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Inventory Optimization in Pharmacy Using Inventory Simulation-Based Model During the Covid-19 Pandemic

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ABSTRACT

The problem that often occurs in raw material inventory is overstock or stockout conditions. The healthcare industry, including pharmaceuticals, has been experiencing uncertainty since the Covid-19 pandemic. Then impacts panic buying and stockpiling, which can lead to unpredictable spikes in demand, stockouts, and disruptions to the inventory system. The research was conducted at ABC Pharmacy in Yogyakarta, which experienced this problem. In this study, optimization of drug supply was carried out by measuring warehouse capacity, and safety stock, increasing the number of orders and reorder points using the Min-Max and the economic order quantity models. A simulation of inventory optimization planning was carried out using Monte Carlo to see inventory projections for the next three months. Overall, the EOQ model simulation shows the most optimal results by showing the average total inventory cost of Rp. 103,579, where this number represents the lowest number of total inventory costs when compared to other simulation models. It also shows that the EOQ model is 86% more efficient in inventory cost than the Min-Max model. Comparison of the total cost of inventory The results of the three methods are calculated according to current demand and simulation of the EOQ method, which produces the minimum total inventory cost, followed by the company's initial model and the Min Max inventory method.

1. INTRODUCTION

The Covid-19 pandemic has affected many industrial sectors around the world until now. The demand for critical goods, such as pharmaceuticals, is rising rapidly in the healthcare industry, one industrial area that has been significantly impacted. Dcode Economic & Financial Consulting conducted a survey where the medical and drug industries were included as potential winners. This industry can still survive in the new normal era (Dcode, 2020). This phenomenon is caused by the massive shift in demand that occurred during the Covid-19 pandemic and posed major challenges in various parts of the industrial supply chain (Zhang et al., 2018).

Since the Covid-19 outbreak, the healthcare sector has been uncertain, especially the pharmaceuticals sector. It affects stockpiling and panic buying, which can cause unforeseen demand surges, stockouts, and disruptions to the inventory system (Friday et al., 2021). Failure to plan demand will be one of the main reasons for supply chain disruption brought on by an abrupt spike in demand (Norhadibah Azman et al., 2018). Therefore, good demand planning is one of the company's main goals in running its business.

The amount of inventory that the company needs to maintain is directly impacted by demand predictions (Hidayatuloh et al., 2022). Inventories that are too little or too much will cause the company's fail (Shafi, 2014). Therefore, inventory management must reduce uncertainty in satisfying demand (Nemtajela & Mbohwa, 2017). Because of this, inventory management must ensure that all requests are satisfied at the lowest possible cost.

By considering the demand unpredictability caused by the Covid-19 epidemic, this study seeks to supply ABC Pharmacy in Yogyakarta with the best alternative inventory management method. Product demand unpredictability is one of the primary sources of uncertainty in inventory planning (Sabah et al., 2019). This study will compare inventory models consisting of the Min-Max and Economic Order Quantity (EOQ) models to find the best inventory strategy pharmacies can implement. The comparison between EOQ and Min-Max was carried out because of the policy of determining the safety stock and reorder points used in both models. Min-Max inventory analysis determines the minimum and maximum inventory values available on demand (Asana et al., 2020).

In contrast, the EOQ method aims to determine the

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number of economic orders by minimizing the total cost of inventory consisting of ordering costs and holding costs (Putra & Rahyuda, 2018; Rambitan et al., 2018). These two inventory methods will be compared with the pharmacy's determining inventory based on the costs incurred. Even though min max and EOQ are not quite contrary in condition, the economic value resulting from the different calculations of the two methods can be a choice of which strategy has the most economical value in inventory cost. The EOQ model considers the trade-off between ordering costs and inventory holding costs. It determines the best order quantity to place in order to reduce the overall cost of maintaining inventory. In contrast, the min-max model does not consider the cost of ordering; it merely determines the minimum and maximum inventory levels.

