Q3 - JOURNAL OF SYSTEM AND MANAGEMENT SCIENCES

https://www.aasmr.org/jsms/

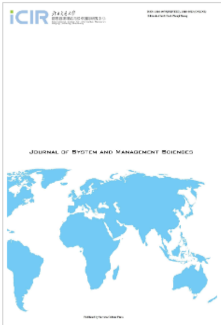
aasmr.org/jsms/

Maps

JOURNAL OF SYSTEM AND MANAGEMENT SCIENCES

- **Home**
- Editorial Board
- Review Process
- Publication Ethics
- Current
- Archives
- Instructions
- Contact

WELCOME TO JSMS



Welcome to the Journal of System and Management Sciences (JSMS), a peer-reviewed, open-access journal dedicated to the latest advancement in the fields of system and management sciences. This journal aspires to publish high-quality, original research articles, review articles, and case studies that contribute significant knowledge and insights to these multidisciplinary fields.

The Journal of System and Management Sciences seeks to provide a global platform for researchers, academicians, and practitioners to share their findings, insights, and innovations. It promotes an interdisciplinary exchange of ideas and knowledge among systems engineers, management professionals, and researchers from related disciplines.

We are committed to maintaining a high standard of excellence and a transparent, rigorous peer-review process. JSMS ensures that published papers enrich the existing body of knowledge, offer practical implications, and pave the way for future research. Authors are encouraged to submit original, unpublished works that are not under review in any other journals. All submissions undergo a meticulous review by our dedicated team of editors and reviewers, ensuring the integrity and quality of the research published in JSMS.

Why Publish with JSMS? **Global Reach:** Your research will be accessible to a global audience of scholars, practitioners, and individuals interested in system and management sciences. **Timely Publication:** We ensure a swift and efficient publication process, making your work available to the scholarly community without unnecessary delay. **Dedicated Support:** Our editorial team provides comprehensive assistance throughout the publication process.

MAIN THEMES

JSMS mainly publishes original research papers and review articles in an interdisciplinary context of management sciences and system engineering. Coverage of JSMS includes but not limited to:

- Systems Theory and Practice
- Innovation and Technology Management
- Business & Economic Ecosystems
- Management Information Systems
- Operations Research and Decision Sciences
- Artificial Intelligence in Business Environment
- Big Data and Business Intelligence
- Project and Quality Management
- Sustainability and Risk Management
- Organizational Behavior and Theory
- Strategic Management and Policy

INDEXED BY

Currently, JSMS has been included in Scopus and Google Scholar.

NEWS

(Mar-21-2024): No.4 of 2024 (Volume 14) has been published online.
(Feb-22-2024): No.3 of 2024 (Volume 14) has been published online.
(Jan-29-2024): No.2 of 2024 (Volume 14) has been published online.
(Jan-3-2023): No.1 of 2024 (Volume 14) has been included in Scopus.
(Dec-16-2023): No.1 of 2024 (Volume 14) has been published online.
(Dec-15-2023): Instructions of authors has been updated. Please check before your consider to submit.
(Dec-15-2023): JSMS will be published monthly from 2024.

CHANGE OF FREQUENCY (IMPORTANT)

Since 2019, JSMS has been included in Scopus. Since then, we received a lot of quality submissions from all over the world. In 2020 and 2023, the average acceptance rate of JSMS is under 30%. There is a long backlog **(it will take at least 9 months from submission to publication)** of submissions in JSMS.
Thus we will change the publishing frequency from 6 times per year to 12 times per year from 2024. Namely, JSMS will publish monthly. For each issue, we will publish less than 35 papers per issue (usually we publish 30 papers per issue to maintain consistency).

JOURNAL OF SYSTEM AND MANAGEMENT SCIENCES

NEWS

New email for submission: jsms@sc-press.com takes effective (Sep-29-2023)
No.5 of 2023 issue was published (Sep-28-2023)
No.4 of 2023 Issue was published (Aug-2-2023)
No.3 of 2023 Issue was published (May-31-2023)
No.2 of 2023 Issue was published (Apr-22-2023)
No.1 of 2023 Issue was published (Feb-28-2023)

EDITORIAL BOARD

Feature Articles

Decision Support Model for Evaluating of Customer Service Performance Using Mamdani and Multi-stage Rule Base (Utama et al.)

Russian-Ukrainian War, Moral and Economic Implications and Cooperation between Countries and Logistics

Artificial Intelligence in Electronic Commerce: Investigating the Customers' Acceptance of Using Chatbots.

More...

JOURNAL OF SYSTEM AND MANAGEMENT SCIENCES

REVIEW PROCESSES OF JSMS

1. Submission of Paper

The corresponding or submitting author submits the paper to the journal. Currently, JSMS only accept submissions by email to the managing editor: jsms@sc-press.com.

2. Editorial Board Assessment

The managing checks the paper's composition and arrangement against the journal's Author Instructions to make sure it includes the required sections and stylizations. In this stage, if the submission is considered as out of scope, it will be rejected immediately. However, the quality of the paper is not assessed at this point.

3. Appraisal by the Editor-in-Chief (EIC)

The EIC checks that the paper is appropriate for the journal and is sufficiently original and interesting. If not, the paper will be rejected without being reviewed.

4. Invitation to Reviewers

The managing editor sends invitations to individuals he believes would be appropriate reviewers. **ALL REVIEWS ARE CONDUCTED EXTERNALLY AND DOUBLE-BLIND.**

5. Review is Conducted

The reviewer sets time aside to read the paper several times. The first read is used to form an initial impression of the work. If major problems are found at this stage, the reviewer may feel comfortable rejecting the paper without further work. Otherwise they will read the paper several more times, taking notes so as to build a detailed point-by-point review. The review is then submitted to the journal, with a recommendation to accept or reject it.

6. Evaluations for Reviews

The EIC considers all the returned reviews before making an overall decision. If the reviews differ widely, the EIC may invite an additional reviewer so as to get an extra opinion before making a decision.

7. Decision Made

The managing editor sends a decision email to the author including any relevant reviewer comments.

8. Next Steps

If accepted, the paper is sent to production. If the article is rejected or sent back for either major or minor revision, the managing editor should include constructive comments from the reviewers to help the author improve the article.

