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# INVENTORY MANAGEMENT WITH DEMAND FORECAST FOR EYEGLASS LENSES USING THE TIME SERIES METHOD AT AN OPTICAL STORE

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***Abstract***
*In the healthcare sector, supply chain management is one of the most important elements since in the logistics of medical devices and pharmaceutical products, patient satisfaction is the main focus in efforts to improve service quality. One of the problems that often occurs in the optical supply chain is inventory control. The optical store is one of the microenterprises engaged in optometric health services. The enclosed supply chain is a three-echelon model, where the store is at the second level. The process of ordering lenses at the store from suppliers is not carried out based on predicted demand. The determination of the safety stock amount and the reorder point also still has a fairly low accuracy there. This is indicated by overstock and stock-out situations that still occur frequently in this company. Overstock causes the product to be damaged because it has been stored for too long and stock out causes lost sales. To solve the problem in this research, the prediction of future demand is overcome by using several time series methods, such as cyclical models, cyclical trend models, and ARIMA models. Forecasting result validation is implemented by calculating the calculation of errors using MAPE, MAD, and MSE then it was found that the forecasting model chosen to predict the demand for the lenses is a cyclical trend model. The result of the demand forecasting and safety stock size calculation with 3 service levels are used as input to determine the reorder point. After observing the condition of the company and the targets set by the company, the calculation results with a service level of 90% is the most possible to be implemented.*



***Keywords:***
*Healthcare; inventory control; demand forecasting; safety stock; reorder point*

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## 1. Introduction

In the health sector, supply chain management is an important element because, in the logistics of pharmaceutical products, patient satisfaction is the main focus in efforts to improve service quality [1]. Improving the quality of healthcare services depends directly on the efficiency of its supply chain management [1]. Health care supply chain covering the supply and demand management of drugs and medical products. Medicines, or healthcare equipment like syringes are some of the most discussed research objects related to their requirements or demand forecasting in the future while those focusing on optical products were hardly found. One of the health services under the optical supply chain is an optometry service company or an optical company/shop/store. Like any other business, optical stores need innovative and operational models to stay competitive in the market. The optical supply chain has its own special models and challenges to meet the needs of patients who have different requirements for their eye health. One of the problems that often occur in the optical supply chain is related to inventory control [2]. Inventory is a factor that is important because it greatly influences the continuity of sales activities [2]. Some important activities in inventory control are demand forecasting, determining the amount of safety stock and reorder points, and several other issues in order to improve the quality of service to customers. Even though [2] discussed inventory management, they did not consider the calculation lies under the information system that they designed while we know that applications without strong formulation in the backend will provide a bare impact on the operational processes in the optical stores.

Inventory is a number of materials in process available in the company for the production process, as well as goods provided to meet demand from customers at any time [3]. Inventory planning has the challenge of serving production needs by minimizing existing inventory stocks to make the costs more efficient which are usually a burden to the company. In the early stages of inventory planning, demand forecasting is required. Forecasting sales of eyeglass lens products is needed to find out the amount of safety stock needed and also the reorder point [4]. Demand forecasting is an important activity in the industrial sector that aims to estimate the amount of product or service to be produced to meet end demand [4]. This is because demand forecasting can affect other work processes, such as purchasing raw materials and production planning [4]. So, we need a forecasting technique that has a high level of accuracy. Forecasting accuracy can be assessed as high if the error calculation is carried out with several selected methods which shows that the error obtained is very small [5]. Forecasting results with the lowest error become input in the calculation of safety stock and reorder point. Safety stock is the minimum amount of inventory that must be owned in each period by a company to overcome the risk of delays in the arrival of materials and possible fluctuations in demand. The calculation of safety stock is based on the service level (probability of fulfilling needs) that has been determined by the company [6]. Service level is a value set by a company that aims to meet customer needs [7]. The reorder point is the inventory level that has been set as the time to reorder to balance the inventory [8]. Reorder point is determined by three factors, namely lead time, safety stock, and average demand (obtained from demand forecasting results [6].

The observed optical store or we can say Store X is one of the micro businesses engaged in optometric health services. This company sells various health eyewear products (lenses and frames) as well as visual inspection services (examination of patient vision) and tinting color services (lens tinting). Single-vision lenses are lenses that have one focus point and function to correct one type of visual impairment, namely nearsightedness or farsightedness [9]. A bifocal lens is a lens that has two focus points and functions to correct two types of visual impairment in one lens, namely nearsightedness (myopia) and old eyes (presbyopia) [10]. The difference between the two lenses is in the number of focus points. Bifocal lenses have two focal points, namely the spherical (SPH) and addition (ADD), while single vision lenses only have one focal point, namely the spherical (SPH). Spheris is a unit of measurement used to indicate the strength of spectacle lenses in correcting vision so that vision is clear again and addition is a measure of correction needed for people with nearsightedness or presbyopia [11].

