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## New Product Demand Forecasting and Inventory Model towards Eyewear Cleaner Product: A Case Study of Nasho Company

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### **Abstract:**

*Nasho Company is Nano-coating business based on chemicals. This business makes a product called "Nasho Self-cleaning liquid for Glasses" that give ability to protect the glass surface by water repellent, anti-fog, anti-dust, and anti-bacteria. This Company desires to do market expansion by finding an occasion to put the product in local optical stores in Bandung. Yet, the target that they already made needs to be cross-checked. On another hand, the productivity and efficiency of production in this Company are low due to order the material and produce the product only when demand comes. Production planning based on forecasting and inventory model is required for solving this problem. As a result, the Company is able to define their market expansion target as well as their material stocking. This research is using Structured Analogy Forecasting technique to define the forecast for new product and Fixed Order Interval with Safety Stock analysis for material stocking. Mix method is used in this research to gain information and identify the product that would be a benchmark in forecasting technique that in line with Inventory Model analysis. As a result of Structured Analogy forecasting, the benchmark product is Expo lenses cleaner using the judgmental process with thematic analysis and Single Exponential Smoothing with  $\alpha= 1,92215$  is applied with MAPE 6,42%, MAD= 59,68, and MSD= 5362,4, as well as demand in next year, would be 10631 bottles of lenses cleaner liquid. By 95% service level for Fixed Order Interval with Safety Stock, the Company would order; 14 l of Ethanol, 2,5 l Polydimethylsiloxane, 2 l of Isopropyl, 870 unit of the bottle, 13 boxes of wiper, 207 A3+ sheets of box, 25 A3+ sheets of the sticker, and 47 sheets of 1 m HVS of Instruction Paper in every 14 working days.*

**Keywords:** Nano-coating, Self-cleaning for glasses, structured analogy forecasting, inventory model, mix method

### **1. Introduction**

The demand for glasses is quite increased. The journal of American Academy of Ophthalmology predicts there is 50% population in the world that would have myopia and 10% of the world population would have high myopia in 2050 (Holden, et al., 2016). On another hand, President Commissioner of Polycore Indonesia, Robert Halim, said, "In Indonesia, there is 10% of population (or 250 million people) that using glasses in 2016" (Kabarbisnis.com, 2016). Optical Nano-coating is forecasted to hit \$14.2 billion in 2021(Gaurav, 2017).

Nasho Self-cleaning Liquid for Glasses as the complementary product of glasses is giving the self-cleaning ability for the glasses surface. This product is using Nano-coating technology for self-cleaning ability. These are some features that this product offer; water repellent that makes water quickly drop from the glass surface to give clear sight for glasses user when riding under the rain; anti-fog ability that makes fog disappear when glasses user is wearing a mask, eating hot food, or riding in a cold day; anti-dust ability which decreases dust that stick on glasses during an extreme outdoor activity such as climbing and bike mountain or preserve their glasses collection; and anti-bacteria ability which comes from ethanol that is able to destruct microorganism and make the glass surface hygiene. This self-cleaning ability is long-lasting for up to 48 hours. From November 2019 until February 2020, the Company successfully sold 126 bottles of products.

The Company already sold Nasho by direct selling and reseller method. For boosting the revenue, the company desire to enter into the glasses shop. Based on Nasho Company's primary research trough glasses shop in Dipatiukur, Nasho Company discovers that glasses shop owners are interested in selling Nasho products in their shop. Table 1 describes the data of glasses shop that Nasho Company visit:

Name	Location	Unit demand/month	Range sell of Glasses (unit/month)	Payment Method
MM UNPAD	Dipatiukur	25	60-200	cash
Reza Optical	Dipatiukur	30	40-150	Pay later
Wahyu Optical	Dipatiukur	25	60-150	Pay later

Table ERROR! NO TEXT OF SPECIFIED STYLE IN DOCUMENT.: Data of Optical Store

After primary study, the Company made a target for products sold as well as joined glasses store to be reseller in 6 months. Figure 1 is the graph of targeted product sold and shop entrance also the gap between targets with current selling.

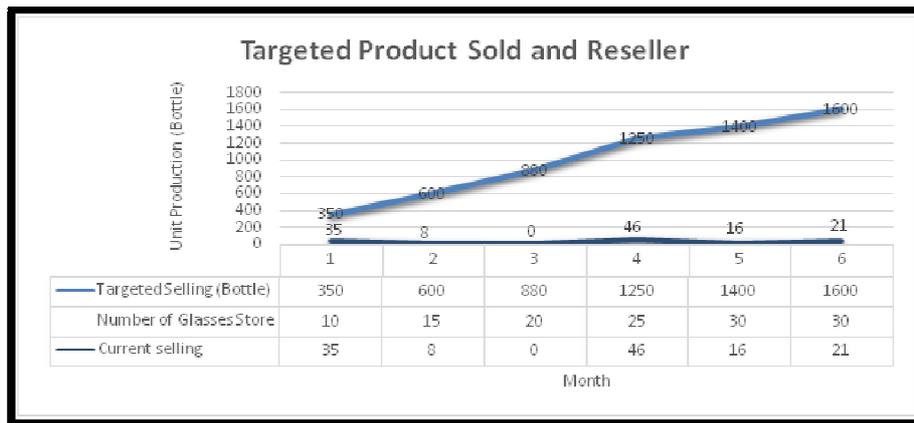


Figure ERROR! NO TEXT OF SPECIFIED STYLE IN DOCUMENT.: Targeted Product Sold and Reseller

The current selling shows the product sold less than 50 bottles/ month when the Company started to sell it by direct selling and reseller. There is a wide gap between the current selling with the targeted selling. Entering the product into glasses shop is required to boosting the selling that targeted start from 350 bottles in the first month until 1600 in the sixth month. Based on this targeted product sold, the Company would receive this profit per month that describes in Figure 2.