JOURNAL OF SYSTEM AND MANAGEMENT SCIENCES

ARCHIVES OF JSMS

https://www.aasmr.org/jsms/vol14/no.3/

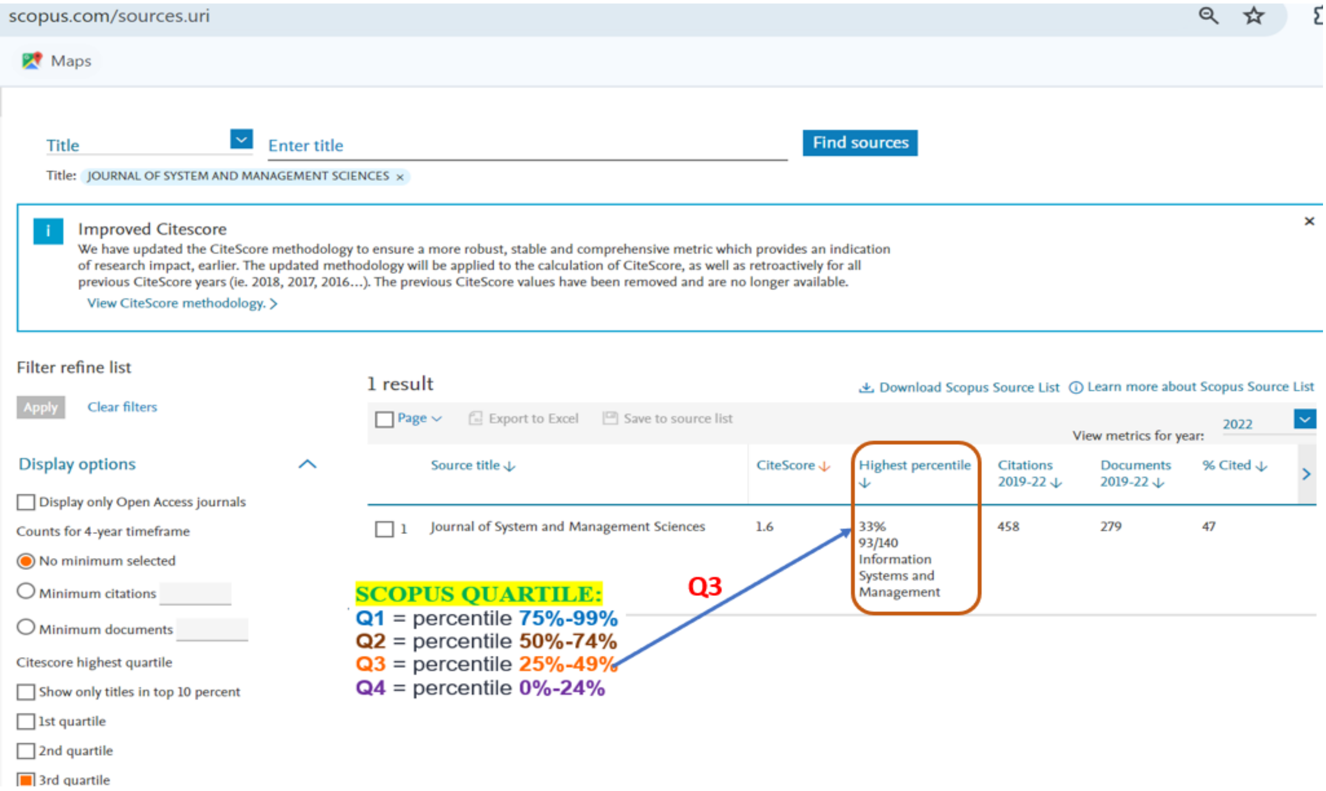
JOURNAL OF SYSTEM AND MANAGEMENT SCIENCES

VOL.14, NO. 3, 2024

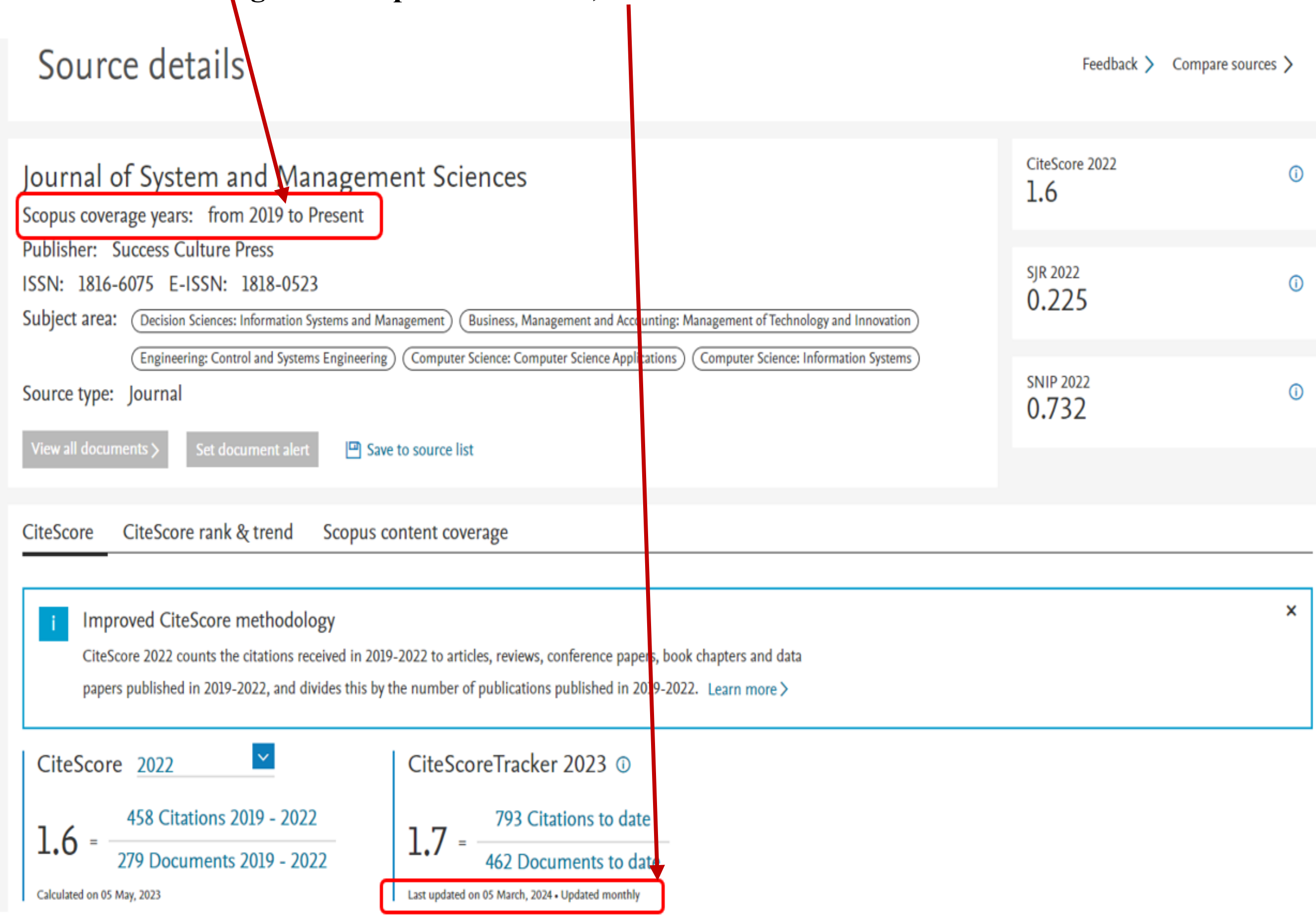
Table of Contents

Pada SCOPUS Source, Percentile = 33% sehingga masuk Q3

Link: https://www.scopus.com/sources.uri



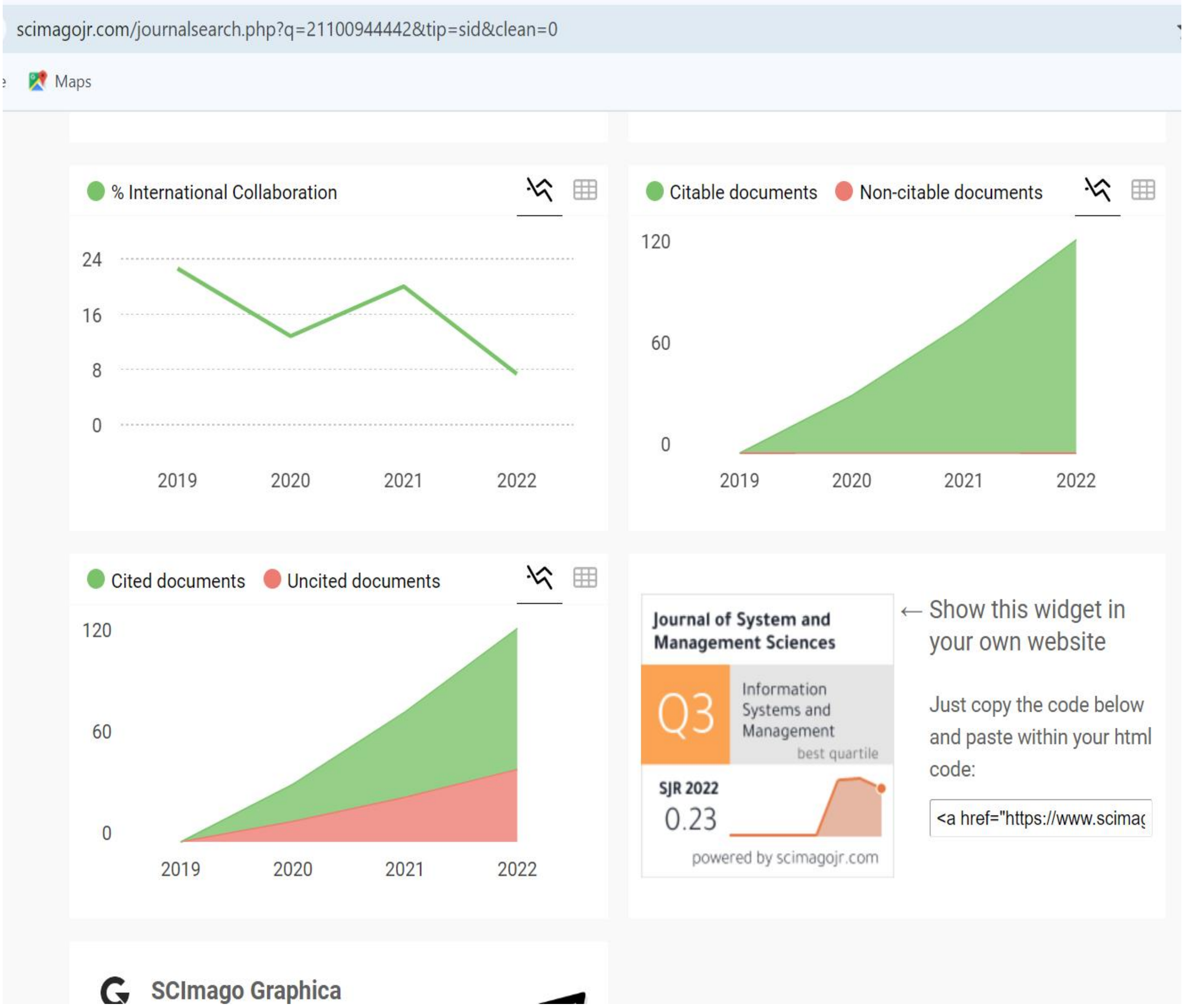
Pada: https://www.scopus.com/sourceid/21100944442 jurnal masih active Scopus coverage from 2019 to Present dengan Last update 5 March, 2024



Pada Scimago Journal & Country Rank: terindex Scopus Q3 dengan SJR 2022 = 0.23. Namun informasi di Scimago tidak up to date setiap bulan seperti halnya Scopus yang update setiap bulan.

Link sbb:

https://www.scimagojr.com/journalsearch.php?q=21100944442&tip=sid&clean=0



ISSN 1816-6075 (Print), 1818-0523 (Online)
Journal of System and Management Sciences
Vol. 14 (2024) No. 3, pp. 514-532
DOI:10.33168/JSMS.2024.0330

Incorporating Time Value of Money into Lot-Sizing Decisions for Improved Supply Chain Performance

Agus Purnomo[1], Syafrianita[2]

[1]Department of Master of Logistics Management, Faculty of Logistics, Technology and Business, Universitas Logistik Dan Bisnis Internasional, Indonesia
[2]Department of Transportation Management, Faculty of Logistics, Technology and Business, Universitas Logistik Dan Bisnis Internasional, Indonesia

aguspurnomo@ulbi.ac.id; syafrianita@ulbi.ac.id

Abstract. Supply chain performance depends heavily on effective inventory management, for which appropriate lot-sizing is critical. This research develops an improved lot-sizing model for material requirements planning (MRP) by incorporating the time value of money. The proposed Silver-Meal method is compared to the traditional approach using data from 5 Indonesian manufacturers. Results indicate 1.78% reduced inventory costs over a 2-year horizon. Further analysis reveals superior performance under varying financial parameters. This research contributes to the literature by addressing limitations in classical MRP models. It provides a valuable decision-making tool for practitioners to enhance supply chain efficiency. Opportunities exist for validating findings across more industry contexts**.**

Keywords: Lot-sizing, Silver-meal, Time value of money, Inventory cost, MRP

1. Introduction

The competitive business environment demands that companies minimize inventory costs and improve SCM performance to meet customer satisfaction (Mbah et al., 2019; Peng et al., 2021), and inventory management practices have a positive effect on the effectiveness and efficiency of the company's SCM performance in the form of responsiveness, effectiveness, reliability, and flexibility (Wasike & Juma, 2020). Companies that increase inventory efficiency would improve financial performance (Anantadjaya et al., 2021), as measured by asset turnover and net margin, along with overall firm performance (Opoku et al., 2020; Zaid et al., 2021).