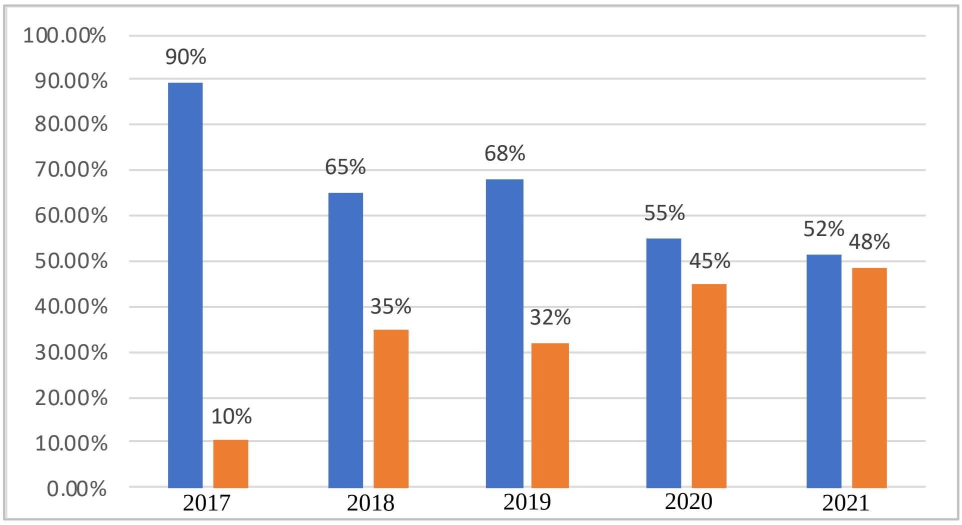


Figure 1. Customer Satisfaction Level

The business model used by Store X is business-to-business (B2B) and business-to-customer (B2C) so that they are not only connected to other business but also reaches the end customer directly. This company is already operating with the STR standard (Registration Certificate) for Health Workers and has suppliers who have permission from the Minister of Health of Indonesia so the optometric equipment sold by this company already has a special standardization in which eye health services are handled by Optic Refractionist (RO). The strategy used in meeting the needs of its customers is make-to-order and make-to-stock. The make-to-stock strategy implemented starts with ordering from several suppliers if the product stock is below the minimum limit (safety stock). After 7 days, the supplier will confirm the availability of the ordered goods and if a purchase order has been made, the required lead time is 3 weeks. Each supplier has varying minimum order requirements. After the company's inventory is fulfilled, then the company will confirm it to the patient. In the course of its business, Store

X evaluates it by distributing questionnaires to see the level of customer satisfaction based on three aspects, namely convenience of place, optical service, and product availability. This was also done as part of the agreement between the company and BPJS Indonesia (Social Security Agency on Health) so that the results of collecting this questionnaire were fully given to BPJS.

The questionnaire distributed used a Likert scale instrument. The Likert scale is a psychometric scale commonly used in questionnaires and is the most widely used scale in survey-related research [12]. The Likert scale used is a 5-point Likert scale with 5 choices, namely Very Disappointing (1 point), Disappointing (2 points), Neutral (3 points), Satisfied (4 points), and Very Satisfied (5 points). From the results of the questionnaire, a recapitulation is carried out by calculating the percentage of customers who choose a scale of 4 (Satisfied) and a scale of 5 (Very Satisfied) each year. From the data obtained from 2017 to 2021, we can see Fig. 1 is a graph that compares the level of customer satisfaction between scales 1-3 (in blue) and scales 4-5 (in orange) at Store X based on product availability. The best possible condition is when all feedback comes in a value of 5 showing the highest level of satisfaction.

From Fig. 1, it can be seen that there has been a significant increase in customer satisfaction from 2017 to 2021 (from 10% to 48%) but the number of respondents who chose a scale of 1-3 is still bigger than the number of respondents who chose a scale of 4-5. This means that the level of customer satisfaction based on product availability is constantly low even after 5 years. As most businesses define goals, this company also wants to increase their level of customer satisfaction in the future which can not be separated from good supply chain management. Therefore they implement a responsive supply chain strategy because they want to meet as many customer needs as possible. The problems that often occur in this strategy are stock-out when patients need it and overstock on several products whose demand does not match the supply provided by the company. Both of these occur because the number of postoperative patients is unpredictable and proper calculations have not been carried out to determine the appropriate safety stock and reorder point. When a stock out occurs, the company's service quality decreases, so it is necessary to determine the right service level in accordance with the company's sales target. Conversely, when there is overstock, some products become damaged. Every lens sold has an expiration date and if the item is not used before the expiration date, the lens will turn yellow (damage) because the coating on the lens fades so the product cannot be resold. These defective products will eventually be discarded or donated to other parties.

Based on the results of discussions with the company, the inventory control system currently used by the company is to set a minimum stock quantity of 200 pairs per type of lens and a maximum stock quantity of 1,800 pairs per type of lens as a consideration. When the amount of available stock is below the minimum stock limit value, the company re-stocks as much as the maximum stock amount. Thus, in determining the number of lenses to be purchased, the company does not adjust to the predicted number of lens demand in the future. This causes a stock out because the lens product inventory that is prepared cannot meet demand and there is no safety stock. Inventory that runs out before this time also causes lost sales so the revenue that the company gets is less than optimal. In essence, in carrying out inventory control, the stage of forecasting or predicting demand is an important initial step so that when you want to order lenses, you can adjust them to predict the number of demands for lenses in the future. Fig. 2 illustrates the supply chain model occupied in the field.