In order to produce more thorough results, this study undertakes inventory planning to estimate the number of requests during a fluctuating pandemic with a minimal error rate. The Monte Carlo simulation is one technique that can be used to describe demand forecasts. The use of Monte Carlo in forecasting is fairly widespread and continues to apply to a wide range of businesses, goods, goals, and uncertainty assumptions. This strategy uses a probabilistic approach to account for uncertainty (Jufriyanto, 2020). The advantage of the Monte Carlo forecasting method is its ability to generate a large number of random number sequences (Lihui et al., 2020). Therefore, the uncertainty of demand due to the Covid-19 Pandemic will be accommodated by the Monte Carlo simulation to provide more extensive results on the inventory strategy.

In order to estimate the demand for pharmacies during the Covid-19 epidemic, this study will implement inventory planning along with Monte Carlo simulations. This study concentrates on the present to offer concrete advantages of drug supply policies. Similar studies have been conducted frequently. Numerous research that combined these two approaches produced substantial findings (Fadhil & Suryani, 2021; Kwak, 2021; Patriarca et al., 2020; Profita, 2017; Utama & Siswanto, 2017). Patriarca et al. (2020) and Kwak (2021) carried out inventory planning for perishable products using the EOQ method. They integrated it with demand simulation to be able to face high uncertainty and a dynamic market. Other studies have carried out inventory control in the health supply chain but did not include quantitative considerations, such as the simulation of future demand (Friday et al., 2021; Kwak, 2021; Patriarca et al., 2020). Some studies above show that it is still very rare for research to use objects similar to this research, with comparisons between inventory and simulation methods to determine the best policy alternatives during the Covid-19 pandemic.

The practical application of this study is to offer crucial details about the ideal amount of medicine supply from pharmacies, which are indicated by the number of orders and the duration between reorders to the available safety stock. Additionally, this study compares the economic merits of the Min-Max and EOQ models to identify a more advantageous solution. Both models will give a thorough overview of the inventory management techniques and procedures used at this pharmacy. Research opportunities regarding supplies during the Covid-19 pandemic and their impact on the supply chain will become available due to research that considers the current real-world situations

2. RESEARCH METHODOLOGY

This study will carry out inventory planning integrated with Monte Carlo simulations for forecasting demand for health products in the form of medicines during the Covid-19 pandemic. In Monte Carlo simulations, uncertain demand is a parameter that refers to the level of variability or randomness in the demand for a product or service. This parameter is frequently modelled as a probability distribution, which may be used to produce a variety of demand scenarios that capture the demand's uncertainty. This study uses uniform distribution to define a probability distribution that reflects the possible range of values the demand could take. The uncertain demand parameter used in the Monte Carlo model has been identified by the acknowledgement of fluctuated demand history in ABC pharmacy for the last three months during the Covid-19 pandemic. Based on the literature study carried out in the previous section, it is concluded that there is still little research that integrates the Min-Max Model EOQ and Monte Carlo models to plan and control the supply of essential products, such as medicines, during the Covid-19 pandemic.

2.1. Research Object

The research was conducted using quantitative methods with mathematical analysis. This research was conducted in the pharmaceutical retail industry in Yogyakarta for 90 days or three months to find historical data on drug demand. The object observed in the study was inventory management in the pharmaceutical retail industry during the COVID-19 pandemic.

2.2. Data Collecting

This research will be conducted using primary data collection, carried out by direct data collection through observations and interviews. The required data are demand data, order lead time, warehouse size data, employee salary data, time of receipt, and the number of defective products. The drug data taken is the highest frequency of demand during the covid 19 pandemic. The data are Fasidol (paracetamol), Intunal-F, Alpara, Methylprednisolone 4 mg, Comvit-C, and Caviplex (Table 1).