Material Requirements Planning (MRP) is a widely utilized method for deciding the type, quantity, and timing of material orders necessary to fulfill the requirements of finished goods as outlined in a production plan (Ramya et al., 2019; Farid et al., 2022). The MRP system is well-suited for products not abiding by the order point policy (OPP) model. It is beneficial when the demand for the final product is independent or when orders for the product can be placed periodically (Wulandari & Donoriyanto, 2022); inventory cost is commonly used as a parameter when making decisions in material requirements planning. The optimization of material requirements and inventory cost savings is achieved by designing appropriate lot sizes, aiming to minimize the total inventory cost (Zhu et al., 2022; Lai et al., 2022).

The current MRP method does not consider the time value of money for inventory costs (Damand et al., 2022), assuming the value of money remains constant throughout the planning period so that total inventory costs do not include interest factors (Lubisia & Okello, 2020; Bogataj et al., 2016). Academics have researched the influence of money's time value in production inventory to determine the optimal order quantity, order interval, and vendor production levels to increase profits (Choudri & Senthilkumar, 2023; Sarkar et al., 2020). However, until now, academics have yet to conduct research that considers the time value of money in determining MRP lot size, which aims to improve the company's SCM performance (Bogataj et al., 2020; Bogataj & Bogataj, 2019). Inspired by existing research gaps, the problem raised in this research is the impact of the time value of money on MRP decisions and identifying optimal lot-sizing strategies to improve the company's SCM performance. Thus, this research aims to develop a lot-sizing model in MRP that considers the time value of money and assesses the impact of the value of money on MRP decisions. The contribution of this research is to state that including the time value of money in lot-sizing in MRP results in a reduction in total inventory costs compared to the lot-sizing method, which does not consider the time value of money. So, the results of this research contribute to developing a better lot-sizing model for MRP planning by incorporating the time value of money and providing a valuable decision-making tool for practitioners to improve supply chain efficiency.

2. Literature Review

The company's current challenges occur due to the increasing complexity of the supply chain, resulting in increased prices, increased lead times, and shortages of raw materials (Tebaldi et al., 2023; Dillon et al., 2023), thus requiring inventory control, which can improve the company's supply chain performance (Becerra et al., 2021; Pattnaik et al., 2021). Inventories are various types of goods organizations store for production or sale to satisfy customer orders, minimize inventory costs, and improve SCM performance (Gebisa & Ram, 2021). Inventory is one of the most expensive assets in many companies, with an average consumption of 40 percent of the invested capital (Gołaś, Z., 2020; Kawase & Iryo, 2023). Companies must optimize inventory to improve SCM and financial performance (Benedict & Emmanuel, 2021; Adelwini et al., 2023). SCM performance is improved by controlling inventory on holding costs, order quantities, safety stock, and reordering (Ahmad, 2022). On the other hand, sharing internal and external inventory information with the company is an approach to optimize inventory control, which might improve the company's SCM performance

(Syafrianita et al., 2023; Debala et al., 2022).

The company can minimize inventory costs by reducing the on-hand inventory level. However, it might lead to dissatisfied customers when the product is out of stock in the market (Yankah et al., 2022). It is ideal for companies to strike a balance or optimize their inventory investment while maintaining high levels of customer service (Ogah et al., 2022; Orobia et al., 2020) to enhance their competitive position and SCM performance (Hashmi et al., 2021). Inventory planning plays a huge role in shaping the performance of manufacturing operations where a shortage of raw materials will halt the production process or change the production schedule (Peinado & Villalobos, 2022), resulting in increased production costs and a shortage of finished goods (Fisher et al., 2022). On the other hand, excess inventory will further cause problems regarding increasing inventory costs such as warehousing costs, capital costs, deterioration, excessive insurance premiums, increasing taxes, and even obsolescence (Adeniyi & Damilola, 2019) and have an impact on eroding profitability (Wolniak, 2020).

Inventory management designs lot-sizing orders to minimize total inventory costs while balancing supply with demand (Tebaldi et al., 2023) and fulfilling more significant order levels and shorter order cycle times (Chandramohan et al., 2023). Determining the lot-sizing of inventory orders is essential for maintaining adequate inventory levels and minimizing inventory costs (Demizu et al., 2023; Piva et al., 2021). Determining the lot-sizing of inventory orders is crucial because it determines the MRP or product distribution to meet the demand for a specific time horizon period and minimizes the total cost of inventory (Charles et al., 2022; Sarkar et al., 2019). Lot-sizing decisions can be incorporated into MRP or integrated with production scheduling to improve product planning decisions and reduce total inventory costs (Jans and Degraeve, 2008). According to various kinds of literature, there are two ways to analyze lot size inventory, taking into account the time worth of money (interest factor). Finding the best values for control variables starts with minimizing average annual expenses. Moreover, the second method minimizes the discounted value of all future costs (Tahmi et al., 2019; Hadley, 1964). Since 1975, many scholars have examined the interest element, or time value of money, in lot-sizing inventory. The lot-sizing inventory models that are considered economical include those that have increased rates for all related costs (Buzacott, 1975); those that are considered economical but also include different rates of inflation for different costs (Misra, 1979); those that are considered economical but also include rates of inflation for all related costs (Bierman & Thomas, 1977); those that are probabilistic and include conditions for inflation (Mirzazadeh, et al., 2009). Even though many ordering lot-sizing methods exist, the Silver-Meal heuristic method has proven more efficient for obtaining the total inventory cost and more effective in computing problem-solving time (Sarkar et al., 2020). This method can also compare changes in the value of money over time, which will affect the company's supply chain performance (Alfares & Turnadi, 2018; Giannoccaro & Pontrandolfo, 2002).

Previous research conducted by academics suggests the need to develop research on the influence of the time value of money in determining lot-sizing in MRP to design the best lot-sizing because the conventional MRP method assumes the value of money in inventory costs remains constant throughout the planning period (Gáti & Bányai, 2023; Dural-Selcuk & Cimen, 2013, Smith & Jose, 2007). The time value of money is an essential concept in economics and financial management to balance preferences for spending money now with inflation. This concept was extensively developed to calculate the difference between the value of future cash flows and outgoing cash flows over a certain period, known as the concept of Net Present Value (Slobodnyak & Sidorov, 2022). Azzamouri et al. (2021) proposed that the concept of the time value of money can be developed in MRP to calculate inventory costs using various lot-sizing methods. Furthermore, Sarkar et al. (2020) proposed that NPV could be formulated into a lot-sizing calculation method to compare with traditional MRP lot-sizing, which does not consider the time value of money. Thus, this study aims to test whether the lot-sizing model based on the time value of money is a better method than the lot-sizing model without considering the time value of money.

3. Research Methodology

In this research, the lot-sizing method used is the Silver-Meal heuristic due to its established effectiveness in terms of total inventory cost and computation time compared to other heuristic methods for determining lot-sizing orders (Alfares & Turnadi, 2018; Anders et al., 2023). Using the Silver-Meal method can support this research because this method calculates the total costs incurred in each period in determining lot sizing so changes in the value of money over time can be expected to have an effect. Consequently, it allows for the expected changes in the value of money over time, thereby anticipating potential impacts.

The sequential logical process of MRP calculation includes the steps of Netting, Lotting, Offsetting, and Exploding, ultimately leading to the generation of Planned Order Releases (PORl.). The input required for MRP calculation comprises the Master Production Schedule (MPS), Bill of Materials (BOM), and Inventory Status (Kiran, 2019). The Stages of problem-solving is illustrated in Figure 1, comprising two distinct stages of calculation:

Stage 1 involves MRP calculations without considering the time value of money. The decision made during this stage serves as a parameter for subsequent analysis.

Stage 2 incorporates the time value of money into MRP calculations. The objective of stage two is to evaluate the impact of the time value of money on existing MRP decisions.

3.1. MRP that does not consider the time value of money (Silver-Meal Conventional Method)

The description of each step in the MRP calculation without considering the time value of money (Silver-Meal Conventional Method) is as follows:

1) Netting: The netting process involves resolving net requirements by subtracting the on-hand quantity from the gross requirements (Ɣ). Gross requirements for level 0 products are obtained from the Master Production Schedule (MPS), while for components, the gross requirements are obtained from the planned order release of their parent product.

The netting calculation process is as follows:

a. Determine Project Available Balance I (Ɋ I), obtainned from subtracting On Hand ($Ɋ_{t-1}$) with Ɣ, adding with Scheduled Receipts (Ƨ), and period (u).

$$Ɋ\,I = Ɋ_{u-1} - Ɣ_u + Ƨ_u \quad (1)$$

b. Decide the Net Requirement (Ƞ) for each period.

$$Ƞ = Ɣ - Ɋ I - Ƨ + \hat{S} \quad (2)$$

If Ɋ I > Safety Stock ($\hat{S}$), the value of Ƞ = 0. However, if Ɋ I < 0, then the value of Ƞ is obtained by reducing $\hat{S}$ with Ɋ I.

2) Lotting involves determining the size of the order quantity to fulfill the net requirements (Ƞ). The process of calculating lot-sizing with the Silver-Meal Heuristic method (Ikasari et al., 2021; Ernawati et al., 2021) is as follows:

a. Calculating the Holding Cost is gained by multiplying the Holding Cost/unit/period by the amount of material stored and the length of time the material is stored.

$$\text{Holding Cost} = ƥƕ \sum_{u=1}^{v} (u-1)\,Ə_u \quad (3)$$

with: ƥ = item cost per-unit; ƕ = Percentage Holding Cost per-period; ƥƕ = Holding Cost per-period; $Ə_u$ = Demand in the uth period; u = Period.

b. The total inventory cost (§ (d)) is calculated as the cumulative cost incurred over d periods. It is determined by summing the holding cost and the total setup cost.

$$§(v) = Ɛ + ꞵƕ \sum_{u=1}^{v} (u-1)\, Ə_u \quad (4)$$

with : Ɛ = Setup Cost per-order

c. Determine the average total inventory cost per period, i.e., the total cost divided by the number of periods.

$$\frac{§(v)}{v} = \frac{Ɛ + ꞵƕ \sum_{u=1}^{v} (u-1) Ə_u}{v} \quad (5)$$

With: v = number of periods per order

d. Determining lot-sizing.