Figure 2: Target Profit

1.1 Problem Statement

Even though Nasho discovers occasion, the demand of product would be impacted by demand dynamic, product life cycle, and other variants as well the rising of the individual product (Heesa & Reinhart, 2015). Then, the target requires to be cross-checked to ensure the production as well as decrease the loss risk. On another hand, Nasho Company production process is not sufficient and productive due to unestablished planning in the Company as well as the material order is done only when demand comes.

In line with market expansion, the Company requires an increase in productivity and efficiency. Not clear goals and planning make the Nasho Company itself is not able to set the production target and only wait for the order comes for production. Thus, the product stock is low. In December 2019, the customer should wait for 5 days until the product comes because of stock out and makes the Company should produce Nasho first.

Then, Nasho Company only orders material when they want to do the production. Therefore the material stocking is low, which gives the potential of high price and scarcity due to high demand. The Company is not able to produce Nasho due high material price and scarcity from April 2020 until July 2020. This low material availability is also giving impact to low product stock. The production process needs suppliers to load the material for production. However, long lead time (1-3 days) makes the process delayed even more if the material is not availed in the targeted vendor, the Company should look for another vendor. In November 2019, the production process was delayed due to no material availability.

As a consequence of this problem, low productivity and low production efficiency exist in operation division nowadays. Since November 2019 until July 2020, Nasho Company only produced 220 bottles. Even more, the production process was stopped in April - June 2020 which shows the unproductivity of Company. On another hand, not efficient production detects due production delayed as well as product delivery's long lead time.

To avoid this problem occur in the more significant demand due to market expansion, it would be necessary to establish production and material stocking planning refer to problems that define. The orientation of new product forecasting is risk management. The range of new product forecasting represents the uncertainty that entered, also discovering the tolerance point of that risk. It would show the possibility as well as the pessimistic of product that sold (Kahn, 2014). Related with stocking problem, Khalid (2008) suggests that supply management in the manufacturing industry needs to gain attention and critical reviews to prevent production process interruptions and improve operational performance. Therefore, the Company decides to create forecasting as its planning reference as well as the inventory model for material supply management.

### 1.2 Research Question

- What is the demand forecasting product of Nasho Self-cleaning Liquid for Glasses?
- What is the inventory model for material supply of Nasho Self-cleaning Liquid for Glasses based on the forecasting result?
- How is the relationship of forecasting data with the inventory model?

### 1.3 Research Objective

- To discover appropriate demand forecasting of Nasho Self-cleaning Liquid for Glasses as the plan based
- To define the inventory model of Nasho Self-cleaning Liquid for Glasses for generating the appropriate number of material stock
- To understand the relationship of forecasting applied and inventory model in this study case

### 1.4 Research Scope and Limitation

The scope of this paper is operational study for Nasho Glasses Self-cleaning Liquid, focusing on local optical store of Bandung city, Indonesia. This work was performed from January until July 2020.

## 2. Literature Review

### 2.1. New Product

The new product could be a result of the product development of an existing product or an innovation that never existed (Mik, 2019). One of kind new product, developed product, is a product with new technology and the current market. Development product is purposed to apply new technology that offers more option for customer. Through this way, Company could increase their product value which is able to compete with other product in the market. There is the risk when release a new product. The riskier scenario comes when the market is unfamiliar with the technology that offers as well as the technology is untested by the company. Then, the less risk scenario comes from new product that purposed for reducing the cost as well as improvement the existing product (Khan, 2006).

### 2.2. Structured Analogy Forecasting

Structured analogy forecasting is a predicting method used given variable trough information about other variables that related but not overlapping the time changes (Cieślak, 2000). This technique purposed to analyze the historical data trend and define the sales pattern of the new product that have similar market conditions, product attribute, and degree of innovation with existed product (Kahn, *New Product Forecasting: An Applied Approach*, 2006, p. 86). Forecasting is made by historical data from past products and aligning profiles of their sales. (Gilliland & Guseman, 2010).

For detecting the past-new product similarity, the judgmental technique forecasting itself is required to reduce the lack of irrelevant information for the new product, which does not have historical data (Gilliland & Guseman, 2010). For removing the judgmental bias in the process, the historical data context is provided in each decision. The statistical analysis would merge with the judgmental analysis. There are six steps to establish an accurate forecast by structured analogy method (Gilliland & Guseman, 2010); query to find products that have similar characteristic, filter to remove unsuitable, model to implement the most suitable statistical method, forecast with the chosen statistical method, and last; override to amend with manual to statistical forecast result.

Delphi method has similarity with Structured Analogy method. Structured Analogy and Delphi method involves the expert into the forecasting process to gain the result. In the Delphi Method, collaboration among experts is required. Meanwhile, in Structured Analogy by the analogy that has been constructed, there would not need to differentiate between the personal and collaborative results of forecast. By this finding, involving the expert with collaborative is not required and recommends done the method by the individual for saving time (Green & Armstrong, 2007).