Table 1. Drugs Demand Data

Period	DEMAND					
	Fasidol	Intuna-F	Alpara	Methylprednisolone	Comvit-C	Caviplex
1	229	100	55	84	25	33
2	273	90	76	134	44	48
3	242	74	22	60	22	39

2.3. Data Processing

This study's data processing for inventory control used the Economic Order Quantity (EOQ) Model, Min Max Inventory Model and Montecarlo Simulation. The use of the EOQ Model and the Min Max Model aims to accommodate various uncertainty factors in predicting lot size determination and reorder points as suggestions in inventory management. Data processing in this study, namely determining the probability distribution, cumulative probability and random number intervals, building the initial and scenario models, and Monte Carlo simulation.

2.3.1. *Economic Order Quantity (EOQ)*

EOQ is an inventory system management method that can minimize total inventory, holding, and ordering costs to reach the optimal point. This model demonstrates how much total material remains to be purchased in each purchase to cover needs for a period (Mapes, 2015). The calculation of inventory optimization using the Economic Order Quantity method is then carried out to determine the comparison of methods. Planning with this EOQ model can help companies minimize inventory levels, costs and the level of stock shortages. When placing an order quantity, also pay attention to the economic aspect, and an optimal number of ordering units can be achieved by keeping costs to a minimum.

$$EOQ = \sqrt{\frac{2SD}{H}} \tag{1}$$

Where EOQ = Economic Order Quantity; S = ordering cost; D = average demand; and H = holding cost.

In calculating safety stock, the approach is used that demand is uncertain, while the lead time for ordering is consistent within one day. The safety stock value is calculated based on the standard deviation of demand per period and the standard deviation of lead time with the formula (2).

$$Sdl = Sd \times \sqrt{l} \tag{2}$$

Where Sdl = standard deviation of demand during lead time; Sd = standard deviation of demand; and l = average lead time.

After the standard deviation of demand during the lead time is known, then the calculation of safety stock with the following formula (3).

$$SS = Z \times Sdl \tag{3}$$

Where SS = safety stock; and Z = value of service level determined from Table Z.

Before calculating the safety stock, it is necessary to determine the service level first. This service level is the percentage of inventory considered safe, and there is no inventory shortage. In this case, the company sets a service level of 95%, or only 5% of stockouts can occur from 100 shipments. With a service level of 95%, the value of the service level in Table Z is 1.65.

Reordering goods after paying attention to the remaining inventory in the warehouse. The assumption in the ROP is that the need for materials or goods is continuous and continuous, thereby reducing the inventory level in the warehouse. If this assumption is not applied, it is necessary to have additional inventory or safety stock.

$$ROP = (d \times l) + SS \tag{4}$$

Where ROP = reorder point; SS = safety stock; d = average demand; and l = average lead time.

Determining order quantity in the form of determining the quantity of each order of goods.

$$Order\ Quantity = 2 \times d \times l \tag{5}$$

2.3.2. *Min-Max Model*

The Min-Max model is a method used in planning raw material inventory by establishing a safety stock inventory policy that must always be available and a company's maximum and minimum inventory values. The Min-Max model stages are (1) determining safety stock, (2) determining inventory reorder points, and (3) determining maximum inventory (Kinanthi et al., 2016).

Monte Carlo simulations provide approximate solutions to various mathematical problems by performing statistical sampling experiments on a computer. Although the method is stochastic, the Monte Carlo method can find approximation solutions to deterministic problems (Heinrich, 1998). The data that will be used in the research is demand data with a certain level of demand to simulate inventory. The detailed data processing process starts by simulating the supply of certain drugs with Monte Carlo.

3. RESULT AND DISCUSSION

Inventory management is the management of goods in a company so that the company does not run out of stock for production activities. The form of inventory in the pharmaceutical industry varies from medicines to medical devices. The research was conducted at one of the pharmaceutical retailers in Yogyakarta.

The research focuses on managing the supply of medicines consumers often demand during the covid 19 pandemic. Drug supplies include Fasidol (paracetamol), Intunal-F, Alpara, Methylprednisolone, Comvit-C, and Caviplex. Good inventory management can be known by calculating inventory optimization using the Min-Max method, the value of safety stock, reorder point and Economic Order Quantity. The results of these calculations will then be input for the Monte Carlo simulation to determine the next inventory forecast. When the inventory is used up and reaches the minimum amount of inventory, an order for raw materials is held. However, if the amount of inventory is below the minimum, there has been an inventory shortage. So, this study tries to simulate inventory using the company's calculations (initial model), the Min Max model and the EOQ model to determine which method gives efficient results.