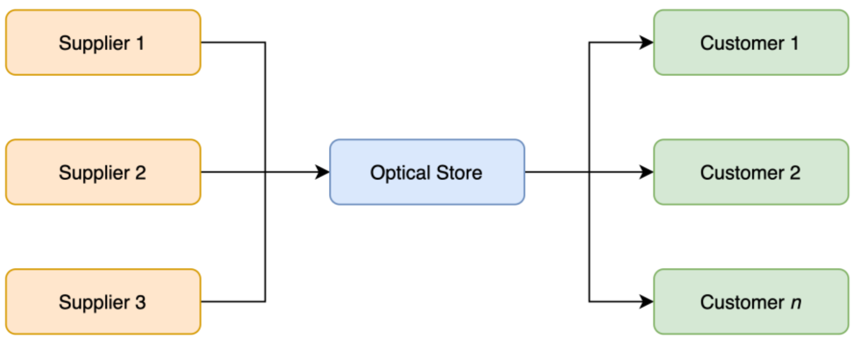


Figure 2. Observed Supply Chain Network

The company applies a three-echelon supply chain model, in which the model consists of suppliers, optical shops (stores), and customers. The store has several suppliers providing the lenses while they also serve multiple customers who are buying the products. This situation is further complicated by the availability of products owned

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by suppliers. Store X has exactly three main suppliers to supply its lens products. Two of them set a minimum order quantity of 2,000 pairs per order and the rest set a minimum order quantity of 1,000 pairs per order. Sometimes when the situation with the demand decreases, the supplier who has the availability of the product ordered is the supplier with a minimum order of 2,000 pairs per order. Determining the minimum number of orders by these suppliers is one of the factors that can increase the risk of overstock at Store X. Figs. 3 and 4 are examples of stock-out and overstock data mapping for certain types of lenses observed in this study (November 2019-October 2022). It can be seen from Fig. 3 and 4 that out-of-stock and excess inventory often occur. Out-of-stock happens when demand in the blue line surpasses the available stock at the store (in orange in the graph) that can be seen in 1st, 2nd, 3rd, 7th, 8th, 13th to 15th, 33rd to 35th month for Single Vision -0,75 lens while for Single Vision +2,25 lens, it happens on the month of 1st, 2nd, 4th, 7th, 15th, 18th, 30th, and 33rd. We can infer that out-of-stock situation is more common to Single Vision -0,75 lens compared to Single Vision +2,25 lens therefore the surplus found more to the latter.