Then, Sales Force approach could be applied in the new product forecasting because of the salesperson have the closest interaction with the customer. Nevertheless, it could generate bias due to the difference of pessimism and optimism of the salesperson (Hyndman & Athanasopoulos, 2018). Structured Analogy Forecasting could remove the bias by providing historical data as well as validation tests (Gilliland & Guseman, 2010).

### 2.3. Moving Average

Moving Average uses the average of most recent  $n$  period data to construct forecasting. This model would be useful when the demand is steady enough or has certain fluctuation over time (Ivanovski, Milenkovski, & Narasanov, 2018). By moving average, the randomness data is moved and generates a smooth trend-cycle (Hyndman & Athanasopoulos, 2018). A 4-month simply moving average is set up by merely summing the demand during the past three-months for deriving 4<sup>th</sup>-month forecasting. The simple moving average that applied in  $n$  month define as:

$$\text{Movingaverage} = \frac{\sum \text{demand in previous } n \text{ periods}}{n} \quad (2.1)$$

### 2.4. Single Exponential Smoothing

The statistical process that used in this research is Single Exponential Smoothing. This method is able to use because of compatibility for using an unclear trend or pattern (Hyndman & Athanasopoulos, 2018). It is relatively easy to use and involves very few historical data. The exponential smoothing formula is:

$$F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1}) \quad (2.2)$$

Where:

$F_t$  = New forecast

$F_{t-1}$  = previous period forecast

$\alpha$  = weigh / constant that  $0 \leq \alpha \leq 1$

$A_{t-1}$  = Previous period of actual demand

### 2.5. Forecast Error

For reducing the rate of error in forecasting, there is measurement that is able to be used when  $X_t$  is the actual result in  $t$  period; then,  $F_t$  is a forecasting value for the same  $t$  period. Means Absolute Derivation (MAD) states forecast deviations in the same data units, by averaging absolute error (deviation) value of all forecasted results. (Makridakis, Wheelright, & McGee, 1983).

$$MAD = \frac{\sum |X_t - F_t|}{n} \quad (2.3)$$

Mean Squared Deviation (MSD) represents the average error of squared between the forecast with the current value.

$$MSD = \frac{\sum_{t=1}^n |X_t - F_t|^2}{n} \quad (2.4)$$

Then, MAPE (Mean Absolute Percent Error) shows the percentage of deviations error forecasting results in any time point (Jay & Render, 2011)

$$MAPE = \frac{1}{n} \sum_{t=1}^n |PE_i| \quad (2.5)$$

Where Percent Error (PE) shows strong intuitive relevance and tells us by what percentage of a given month's forecast was off (Makridakis, Wheelright, & McGee, 1983).

$$PE_t = \left( \frac{X_t - F_t}{X_t} \right) \times 100\% \quad (2.6)$$

### 2.6. Safety Stock and Inventory Model

Safety stock is the key to avoid the variation of demand during the lead time and depends on forecast accuracy, reliability of suppliers, and customer service level. Thus, a task of safety stock is to maintain a suitable level inventory of customer service (Basu & Wright, 2008). Fixed Interval Ordering (Time Period) is an inventory model that is used when the order should be placed at the time that had been setting. In this research, the focus of variation is a demand with constant lead time. The order size in Fixed Order Interval with Safety Stock expresses as (Stevenson, 2012):

$$\text{Amount to order} = \frac{\text{Expected demand during protection interval}}{\text{interval}} + \text{Safety stock} - \text{Amount on hand at reorder time}$$

$$q = \bar{d}(OI + LT) + z\sigma_d\sqrt{OI + LT} - A \quad (2.7)$$

When:

$q$  = Amount of order

$\bar{d}$  = Average forecast in workdays

$OI$  = Order Interval

LT= Lead time

$\sigma_d$ = Standard deviation of demand/day

z= Service level

A= Amount on hand at reorder time

When  $\sigma_d$  is used on forecasting data, it would express as (Haris, 2010):

$$\sigma_d = \sqrt{\frac{\sum_{t=1}^n (F_t - X_t)^2}{N}} \quad (2.8)$$

When:

$F_t$ = Forecast demand data

$X_t$ = Actual demand data

N= Workdays in year

Service Level means the probability of stock availability during lead time and order interval. Therefore, the stock that Company has would be sufficient when the demand come based on the service level that set. Lead time means the time that required since the product order until it receive. Then, Order Interval means the time that required between orders that placed (Stevenson, 2012).