The required data is historical data in the form of demand for medicines collected as input from data processing on the Min-Max and EOQ methods. The data used are requests for Fasidol, Intunal-F, Alpara, methylprednisolone, Comvit-c, and Caviplex for a minimum of three months. Most of the inventory in retail pharmacies is fast-moving products, so inventory determination will be carried out again if orders from customers or goods run out. Table 1 presents requests for drugs for three months.

3.1. Min-Max Model

The Min-Max model begins with calculating the average demand for goods and the lead time for ordering goods. Furthermore, the safety stock, reorder point, order quantity and maximum inventory are calculated. The average lead time for each drug

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Table 2. Inventory Optimization (Min-Max Model)

	Fasidol	Intunal-F	Alpara	Methylprednisolone	Comvit-C	Caviplex
Average demand	8.27	2.93	1.70	3.09	1.01	1.33
Average leadtime	1.00	1.00	1.00	1.00	1.00	1.00
Safety Stock	7.37	3.06	2.76	3.76	2.02	2.52
Reorder points	15.64	5.99	4.46	6.85	3.03	3.86
Order Quantity	16.53	5.87	3.40	6.18	2.02	2.67
Maximum stock	23.90	8.92	6.16	9.93	4.04	5.19

Table 3. Inventory Optimization (EOQ Model)

	Fasidol	Intunal-F	Alpara	Methylprednisolone	Comvit-C	Caviplex
Holding cost	600	500	1400	800	2000	1200
Ordering cost (per order)	128750	128750	128750	128750	128750	128750
Demand	744	264	153	278	91	120
Reorder point	15.64	5.99	4.46	6.85	3.03	3.86
EOQ	565.07	368.73	167.75	299.13	108.24	160.47

procurement is one day. The results of calculations for inventory optimization using the Min-Max model are shown in Table 2.

The certainty of the order lead time, which takes only one day, allows this pharmaceutical retailer to have no shortage of stock if there is a demand for medicines. The existence of safety stock or additional supplies also makes it easier for the company to meet the demand for medicines customers need. The supply of medicines during the pandemic tends to increase, and so far, the company can still provide the products needed due to the short lead time. So, there is no decrease in delivery performance caused by vendor shipping delays.

3.2. Economic Order Quantity

Determination of holding costs, ordering costs and other costs related to ordering goods activities must be calculated before calculating EOQ. The cost of storage, in this case, is taken from 10% of the price of raw materials or goods per unit per year. Ordering costs are the accumulation of transportation, telephone, administrative, and employee wages when ordering activities. Overall inventory optimization calculations using the EOQ model are shown in Table 3.

3.3. Monte Carlo Simulation

The Monte Carlo simulation predicts the probability of demand for 90 days. This Monte Carlo model will be applied to each scenario, namely the initial model, scenario 1st, and scenario 2nd. In addition, it becomes a tool to anticipate the soaring demand in each scenario. The requested data collected for the simulation is obtained from generating random numbers.

The data used in the input of the Monte Carlo model in the initial model, scenario one for the Min-Max model and scenario two for the EOQ model. In the initial model, the ROP for Fasidol, Intunal-F, Alpara, Methylprednisolone, Comvit-c, and Caviplex was 20 strips. Reorders for these drugs must be made when supplies reach below 20 strips. Order quantity shows how much reordering must be done, for reordering Fasidol has the greatest value at 150 strips than other types of drugs.

3.4. Initial Model

The initial model is a model that is under the real system, meaning that the data entered in the model comes from company data. The initial model development aims to determine the replication results of the simulation results for further comparison with the scenario model simulation results. The simulation in the initial model was carried out for 90 replications. In the real system, it is known that the company does not implement safety stock. Reorder point inventory of 20 strips.

