Numeric model to predict the location of market demand and economic order quantity for retailers of supply chain

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Abstract. Polynomials and Spline regression are the numeric model where they used to obtain the performance of methods, distance relationship models for cement retailers in Banda Aceh, predicts the market area for retailers and the economic order quantity (EOQ). These numeric models have their difference accuracy for measuring the mean square error (MSE). The distance relationships between retailers are to identify the density of retailers in the town. The dataset is collected from the sales of cement retailer with a global positioning system (GPS). The sales dataset is plotted of its characteristic to obtain the goodness of fitted quadratic, cubic, and fourth polynomial methods. On the real sales dataset, polynomials are used the behavior relationship x-abscissa and y-ordinate to obtain the models. This research obtains some advantages such as; the four models from the methods are useful for predicting the market area for the retailer in the competitiveness, the comparison of the performance of the methods, the distance of the relationship between retailers, and at last the inventory policy based on economic order quantity. The results, the high-density retail relationship areas indicate that the growing population with the construction project. The spline is better than quadratic, cubic, and four polynomials in predicting the points indicating of small MSE. The inventory policy usages the periodic review policy type.

1. Introduction
The retail is transactions between the business store in the particular area to the consumer where it involves the money, service, and goods, and it is called retailer. The retailer usually uses the prediction of customer need-based on the historical data. There are many methods used to predict the demand based on the area clusters by retailers [1]. The regression of the market area for the retailer is significant in the competitiveness of business. The prediction will determine the level of profit for the single business company. The prediction methods could be used to predict the certain point of sales dataset in the retailer in the supply chain [2].

Before tsunami 2004, The Lafarge Cement Indonesia-Aceh (LCI) is a single cement producer and distributes them to the distributors for all over Aceh province. The cement product is called semen andalas. When the tsunami came, many infrastructures include LCI Aceh were destroyed by the wave of a tsunami. This situation pushed the mitigation condition for the cement need in Aceh Province. The emergency cement needs to build the infrastructure in fast many rebuilding infrastructures in Aceh province where it was needed as soon as possible. The local government took place the new regulations that allow Padang cement substitute the market area in Aceh province while waiting the
LCI-Aceh recovered the plant. Nowadays, there are two competitor cement products in retailers in Aceh province.

Serambi Indonesia (2017) supposed that the demand of cement fluctuated based on the infrastructure market demand need. The distributors predict the market based on the retailer’s requirement. Nowadays, the infrastructure project of the subsidiary house is rapidly increased to build the community houses. Cement demand is higher than the LCI-Aceh production. The situation creates the distributors highlight the purchase order (PO) from the beginner order of wholesalers and retailers. This condition influences the housing contractors to get the appropriate amount of cement to their project [3].

Moreover, the cement production is influenced by the determinants of cement demand from the infrastructure buildings environmental. This creates the challenges to the producer of cement and their supply chain to fulfill the market demand in Aceh province, especially in Banda Aceh and Aceh Besar districts. The cement demand has the trend of fluctuating increase characteristic. Based on these situations the local business can be the entrepreneurship of distributors and retailers. Hence, the retailers have high competitiveness in the region of their place due to many new growth retailers and the distance relationships among the retailers are a very closed each other. It influences the retailers to get the more revenue.

There are some prediction models to predict the location of the relationship retailer places. In the beginning, it is better to see in overall view of the place for the retailer geographic positions. This study used the GPS to track the point on the real geographic dataset. Then, it was overlaid on the google map to measure the distances. Then, it produced the waypoint before the data plotted on the x-abscissa and y-ordinate graph.

The contribution of this paper is to explore some advantages. They are to produce the performance of numerical spline and polynomials models, estimate the relationship area for the retailers, predict the demand area of customer demand from a retailer in the region of less than 1 km. At last, measure the factor economic order quantity in the case of this characteristic to determine the inventory policy on the retailer level.

2. The Methods
2.1. Data collection
The data are collected by the open-source internet of google map. This method can measure the distance between the points in the driving direction. This method is a very quick result to obtain the retailer's distance the relationship between them and from customer area to the retailers. The raw data were collected by using the GPS Garmin tool before they were overlaid on the paper map. However, this method applies in manually to obtain the distance in the engine map point’s record. Furthermore, this method is very simple and be the basic approach to calculate in the paper map sales region. This process has the similar characteristic procedure when using the geographic information system (GIS) method capability to measure the distance of the track point on the paper map. As our objectives here is to obtain the efficiency but still have a precision of it where it is compared to the manual ruler based.

