et al., 2021).

The managerial implications of these findings can be summarized in several areas of work. First, there needs to be an operating procedure document that specifies the Economic Order Quantity, reorder point, safety stock, and service level target per item, while also reminding staff of space limitations to prevent stockpiling. For high-volume materials, staggered deliveries and lot splitting will maintain material flow. Second, organizations need a control board that displays key parameters: average daily demand, standard deviation of demand, lead time, service level targets, safety stock, reorder points, order frequency, fulfillment rate, and space utilization. Monitoring should focus on items with high risk priority (Triana & Kartika, 2023). Third, for chemicals, implementing earlier output according to expiration dates, periodic packaging inspections, and strict visual control are important to reduce quality deterioration. Fourth, periodic inventory checks based on value classification for example, class A more often than class C can reduce the difference between physical and administrative stock while improving detection capabilities.

Good policies must also be resilient to parameter changes. Therefore, sensitivity tests on order costs and storage costs (e.g., a twenty percent increase or decrease) and variations in service level targets (e.g., ninety to ninety-seven and a half percent) need to be conducted to assess the robustness of decisions on order size, safety stock, and reorder points. Parameter reviews should be conducted at least quarterly or when there are significant changes in demand patterns, item composition, or supplier policies. A continuous improvement approach to warehouse operations provides a practical framework for this review cycle, including limited implementation tests prior to expansion.

The limitations of the study should be noted so that the improvement agenda is clear. The Failure Mode and Effects Analysis assessment only involved three main assessors; although experienced, differences in opinion may arise. Future research could expand the cross-functional panel and measure inter-rater agreement to improve reliability (Salisyah & Rahmawati, 2024; Syamsiah et al., 2023). Storage cost estimates can also be refined through an activity-based costing approach so that the costs of space, equipment, and energy are reflected in more detail (Sari et al., 2022). For contexts with highly variable demand and lead times, periodic review policies or Monte Carlo simulations can be used to evaluate the desired service level before it is established as an operational standard (Vinet & Zhedanov, 2011).

Overall, the synthesis between process risk maps and Economic Order Quantity policies supplemented by safety stock and reorder points provides a measurable path to reducing relevant costs and maintaining supply reliability. When item-by-item procedures are established, control boards are implemented, and sensitivity tests are conducted periodically, organizations have a clear mechanism for maintaining warehouse performance at a stable level that can be improved over time.

CONCLUSION

This study concludes that combining process risk mapping using Failure Mode and Effects Analysis with Economic Order Quantity-based inventory policy design, supplemented with safety stock and reorder points, is an effective and operational approach to achieving the research objectives. First, Failure Mode and Effects Analysis successfully revealed the most pressing sources of inefficiency in the warehouse, particularly the tendency to over-order, the mismatch between order quantities and space capacity, and weaknesses in the accuracy of inventory recording and checking, while also prioritizing improvements based on severity, probability of occurrence, and detectability. Second, the Economic Order Quantity calculation, aligned with the risk findings, produced a more accurate order size, while the determination of safety stock and reorder points, which took into account demand variation and supplier lead times, was able to maintain service levels without creating excess inventory. This approach reduces unnecessary ordering frequency, lowers ordering and storage costs, and minimizes the risk of stockouts for critical items. Third, the research results provide a clear operational basis through the development of procedures for each item, the arrangement of staggered deliveries for large items so that space capacity remains under control, and the implementation of control boards with key parameters and periodic sensitivity reviews so that decisions remain based on the latest data. Overall, the combination of process risk maps and measurable inventory policies provides a direct answer to the research objectives, namely clarifying improvement priorities, determining efficient order sizes and times, and maintaining reliability of availability. This framework can be replicated in similar warehouse contexts, while also serving as a foundation for continuous improvement through periodic reviews of cost parameters, demand variations, and waiting times.

REFERENCES

Adi, M., Barkah, M., & Lestari, N. A. (2023). Penerapan Metode Economic Order Quantity (Eoq) Terhadap Sistem Informasi Persediaan Barang Berbasis Web (Studi Kasus : Pt. Rajawali Nusindo). In *Jurnal Inovasi Ilmu Komputer* (Vol. 2, Issue 1). PT. Rajawali Nusindo.