Meanwhile, the order quantity for each drug is 150 strips of Fasidol, 75 strips of Intunal-F, 45 strips of Alpara, 60 strips of Methylprednisolone 4 mg, 20 strips of Comvit-C, and 30 strips of Caviplex. The results of the simulation show that there is no stock out. While the average value of overstock or final inventory for Fasidol is 86 strips, Intunal-F is 56 strips, Alpara is 44 strips, Methylprednisolone 4 mg is 47 strips, Comvit-C is 29 strips, and Caviplex is 32 strips. Inventory comparison for each type of drug can be seen in Fig. 1.

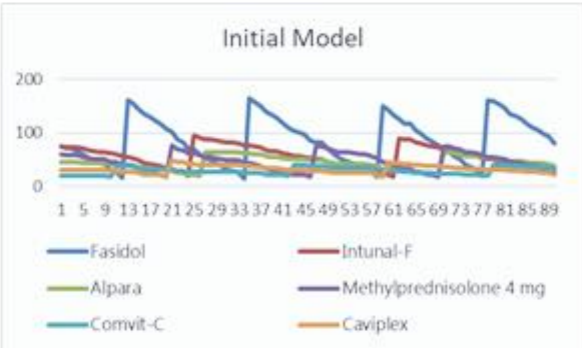

Figure 1. Initial Model Simulation

3.5. Simulation

Scenario 1 is built using the Min-Max model's calculated data. The Monte Carlo simulation scenario 1st was built with assumptions for implementation within 90 days. The calculation results using the Min-Max model for the safety stock of Fasidol is four strips, Intunal-F is two strips, Alpara is two strips, Methylprednisolone 4 mg is two strips, Comvit-C is one strip, and Caviplex is two strips (Fig. 2). The reorder point for Fasidol is seven strips, Intunal-F is three strips, Alpara is three, Methylprednisolone 4 mg is four, Comvit-C is two, and Caviplex is three. Order Quantity Fasidol is 16

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strips, Intunal-F is six strips, Alpara is four strips, Methyl-prednisolone 4 mg is seven strips, Comvit-C is 3 strips, and Caviplex is 4 strips. The results of the simulation show that there is no stock out. While the average value of overstock or final inventory for Fasidol is 22 strips, Intunal-F is 20 strips, Alpara is 15 strips, Methyl-prednisolone 4 mg is 15 strips, Comvit-C is seven strips, and Caviplex is 11 strips.

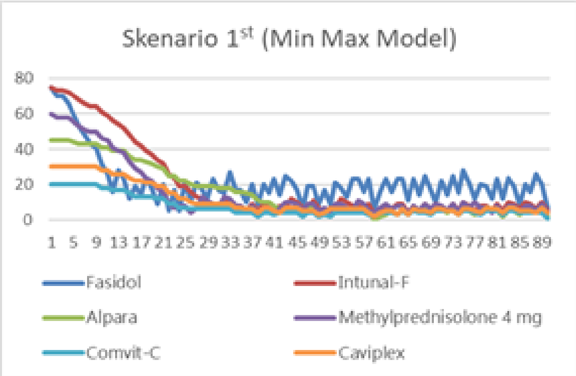

Figure 2. Scenario 1 Simulation

Scenario 2 was built using the calculated data using the EOQ model. The scenario 2nd EOQ simulation was built with assumptions for deployment within 90 days . The results of calculations using the EOQ model for the safety stock of Fasidol are four strips, Intunal-F is two strips, Alpara is two strips, Methylprednisolone 4 mg is 2 strips, Comvit-C is one strip, and Caviplex is two strips. The reorder point for Fasidol is sixteen strips, Intunal-F is six strips, Alpara is four strips, Methylprednisolone 4 mg is seven, Comvit-C is three, and Caviplex is four. The economic Order Quantity of Fasidol is 295 strips, Intunal-F is 192 strips, Alpara is 87 strips, Methylprednisolone 4 mg is 156 strips, Comvit-C is 56 strips, and Caviplex is 84. The results of the simulation show that there is no stock out. While the average value of overstock or final inventory for Fasidol is 148 strips, Intunal-F is 103 strips, Alpara is 44 strips, Methylprednisolone 4 mg is 73 strips, Comvit-C is 30 strips, and Caviplex is 47 strips. Fig. 3 shows the amount of inventory for each type of drug using the EOQ model.