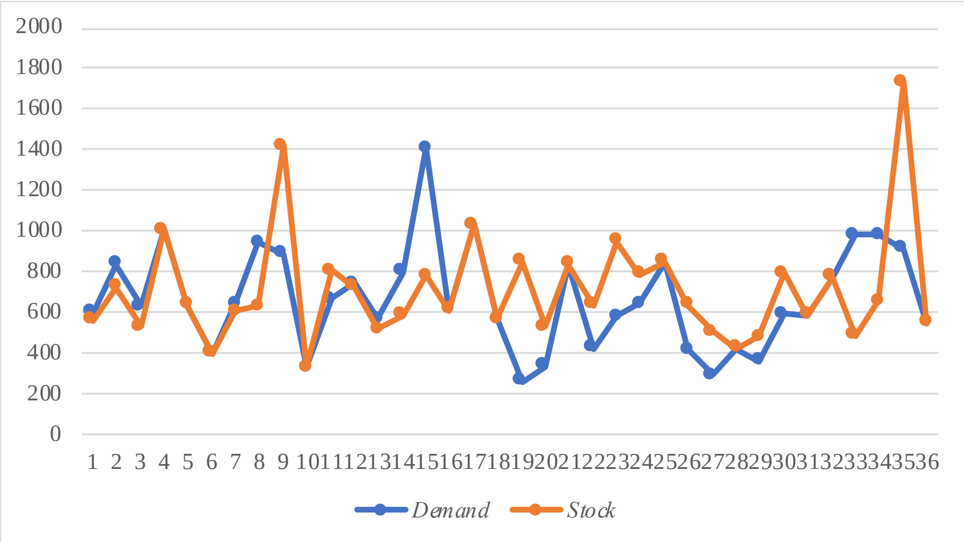


Figure 3. Stock-Out dan Over Stock Single Vision -0,75 Lens

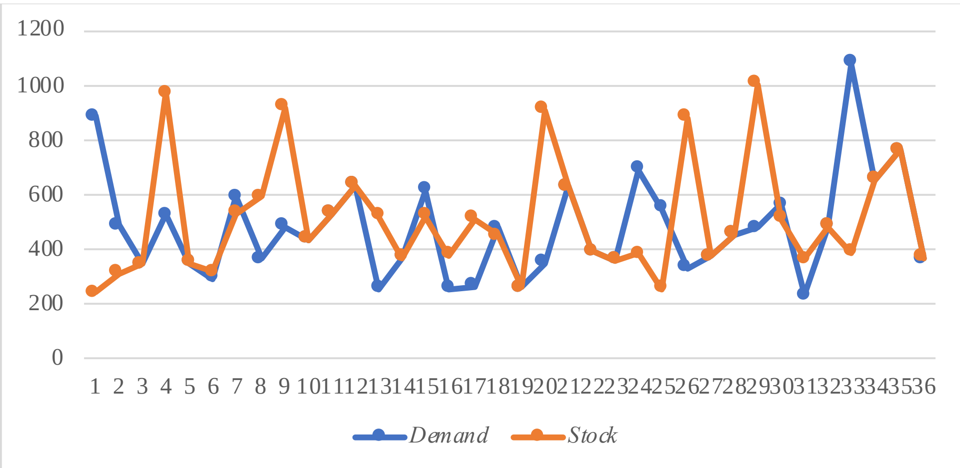


Figure 4. Stock-Out dan Over Stock Single Vision +2,25 Lens

Out-of-stock is the most common situation compared to excess inventory. This can happen because the company has not determined the safety stock to avoid out-of-stock situations and the determination of reorder points that need improvement therefore in this study, forecasting the number of lenses in the future and interpreting the forecast results with the selected method for each type of lens. Reviewing research conducted by [13] regarding production forecasting at battery cage manufacturing companies, the cyclic model was chosen as the best forecasting model compared to the exponential model because it has a higher level of accuracy. According to research conducted by [14] regarding pozzolan inventory control, the cyclical trend model is a forecasting model that has the highest level of accuracy when compared to exponential, quadratic, linear, and cyclical models. This means that the trend parameter has an influence on the accuracy of forecasting results. Research conducted by [15] shows that the implementation of the ARIMA model in forecasting shows a high level of accuracy with a recorded error value (using the MAPE method) of 16.48%. After reviewing previous research and seeing the pattern of demand shown in the demand for single vision and bifocal lenses, several models selected in this study are models that are included in the time series statistical method, namely cyclical, cyclical trend, ARIMA (Autoregressive Integrated Moving Average). Based on research [16], [17], and [18] considering the forecasting model used in this study, in calculating errors we use the MAPE (Mean Absolute Percentage Error), MAD (Mean Absolute Deviation), and MSE (Mean Square Error) methods. After obtaining product forecasting results from the best forecasting method, a safety stock calculation is carried out that is adjusted to the company's service level. After that, a reorder point is determined based on the lead time, average demand, and safety stock that has been obtained from the previous stage.

## 2. Methodology

In this study, the method used was the descriptive method with a quantitative approach. Several steps are taken to conduct this research they are:

1. Observations are made for lens sales activities at the store. In this stage, the business activity processes that exist are studied to understand the systems applied.
2. Identification of the problem. After carrying out the observation process, we identify the main problem based on a study of the literature and investigate the existing conditions. This stage is carried out to determine the research focus by selecting the problems to be researched and resolved. The formulation of the problem is done by asking questions about the problem to be solved.
3. A literature study is carried out to increase knowledge about problems that are similar to the problems found at the observation sites that have been studied before.
4. Data collection is done by collecting the data needed in the research process. The data are divided into two types based on how to obtain them, namely primary data and secondary data. Primary data was obtained through observation and interviews, while secondary data was obtained from historical data from the store. The data collected in this study were:
    a. Primary data:
        i. The most frequently stocked out or overstocked lenses.
        ii. Data on customer satisfaction levels.
        iii. Lead time data.
        iv. Company-level service data.
        v. Data on the number of reorders.
    b. Secondary data:
        i. The organizational structure of the store.
        ii. Monthly demand in 2018-2022.
5. Data processing is one of the important processes in conducting research. The following are the steps taken in the data processing:
    a. Aggregation of Lens Demand Data

        In the initial stages of data processing, aggregation of lens demand data was taken for product types that have a critical demand and are most often experiencing stock out or over stock.
    b. Plotting of Aggregated Data Results

        Plotting the result of the aggregation to visualize the data pattern formed from the single vision and bifocal lens demand data that had been aggregated in this study.
    c. Data Stationarity Test

A stationary test was carried out using the ADF Test (Augmented Dickey-Fuller Test) to ascertain whether the data possessed could be processed using the ARIMA forecasting model. This stage ensures the forecasting results are not biased and the selected forecasting model is the best model.

d. Determination of the Parameters of the Forecasting Method

Forecasting parameters are determined to control several aspects of demand forecasting, such as handling missing values, detecting outliers, validating fit and forecasting, and forecasting sparse data. For cyclic and cyclic trend models, the parameters are determined using the sine and cosine (trigonometry) approach which forms special equations with the parameter names *a*, *b*, and *c*. As for the ARIMA model, the parameters are determined by the number of lag observations, the number of differencing transformations needed to become stationary values, and the component that shows the lag of the error component which is part of the time series. However, in this study, the forecast with the best ARIMA model feature was used in determining the best parameters of *p*, *d*, and *q*.

e. Lens Demand Forecasting

Demand forecasting is applied for the next one-year period, using cyclical models, cyclical trends, and ARIMA (Autoregressive Integrated Moving Average). The determination of these methods was referred to comparison compatibility regarding data type, number of data available, and also planning horizon, as resumed from [19] and shown in Table 1.