Ahmad, A., & Sholeh, B. (2019). Analisis Pengendalian Persediaan Bahan Baku Dengan Menggunakan Metode Economic Order Quantity Pada Usaha Kecil Dan Menengah (Ukm) Dodik Bakery. *Jurnal Riset Akuntansi Terpadu*, *12*(1). https://doi.org/10.35448/jrat.v12i1.5245

Alnahhal, M., Aylak, B. L., Al Hazza, M., & Sakhrieh, A. (2024). Economic Order Quantity: A State-of-the-Art in the Era of Uncertain Supply Chains. *Sustainability (Switzerland)*, *16*(14), 5965. https://doi.org/10.3390/su16145965

Asril, Z., Engkizar, Syafril, S., Arifin, Z., & Munawir, K. (2023). *Perspective Chapter: A Phenomenological Study of an International Class Program at an Indonesian University*. https://doi.org/10.5772/intechopen.110325

Barros, J., Cortez, P., & Carvalho, M. S. (2021). A systematic literature review about dimensioning safety stock under uncertainties and risks in the procurement process. *Operations Research Perspectives*, *8*, 100192. https://doi.org/10.1016/j.orp.2021.100192

Daffa Roghib, & Aqwa Naser Daulay. (2023). Analisis Prosedur Akuntansi Pengadaan Barang dan Jasa di Dinas Sosial Provinsi Sumatera Utara. *GEMILANG: Jurnal Manajemen Dan Akuntansi*, *4*(1), 28–37. https://doi.org/10.56910/gemilang.v4i1.988

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

Dewi, P. C. P., Herawati, N. T., & Wahyuni, M. A. (2025). Peran Pendidikan Islam Dalam Membangun Karakter Generasi Muda di Tengah Arus Globalisasi. *Jurnal IHSAN Jurnal Pendidikan Islam*, *3*(2), 370–380. https://doi.org/10.61104/ihsan.v3i2.987

Du, H., Li, M., Xu, Y., & Zhou, C. (2023). An Ensemble Learning Approach for Land Use/Land Cover Classification of Arid Regions for Climate Simulation: A Case Study of Xinjiang, Northwest China. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, *16*, 2413–2426. https://doi.org/10.1109/JSTARS.2023.3247624

Elvina, T., Dwicahyani, A. R., Industri, T., Industri, T., Adhi, T., & Suarabaya, T. (2022). Pengendalian Kualitas Menggunakan Metode Lean Six Sigma dan FMEA untuk Mengurangi Produk Cacat Panci Anodize PT.ABC. In *Seminar Nasional Teknologi Industri Berkelanjutan II* (Vol. 02, pp. 294–304).

Eriyanti, F., Engkizar, E., Alhadi, Z., Moeis, I., Murniyetti, M., Yulastri, A., & Syafril, S. (2020). The Impact of Government Policies towards the Economy and Education of Fishermen's Children in Padang City. *IOP Conference Series: Earth and Environmental Science*, *469*(1), 12057. https://doi.org/10.1088/1755-1315/469/1/012057

Fachrezy, N. E., & Setiafindari, W. (2024). Analisis Persediaan Bahan Baku Roti Dengan Metode Economic Order Quantyty (Eoq) Dan Just in Time (Jit) Pada Perusahaan Roti. *Jurnal Ilmiah …*, *2*(7), 93–103. https://ejurnal.kampusakademik.co.id/index.php/jiem/article/view/1830

Geofanny, G. K., & Tanaamah, A. R. (2022). Sistem Manajemen Risiko Berbasis ISO 31000:2018 Di PT. Bawen Mediatama. *Jurnal Teknik Informatika Dan Sistem Informasi* , *9*(4), 2870–2878. http://jurnal.mdp.ac.id

Jan, A. H., & Tumewu, F. (2019). Analisis Economic Order Quantity (Eoq) Pengendalian Persediaan Bahan Baku Kopi Pada Pt. Fortuna Inti Alam. *Jurnal EMBA: Jurnal Riset Ekonomi, Manajemen, Bisnis Dan Akuntansi*, *7*(1). https://doi.org/10.35794/emba.v7i1.22263

Klarić, K., Perić, I., Vukman, K., Papić, F., Klarić, M., & Grošelj, P. (2025). Hybrid MCDM-FMEA Model for Process Optimization: A Case Study in Furniture Manufacturing. *Systems*, *13*(1), 14. https://doi.org/10.3390/systems13010014