![Figure 1. The spread of cement retailers and their customer’s area.](image-url)
The area for this dataset is a relatively new area to obtain the quality of the dataset. The data are collected from 100 cement retailers that were collected tracking the points manually. Figure 1 shows that the analysis of the retailer area relationship requires the data of the retailer's distance each other and the area of representing one sales region from the retailer. Then the data overlay the distance on the google map and their customer regions around Banda Aceh.

2.2. Spline and Polynomial models

The Spline and polynomial methods are applied due to these methods can work more accuracy than the linear method for the un-linear dataset. The spline can overlay the points with the very small deviation between the real dataset, and the polynomial can do the better than the linear model in the un-linear and dispersion distribution.

Polynomial regression is indeterminate of variables where it involves the coefficients or mathematical functions.

\[ Y = \beta_0 + \beta_1 x + \beta_2 x^2 + \cdots + \beta_r x^r + e \]  

(1)

Where \( \beta_0, \beta_1, \ldots, \beta_r \) are regression coefficients where it would estimate the value. If the dataset consists of \( n \) pairs \((x_i, y_i), i = 1, \ldots, n\) then the least squares estimators of \( \beta_0, \ldots, \beta_r \) called them \( \beta_0, \ldots, \beta_r \) are the values to minimize.

\[ \sum_{i=1}^{n} (Y_i - B_0 - B_1 x_1 - B_2 x_1^2 - \cdots - B_r x_1^r)^2 \]  

(2)

To determine these estimators, the partial derivatives concerning \( B_0, B_1, \ldots, B_r \) of the previous sum of squares, and set these equal to 0 to determine the minimizing value on doing so, and then rearranging the answer from the equations. The least square estimators should be \( \beta_0, \beta_1, \ldots, \beta_r \) satisfy the following set of \( r + 1 \) linear equations is named the normal of formula.

The polynomial equation with the single variable is \( 2x^3 - 2x^2 + 2x - 5 \) and with two variables are \( 2xy^3 - 2xy^2 + 2x - 5 \). The polynomial equations represent in many real areas of science, chemistry, physics, economic, statistic, mechanical design, and mathematics. Many problems can be solved to apply with the advanced mathematical function such as algebraic, calculus, geometric, and polynomial. These usually use many variables to identify the real cases [4].

Spline regression is the numerical analysis that is the unique piecewise polynomial. The spline polynomials usually produce the minimal error when it is applied in the best fit on the real dataset. It can avoid the problem of oscillation occur between the points in the interpolating case.

\[ S^n(x) = \sum_{j=0}^{n} a_j x^j + \sum_{t=1}^{n} d_t (x - \varepsilon_t)^n \]  

(3)

Where, the symbol of a parameter coefficient of independent variables, \( x \) is the independent variable, \( \varepsilon \) is knotted the point, \( d \) is the parameter coefficient of the knot, \( n \) is the degree of the spline and under the restriction, in Equation (2) as follow:

\[ (x - \varepsilon_1)^n = \begin{cases} 0, & x \leq \varepsilon_1 \\ (x_1 - \varepsilon_1, & x \geq \varepsilon_1 \end{cases} \]  

(4)

In this logic, the knot points and the \( \varepsilon_1 \) are known in advance. The parameters of spline \( a_j \) and \( d_t \). Spline is linear in this parameter [5].

The goodness of fit for sales data is the fundamental to obtain the best models in statistical methods to realize the behavior relationship between the data and the predicted dataset. It is quite important to understand the underlying behavior market dataset in the entire market environment.
Furthermore, the equation from the goodness of fit can be determined by the adding explanatory variables. Whether these variables are meaningless to be accurate in the fitting where measured by \( R^2 \) statistic [6].

Some problem is using the polynomial equation to predict the sales-distance relationship among them. The reasons are the weak theoretical support, the allowance of negative sales, and non-monotone behavior, unclear elasticity, intractable structural form.

However, some factors are offered by the shop where they have different attributes, such as offer the diversification products, more services, expensive goods, or other factors. The other location of the shop may offer differences factor where it would make affecting sales factor that offers to customers.