Table 1. Demand Forecasting Methods using Statistics and Machine Learning

| Forecasting Method | Data Type | Number of Datapoint | Forecasting Planning Horizon |
|---|---|---|---|
| Naive | Stationary | 1-2 | Very short |
| Moving Average | Stationary | As minimum as same with its moving average period | Very short |
| Simple Exponential Smoothing | Stationary | 5-10 | Short |
| Adaptive Response Exponential Smoothing | Stationary | 10-15 | Short |
| Holts Exponential Smoothing | Trend Linear | 11-15 | Short to Medium |
| Winters Exponential Smoothing | Trend and Stationary | Minimum 4 or 5 for each season | Short to Medium |
| Trend Regression | Trend Linear and Non-Linear, with or without Seasonal | Minimum 10 with 4-5 for every season if applied | Short to Medium |
| Causal Regression | All kinds of data | Minimum 10 for the independent variable | Short, Medium, and Long |

| | | | |
|---|---|---|---|
| Time Series Decomposition | Trend, Seasonal, and Cyclic | Minimum 2 peak points in a cycle | Short, Medium, and Long |
| ARIMA | Stationary | 50 | Short, Medium, and Long |

f. Forecasting Validation

The forecast validation stage is done by calculating and selecting the lowest error to determine the appropriate forecasting method for the lens demand pattern. The error measurement methods used are Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), and Mean Square Error (MSE).

g. Forecasting Verification

After obtaining the results of forecasting with the selected method (with the lowest error), a verification process is conducted using the moving range chart method. This stage is implemented to ensure that the model used is mathematically appropriate and already reflects the conceptual model before executing the analysis of the results. The moving range chart method is used to test the stability of the causal system that affects demand.

h. Calculation of Safety Stock Size

After obtaining the results of demand forecasting, a safety stock calculation is calculated by multiplying the selected forecasting results with the service level set by the company. The service level value is shown in percentage form with a maximum limit of 100%. In the safety stock calculation, the service level is converted to a constant obtained from the normal distribution z table.

i. Determination of the Reorder Point

After forecasting demand and calculating safety stock, a reorder point is determined. The reorder point is the time when inventory conditions have reached a certain level, a product must be reordered to balance the product inventory. In determining the reorder point, a calculation is done involving three elements, namely the demand, safety stock, and lead time.

6. Analysis of Calculation Results

At this stage, an interpretation of all the results of the calculations carried out in this study is conducted by elaborating the results of data processing so that conclusions can be drawn in the form of the selected forecasting method, predictions of demand for the next 12 periods, amount of safety stock, and reorder points. This stage is also carried out to facilitate the process of drawing conclusions and suggestions in the last stage of this research.

## 3. Result and Discussion

### *A. Cyclic Model*

The data used is historical data on demand for single vision and bifocal lenses from the Operations Division. The data obtained is daily data which is accumulated into monthly data for the period of November 2018 - October 2022 as shown in Table 2. Table 3 covers the detailed list of single-vision and bifocal lens products that are considered the object of this study.

Table 2. Number of Demand for Single Vision Lenses and Bifocals for the 1st Year

| Month | Demand Data | |
|---|---|---|
| | Single Vision | Bifocal Kryptok |
| 1 | 2,270 | 2,156 |
| 2 | 1,802 | 1,767 |
| 3 | 1,461 | 1,295 |
| 4 | 2,373 | 2,111 |

| | | |
|---|---|---|
| 5 | 1,374 | 1,547 |
| 6 | 1,195 | 1,212 |
| 7 | 1,738 | 1,963 |
| 8 | 1,850 | 1,765 |
| 9 | 1,996 | 1,590 |
| 10 | 990 | 1,866 |

Table 3. Detailed Data Name and Type of Lens

| No. | Lens Name | Lens Type |
|---|---|---|
| 1 | Single Vision -0.75 | Single Vision |
| 2 | Single Vision +2.25 | |
| 3 | Single Vision +3.5 | |
| 4 | Bifocal Kryptok SPH 0 ADD 1.25 | Bifocal Kryptok |
| 5 | Bifocal Kryptok SPH 0.25 ADD 2.25 | |
| 6 | Bifocal Kryptok SPH 0.5 ADD 3 | |

Calculation of the constant values of other parameters is conducted using the parameter equations in the cyclic model. After obtaining the constant values of parameters $a$, $b$, and $c$, forecasting calculations ($y'$) are performed. The following is a forecasting calculation with a cyclical model in period 36:

$$y' = a + b\cos\frac{2\pi t}{n} + c\sin\frac{2\pi t}{n}$$
$$y' = 3.334{,}0278 + 114{,}66649 \times 1 + 241{,}070309 \times 0$$
$$y' = 3.448{,}69 \text{ pairs}$$
$$y' \approx 3.449 \text{ pairs}$$

After obtaining the forecasting results using the cyclical model, error calculations are performed using the MAPE, MAD, and MSE methods as follows in Table 4.