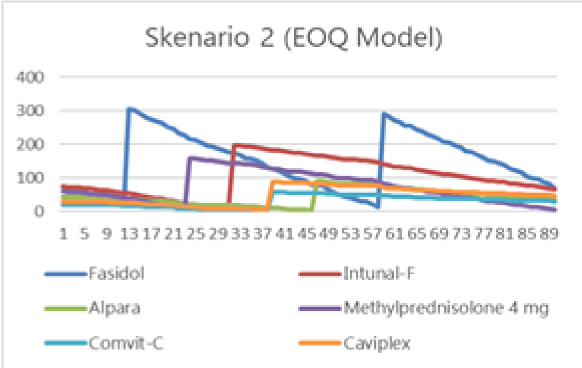

Figure 3. Scenario 2 Simulation

3.6. Comparison Analysis

A comparison of simulations is carried out from the initial model based on company policy in determining orders, perpetual inventory simulation using reorder points, and Min-Max inventory simulation using minimum stock in determining orders. There is a difference in the number of times an order is placed for 34 weeks, and it can be seen in the perpetual inventory simulation table that orders 20 times, the periodic table inventory simulation orders 17 times, and the Min-Max inventory simulation table orders ten times with a higher number of orders. Great for keeping stock of supplies. There is a difference in the number of times an order was made during the 90 days of simulation on each model in each type of drug (Table 4).

When viewed from the aspect of ordering costs, the simulation using the EOQ model has the lowest total order cost, with an average total order cost of Rp. 40,833. Meanwhile, the highest average total order cost is a simulation using the min-max model, which is Rp. 723,333 with an average number of orders 21 times. The lowest average holding cost is Rp. 14,083 the results of the Min-Max model simulation. On the contrary, the simulation with the EOQ model shows the highest average total holding cost of Rp. 62,746. Overall, the EOQ model simulation shows the most optimal results by showing the average total inventory cost of Rp. 103,579, where this number represents the lowest number of total inventory costs when compared to other simulation models. Comparison of the total cost

Table 4. Data Comparison

	Variable	Fasidol	Intunal-F	Alpara	Methylprednisolone 4 mg	Comvit-C	Caviplex	Total Average
Initial Model	Total Holding Cost	51487	27994	61693	37396	57844	38093	45751
	Frequency of order	4	2	2	3	3	2	3
	Total Order Cost	140000	70000	70000	105000	105000	70000	93333
	Total Inventory Cost	191487	97994	131693	142396	162844	108093	139085
Scenario 1 (Min-Max)	Total Holding Cost	13020	9911	21653	12222	14600	13093	14083
	Frequency of order	31	22	18	25	14	14	21
	Total Order Cost	1085000	770000	630000	875000	490000	490000	723333
	Total Inventory Cost	1098020	779911	651653	887222	504600	503093	737417
Scenario 2 (EOQ)	Total Holding Cost	88820	51344	61740	58302	60333	55933	62746
	Frequency of order	2	1	1	1	1	1	1
	Total Order Cost	70000	35000	35000	35000	35000	35000	40833
	Total Inventory Cost	158820	86344	96740	93302	95333	90933	103579

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of inventory The results of the three methods are calculated according to current demand and simulation of the EOQ model, which produces the minimum total inventory cost, followed by the company's initial model and the Min Max inventory method. It shows that the EOQ model is a better method than the company's initial and Min Max models.