### 3. Conceptual Framework

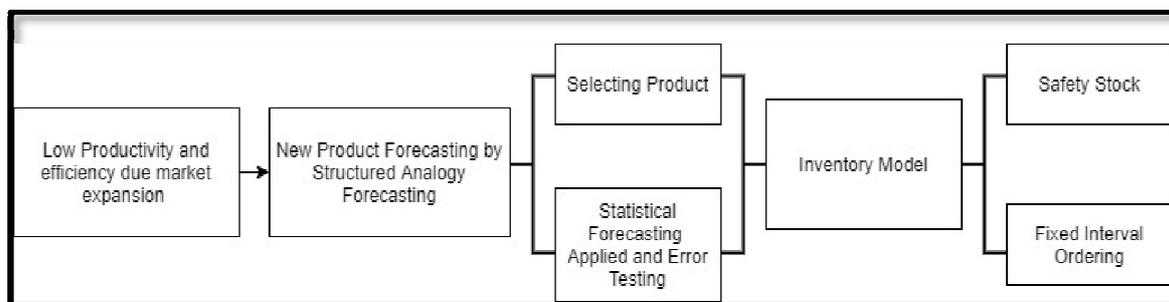


Figure 3: Research Framework

Figure 3 explains the framework in this case. The Company desires to do market expansion. Internally, Nasho Company production process nowadays is not sufficient and productive due to unestablished planning in the Company also only orders material and produce when demand comes. Finding market expands occasion, the Company is set off for establishing forecasting as their planning reference. To analyst forecasting of this case, the author using the Structured Analogy Method, which uses structured interview and statistical method, Moving Average and Exponential Smoothing. For detecting the error, Mean Absolute Percent Error (MAPE), Mean Squared Deviation (MAD), Mean Squared Deviation (MSD) is used for knowing the accuracy of the forecast. The less error that detects would be used as a forecasting result.

Inventory management is a good indicator of the effectiveness of supply chain management. One of technique to optimizing the inventory level is Safety Stock. Safety stock is the key to against the variation of demand during the lead time and depends on forecast accuracy, reliability of suppliers, and customer service level. Based on this, the Company should make its safety stock model for ensuring the existence of material stock. Fixed Interval Ordering is a model for stocking the material based on the time that had been setting. Therefore, the Company perceives how much or many materials should be ordered at setting time until the next period of order. Production efficiency and productivity would increase due to the plan that is already setting by forecasting analysis that in line with inventory models for ensuring the existence of material stock.

### 4. Methodology

This research uses Mix Method, which combines qualitative and quantitative approaches through the study. Mixed method had emerged in the social and behavioral during the past two decades, joining qualitative and quantitative methods of scholarly inquiry as the 'third research community' (Teddlé & Tashakkori, 2009). Quantitative method is attempting to explain phenomena by gathering numerical data, which is analyzed using mathematically based methods, especially statistics (Aliaga & Gunderson, 2002). Qualitative research works mostly from the constructivists (or interpretivist) paradigm, which supports the notion that many realities are constructed and researcher engages participant (Teddlé & Tashakkori, 2009). This study is using sequential mixed design, which means first phase occurs by one method (qualitative or quantitative) and the next phase use another method for developing the result from the first phase (Teddlé & Tashakkori, 2009).

The qualitative method by structured interview and analyze it using Thematic Analysis for clarification study and addressing the pattern of data (Boyatzis, 1998). This analysis provides a systematic system for data analyzing which one of

application based on code and categorize the data based on the themes (Alhojailan, 2012). The dimension that defines at the end of thematic analysis is essential for synchronization between the data and research problem (Boyatzis, 1998).

This research used purposive sampling that involves identifying subgroups in a population and then selecting cases (participant) from each subgroup in a purposive manner. Purposive sampling is required less than 30 samples (Graff, 2017), where in small size needs 4 – 10 samples (Creswell, 2010). The criteria of glasses store that would be interviewed are operated for more than two years, selling lenses cleaner in the last one year, selling >60 glasses/ month, and located in Bandung.

The criteria of the shops are constructed by some considerations. First, ensuring the shop is selling actively. The location must same with the company sales target, which in Bandung. Then, to ensure the product could be forecasted, lenses cleaner product must be sold minimum one year.

For the person that interviewed in this research require:

- Owner or manager of the store
- Have in charge minimum for 2 years in the store
- Knowing the product specification and demand of the product.

By person criteria that mentioned, this research would gain the data that required for analysis process and it could be validated. The store profile and personal profile that takes is related to the market expansion plan to enter the product through a local optical store. Knowing the data from the targeted expansion would construct accurate planning.

Then, for the quantitative approach, the data that would gain is based on the Company's historical data based on vendor lead time as well as production historical data. Then, the historical data from Nasho product survey in 2019 is required for triangulation process on data validation in the analysis. Secondary data from book, journal, as well as literature review is required to examining the applied of data with the analysis.

In the first step of analysis, Structured Analogy Forecasting is focusing on selecting product and using statistical approach for forecasting the product that has similarities with the new product. The selection process requires product specification, price, and sales pattern from the data collection. The data that already collect is analyzed by Thematic Analysis for define the pattern of data. In this research, the product that would be forecasted is the product with the highest-selling after sales pattern elimination as assumed that the product ready to fulfill local optical store demand in Bandung. It is in line with the Company's purpose for doing market expansion through the local optical store.

After finding suitable products, the statistical method of forecasting would be constructed using Minitab series 18. There are 2 kinds of statistical analysis; moving average and exponential smoothing. The method that this research is used to adjust with the business condition. The moving average method is used because of the primary research that the Nasho Company did show that cleaner liquid sales are relatively steady. On another hand, Exponential smoothing is used because method compatibility for applied in few historical data as well as the compatibility of used to detect the weight of result comes from the past period or current period by the constant( $\alpha$ ). The forecasting that used is the lowest MAPE, MSD, and MAD.

Next, the author applies the Fixed Interval Ordering with the Safety Stock technique for establishing optimizing the inventory level based on the forecasting data. Safety stock is purposed to maintain a suitable level inventory of customer service (Basu & Wright, 2008) while Fixed Interval Ordering defines the number of orders in setting time. Due to the forecasting based planned in this study, amount on hand at reordering time is not applied and estimated as 0. z is estimated as 0.05 that represents there is 5% material stock out of the time.