This study collects the data from the distance of the cement product in their retailers and consumers. In such case, the data are available for sales from retailers and the factors that distinguish retail outlets, and the predictive model can be drawn as

\[
S_i = f(d, m, y)
\]  

(5)

Where \( S_i \) shows the sales of the store \( i \) in the region, \( d \) is a vector of distance variables. This means that the distance between the store \( i \) and another store, \( m \) is a vector of amnesty variables such as size, hours, quality or price merchandise, and the atmosphere of the area surrounding the retail outlet, and \( y \) is a vector of data on the disposal income available to the customer in the area. The income variable comes from the retails outlet from different areas.

The distance in the demand equation is an indicator of time and other costs of traveling to and from the retailer and customer to the retailer. Part of the time cost is the same whether the trip is across the street. If the customer within 1 km and other 5 km, it means that it is indeed closer than the majority is 10 km or more away.

The normal equations (2) continue the calculation to fit a polynomial to determine the necessary degree of a polynomial by a scatter diagram.

\[
\sum_{i=1}^{n} Y_i = B_0 n + B_1 \sum_{i=1}^{n} x_i + B_2 \sum_{i=1}^{n} x_i^2 + \ldots + B_r \sum_{i=1}^{n} x_i^r
\]  

(6)

\[
\sum_{i=1}^{n} x_i Y_i = B_0 \sum_{i=1}^{n} x_i + B_1 \sum_{i=1}^{n} x_i^2 + B_2 \sum_{i=1}^{n} x_i^3 + \ldots + B_r \sum_{i=1}^{n} x_i^{r+1}
\]  

(7)

\[
\sum_{i=1}^{n} x_i^2 Y_i = B_0 \sum_{i=1}^{n} x_i^2 + B_1 \sum_{i=1}^{n} x_i^3 + \ldots + B_r \sum_{i=1}^{n} x_i^{r+2}
\]  

(8)

\[
\sum_{i=1}^{n} x_i^r Y_i = B_0 \sum_{i=1}^{n} x_i^r + B_1 \sum_{i=1}^{n} x_i^{r+1} + \ldots + B_r \sum_{i=1}^{n} x_i^{2r}
\]  

(9)

The explanation of the polynomial can be emphasized to the lowest possible degree that appears to describe the spread of data. To obtain the degree of \( n \) where \( n \) pairs \((x_i, Y_i)\), \( i=1, \ldots, n \), it would be hard to fit. The polynomial solution model is noted in Equation (2). Cubic spline interpolation is a good global interpolation; furthermore, it is easy to separate. This can be explored with the function of the spline curve with the computed from [7].

\[
f'_{i,i+1}(x) = k_{i+1} \frac{3(x-x_{i+1})^2}{x_{i+1}-x_{i}} - k_i \frac{3(x-x_i)^2}{x_{i+1}-x_{i}} - k_{i+1} \frac{x-x_i}{x_{i+1}-x_{i}}
\]  

(10)

\[
f'_{i,i+1}(x) = k_i \frac{x-x_{i+1}}{x_{i}-x_{i+1}} - k_{i+1} \frac{x-x_i}{x_{i}-x_{i+1}}
\]  

(11)

There are various measures of forecast errors. One of them is a mean squared error (MSE). The MSE is the square of quantity the unit term of an equal to the original value, which is the difference between the actual value and an estimated value, it can be defined in Equation 1.
\[ MSE = \frac{\sum_{i=1}^{n} (Y_t - \hat{Y}_t)^2}{n} \] (12)

Where:
- \( Y_t \) is actual value for a period \( t \),
- \( \hat{Y}_t \) is a period value of a forecast \( t \), and
- \( n \) is a period number

Defining market area, the relationship between the sales and distance in a quantitative manner is called the trade areas that are created on the density of sales. It is expected the retail to attract from different geographic areas. It depends on the purpose of analysis. It can be divided into the primary, secondary and tertiary market areas. Primary is the consumer very closest to the retailer and followed by the secondary and tertiary market area. The closest distance of retailer would have the high density of the population in the area. The criteria of the market area can also determine by the AHP method [8].

2.3. Determinant of demand

Demand forecasting is the process of predicting demand need in the future from the sale or historical dataset. This study took the sample from some retailers to obtain the information of the demand in the sales area of their locations. Most of the retailers used the similar system to predict the demand from belong customers and how they keep the safety stock on the certain level in their store or warehouse.