Lot-sizing is determined by the most minor average total cost per period $\frac{§(v)}{v}$. Lot-sizing is the number of orders that fulfill equation 6.

$$\frac{§(v+1)}{v+1} > \frac{§(v)}{v} \quad (6)$$

The process is executed in iterations. If the average total cost at period v+1 is more significant than at period v, then the calculation for a single order stops here.

e. Determine the total cost of inventory per year. Once the lot sizing is decided, the following step involves calculating the total inventory cost required to fulfill the material needs throughout the 12 periods. This calculation encompasses material purchase, storage, and ordering costs to determine the comprehensive total inventory cost.

$$Ʒ = \sum C + \sum ꞵƕ \,.\, Ɵ_m + \sum ꞵƏ_v \quad (7)$$

With: Ʒ = Total inventory cost per year; $Ɵ_m$ = The amount of material stored in the m-th period; $Ə_v$ = Total demand during d periods; $ꞵƕ.Ɵ_m$ = Total Holding Cost in the mth period; ꞵ. $Ə_v$ = item cost multiplies demand in the mth period, while Ɛ, ꞵ, ƕ, $Ə_u$ have been defined previously.

3) Offsetting involves determining the appropriate timing for placing an order to fulfill the net requirements (NR). The ordering time is calculated by subtracting the net requirements period from the Lead Time.

4) Exploding. After establishing the PORl., the calculations for Ɣ at the lower levels of the BOM are conducted based on the order plan.

Project Available Balance II (Ƣ II) is obtained by subtracting Planned Order Receipts (Ʊ) by Ƣ I.

$$Ƣ\ II = Ʊ + Ƣ\ I \quad (8)$$

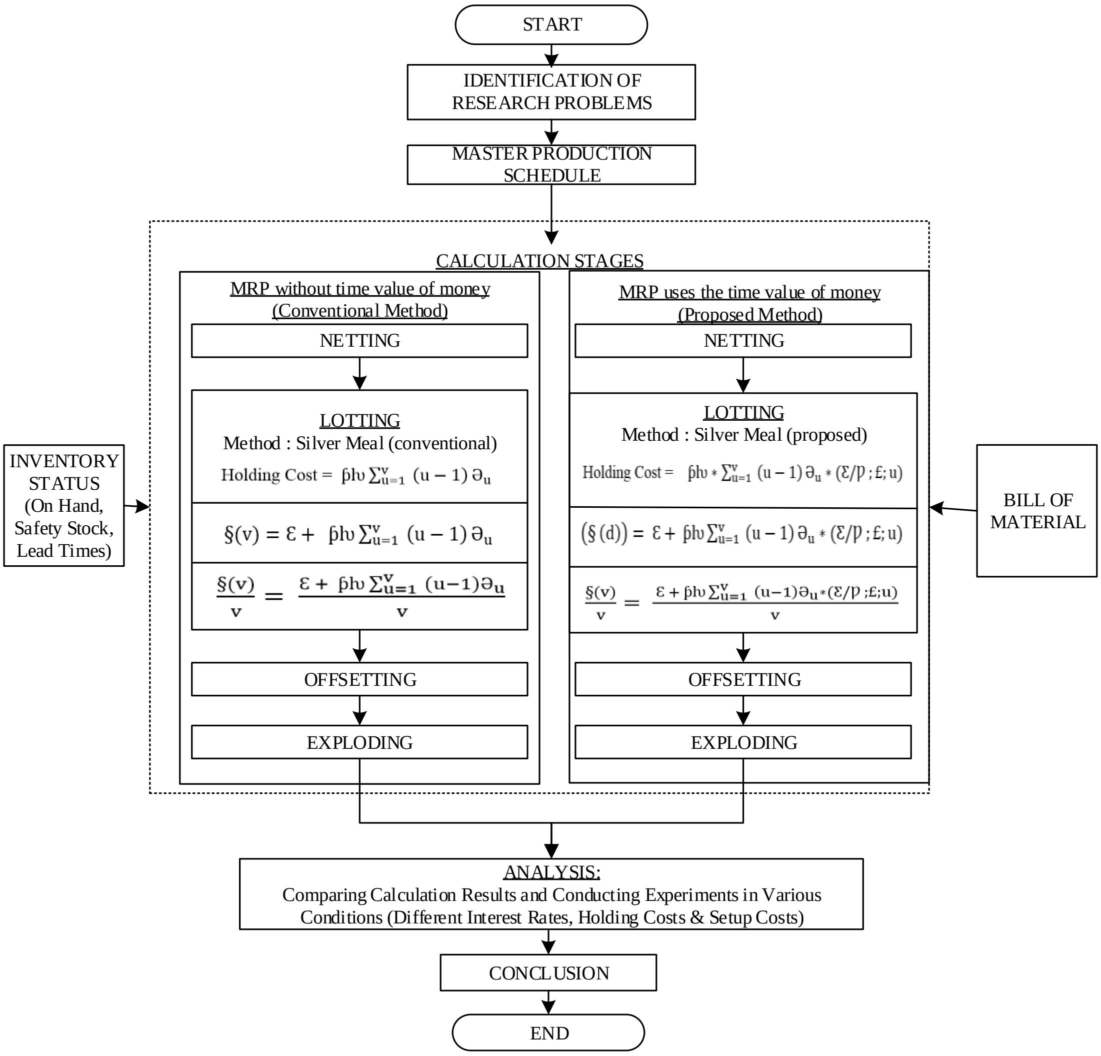


Fig. 1. The Stages of problem-solving

3.2. MRP that considers the time value of money (Silver-Meal Proposed Method)

The working steps and calculation processes in the netting, offsetting, and exploding stages remain the same as in Stage 1. However, the lotting calculation differs due to the inclusion of the time value of money in the calculation. The following is a description of each MRP calculation step considering the time value of money:

1) Calculating Holding Cost. The Holding cost is obtained by multiplying the Holding Cost/unit/period by the amount of material stored and the time the material is stored. Subsequently, to incorporate the time value of money, the Holding Cost is multiplied by a compound amount factor for a single payment, as depicted in equation 9.

$$\text{Holding Cost} = \text{ꞵƕʋ} * \sum_{u=1}^{v} (u-1)\, \text{Ə}_u * (\text{Ƹ}/\text{Ƥ}\,;\pounds;u) \tag{9}$$

With: £ = Interest rate; Ƹ = Future Value; Ƥ = Present Value; while ꞵƕʋ, u, Ə_u, and v have been defined earlier.

2) Calculating the total inventory cost (§ (d)). The total inventory cost is still calculated in the same manner. The total cost is obtained by summing up the Holding Cost.

$$\big(\S\,(d)\big) = \text{Ɛ} + \text{ꞵƕʋ} \sum_{u=1}^{v} (u-1)\, \text{Ə}_u * (\text{Ƹ}/\text{Ƥ}\,;\pounds;u) \tag{10}$$

3) Determining the average total inventory cost (§ (v)/v) deals with calculating the average cost of inventory to be incurred per period. This is achieved by dividing the total inventory cost by the number of periods (v).

$$\frac{\text{§}(v)}{v} = \frac{\text{Ɛ} + \text{ƀƕ} \sum_{u=1}^{v} (u-1)\text{Ə}_u * (\text{Ɛ}/\text{Ƥ} ;\text{£};u)}{v} \tag{11}$$

4) Determining lot-sizing. Lot sizing is determined using the same method. It is obtained based on the most minor average total cost per period $\frac{\text{§}(v)}{v}$.

5) Determining the total inventory cost per year. The total inventory cost is determined based on the established lot-sizing decision. It includes the summation of the material price, setup cost, and holding cost required to fulfill material needs throughout 24 periods. In order to obtain the present value, the inventory cost is discounted to the present by multiplying each inventory cost component with the respective single payment present worth factor.

4. Results

The subjects of this research are five companies that are producers of Intraocular Lens products in Indonesia and are considered the research population because no more companies produce similar products. The companies producing Intraocular Lens products that are the subject of research are as follows:

1) PT Yota Medika Indonesia (Yotamed) is a manufacturer of eye health devices (including Intraocular Lens products) which was founded in early 2019. The manufacturing location is in the Jakarta Industrial Estate Pulogadung industrial area. Has regional distribution in 17 provinces in Indonesia.

2) PT Nittoh Presisi Indonesia was founded in 1995 with a manufacturing location in Bogor, West Java. Produces various eye lens products including Intraocular Lens products. Has regional distribution in 15 provinces in Indonesia.

3) PT Alcon Indonesia was founded in 1990 with a manufacturing location in the Jababeka industrial area, Banten province. Produces various eye lens products including Intraocular Lens products. Has regional distribution in 10 provinces in Indonesia.

4) PT Rohto Laboratories Indonesia was founded in 1988 in Indonesia with manufacturing locations in Bandung Regency, West Java. Produces various eye lens products including Intraocular Lens products. Has regional distribution in 19 provinces in Indonesia.

5) PT Gelflex Indonesia was founded in 2008 with a manufacturing location in the Sarana Industri Point area, Batam, Riau Island. Produces various eye lens products including Intraocular Lens products. Has regional distribution in 16 provinces in Indonesia.