Kusuma Ningrat, N., & Gunawan, S. (2023). Pengendalian Persediaan Bahan Baku Untuk Meningkatkan Efisiensi Biaya Persediaan Dengan Menggunakan Metode Eoq (Economic Order Quantity) Di Umkm Kerupuk Nusa Sari Kecamatan Cimaragas Kabupaten Ciamis. *Jurnal Industrial Galuh*, *5*(1), 18–28. https://doi.org/10.25157/jig.v5i1.3058

Laoli, S., Zai, K. S., & Lase, N. K. (2022). Penerapan Metode Economic Order Quantity (Eoq), Reorder Point (Rop), Dan Safety Stock (Ss) Dalam Mengelola Manajemen Persediaan Di Grand Katika Gunungsitoli. *Jurnal EMBA*, *10*(4), 1269–1273.

Maputra, Y., Syafril, S., Wekke, I. S., Juli, S., Anggreiny, N., Sarry, S. M., & Engkizar. (2020). Building Family's Social Resilience through Batobo Culture: A community environment proposal. *IOP Conference Series: Earth and Environmental Science*, *469*(1), 12062. https://doi.org/10.1088/1755-1315/469/1/012062

Miles, M., Huberman, M., & Saldana, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook*. SAGE Publications, Inc.

Milewski, D., & Wiśniewski, T. (2022). Regression analysis as an alternative method of determining the Economic Order Quantity and Reorder Point. *Heliyon*, *8*(9), 10643. https://doi.org/10.1016/j.heliyon.2022.e10643

Myint, K. Z., & Kyaw, N. M. (2024). The Innovative Econometric Approaches for Predicting Myanmar's Central Region as a New Economic Hub. *International Journal of Multidisciplinary Research of Higher Education (IJMURHICA*, *7*(3), 165–176. https://doi.org/10.24036/ijmurhica.v7i3.228

Nawawi, Zaim, M. A., Ibrahimy, A. A., Yasid, & Achak, A. H. (2023). Islamic

Law at the Grassroot; SIGMA Program at Bhasa Radio Situbondo and Its Controversy. *Al-Ihkam: Jurnal Hukum Dan Pranata Sosial*, *18*(1), 224–247. https://doi.org/10.19105/al-lhkam.v18i1.8332

Nobil, A. H., Sedigh, A. H. A., & Cárdenas-Barrón, L. E. (2020). Reorder point for the EOQ inventory model with imperfect quality items. *Ain Shams Engineering Journal*, *11*(4), 1339–1343. https://doi.org/10.1016/j.asej.2020.03.004

Prianto, B., Rahmani, N. A. B., & Nasution, J. (2024). Pengaruh Kecerdasan Emosional, Disiplin Kerja Dan Lingkungan Kerja Terhadap Produktivitas Kerja Karyawan (Studi Karyawan Bank Muamalat Cabang Stabat Kabupaten Langkat). *Jesya*, *7*(2), 1971–1982. https://doi.org/10.36778/jesya.v7i2.1748

Prihasti, D. A., & Nugraha, A. A. (2021). Analisis Manajemen Persediaan Dengan Metode Economic Order Quantity (EOQ) Pada Persediaan Bahan Baku UKM Bydevina. *Indonesian Accounting Literacy Journal*, *1*(3), 537–548. https://doi.org/10.35313/ialj.v1i3.3230

Putri, A. A., & Sunarso, S. (2024). Analisis Pengendalian Persediaan Bahan Baku Dengan Metode Material Requirement Planning Pada Usaha Industri Tempe Berkah Makmur Di Matesih Karanganyar. *Jurnal Manajemen Dan Bisnis*, *3*(1), 172–185. https://doi.org/10.36490/jmdb.v3i1.1303

Qanitah, A. S., Nasution, U. C. M., & Mulyati, D. J. (2025). Analisis Pengendalian Persediaan Bahan Baku dengan Metode Material Requirement Planning (MRP) dalam Upaya Meningkatkan Efisiensi Biaya di PT. Arjuna Utama Kimia Surabaya (ARUKI). *Journal Social Society*, *5*(1), 649–662. https://doi.org/10.54065/jss.5.1.2025.742