2.4. Determine the economic order quantity

One of the main objectives of this study is to determine the policy through the economic order quantity at the retailer level. In the real case, the retailers have a different system when they keep the inventory in the store and the policy of the retailers. Nevertheless, most of them have the assumption the safety stock on the level of 10% to 25%. The probability of the demand has the fluctuation in each month where it correlates to the stock inventory system in the retailer [9].

In real life situations, the review of inventory is mandatory to do regular intervals to manage the buffer in the store. The certain amount of quantity must be ordered. The review of safety stock is in the policy reviews the situation when the inventory falls under reorder point, where the store or warehouse places an order. In theoretical, this model is named the \( s, S \) policy. Where \( s \) is the reorder point and \( S \) is maximum order size. The notation \( s \), \( S \) means that the inventory fall below \( s \) then the system places an order to bring inventory to \( S \). The EOQ formula can be seen in the Equation (13).

\[ h = \frac{z x b}{t} \] (13)

Where \( z \) is the safety factor is chosen from the table of probability service level, \( b \) is periodic time per year. The stock out during lead time is precisely \( 1 - \alpha \), it means that reorder level in the condition of (14).

\[ Pr[D \geq L x \bar{D} + z x sd x \sqrt{L}] = 1 - \alpha \] (14)

Where \( D \) is demand during lead time, \( L \) is lead time, \( \bar{D} \) = average demand, \( sd \) is standard deviation and \( \alpha \) is service level.

\[ Q = \sqrt{\frac{2 x k x \bar{D}}{h}} \] (15)
Where \( k \) is ordering cost, \( \bar{D} \) is average demand, \( h \) is the holding cost. In addition, the safety stock position is in the Equation of (16).

\[
z x s d x \sqrt{L}
\]

The expected level of inventory immediately after receiving the order is in the Equation (17).

\[
Q + z x s d x \sqrt{L}
\]

Thus, the average inventory level is the average of these two values with Equation (18)

\[
\frac{Q}{2} + z x s d x \sqrt{L}
\]

In the periodic review policy, the base stock level is formed by two variable; they are average demand during an interval of \( r + L \) days, where is shown in Equation (19)

\[
(r+L) x \bar{D}
\]

In this equation, \( r \) is the length of the review period, where the orders are placed every \( r \) periods. While the safety stock can be illustrated in Equation (20)

\[
\frac{Q}{2} + z x s d x \sqrt{r + L}
\]

Hence, the expected level of inventory after receiving an order is equal to (21). [10].

\[
r x \bar{D} + z x s d x \sqrt{r + L}
\]

Moreover, the safety stock is equal to (22).

\[
z x s d x \sqrt{r + L}
\]

\[
\frac{r x \bar{D}}{z} - r x s d x \sqrt{r + L}
\]

The average inventory level is in the (23) has the value where the inventory keeps on the demand average from the customer need.

3. Result and Discussion

3.1. Spline and Polynomial models

Figure 2 is the underlying sales-distance relationship between the retailers in the area for 100 points. The spread of this dataset, it shows that the retailers are mostly building around the high density of population.

![Figure 2. Underlying sales-distance relationship using waypoints of Garmin GPS.](image-url)
This study develops the spatial dimension to use the Garmin GPS and spatial GIS software to obtain the result of retailer points [11]. The spatial dimension dataset obtains with the Garmin GPS type PSMAP-64s to track the points in the area of cement retailers. Moreover, the dataset from the GPS type was overlaid on the google map to view the points to measures the weight distance between the retailer points with the spline, quadratic, cubic, and four-degree polynomials.

\[ y = 0.00013 X^2 - 0.019 X + 1.2 \]  \hspace{1cm} (24)

\[ y = -6.7e-06 X^3 + 0.0011 X^2 - 0.06 X + 1.6 \]  \hspace{1cm} (25)

\[ y = 1.1e-07 X^4 - 2.8e-05X^3 + 0.0025X^2 - 0.092X + 1.8 \]  \hspace{1cm} (26)

The model of $X$-abscissa for the quadratic, cubic and four degrees have their values itself, and this means that the model has different characteristic when they are transformed into the plot fitting models.
Table 1. The comparison of MSE in four methods.