This product is a replacement lens implanted in the eye after cataract removal surgery. The supply of raw materials and work in the process comes from companies in China and Europe, so the supply chain becomes complex. This product was chosen because of its high demand and the price of components that vary from cheap to expensive, making it suitable for this research case. Data was obtained from the company's accounting and production planning department with an agreement that each company's data could not be published because it was confidential and only average data from five companies could be published. Thus, this study only uses average data from five Intraocular Lens companies in 2023 to present information on component names, levels in the product structure, lead times, quantities available, and associated costs for Intraocular Lens products and their components, as shown in Table 1.

Table 1: Product data of Intraocular Lens and its forming components (the year 2023)

No	Component Name	Levels in the BOM	Lead Time (week)	On Hand Inventory	Item Cost/unit (IDR)	Holding Cost/unit/ month (IDR)	Setup Cost (IDR)
1	Intra Ocular Lens	0	1	450	13,000	217	10,000,000
2	PMMA Medical Grade	1	1	25	11,000	183	10,000,000
3	Humidichip	1	1	25	6,750	158	10,000,000
5	EO gas Cartridge	1	1	1	225,000	3,750	4,500,000
6	Bio Indicator	1	1	1	95,000	1,583	4,000,000

The calculation results underline the disparity in lot-sizing decisions between MRP using the Conventional Silver-Meal Method and MRP using the proposed Silver-Meal Method based on the Time Value of Money. The results of these two methods can be compared if the value of money is included in the decision to determine lot size with the Conventional Silver Meal Method.

The total inventory cost is calculated based on the lot-sizing decisions acquired from the Conventional Silver Meal Method after accounting for the value of money. This total inventory cost requires multiplying each cost component in the nth period by a single payment compound amount factor. The storage costs per period vary due to the inclusion of opportunity cost as one of the holding cost components, which is separately computed to determine the single payment compound amount factor. The following part presents the calculation of the total inventory cost for Intraocular Lens products, incorporating the Time Value of Money with an interest rate of 0.813% per month. The lot-sizing decision is based on the calculation outcomes in Stage 1.

Item Cost (1^{st} period) = Number of components per order * component price per unit * (Ƹ/Ƿ ; £; 1) = 19,800 units * IDR 13,000 * 1.008 = IDR 259,491,375

Holding Cost (1st period) = ∑ Components * Holding Cost * (Ƹ/Ƿ ; £; 1) = 15,000 * IDR 111 * 1.0081 = IDR 1,679,158

Setup Cost (1st period) = Setup Cost * (Ƹ/Ƿ ; £; 1) = IDR 10,000,000 * 1.0081 = IDR 10,081,250

Inventory Cost/month (1st period) = IDR 259,491,375 + IDR 1,679,158 + IDR 10,081,250 = IDR 271,251,783

Inventory Cost/order (1st period) = IDR 271,251,783 + IDR 1,128,534 + IDR 568,852 = IDR 272,949,169

The calculation example illustrates a precise figure of how the item, holding, and setup costs are calculated for the first period. By applying the same calculation approach to subsequent periods, up to the 24^{th} period, it becomes feasible to determine the total inventory cost per month and the total inventory cost per order. These figures are obtained by considering the lot sizing, item cost, quantity of items stored, and holding cost for each period.

The Intraocular Lens product comprises four components: PMMA Medical Grade, Humidichip, Bio Indicator, and EO Gas Cartridge. By utilizing the same method as previously described, it is possible to calculate the Total Inventory Cost for each component. Table 2 shows the Total Inventory Cost calculation results for all the Intraocular Lens Components, utilizing the Conventional Silver-Meal Method with some considerations for the Time Value of Money.

Table 2: Total inventory cost for Intraocular lens product and its components based on the conventional
silver-meal method with time value of money taken into account (Conventional Method)

Component	Order Frequency	Order	Number of Components (units)	Period Requirements	Cost per Order (IDR)	Total Cost (IDR)
Intra Ocular Lens	6	I.iol	19,800	1-4	72,949,169	1,792,901,410
		II.iol	20,000	5-8	84,636,073	
		III.iol	20,000	9-12	95,000,100	
		IV.iol	20,000	13-16	03,672,187	
		V.iol	20,000	17-20	13,662,468	
		VI.iol	20,000	21-24	23,981,413	
PMMA Medical Grade	6	I.pmg	19,800	1-4	227,525,000	1,494,126,960
		II.pmg	20,000	5-8	37,566,596	
		III.pmg	20,000	9-12	245,382,120	
		IV.pmg	20,000	13-16	53,454,761	
		V.pmg	20,000	17-20	261,792,977	
		VI.pmg	20,000	21-24	70,405,506	
Humidichip	6	I.hmc	19,800	1-4	197,862,500	1,300,994,639
		II.hmc	20,000	5-8	06,579,649	
		III.hmc	20,000	9-12	213,375,756	
		IV.hmc	20,000	13-16	20,395,444	
		V.hmc	20,000	17-20	227,646,067	
		VI.hmc	20,000	21-24	35,135,223	
bnro Indicator	6	I.bnr	19,800	1-4	41,525,000	273,182,749
		II.bnr	20,000	5-8	43,381,726	
		III.bnr	20,000	9-12	44,808,909	
		IV.bnr	20,000	13-16	46,283,043	
		V.bnr	20,000	17-20	47,805,674	
		VI.bnr	20,000	21-24	49,378,397	
EO Gas Cartridge	6	I.egc	19,800	1-4	93,375,000	614,604,936
		II.egc	20,000	5-8	97,608,885	
		III.egc	20,000	9-12	100,820,045	
		IV.egc	20,000	13-16	104,136,847	
		V.egc	20,000	17-20	107,562,767	
		VI.egc	20,000	21-24	111,101,393	
					Total Inventory Cost	5,477,810,694

This section illustrates the results of the lotting process in MRP using the proposed Silver Meal Method, incorporating the Time Value of Money. The calculations for Item Cost, Holding Cost, and Setup Cost are directly performed by considering the Time Value of Money. Following is an example of the lot-sizing calculation for finished Intraocular Lens products. Similarly, the lot-sizing for the four components, PMMA Medical Grade, Humidichip, Bio Indicator, and EO Gas, uses the same approach. The results of the Total Inventory Cost calculation for all the Intraocular Lens Components are summarized in Table 3.

Item Cost (1st period) = Number of components per order * component price per unit * (F/P;i%;1) = 29,800 * IDR 13,000 * 1.0081 = IDR 390,547,625

Holding Cost (1st period) = ∑ Components * Holding Cost * (Ƹ/Ƿ ; £; 1) = 25,000 * IDR 217 *

1.0081 = IDR 2,798,597

Setup Cost (1st period) = Setup Cost * (Ɛ/Ƥ ; £; 1) = IDR 10,000,000 * 1.0081 = IDR 10,081,250

Inventory Cost/month (1st period) = IDR 390,547,625 + IDR 2,798,597 + IDR 10,081,250 = IDR 403,427,472

Inventory Cost/order (1st period) = IDR 403,427,472 + IDR 2,257,068 + IDR 1,706,555 + IDR 1,146,947 + IDR 578,133 = IDR 409,116,176

Table 3: Total inventory cost for Intraocular lens product and its components based on silver-meal method that has taken into account time value of money (Proposed Method)

Component	Order Frequency	Order	Number of Components (unit)	Period Requirements	Cost per Order (IDR)	Inventory Cost (IDR)
Intra Ocular Lens	4	I.iol	29,800	1-6	409,116,176	1,771,361,376
		II.iol	30,000	7-12	432,221,655	
		III.iol	30,000	13-18	453,725,127	
		IV.iol	30,000	19-24	476,298,418	
PMMA Medical Grade	4	I.pmg	29,775	1-6	337,525,000	1,462,425,188
		II.pmg	30,000	7-12	356,915,349	
		III.pmg	30,000	13-18	374,672,255	
		IV.pmg	30,000	19-24	393,312,584	
Humidichip	4	I.hmc	29,775	1-6	295,242,008	1,279,188,480
		II.hmc	30,000	7-12	312,192,675	
		III.hmc	30,000	13-18	327,724,581	
		IV.hmc	30,000	19-24	344,029,216	
Bio Indicator	4	I.bnr	595	1-6	61,016,766	264,476,885
		II.bnr	600	7-12	64,555,096	
		III.bnr	600	13-18	67,766,778	
		IV.bnr	600	19-24	71,138,245	
EO Gas Cartridge	4	I.egc	595	1-6	139,499,297	604,789,239
		II.egc	600	7-12	147,630,096	
		III.egc	600	13-18	154,974,844	
		IV.egc	600	19-24	162,685,002	
					Total Inventory Cost	5,382,241,168

The Lot-sizing decision using the proposed Silver-Meal Method leads to a Total Inventory Cost savings of IDR 95,569,526 (1.78%) for a 24-month MRP planning period, as shown in Table 4. This shows that the performance of the Silver-Meal Proposed Method surpasses that of the Silver-Meal Conventional Method. The efficiency achieved in total inventory cost positively influences the company's SCM performance. Therefore, the time value of money significantly influences the outcomes of Lot-sizing decisions in MRP, as these decisions can effectively reduce the overall inventory cost.

Therefore, the time value of money provides better decision results for Lot sizing in MRP, as this decision can effectively reduce the overall inventory costs.

Table 4: The difference in total inventory cost between the silver-meal conventional method and the silver-meal proposed method

Components	Total Inventory Cost		Difference (IDR)
	MRP with the Conventional Silver-Meal Method (IDR)	MRP with the Silver-Meal Method which Considers the Time Value Of Money (IDR)	
Intra Ocular Lens	1,792,901,410	1,771,361,376	(21,540,034)
PMMA Medical Grade	1,496,126,960	1,462,425,188	(33,701,772)
Humidichip	1,300,994,639	1,279,188,481	(21,806,158)
Bio Indikator	273,182,749	264,476,884	(8,705,865)
EO Gas Cartridg	614,604,936	604,789,239	(9,815,697)
Difference	5,477,810,694	5,382,241,168	(95,569,526)

The difference in total inventory cost between the conventional silver-meal method and the silver-meal proposed method can be depicted using the bar diagram in Figure 2.