However, the EOQ model is generally thought to be better than the Min-Max model for a number of reasons, aside from the calculation results that demonstrate that the economic value of the EOQ model is superior to the Min-Max model: (1) Since the EOQ model reduces the overall cost of holding inventory while satisfying customer demand, it offers better inventory control. The Min-Max strategy, on the other hand, could result in surplus inventory, which would raise holding costs and possibly cause waste or obsolescence. (2) Demand, lead time, and ordering expenses are variables that the EOQ model considers when determining the ideal order quantity. While the Min-Max model may not always be the best option, it does rely on the predetermined minimum and maximum inventory levels. (3) The EOQ model considers demand variability by calculating safety stock. In contrast, The Min-Max approach does not expressly consider demand variations, which could result in stockouts or excess inventory.

4. CONCLUSION

This study aims to determine the best inventory management strategy, limited to one pharmaceutical business. Inventory parameters are simulated using Monte Carlo to predict the probable amount of inventory. The three approaches that have been compared show that the EOQ model can produce the lowest inventory costs for current and future demand. The EOQ model simulation shows the most optimal results by showing the average total inventory cost of Rp. 103,579, where this number represents the lowest number of total inventory costs when compared to other simulation models.

On that basis, the EOQ model can be one of the suggestions for determining drug supply policies that the company owner will determine. The Min-Max model is a straightforward method that could produce suboptimal inventory levels, but the EOQ model is a more thorough approach that considers various aspects to establish the best order quantity. Identification of inventory policies that can be general and comprehendsive is one of the development opportunities that can be carried out for further determination. In addition, it is necessary to consider other inventory models not discussed in this study to find the possibility of a better inventory policy solution in the future.

REFERENCES

Asana, I. M. D. P., Radhitya, M. L., Widiartha, K. K., Santika, P. P., & Wiguna, I. K. A. G. (2020). Inventory control using ABC and min-max analysis on retail management information system. *Journal of Physics: Conference Series*, *1469*(1), 12097. https://doi.org/10.1088/1742-6596/1469/1/012097

Dcode. (2020). *Dcode EFC Expectations in March 2020*. Dcode Economic & Financial Consulting. https://img1.wsimg.com/blobby/go/2cdd937c-6619-4712-8b7c-e0cc3b5ce6a5/Dcode EFC-Economic Sectors More than One Year.pdf

Fadhil, M., & Suryani, E. (2021). Inventory Planning for XYZ Mart using EOQ and Monte Carlo. *IPTEK Journal of Proceedings Series*, 233–237. https://doi.org/10.12962/j23546026.y2020i3.11217

Friday, D., Savage, D. A., Melnyk, S. A., Harrison, N., Ryan, S., & Wechtler, H. (2021). A collaborative approach to maintaining optimal inventory and mitigating stockout risks during a pandemic: capabilities for enabling health-care supply chain resilience. *Journal of Humanitarian Logistics and Supply Chain Management*, *11*(2), 248–271. https://doi.org/10.1108/JHLSCM-07-2020-0061

Heinrich, S. (1998). Monte Carlo Complexity of Global Solution of Integral Equations. *Journal of Complexity*, *14*(2), 151–175. https://doi.org/10.1006/jcom.1998.0471

Hidayatuloh, S., Febriani, A., Samodro, G., & Indarwati, T. (2022). Improved Warehousing Performance Using the Frazelle Model in Pharmacies During a Covid-19 Pandemic. *Jurnal Ilmiah Teknik Industri*, *21*(1), 83–90. https://doi.org/10.23917/jiti.v21i1.17182

Jufriyanto, M. (2020). Peramalan Permintaan Keripik Singkong Pada UMKM Difaa dengan Simulasi Monte Carlo. *Jurnal Teknik Industri: Jurnal Hasil Penelitian Dan Karya Ilmiah Dalam Bidang Teknik Industri*, *6*(2), 107–113. https://doi.org/10.24014/jti.v6i2.10452

Kinanthi, A. P., Herlina, D., & Mahardika, F. A. (2016). Analisis Pengendalian Persediaan Bahan Baku Menggunakan Metode Min-Max (Studi Kasus PT.Djitoe Indonesia Tobacco). *PERFORMA : Media Ilmiah Teknik Industri*, *15*(2), 87–92. https://doi.org/10.20961/performa.15.2.9824