Structured Analogy Forecasting technique is used based on the consideration of product requirements that could be forecasted and sample. Nasho Self-cleaning Liquid for Glasses has similar characteristics with the product that already entrance in the market. It has same form, same application, and similar price. The existing product is liquid bottle spray that applied by spray the liquid on glasses surface. The price of Nasho is convenient from similar product in optical store. The innovation of product is improvement in product function from cleaner to self-cleaning that still relate. Besides, Nasho Company add box, fabric wiper, as well as instruction paper to increasing the product value. Then, the market is same which targeted the glasses user. On another hand, the sample in this research is the owner or manager of glasses store in Bandung. The communication due to the research is quite difficult due to limited time of each expert that makes collaboration among experts could not be done. Structured Analogy Forecasting could be done individually. Therefore, the research could be done. By step of Structured Analogy Forecasting, the bias from the sample could be removed by providing historical data as well as validity test. Fixed Interval Ordering with Safety Stock is used due to the existence of forecasting results that could predict the demand in the next period. This method requires period checking and making the planning based on the next period demand. Therefore, the Company is able to construct the material stocking planning and minimize warehouse used due to limited space. Production efficiency and productivity would increase due to the plan that is already setting by forecasting analysis that in line with inventory models for ensuring the existence of material stock.

## 5. Findings and Argument

In this research, the product that would be forecasted is the product with the highest-selling after sales pattern elimination as assumed that it ready to fulfill local optical store demand in Bandung. It is in line with the Company's purpose for doing market expansion through the local optical store. The selling data is taken since April 2019-March 2020 that consider of shop closing due to COVID-19 in Bandung.

Represent by Table 2; 4 dimensions are used for grouping the data that already gain. There is 7 store that interviewed that located on Dipatiukur, Dago, Sukajadi, and ABC Street, Braga.

<b>Dimension</b>
Business Background
Product Specification
Product Price
Product Sales Demand

*Table 2: Research Dimension*

In the store A, the author interviewed the glasses shop owner that has managed his shop since established. Store A was established in 2002, which means they already operate for 18 years. The price range of glasses that it sold is Rp. 50.000 – Rp. 200.000 per month with total sell 100-500 pieces of glasses. Store A sells lens cleaner from Expo brand, which functions just as a cleaner. This cleaner form is 30 ml spray bottle. The price of the product is Rp. 15.000 and free if the customer purchase the glasses start from Rp. 500.000. Regularly, they put 2 dozens of lenses cleaner/ month to fulfill the demand that is mostly giving the product as a bonus from 15 glasses purchasing. There were just 10 bottles that sold in a month.

In the store B, the author interviewed the glasses shop manager that has managed his shop since 10 years ago. Store B has been operated for 15 years since 2005. It sells glasses with price range Rp 200.000 up to above Rp 500.000. In a month, the store can sell 90-100 glasses. This store sells Expo as lenses cleaner product. This product function is only cleaner with 30 ml bottle spray. Store B sells Expo lenses cleaner for Rp. 10.000. If the customer buys frame and lenses in this store with minimal purchasing Rp. 400.00, they will get this product free. Mostly, the demand for lenses cleaner comes from the lenses with the frame purchasing. The standard demand estimation is 40-50 bottles per month. The high season of demand is in July and August when new college student starts their academic year.

In the store C, the author interview the glasses shop manager that has managed his shop since established. Store C has been operated for 6 years. Averagely, the store is able to sell 150 glasses/ month. It sells glasses with price range Rp. 150.000- Rp. 1.000.000. The lenses cleaner that sells in this store is Executive. The product feature is just cleaning the lenses with bottle spray. A bottle contains 30 ml of liquid. For minimal glasses purchasing Rp. 350.000, the customer would get the product free. This product is sold for Rp. 15.000. To fulfill the demand, the store needs 2-3 dozen of cleaners in a month regularly.

In the store D, the author interviewed the glasses shop manager that has managed his shop more than 5 years. Store D has been operated for almost 40 years. This store sells 100 pieces of glasses regularly in a month as well as 200 pieces of glasses in high demand season. The price range of glasses in this store starts from Rp 150.000 – Rp 2.000.000. Store D sells the lenses cleaner product from NexQ. It is a lenses cleaner with a spray bottle that contains 60 ml liquid. This product sells for Rp. 15.000. The store would give this product freely as a bonus as well as the customer asks them to give the product. Store D never count the demand of product accurately, but they need around 2-5 box that contains 12 bottles of cleaner/ box regularly. The high demand season comes from at the beginning of the year, early school semester, also at the end of the year.

In the store E, the author interviewed the glasses shop manager that has managed the shop since 5 years ago. Store E has been operated for 9 years as a branch store that had been established 20 years ago. In a day, this store able to sold 20 glasses per day with averagely 100-200 glasses per month. This store sells Expo lenses cleaner with just cleaner ability for Rp. 10.000. This product form is a spray bottle with 30 ml liquid. If the customer buy frame includes lenses, not only lenses, they would give this product freely. Per month, they need around 100 – 200 bottles of product regularly. In the high demand season, which happened in Ramadhan and nearly Eid Fitri, the demand increase up to 200 bottles.