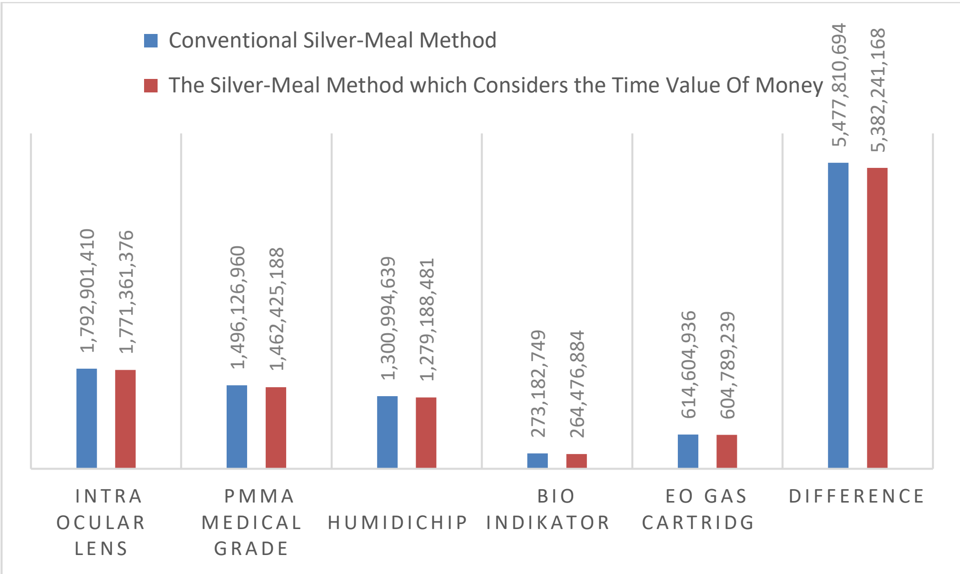


Fig. 2: The difference in total inventory cost between the silver-meal conventional method and the silver-meal proposed method

This section analyzes the impact of changes in interest rates on the performance of the Silver-Meal Proposed Method for Intraocular Lens Finished Goods. The Silver-Meal Conventional Method is also examined with varying interest rates to facilitate a comparison between the two methods. MRP calculation experiments were conducted using a lower interest rate of 0.125% per month, contrasting with the previous interest rate of 0.813% per month.

The calculations were performed consistently, and the outcomes are presented in Table 5. At the lower interest rate of 0.125% per month, both methods illustrate comparable performance in terms of lot-sizing decisions and total inventory cost. Consequently, as the interest rate decreases, its impact on the MRP lot-sizing decisions for both methods becomes less significant, and vice versa.

Table 5: Total inventory cost with the silver-meal proposed method at a low-interest rate (0.125 per month)

Order	Lot Sizing (unit)	Period Order	Cost per Order (IDR)
I	19,800	1-4	273,759,284
II	20,000	5-8	277,746,940
III	20,000	9-12	279,138,280
IV	20,000	13-16	280,536,591
V	20,000	17-20	281,941,906
VI	20,000	21-24	283,354,261
		Total Inventory Cost	1,676,477,262

This section analyzes the impact of changes in Setup Cost on the performance of the Silver-Meal Proposed Method for Intraocular Lens finished goods. Setup Cost changes are also tested on the Silver-Meal Conventional Method to enable a comparison between the two methods. MRP calculation experiments for both approaches were conducted using an initial Setup Cost of IDR 10,000,000 and lower Setup Costs of IDR 7,000,000 and IDR 4,000,000. The calculations were performed consistently, and the results are presented in Table 6. Based on the calculation results illustrated in Table 6, it is evident that the Silver-Meal Proposed Method exhibits greater efficiency, irrespective of whether the Setup Costs are high or low. In short, significant or minor changes in Setup Cost have no impact on the MRP lot-sizing decision outcomes for both methods. However, the Silver-Meal Proposed Method demonstrates superior performance consistently, regardless of the magnitude of the Setup Cost variations.

Table 6: Comparison of lot-sizing and total inventory cost for both methods under different setup cost conditions

Setup Cost (IDR)	Silver-Meal Conventional Method				Silver-Meal Proposed Method				Difference (IDR)
	Order Fre-quency	Period Require-ments	Cost per Order (IDR)	Total Inventory Cost (IDR)	Order Fre-quency	Period Requi-rements	Cost per Order (IDR)	Total Inventory Cost (IDR)	
10,000,000	6	1-4	272,949,169	1,792,901,410	4	1-6	409,116,176	1,71,361,376	21,540,034
		5-8	284,636,073			7-12	432,221,655		
		9-12	295,000,100			13-18	453,725,127		
		13-16	303,672,187			19-24	476,298,418		
		17-20	313,662,468			-	-		
		21-24	323,981,413			-	-		
7,000,000	6	1-4	269,924,794	1,773,195,607	5	1-5	337,719,231	1,765,828,009	7,367,598
		5-8	281,512,201			6-10	354,393,194		
		9-12	290,773,458			11-15	369,026,281		
		13-16	300,339,394			16-20	384,263,576		
		17-20	310,220,033			20-24	320,425,727		
		21-24	320,425,727			-	-		
4,000,000	8	1-3	199,679,456	1,762,033,886	6	1-4	266,900,419	1,753,399,808	8,634,078
		4-6	207,271,831			5-8	278,388,330		
		7-9	212,365,243			9-12	287,456,817		
		10-12	217,583,818			13-16	297,00,602		
		13-15	222,930,632			17-20	306,777,598		
		16-18	228,408,836			21-24	316,870,042		
		19-21	234,021,660			-	-		
		22-24	239,772,410			-	-		

In this part of the research, the effect of changes in Holding Cost on the performance of the Silver-Meal Proposed Method for Intraocular Lens finished goods will be examined. Furthermore, Holding Cost variations will be tested on the Silver-Meal Conventional Method to enable a comparison between the two methods. MRP calculation experiments were conducted using different Holding Cost levels: 30% of Item Cost, 20%, and 15%. The interest rate used remained constant at 0.813% per month. The calculations were performed consistently, and the results are presented in Table 7. Based on the calculation results shown in Table 7, it can be observed that the Silver-Meal Proposed Method demonstrates greater efficiency at Holding Cost levels of 20% and 15%. However, when the Holding Cost is set at 30%, both methods exhibit similar outcomes. Therefore, alterations in the level of Holding Cost have no impact on the MRP lot-sizing decision outcomes for these two methods.

Table 7: Comparison of lot-sizing and total inventory cost for both methods under different holding cost conditions

Holding Cost (IDR)	Silver-Meal Conventional Method				Silver-Meal Proposed Method				Difference (IDR)
	Order Fre-quency	Period Require-ments	Cost per Order (IDR)	Total Inventory Cost (IDR)	Order Fre-quency	Period Require-ments	Cost per Order (IDR)	Total Inventory Cost (IDR)	
30% per year	6	1-4	276,243,359	1,814,365,230	6	1-4	276,243,359	1,814,365,230	-
		5-8	288,038,635			5-8	288,038,635		
		9-12	297,514,601			9-12	297,514,601		
		13-16	307,302,308			13-16	307,302,308		
		17-20	317,412,015			17-20	317,412,015		
		21-24	327,854,312			21-24	327,854,312		
20% per year	6	1-4	272,949,169	1,792,901,510	4	1-6	409,116,655	1,771,361,376	21,540,134
		5-8	284,636,173			7-12	432,221,655		
		9-12	294,000,100			13-18	453,725,127		
		13-16	303,672,187			19-24	476,298,418		
		17-20	313,662,468			-	-		
		21-24	323,981,413			-	-		
15% per year	5	1-5	337,990,993	1,768,603,493	3	1-8	539,844,096	1,736,039,100	32,564,393
		6-10	354,676,177			9-17	578,744,634		
		11-15	369,320,949			17-24	617,450,370		
		16-20	384,570,411			-	-		
		21-24	322,044,963			-	-		

5. Discussion

Based on the analysis of the findings, lot sizing using the Silver-Meal Proposed Method (considering the time value of money) results in low total inventory cost savings during the MRP planning period. The amount of cost savings obtained by the proposed method compared to the conventional method is IDR 95,569,526 or 1.78% during the production planning period. These findings indicate that the performance of the Proposed Silver-Meal Method is better than the Conventional Silver-Meal Method. Thus, the time value of money affects the results of the lot-sizing decision at MRP, where the result can make the total inventory cost-efficient. It was consistent with previous studies that the concept of the time value of money will contribute to saving inventory costs if applied to lot-sizing inventory (Gáti & Bányai, 2023) and has an impact on improving the company's SCM performance (Gebisa & Ram, 2021).

This study also conducted a sensitivity analysis of changes in interest rates, changes in setup costs, and changes in holding costs on the performance of the Silver-Meal Proposed Method. The findings of the sensitivity analysis prove that the lower the interest rate, the lower the MRP lot-sizing decision for these two methods, and vice versa. This analysis aligns with previous research on inventory with discounted cash flows, which analyzed various interest rates (Ghiami, 2023). In addition, this study also proves that changes in setup costs and holding costs, both large and small, do not affect the results of MRP lot-sizing decisions from these two methods, which means that the Silver-Meal Proposed Method still shows better performance. This changing relationship strengthens the results of previous research (Taghavifar & Perera, 2023) that changes in setup costs and holding costs do not affect lot-sizing decisions on the cost assessment and do not affect lot-sizing inventory decisions (Choudri & Senthilkumar, 2023; Sarkar et al., 2020).

This study implies that manufacturing company managers must design lot-sizing orders for raw materials that consider the time value of money so that total inventory costs become efficient and SCM performance increases. The amount of lot sizing can be calculated using the Silver-Meal heuristic model approach by considering the time value of money using the Net Present Value (NPV) concept. The amount of lot sizing can also be calculated using other heuristic models, namely Lot-for-lot Ordering, Periodic Order Quantity, Wagner-Within Algorithm, Least Unit Cost, Part-Period Algorithm, and Incremental Part-Period Algorithm (Simpson, 2001).