Kwak, J.-K. (2021). An Order-Up-to Inventory Model with Sustainability Consideration. *Sustainability*, *13*(23), 13305. https://doi.org/10.3390/su132313305

Lihui, W., Liwei, T., Shenyang, L., & Yan, L. (2020). Inventory Optimization Models of Equipment Spare Parts Based on Computer Simulation. *2020 IEEE International Conference on Power, Intelligent Computing and Systems (ICPICS)*, 235–237. https://doi.org/10.1109/ICPICS50287.2020.9202064

Mapes, J. (2015). Economic Order Quantity. In *Wiley Encyclopedia of Management* (pp. 1–2). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118785317.weom100101

Nemtajela, N., & Mbohwa, C. (2017). Relationship between Inventory Management and Uncertain Demand for Fast Moving Consumer Goods Organisations. *Procedia Manufacturing*, *8*, 699–706. https://doi.org/10.1016/j.promfg.2017.02.090

Norhadibah Azman, S., Suzana Jaafar, H., Alam, P., & Author, C. (2018). Supply Chain Disruptions That Impact on Factors of Supply Chain Efficiency Performance and Competitiveness. In *Advances in Transportation and Logistics Research* (Vol. 1). https://proceedings.itltrisakti.ac.id/index.php/ATLR/article/view/34

Patriarca, R., Di Gravio, G., Costantino, F., & Tronci, M. (2020). EOQ inventory model for perishable products under uncertainty. *Production Engineering*, *14*(5-6), 601–612. https://doi.org/10.1007/s11740-020-00986-5

Profita, A. (2017). Optimasi Manajemen Persediaan Darah Menggunakan Simulasi Monte Carlo. *Journal of Industrial Engineering Management*, *2*(1), 16–24. https://doi.org/10.33536/jiem.v2i1.101

Putra, I. M. A. D., & Rahyuda, A. G. (2018). Analisis Kinerja Manajemen Persediaan Di Barjaz Company Menggunakan Pendekatan EOQ. *E-Jurnal Manajemen Universitas Udayana*, *8*(1), 7163–7190. https://doi.org/10.24843/EJMUNUD.2019.v08.i01.p08

Rambitan, B. F., Sumarauw, J. S. B., & Jan, A. H. (2018). Analisis Penerapan Manajemen Persediaan Pada CV. Indospice Manado. *Jurnal EMBA*, *6*(3), 1448–1457. https://ejournal.unsrat.ac.id/index.php/emba/article/view/20228

Sabah, B., Nikolay, T., & Sylverin, K.-T. (2019). Production planning under demand uncertainty using Monte Carlo simulation approach: a case study in fertilizer industry. *2019 International Conference on Industrial Engineering and Systems Management (IESM)*, 1–6. https://doi.org/10.1109/IESM45758.2019.8948112

Shafi, M. (2014). Management of Inventories in Textile Industry : A Cross Country Research Review. *Singaporean Journal of Business , Economics and Management Studies*, *2*(7), 45–59. https://doi.org/10.12816/0004017

Utama, I. T., & Siswanto, N. (2017). Inventory System Planning of Margarine and Shortening Ingredient With Monte Carlo Simulation in Addition To Economic Order Quantity (EOQ) Method on PT . Smart Tbk. *E-Jurnal SPIRIT PRO PATRIA*, *3*(September), 2. https://jurnal.narotama.ac.id/index.php/patria/article/view/425

Zhang, T., Chen, X., Yu, Z., Zhu, X., & Shi, D. (2018). A Monte Carlo Simulation Approach to Evaluate Service Capacities of EV Charging and Battery Swapping Stations. *IEEE Transactions on Industrial Informatics*, *14*(9), 3914–3923. https://doi.org/10.1109/TII.2018.2796498

http://dx.doi.org/10.30656/intech.v9i2.5820