Rachmawati, A., & Surya, S. (2025). Mediating Effects of Innovation Capability on Market Orientation and Community Economic Enterprise Performance. *International Journal of Multidisciplinary Research of Higher Education (IJMURHICA*, *8*(2), 183–196. https://doi.org/10.24036/ijmurhica.v8i2.269

Rahma, T., & Azhar, Z. (2024). Analysis of Economic Growth During the Crisis in Indonesia. *International Journal of Multidisciplinary …*, *7*(2), 82–89. https://doi.org/10.24036/ijmurhica.v7i2.176

Ratningsih, R. (2021). Penerapan Metode Economic Order Quantity (EOQ) Untuk Meningkatkan Efisiensi Pengendalian Persediaan Bahan Baku Pada CV Syahdika. *Jurnal Perspektif*, *19*(2), 158–164. https://doi.org/10.31294/jp.v19i2.11342

Rayoga, R. Z. (2024). Analisis Risiko K3 Dengan Menggunakan Job Safety Analysis Dan Metode Fmea Pada Warehouse Pt Abc. *Industrial Engineering Online Journal*, *13*(3).

Ridwan, A., Ferdinant, P. F., & Laelasari, N. (2019). Simulasi Sistem Dinamis Dalam Perancangan Mitigasi Risiko Pengadaan Material Alat Excavator Dengan Metode Fmea Dan Fuzzy Ahp. *FLYWHEEL : Jurnal Teknik Mesin Untirta*, 51. https://doi.org/10.36055/fwl.v0i0.5247

Salisyah Salsabilah, & Nur Rahmawati. (2024). Operational Risk Mitigation Strategy in the Engineering Department : A Case Study of PT XYZ. *International Journal of Mechanical, Industrial and Control Systems Engineering*, *1*(4), 56–64. https://doi.org/10.61132/ijmicse.v1i4.129

Sari, M., Hanum, S., & Rahmayati, R. (2022). Analisis Manajemen Resiko Dalam Penerapan Good Corporate Governance : Studi pada Perusahaan Perbankan di Indonesia. *Owner*, *6*(2), 1540–1554. https://doi.org/10.33395/owner.v6i2.804

Susanti, D. A., Yulianto, L., Reza, V., Kurniawan, B., Nurhayati, E. &, & Rezalti, D. T. (2023). Analisis Lean Manufacturing Pendekatan VSM dan FMEA Untuk Meminimasi Pemborosan Pada Salah Satu Perusahaan Logam. In *Prosiding Seminar Nasional Teknik Industri (SENASTI)* (Vol. 1, p. 2023).

Tang, Y., Sun, Z., Zhou, D., & Huang, Y. (2024). Failure mode and effects analysis using an improved pignistic probability transformation function and grey relational projection method. *Complex and Intelligent Systems*, *10*(2), 2233–2247. https://doi.org/10.1007/s40747-023-01268-0

Triana, N. E., & Kartika, H. (2023). Perbaikan Tata Letak Dan Sistem Penyimpanan Barang Di Gudang Finish Goods Menggunakan Metode Class Based Storage. *Jurnal PASTI (Penelitian Dan Aplikasi Sistem Dan Teknik Industri)*, *16*(3), 348. https://doi.org/10.22441/pasti.2022.v16i3.009

Vikaliana, R., Ompusunggu, E. C., & Aryani, F. (2024). Analisis Penerapan Metode Economic Order Quantity (EOQ) pada Pengendalian Persediaan Material Pelumas di Pabrik Minyak Kelapa Sawit. *Jurnal USAHA*, *5*(2), 139–159. https://doi.org/10.30998/juuk.v5i2.3529

Vinet, L., & Zhedanov, A. (2011). A "missing" family of classical orthogonal polynomials. In *Journal of Physics A: Mathematical and Theoretical* (13th ed., Vol. 44, Issue 8). Pearson. https://doi.org/10.1088/1751-8113/44/8/085201

Yuliatin Ali Syamsiah, Dwi Sukma Donoriyanto, & Isna Nugraha. (2023). Pengendalian Risiko dan Optimalisasi Persediaan Bahan Baku pada Usaha Kecil: Pendekatan Metode FMEA dan EOQ. *Jural Riset Rumpun Ilmu Teknik*, *2*(2), 158–171. https://doi.org/10.55606/jurritek.v2i2.2566