Managers can adopt the time value of money based lot size model that has been developed by researchers because this model significantly reduces the total cost of inventory. This finding is in line with studies on applying the time value of money to inventory management, which shows a positive contribution to saving inventory costs (Slobodnyak & Sidorov, 2022; Azzamouri et al., 2021). Increasing the performance of SCM in manufacturing is important because manufacturing is the leading sector for driving the Indonesian economy (Wolok et al., 2023), as well as being a productive component contributing to Indonesia's economic growth (Praharsi, 2021; Arzia & Sentosa, 2019).

However, in real-world applications, managers must pay attention to additional discounts suppliers offer when they purchase specific quantities of goods. Therefore, lot-sizing decisions made with the proposed Silver-Meal method cannot be implemented. Likewise, if uncertain conditions occur, such as uncertainty in demand or order lead times, lot-sizing decisions made using the proposed Silver-Meal method cannot be applied.

6. Conclusion

The proposed Silver-Meal lot-sizing model incorporates the time value of money into MRP decisions, demonstrating 1.78% inventory cost savings over 2 years for Indonesian manufacturers. Performance gains were consistent under fluctuating interest rates, holding, and setup costs. However, research generalizability is limited due to the small, localized sample. Future studies can apply the model to larger, more diverse industrial datasets. From a practical viewpoint, the model provides managers with an improved decision-making tool to reduce inventory costs and boost supply chain efficiency. However, real-world implementation challenges remain for complex global networks. Additional optimization and customization would be beneficial.

References

Adelwini, B. B., Toku, L. I., & Adu, O. F. (2023). Investigating the effects of logistics management on organizational performance: New evidence from the manufacturing industry. *Journal of Accounting, Business and Finance Research*, *16*(1), 1-11. https://doi.org/10.55217/102.v16i1.606

Adeniyi, O. S., & Damilola, O. O. (2019). The cost implication of inventory management in organized systems. *International Journal of Engineering and Management Research*, *9*(1), 115-126. https://doi.org/10.31033/ijemr.9.1.11

Ahmad Jauhari, W. (2022). Sustainable inventory management for a closed-loop supply chain with energy usage, imperfect production, and green investment. *Cleaner Logistics and Supply Chain*, *4*, 100055. https://doi.org/10.1016/j.clscn.2022.100055

Alfares, H. K., & Turnadi, R. (2018). Lot sizing and supplier selection with multiple items, multiple periods, quantity discounts, and backordering. *Computers & Industrial Engineering*, *116*, 59-71. https://doi.org/10.1016/j.cie.2017.12.019

Anantadjaya S. P., Nawangwulan I. M., Irhamsyah M., & Carmelita P.W. (2021). Supply chain management, inventory management & financial performance : evidence from manufacturing firms. *Linguistics and Culture Review*, *5*(1), 781-794. https://doi: 10.37028/lingcure.v5nS1.1463.

Anders Segerstedt, Abdul-Jalbar, B., & Björn Samuelsson. (2023). Reformulated Silver-Meal and Similar Lot Sizing Techniques. Axioms, 12(7), 661–661. https://doi.org/10.3390/axioms12070661

Arzia, F. S., & Sentosa, S. U. (2019). Faktor-faktor Yang mempengaruhi produksi industri manufaktur Di Indonesia. *Jurnal Kajian Ekonomi dan Pembangunan*, *1*(2), 365. https://doi.org/10.24036/jkep.v1i2.6178

Azzamouri, A., Baptiste, P., Dessevre, G., & Pellerin, R. (2021). Demand-driven material requirements planning (DDMRP): A systematic review and classification. *Journal of Industrial Engineering and Management*, *14*(3), 439. https://doi.org/10.3926/jiem.3331

Becerra, P., Mula, J., & Sanchis, R. (2021). Green supply chain quantitative models for sustainable inventory management: A review. *Journal of Cleaner Production*, *328*, 129544. https://doi.org/10.1016/j.jclepro.2021.129544

Benedict, A. B., & Emmanuel, G. A. (2021). Examination of the effect of logistics functions on the financial performance of organization. *International Journal of Engineering Technologies and Management Research*, *8*(3), 18-26. https://doi.org/10.29121/ijetmr.v8.i3.2021.875

Bierman, H., & Thomas, J. (1977). Inventory Decisions Under Inflationary Conditions. Decision Sciences, 8(1), 151–155. https://doi.org/10.1111/j.1540-5915.1977.tb01073.x

Bogataj, D., Aver, B., & Bogataj, M. (2016). Supply chain risk at simultaneous robust perturbations. International Journal of Production Economics, 181. https://doi.org/10.1016/j.ijpe.2015.09.009

Bogataj, D., & Bogataj, M. (2019). NPV approach to material requirements planning theory–a 50-year review of these research achievements. In International Journal of Production Research (Vol. 57, Issues 15–16). https://doi.org/10.1080/00207543.2018.1524167

Bogataj, D., Hudoklin, D., Bogataj, M., Dimovski, V., & Colnar, S. (2020). Risk mitigation in a meat supply chain with options of redirection. Sustainability (Switzerland), 12(20). https://doi.org/10.3390/su12208690

Buzacott, J. A. (1975). Economic Order Quantities with Inflation. Journal of the Operational Research Society, 26(3), 553–558. https://doi.org/10.1057/jors.1975.113

Chandramohan, J., Asoka Chakravarthi, R. P., & Ramasamy, U. (2023). A comprehensive inventory management system for non-instantaneous deteriorating items in supplier-retailer-customer supply chains. *Supply Chain Analytics*, *3*, 100015. https://doi.org/10.1016/j.sca.2023.100015

Charles, M., Dauzère-Pérès, S., Kedad-Sidhoum, S., & Mazhoud, I. (2022). Motivations and analysis of the capacitated lot-sizing problem with setup times and minimum and maximum ending inventories. *European Journal of Operational Research*, *302*(1), 203-220. https://doi.org/10.1016/j.ejor.2021.12.017

Choudri, V., & Senthilkumar, C. (2023). Effect of time value of money in production inventory models for deteriorative items with price - exponential demand - in third order equation. *International Journal of Procurement Management*, *17*(2), 229-254. https://doi.org/10.1504/ijpm.2023.130738

Damand, D., Lahrichi, Y., & Barth, M. (2022). A simulation-optimization approach to parameterize demand-driven material requirements planning. *IFAC-PapersOnLine*, *55*(10), 263-268. https://doi.org/10.1016/j.ifacol.2022.09.626

Debala, G., Khan, S. T., & Bhat, M. A. (2022). Inventory management and organizational performance: Evidence from ethiopian public sector organizations. *International Journal of Auditing and Accounting Studies*, *4*(2), 231-247. https://doi.org/10.47509/ijaas.2022.v04i02.04

Demizu, T., Fukazawa, Y., & Morita, H. (2023). Inventory management of new products in retailers using model-based deep reinforcement learning. *Expert Systems with Applications*, *229*, 120256. https://doi.org/10.1016/j.eswa.2023.120256

Dillon, M., Vauhkonen, I., Arvas, M., Ihalainen, J., Vilkkumaa, E., & Oliveira, F. (2023). Supporting platelet inventory management decisions: What is the effect of extending platelets' shelf life? *European Journal of Operational Research*, *310*(2), 640-654. https://doi.org/10.1016/j.ejor.2023.03.007

Dural-Selcuk, G., & Cimen, M. (2013). Optimal Lot Sizing with NPV Approach for Inventory Systems with Constant Demand. IFAC Proceedings Volumes, 46(9), 1997–2002. https://doi.org/10.3182/20130619-3-ru-3018.00308

Ernawati, D., Dewi, S., Sari, N. K., & Budianto, K. (2021). Ordering size optimization of raw material to minimize inventory costs using the Wagner-within algorithm and silver-meal methods. *E3S Web of Conferences*, *328*. https://doi.org/10.1051/e3sconf/202132805002

Farid, Haryani, S., & Aldini, F. (2022). Analysis of the Application of Material Requirement Planning Method in Nature to Achieve the Production Targets of the Moraja Donggala Social Forestry Business Group. *International Journal of Health, Economics, and Social Sciences*, *4*(4), 243–251. https://doi.org/10.56338/ijhess.v4i4.2895

Fisher, K. J., Otto, J., & Han, C. (2022). Customer-country diversification and inventory efficiency: Comparative evidence from the manufacturing sector during the pre-pandemic and the COVID-19 pandemic periods. *Journal of Business Research*, *148*, 292-303. https://doi.org/10.1016/j.jbusres.2022.04.066

Gáti, K. V., & Bányai, T. (2023). Impact of dynamic lot sizing techniques on costs of material requirement planning. *Advanced Logistic Systems - Theory and Practice*, *17*(1), 71-78. https://doi.org/10.32971/als.2023.009

Gebisa, D. A., & Ram, T. (2021). The effect of information sharing and inventory management in the supply chain practices on firms' performance: Empirical evidence from some selected companies of Ethiopia. *International Journal of Industrial Engineering and Operations Management*, *03*(01), 1-15. https://doi.org/10.46254/j.ieom.20210101

Ghiami, Y. (2023). An analysis of production and inventory models with discounted cash-flows.