Table 4. Cyclical Model Error Calculation

| Period | $t$ | $t^2$ | Actual ($y$) | Forecast ($y'$) | Error ($e = y - y'$) | Percentage of Error | Absolute Error | $e^2$ |
|---|---|---|---|---|---|---|---|---|
| 25 | 25 | 625 | 3,619 | 3,069 | 550 | 15% | 550 | 302,500 |
| 26 | 26 | 676 | 2,510 | 3,077 | -567 | 23% | 567 | 321,489 |
| 27 | 27 | 729 | 2,540 | 3,093 | -553 | 22% | 553 | 305,809 |
| 28 | 28 | 784 | 3,666 | 3,117 | 549 | 15% | 549 | 301,401 |
| 29 | 29 | 841 | 2,263 | 3,147 | -884 | 39% | 884 | 781,456 |
| 30 | 30 | 900 | 2,636 | 3,183 | -547 | 21% | 547 | 299,209 |
| 31 | 31 | 961 | 2,284 | 3,224 | -940 | 41% | 940 | 883,600 |
| 32 | 32 | 1,024 | 3,992 | 3,267 | 725 | 18% | 725 | 525,625 |
| 33 | 33 | 1,089 | 4,514 | 3,313 | 1201 | 27% | 1201 | 1,442,401 |
| 34 | 34 | 1,156 | 3,610 | 3,360 | 250 | 7% | 250 | 62,500 |
| 35 | 35 | 1,225 | 3,562 | 3,406 | 156 | 4% | 156 | 24,336 |
| 36 | 36 | 1,296 | 3,501 | 3,449 | 52 | 1% | 52 | 2,704 |

| | | | |
|---|---|---|---|
| Total | 233% | 6,974 | 5,253,030 |

Getting the errors using the three methods of MAPE, MAD, and MSE, the results summary of the error calculations is carried out in Table 5.

Table 5. Summary of Error Calculation for Cyclical Model

| MAPE | MAD | MSE |
|---|---|---|
| 19,42% | 581.167 | 43,7752.5 |

*B. Autoregressive Integrated Moving Average*

Forecasting with the ARIMA model is executed using the Minitab 21.3 software. In the first stage, 36 periods of historical data were input and data plotted. Continued, a stationary test was carried out using the Augmented Dickey-Fuller (ADF) test, as a requirement for forecasting with the ARIMA model. In the stationary test using the ADF Test, there are two hypotheses with the following information:

$H_0$ (null hypothesis): Non-stationary data

$H_1$ (alternative hypothesis): Stationary data

With a statistical test of -5.94371 and a specified significance level of 0.05 (95% confidence level), it can be concluded reject the null hypothesis because the data is stationary without differencing (the result of statistical test ≤ critical value -2.94851). Because the data is stationary, there is no need for a data transformation process hence we determine the best model using the best ARIMA model feature in Minitab. This stage is utilized to determine the parameters of *p* (the number of lag observations), *d* (the number of differencing transformations required by the time series data so that the data is stationary), and *q* (the lag of the error component). From the use of the Best ARIMA Model in Minitab, the parameter estimation results can be seen in Fig. 5.

**Final Estimates of Parameters**

| Type | | Coef | SE Coef | T-Value | P-Value |
|---|---|---|---|---|---|
| AR | 1 | 0.99991 | 0.00287 | 348.18 | 0.000 |
| MA | 1 | 0.893 | 0.196 | 4.54 | 0.000 |
| MA | 2 | 0.134 | 0.216 | 0.62 | 0.538 |
| MA | 3 | -0.054 | 0.181 | -0.30 | 0.769 |

Figure 5. Parameter Estimation Result

It was found that the best model was ARIMA (1,0,3) with the smallest corrected Akaike Information Criterion (AIC) value of 594,909. After obtaining the best ARIMA model, forecasting was calculated for the next 12 periods. The ARIMA model used is (1,0,3) and forecasting is done using the ARIMA feature found on the Stats Tab and the Time Series Menu. Fig. 6 is the result of forecasting using the ARIMA model (1,0,3) for $25^{th}$ to $36^{th}$ month.

*C. Forecasting Validation*

After forecasting is tried using several models, namely Cyclic, Cyclical Trend, and Autoregressive Integrated Moving Average (ARIMA), the validation stage is continued by summarizing the error measurement results in percentage form to determine the best forecasting method with the smallest error value. From the results of the error recapitulation shown in Table 6, it can be concluded that the best forecasting method selected for single vision and bifocal lenses is the cyclical trend model with an error value of 15,29% (MAPE); 538.333 (MAD); and 466,615 (MSE).