In the store F, the author interviewed the glasses shop manager that has managed the shop since established. Store F has been operated for around 2-3 years. This store sold the glasses start from Rp 280.000 up to Rp. 4.000.000 for original glasses. Estimated, they able to sold 150-200 glasses per month. The lenses cleaner product that sells in this store is New Glow from Kreasi Jaya Product. This cleaner only has cleaning ability with a spray bottle that contains 30 ml liquid. This product sells for Rp. 20.000. If the customer purchase more than Rp. 500.000, the store would give the product as a bonus. The demand for this product in this store is half from the glasses that sold, which mean it is 75-100 bottle. The high season demand is when the academic calendar started for student and college student. In that season, the demand for cleaner is increased into 100-150 bottle. Averagely, the demand from this product comes from the bonus system.

In the store G, the author interviewed the glasses shop owner that has managed her shop since established. Store G has been operated for 2 years. This store is a wholesaler that serves for optical stores in Bandung and Bandung Barat. The glasses that sell in this store start from Rp. 250.000 up to Rp. 4.000.000. There are several prices for the glasses, such as package price, good-product price, and original product price. Approximately, this store is able to sell 150-300 pcs of glasses/month. This store sells 2 lenses cleaner product; Expo and Executive. Both of the product only have cleaning ability by spray bottle with 30 ml liquid. Those product sell for Rp. 15.000. The cleaner product this store is sold faster. In a month, Store G sells need 100 dozens cleaner as the total of both products. The demand is increase in the Hadj season, which a customer can buy 2 dozens cleaner as stock there. In this season, the store needs 120-150 dozens of cleaner.

As the validation of this interview result, this research has done triangulation by observation of the product. The product that mentioned above is Expo, Executive, New Glow, and NexQ. Based questioner that Nasho Company have spread at the end of 2019, we got 53 respondent. Based on Figure 4, the glasses user that have lenses care product is 43% from the respondents; meanwhile, there are 57% glasses user do not have lenses care product. 8 brands are used by people who have lens care products. Figure 5 explains the distribution of each brand. 59% of users do not know what brand which they use. Therefore, it defines as unknown on the chart.

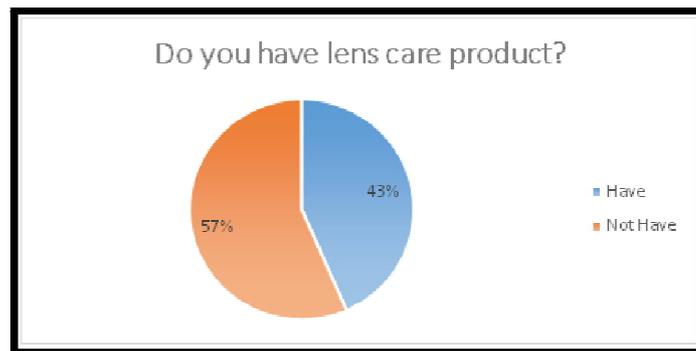


Figure 4: Belong of Lenses Care Product]



Figure 5: Product Brand Distribution

Based on the product used, Table 3 defines the price rate of each brand that used by the respondent.

Brand	Price Rate
Lens cleaner	Rp 15.000
Unknown	Rp 30.000 - Rp 80.000
Pembersih dari optik melawai	Rp 55.000
New Glow	Rp 10.000 - Rp 20.000
Expo Lens Cleaner	Rp 20.000
Executive lens cleaner	Rp 15.000
Essilor lens cleaner	Rp 50.000
SiClair	Rp 150.000

Table 3: Product Price Rate

The selecting product process on Structured Analogy Forecasting is done by first selecting the product based on product specification that contains function, form, size, as well as product price. Based on data, there is 4 brand that sold at the 7 local optical stores in Bandung with detail in Table 4. NexQ product is eliminated due to the size that not same with Nasho product. As the development of the current product from lens cleaning to self-cleaning for lens, the lens cleaning function is still acceptable to be the benchmark of this forecasting method.

Brand	Function	Form	Size	Price Rate
Expo	Lens cleaning	Spray bottle only	30 ml	0 - Rp. 20.000
Executive	Lens cleaning	Spray bottle only	30 ml	0 - Rp. 15.000
New Glow	Lens cleaning	Spray bottle only	30 ml	0 - Rp. 20.000
NexQ	Lens cleaning	Spray bottle only	60 ml	0 - Rp. 10.000

Table 4: Product Specification and Price Brief

Figure 6 shows the sales pattern and number of selected product demand. The sales pattern on New Glow product is not similar with 2 other products. Therefore, the New Glow is eliminated to be forecasted. Then, there is Executive and Expo. Expo is selected to be forecasted because this product demand is highest among Executive brand.