Omega, *117*, 102847. https://doi.org/10.1016/j.omega.2023.102847

Giannoccaro, I., & Pontrandolfo, P. (2002). Inventory management in supply chains: A reinforcement learning approach. *International Journal of Production Economics*, *78*(2), 153-161. https://doi.org/10.1016/s0925-5273(00)00156-0

Gołaś, Z. (2020). The effect of inventory management on profitability: Evidence from the Polish food industry: Case study. *Agricultural Economics (Zemědělská ekonomika)*, *66*(5), 234-242. https://doi.org/10.17221/370/2019-agricecon

Hadley, G. (1964). A Comparison of Order Quantities Computed Using the Average Annual Cost and the Discounted Cost. Management Science, 10(3), 472–476. https://doi.org/10.1287/mnsc.10.3.472

Hashmi, A. R., Amirah, N. A., & Yusof, Y. (2021). Organizational performance with disruptive factors and inventory control as a mediator in public healthcare of Punjab, Pakistan. *Management Science Letters*, *11*(1), 77-86. https://doi.org/10.5267/j.msl.2020.8.028

Ikasari, D. M., Lestari, E. R., & Ni'matul, Y. (2021). Inventory control analysis of frozen processed shrimp using silver meal heuristic method (case study at PT. X Malang, East Java, Indonesia). *IOP Conference Series: Earth and Environmental Science*, *733*. https://doi.org/10.1088/1755-1315/733/1/012062

Jans, R., & Degraeve, Z. (2008). Modeling industrial lot sizing problems: a review. International Journal of Production Research, 46(6), 1619–1643. https://doi.org/10.1080/00207540600902262

Kawase, R., & Iryo, T. (2023). Optimal stochastic inventory-distribution strategy for damaged multi-Echelon humanitarian logistics network. *European Journal of Operational Research*, *309*(2), 616-633. https://doi.org/10.1016/j.ejor.2023.01.048

Kiran, D. R. (2019). Material requirement planning. *Production Planning and Control A Comprehensive Approach*, 429-439. https://doi.org/10.1016/b978-0-12-818364-9.00030-5

Lai, D., Li, Y., Demir, E., Dellaert, N., & Van Woensel, T. (2022). Self-adaptive randomized constructive heuristics for the multi-item capacitated lot sizing problem. *Computers & Operations Research*, *147*. https://doi.org/10.1016/j.cor.2022.105928

Lubisia, B. N., & Okello, D. J. (2020). Influence of E-Procurement on Supply Chain Performance of Safaricom Limited Company: Greater Western and Rift Region in Kenya. *The International Journal of Business & Management*, *8*(7). https://doi.org/10.24940/theijbm/2020/v8/i7/bm2007-067

Mbah, S., Obiezekwem J., & Okuoyibo A. (2019). Inventory Management and Operational Performance of Manufacturing Firms in South-East Nigeria. *International Business Research*, *12*(7), 76-82. https://doi:10.5539/ibr.v12n7p76.

Mirzazadeh, A., Seyyed Esfahani, M. M., & Fatemi Ghomi, S. M. T. (2009). An inventory model under uncertain inflationary conditions, finite production rate and inflation-dependent demand rate for deteriorating items with shortages. International Journal of Systems Science, 40(1), 21–31. https://doi.org/10.1080/00207720802088264

Misra, R. B. (1979). A note on optimal inventory management under inflation. Naval Research Logistics Quarterly, 26(1), 161–165. https://doi.org/10.1002/nav.3800260116

Ogah, M., Asiegbu, G., & Moradeyo, N. (2022). Effect of raw material inventory on operational performance in an emerging economy: Insight from the Nigerian manufacturing sector. *International Journal on Recent Trends in Business and Tourism*, *6*(2), 31-43. https://doi.org/10.31674/ijrtbt.2022.v06i02.003

Opoku R. K., Fiati H. M., Kaku G., Ankomah J., & Opoku-Agyemang F. (2020). Inventory management practices and operational performance of manufacturing firms in Ghana. *Advances in Research*, *21*(10), 1-18, https://doi: 10.9734/air/2020/v21i1030246.

Orobia, L. A., Nakibuuka, J., Bananuka, J., & Akisimire, R. (2020). Inventory management, managerial competence, and financial performance of small businesses. *Journal of Accounting in Emerging Economies*, *10*(3), 379-398. https://doi.org/10.1108/jaee-07-2019-0147

Pattnaik, S., Nayak, M. M., Abbate, S., & Centobelli, P. (2021). Recent trends in sustainable inventory models: A literature review. *Sustainability*, *13*(21), 11756. https://doi.org/10.3390/su132111756

Peinado-Guerrero, M. A., & Villalobos, J. R. (2022). Using inventory as energy storage for demand-side management of manufacturing operations. *Journal of Cleaner Production*, *375*. https://doi.org/10.1016/j.jclepro.2022.134213

Peng Y. T., Zhang J. Y., & Chang J. S. (2021). Exploring the relevance of intangible assets and capital structure. *International Journal of Trade, Economics and Finance, 12*(6), 144-148. https://doi: 10.18178/ijtef.2021.12.6.709

Piva, E., Tebaldi, L., Vignali, G., & Bottani, E. (2021). Simulation of different reordering policies for optimizing the inventory of perishable food: An Italian case study. *International Journal of Food Engineering*, *18*(3), 201-238. https://doi.org/10.1515/ijfe-2021-0047

Praharsi, Y., Jami'in, M. A., Suhardjito, G., Reong, S., & Wee, H. M. (2021). Supply chain performance for a traditional shipbuilding industry in Indonesia. *Benchmarking: An International Journal*, *29*(2), 622-663. https://doi.org/10.1108/bij-05-2020-0232

Ramya, G., Chandrasekaran, M., & Shankar, E. (2019). Case study analysis of job shop scheduling and its integration with material requirement planning. *Materials Today: Proceedings*, *16*(2), 1034-1042. https://doi.org/10.1016/j.matpr.2019.05.192

Sarkar, B., Ullah, M., & Choi, S. (2019). Joint inventory and pricing policy for an online to offline closed-loop supply chain model with random defective rate and returnable transport items. *Mathematics*, *7*(6), 497. https://doi.org/10.3390/math7060497

Sarkar, S., Giri, B. C., & Sarkar, A. K. (2020). A vendor–buyer inventory model with lot size and production rate dependent lead time under time value of money. *RAIRO - Operations Research*, *54*(4), 961-979. https://doi.org/10.1051/ro/2019030

Simpson, N. C. (2001). Questioning the relative virtues of dynamic lot sizing rules. Computers & Operations Research, 28(9), 899–914. https://doi.org/10.1016/s0305-0548(00)00015-0

Slobodnyak, I., & Sidorov, A. (2022). Time value of money application for the asymmetric distribution of payments and facts of economic life. *Journal of Risk and Financial Management*, *15*(12), 573. https://doi.org/10.3390/jrfm15120573

Smith, N. R., & Jose Luis Martinez-Flores. (2007). Discrepancies in solutions between traditional and net present value formulations of finite horizon, discrete-time economic lot size problems. International Journal of Production Research, 45(24), 5731–5741. https://doi.org/10.1080/00207540600891416

Syafrianita, S., Putro, H. P., Yudoko, G., & Fahmi, F. Z. (2023). A combined fuzzy AHP with fuzzy TOPSIS to locate industrial supporting bonded logistics centers. *TELKOMNIKA (Telecommunication Computing Electronics and Control)*, *21*(4), 797-804. https://doi.org/10.12928/telkomnika.v21i4.23973

Tahami, H., Mirzazadeh, A., & Gholami-Qadikolaei, A. (2019). Simultaneous control on lead time elements and ordering cost for an inflationary inventory-production model with mixture of normal distributions LTD under finite capacity. RAIRO - Operations Research, 53(4), 1357–1384. https://doi.org/10.1051/ro/2019060

Taghavifar, H., & Perera, L. P. (2023). Life cycle emission and cost assessment for LNG-retrofitted vessels: The risk and sensitivity analyses under fuel property and load variations. *Ocean Engineering*, *282*, 114940. https://doi.org/10.1016/j.oceaneng.2023.114940

Tebaldi, L., Bigliardi, B., Filippelli, S., & Bottani, E. (2023). EOI or EOQ? A simulation study for the inventory management of a company operating in the railway sector. *Procedia Computer Science*, *217*, 1532-1541. https://doi.org/10.1016/j.procs.2022.12.353

Wasike E.R., & Juma D. (2020). Influence of Logistics Management Practices on the Logistic Performance of Humanitarian Organizations in Kakamega County, Kenya. *International Journal of Scientific and Research Publications*, *10*(9), 97-109. https://doi : 10.29322/IJSRP.10.09.2020.p10513

Wolniak, R. (2020). Main functions of operation management. *Production Engineering Archives*, *26*(1), 11-14. https://doi.org/10.30657/pea.2020.26.03

Wolok, E., Yapanto, L. M., Lapian, A. L., Wolok, T., & Aneta, A. (2023). Manufacturing industry strategy in increasing the acceleration of economic growth in Indonesia. *International Journal of Professional Business Review*, *8*(4), e01927. https://doi.org/10.26668/businessreview/2023.v8i4.1927

Wulandari, S. K., & Donoriyanto, D. S. (2022). Inventory control of brown paper raw materials using the material requirement planning method in a paper company. *Journal of Industrial Engineering Management*, *7*(3), 215-224. https://doi.org/10.33536/jiem.v7i3.1202

Yang, H.-L., Teng, J.-T., & Chern, M.-S. (2001). Deterministic inventory lot-size models under inflation with shortages and deterioration for fluctuating demand. Naval Research Logistics, 48(2), 144–158. https://doi.org/10.1002/1520-6750(200103)48:2%3C144::aid-nav3%3E3.0.co;2-8

Yankah, R., Osei, F., Owusu-Mensah, S., & Agyapong, P. J. (2022). Inventory management and the performance of listed manufacturing firms in Ghana. *Open Journal of Business and Management*, *10*(05), 2650-2667. https://doi.org/10.4236/ojbm.2022.105132

Zaid, A., Sleimi, M., & Alaqra, N. (2021). Environmental logistics management, stakeholders pressures, and sustainable performance. *Journal of the University of Shanghai for Science and Technology*, *23*(1), 391-396. https://doi.org/10.51201/jusst12577

Zhu, B., Zhang, Y., Ding, K., Chan, F. T., Hui, J., & Zhang, F. (2022). Lot-sizing decisions for material requirements planning with hybrid uncertainties in a smart factory. *Advanced Engineering Informatics*, *51*. https://doi.org/10.1016/j.aei.2022.101527