*D. Forecasting Verification*

After getting the results of forecasting with the selected method (with the lowest error), a verification process is performed using the moving range chart method, to ensure that the model used is mathematically appropriate and already reflects the conceptual model before carrying out the analysis of the calculation results. The moving range chart method is used to test the stability of the causal system that affects demand. The following chart in Fig. 7 is a recapitulation of the Moving Range calculation in which the orange line represents the upper control limit (UCL) while the green line represents the lower control line (LCL). The UCL value is a little bigger than 2.000 units, so does the LCL but in negative direction.

Table 6. Recapitulation of Error Calculations for Each Forecasting Model

| No. | Forecasting Model | Error Calculation Method | | |
|---|---|---|---|---|
| 1 | Cyclical | 19,42% | 581.167 | 437,753 |
| 2 | Cyclical Trend | 15,29% | 538.333 | 466,615 |
| 3 | ARIMA (1,0,3) | 21,71% | 612.493 | 529,754 |

**Forecasts from Time Period 24**

| Time Period | Forecast | SE Forecast | 95% Limits Lower | 95% Limits Upper | Actual |
|---|---|---|---|---|---|
| 25 | 3469.97 | 736.895 | 2025.36 | 4914.57 | 3619 |
| 26 | 3370.86 | 741.092 | 1918.03 | 4823.69 | 2510 |
| 27 | 3395.19 | 741.366 | 1941.82 | 4848.56 | 2540 |
| 28 | 3394.88 | 741.619 | 1941.02 | 4848.75 | 3666 |
| 29 | 3394.57 | 741.871 | 1940.21 | 4848.93 | 2263 |
| 30 | 3394.26 | 742.123 | 1939.40 | 4849.11 | 2636 |
| 31 | 3393.95 | 742.376 | 1938.60 | 4849.30 | 2284 |
| 32 | 3393.64 | 742.628 | 1937.79 | 4849.48 | 3992 |
| 33 | 3393.32 | 742.880 | 1936.99 | 4849.66 | 4514 |
| 34 | 3393.01 | 743.131 | 1936.18 | 4849.84 | 3610 |
| 35 | 3392.70 | 743.383 | 1935.38 | 4850.03 | 3562 |
| 36 | 3392.39 | 743.635 | 1934.57 | 4850.21 | 3501 |

Figure 6. ARIMA Model Calculation Results

Seeing Fig. 7, we can conclude that there are no sudden trend fluctuations or cycles that cause a decrease in forecasting accuracy. This is indicated by the moving range values which are below UCL and above LCL thus the forecasting results of the cyclical trend model are verified to be acceptable.

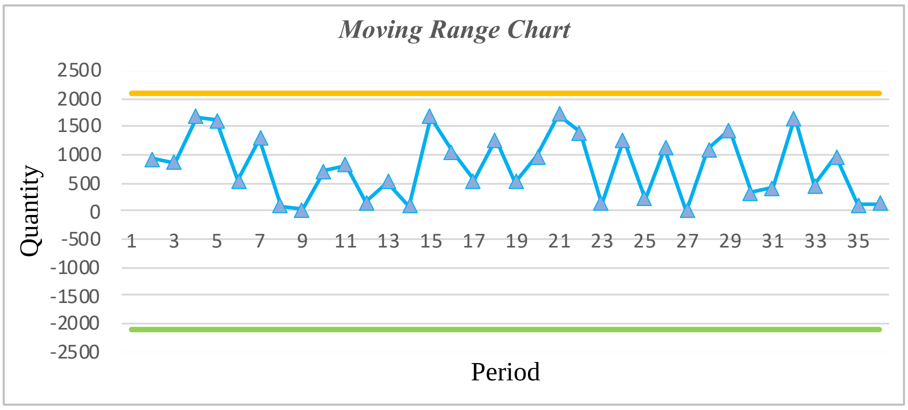


Figure 7. Moving Range Chart

The following stage is the calculation of next year's demand forecasting, safety stock and reorder point determinations for each lens type. Continued scenario experiments show that the size of the safety stock that must be determined by the company will adjust to the service level that has been defined, as well as the reorder point. Fig. 8 is a graph of the relationship between the specified service level and the determination of the size of the safety stock.