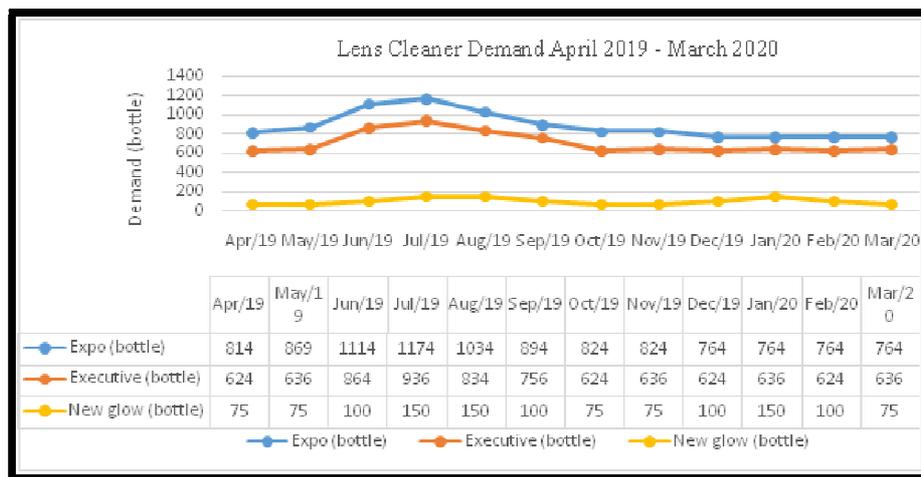


Figure 6: Lens Cleaner Demand April 2019- March 2020

Based on statistical process using Minitab series 18, Single Exponential Smoothing with  $\alpha = 1,92215$  is the statistical technique applied in this forecasting with MAPE 6,42%, MAD= 59,68, and MSD= 5362,4 that shows in Figure 7. Demand in next year would be 10631 bottles of lenses cleaner liquid. This result of forecasting would be used on Fixed Order Interval Model with Safety Stock analysis. This forecasting result is lowest error rather than 2 other techniques that showed in Table 5. MAPE between 4-month Moving Average with Single Exponential Smoothing with optimal  $\alpha = 1,92215$  is same. Based on the application guideline, MSD has more significant effect rather than MAD because this measurement is able to calculate the accuracy of the time series value that be used (Minitab.Inc, 2019). It means the time series value by Single Exponential Smoothing with optimal  $\alpha = 1,92215$  is more accurate rather than 4-month Moving Average. Based on this, Single Exponential Smoothing with  $\alpha = 1,92215$  is the statistical method applied in this forecasting. Figure 8 represent the actual and forecast data comparison. In a one period forecast, the demand of product in a year would be 10631 bottles of lens cleaner.

Forecasting Method	MAPE	MSD	MAD
3-month Moving Average	7,14%	8403,89	69,33
4-month Moving Average	6,42%	6249,87	58,68
Single Exponential Smoothing $\alpha = 1,92215$	6,42%	5362,64	59,68