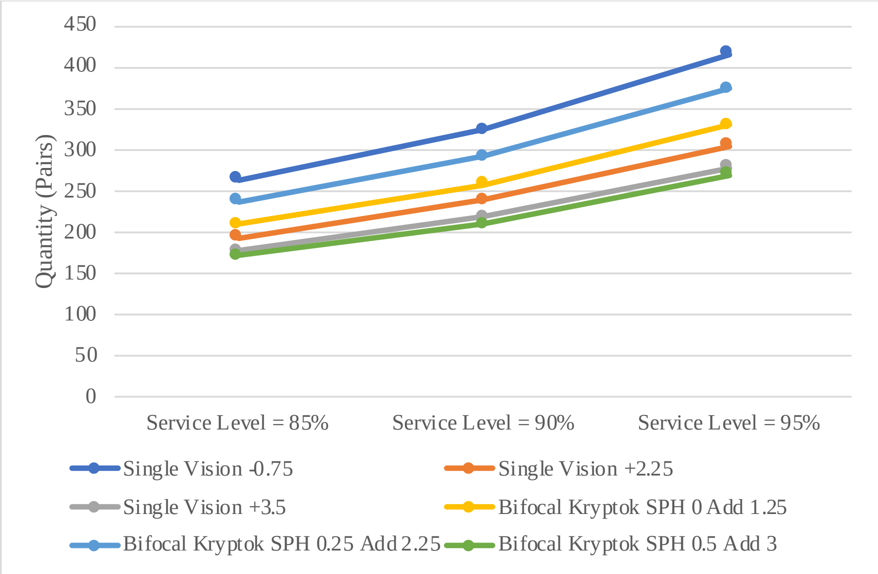


Figure 8. Relationship between Service Level and Safety Stock Quantity

We can see that the higher the service level, the greater the size of the safety stock, and also the reorder point. From Fig. 9 it can be known that the higher the service level, the faster the store has to place an order again (reorder). Considering this condition and the targets set by the store, the calculation shows that a service level of 90% is the most likely service level to be implemented.

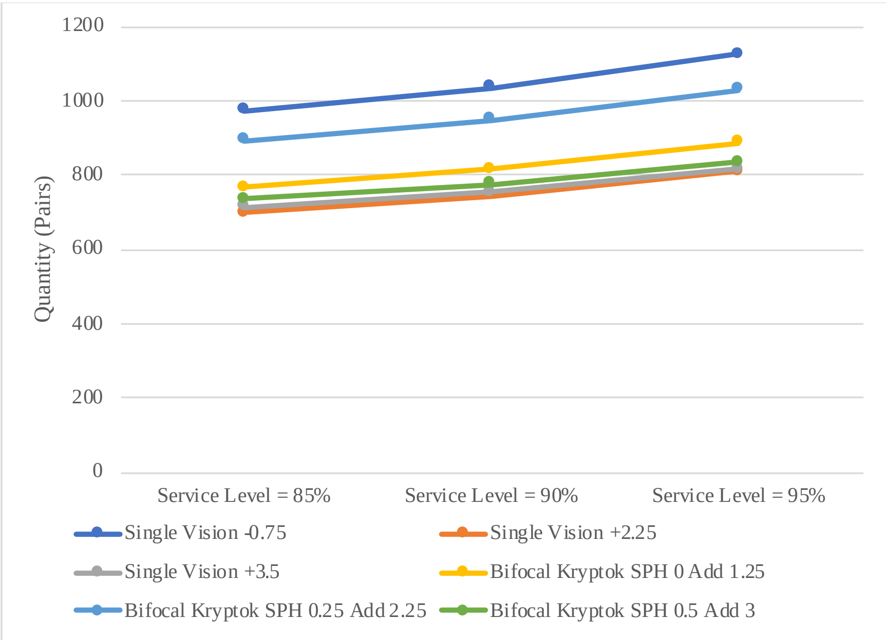


Figure 9. Relationship between Service Level and Reorder Point

## 4. Conclusion

The forecasting method chosen to meet the demand for single vision and bifocal lens products is the Cyclical Trend method with an error value of 15.29% (MAPE); 538.333 (MAD); and 466,615 (MSE). The results of forecasting the demand for single vision and bifocal lens products for the next year in Store X are for Single Vision -0.75 lenses of 8,511 pairs, Single Vision +2.25 lenses of 6,059 pairs, Single Vision +3.5 lenses of 6,437 pairs, Bifocal Kryptok SPH 0 ADD 1.25 of 6,692 pairs, Kryptok Bifocal lenses SPH 0.25 ADD 2 .25 of 7,866 pairs, and 6,761 pairs of Kryptok SPH 0.5 ADD 3 bifocal lenses. The safety stock for each product is 415 pairs of Single Vision -0.75 lenses, 305 pairs of Single Vision +2.25 lenses, 278 pairs of Single Vision +3.5 lenses, 374 pairs of SPH 0 ADD 1.25 Kryptok Bifocal lenses, 374 pairs of SPH Kryptok Bifocal lenses 0.25 ADD 2.25, and SPH

Kryptok Bifocal lenses 0.5 ADD 3 as many as 269 pairs. The number of reorder points for each product will be ordered again when the supply condition has reached a certain level where 1,125 pairs of Single Vision -0.75 lenses, 810 pairs of Single Vision +2.25 lenses, 815 pairs of Single Vision +3.5 lenses, 887 pairs of Bifocal Kryptok SPH 0 ADD 1.25, 1.0 Bifocal Kryptok SPH 0.25 ADD 2.25 30 pairs, and 833 pairs of Kryptok SPH 0.5 ADD 3 bifocal lenses.

Future research can advance the experiment by investigating other forecasting methods to enrich comparative analysis using such these models: the Linear Regression model, Exponential Smoothing, Multiplicative Holt-Winters, Additive Holt-Winters, Double Seasonal Holt-Winters, SARIMA, and other time series forecasting models.

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