Table 5: Forecasting Error Result Comparison

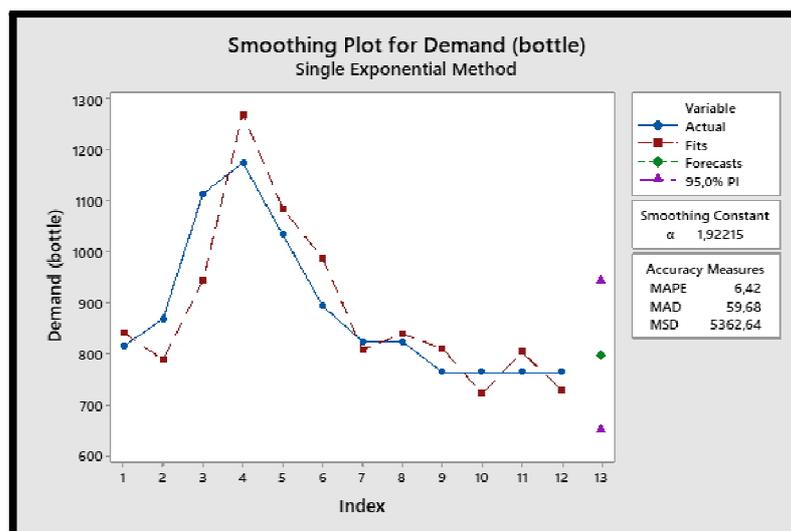


Figure 7: Single Exponential Smoothing Result

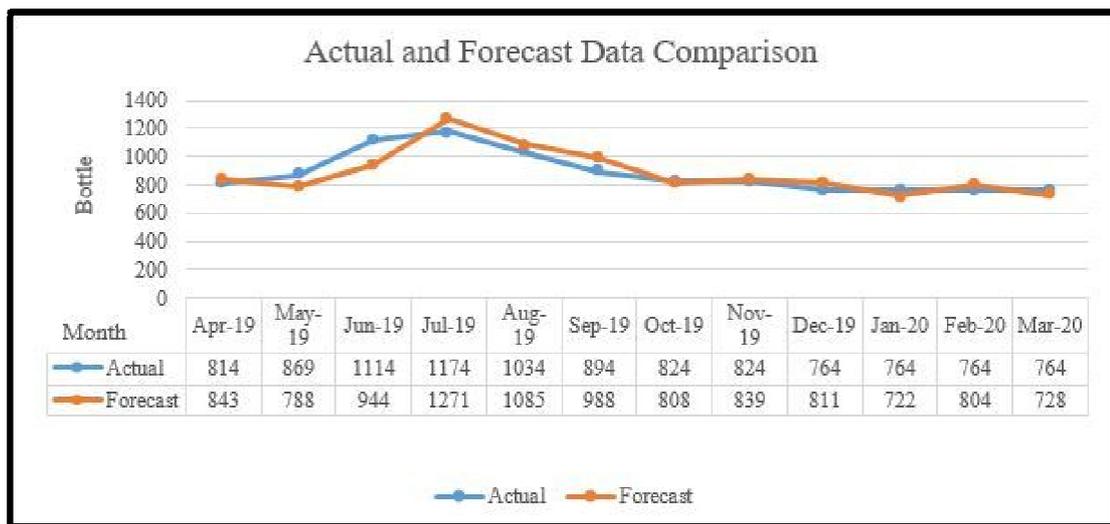


Figure 8: Actual and Forecast Data Comparison

The next analysis is Fixed Order Interval and Safety Stock. Table 6 shows the detail of analysis calculation. The average demand material in workdays is calculated based on the amount of material demand in a year per 240 workdays (20 workdays/ month). Order interval (OI) or the length of order time for all materials is 14 days. Lead time (LT) or time that is required from order time until material arrive is 1 day for liquid material, 3 days for bottle and wiper, 2 days for box, sticker, and instruction paper. The service level that is used is 95% with  $z=1,65$  that represents there just 5% possibility of stock out. Due to the forecasting data used, the amount on hand at reorder time is not applied and estimated as 0. The amount of order would be round up due to fulfilling the minimum order. As a result that represents in Table 6 is represent the safety stock and the number of order by Fixed Order Interval. By 95% service level for Fixed Order Interval with Safety Stock, the Company would order; 14 l of Ethanol, 2,5 l Polydimethylsiloxane, 2 l of Isopropyl, 870 unit of the bottle, 13 boxes of wiper, 207 A3+ sheets of box, 25 A3+ sheets of the sticker, and 47 sheets of 1 m HVS of Instruction Paper in every 14 working days.

Indicator	Liquid Demand Required			Packaging Required				
	Ethanol	Poly dimethyl siloxane	Isopropyl	Bottle	Wiper	Box	Sticker	Instruction Paper
Average demand material/ work day	0,8 l	0,1 l	0,1 l	44,3 unit	0,6 box	11,1 A3+ sheets	1,3 A3+ sheets	2,5 sheets of 1 m HVS
Lead time (day)	1	1	1	3	3	2	2	2
Order Interval (day)	14	14	14	14	14	14	14	14
$z$	1,65	1,65	1,65	1,65	1,65	1,65	1,65	1,65
$\sigma_d$	0,3 l	0,1 l	0,02 l	17 unit	0,2125 box	4,25 A3+ sheets	0,5 A3+ sheets	1 sheets of 1 m HVS
Safety stock	2 l	1 l	1 l	116 unit	2 boxes	29 A3+ sheets	4 A3+ sheets	7 sheets of 1 m HVS
Amount order in hand	0	0	0	0	0	0	0	0
Number of orders	14 l	2,5 l	1,6 l	869,1 unit	12,2 boxes	206,6 A3+ sheets	24,8 A3+ sheets	47 sheets of 1 m HVS
Round up	14 l	2,5 l	2 l	870 unit	13 boxes	207 A3+ sheets	25 A3+ sheets	47 sheets of 1 m HVS

Table 6: Order by Fixed Order Interval with Safety Stock Calculation

The forecasting method is purposed to be the base of the production plan, while Inventory Model is used as the stocking method. Analogy forecasting is used due to new product status in this case. This method is able to construct a forecast number by historical data of similar past products that could not be done by new products with a lack of data. As a result, Nasho, as a new product, is able to construct production planning based on the Structured Analogy Forecasting result. The demand is already known. Refer to the forecasting result, safety stock model in the material stocking could be calculated for ensuring the stock availability. Then, Fixed Order Interval model is calculated based on the regular ordering every 14<sup>th</sup> workdays. This model is compatible with forecasting data because forecasting could define the number of demands at a specific time. Thus, the Company could construct the budgeting for their material stocking in that period.

## 6. Conclusions

As a result of Structured Analogy forecasting, the benchmark product is Expo lenses cleaner. The forecasting technique that used is single Exponential Smoothing with  $\alpha=1,92215$  is applied with MAPE 6,42%, MAD= 59,68, and MSD= 5362,4, as well as demand in next year, would be 10631 bottles of lenses cleaner liquid. This forecast result is used as the base of production plan. By 95% service level for Fixed Order Interval with Safety Stock for inventory model, the Company would order; 14 l of Ethanol, 2,5 l Polydimethylsiloxane, 2 l of Isopropyl, 870 unit of the bottle, 13 boxes of wiper, 207 A3+ sheets of box, 25 A3+ sheets of the sticker, and 47 sheets of 1 m HVS of Instruction Paper in every 14 working days. The forecasting method is purposed to be the base of the production plan, while Inventory Model is used as the stocking method. Analogy forecasting is could generate the number of forecast. Based on the forecast that already define, the Company is able to define the number of order that could ensure their material stocking. This model is compatible with forecasting data because forecasting could define the number of demands at a specific time. As a result of this research, the Company could construct the budgeting for their material stocking in that period.

After Nasho Self-cleaning Liquid for Glasses sold in the market, the Company should keep the demand data as the base of forecasting when they would release another new product that similar to Nasho product. Analogy Forecasting is able to be used in this case. By recording the data accurately, the Analogy Forecasting result would be closer to the demand for the new product itself. In another hand, this data may be used on the product forecasting that would assist the future plan. On another hand, Covid-19 pandemic may affect the demand for the real condition itself since this research using a usual condition scenario. This research recommends to study about the demand condition based on Covid-19 that would be useful as the directive if there is another pandemic in the future.

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