|        | Spline | Polynomial |
|--------|--------|------------|
| MSE    | 0.0000 | 0.2428     |
|        |        | 0.1974     |
|        |        | 0.1744     |

Moreover, each model should have the different mean squared error. The comparison of mean square error for spline and polynomial methods can be shown in the following table 1. The table indicates that the spline has the best MSE compared to other polynomials, such as in quadratic, cubic and fourth polynomial. The spline does the best work to explain the variations of the dataset. The line goes down at the end indicates that the curve is formed from the closer distribution of the dataset. This line helps to understand the estimate a behavior relationship of data. Getting the excellent model means that the understanding not just one situation, but an entire market. Furthermore, the well-known result from econometrics that the goodness of fit from any equation can be adding more explanatory variables, even if these variables are meaningless.

The interesting for polynomial equations to model the distance sales relationship at the end of the line usually goes down. The concept that good fit is a good thing. The go down to the line depending on the degree of the polynomial pattern and this shows that the polynomial has a weakness or problems to the sales distance, there are some factors where the consumer want to choose the distance to shop.

1. There is no data to identify the behavior of the customer when they choose the shop to buy. Moreover, they compare the low price to other distance.
2. Some consumers want to buy goods in the difference distance due to the service and quality of the goods. It is hard to identify the loyal consumers.
3. The closest distance is just the cost advantage for the customers whether it is still a consideration for the consumer. It means that the distance has a value of time and the costs when going to the retailer for consumers.
4. Cannibalism is the variation of a new product with the low price. This situation can absorb many consumers. These situations make convenience for the customer to get the new series of products but contribute the new problem for retailers.

![Figure 5. The distribution of the closer dataset from the fourth-degree polynomial.](image-url)
The distance identifies just for predicting the area of potential customers due to no guaranty that the closest distance between consumers to the retailer will get many buyers. Even though mathematical models are used to predict the distance of retailer to the customer, it just only the hopes of predicting. The minimum and the maximum area of predicting may be a solution to minimize the error of predicting.

Figure 5 shows the minimum distance truncation where it is many residential properties in the area of one km or more of the retail establishment. The overestimate occur when the minimum retail distance of zero of the total sales of the store with a primarily residential customer base, or allow a handful of observations to bias the estimated parameters of the model. The distance sales relationship is the fundamental of customer demand.

The point of retailers who have the closest distance each other where it less than 1 km drawn in the first range. Moreover, the points which outside the first range are the long distance with the low density of population.

3.2 Stock inventory model for retailer

Understanding the stock control in the retailers is mandatory important to maintain the customer need. The study took some samples of the inventory system from the fields. Each retailer has the different policy of stock inventory to fulfill the demand.

It is commonly they keep the safety stock at a low level of percentage in the store for rolling reorder of stock. They also refuse the system that the order in big batches because it is not necessary. If high inventory is savings in the store, it would be high risk for inventory cost in holding cost. Most of the retailer controls the level of inventory in every two weeks with one month's order cost. Some time the retailer order out of schedule to fulfill many customer requirements. This happens when the contractor has many jobs for building the government infrastructure and the house of community. This system is more appropriately used the periodic review policy. Let say the probability condition, if there are 1000 sacks sales per month, means that the retailer will keep the same amount about 1000 sacks. This condition will calculate the average demand is 500 sacks include the safety stock is 100 sacks. Means when the stock fall under the safety stock, and even at zero points the retailer start to reorder min around 150 until 250 sacks per week while the lead time is one week. This means that the average level of demand reduces to be around 125 sack per weeks with the safety stock is 25 sacks per week. The retailer can control the store more economic in a week or 2 weeks than they must order and keep in big baths. This is a significant reduction in stock and cost without any effect on customer service. The probability demand must be quite considered by the retailer to obtain revenue.

In the probability situation, the scheduling of order is not appropriate to do so, but based on the short demand requirement control can obtain the advantage to the retailer.

3.3 EOQ retailer model

Local retailers in this area have the characteristic of the probabilistic EOQ system. Even though, in practise, there are no certain rules how to determine the order quantity in the inventory system in the supply chain.

There are some policies to determine the condition of stocks, periodic review policy and continues order policy at the across of the supply chain. In the periodic review policy, the system of the inventory model considers on bath size, $Q$, where to keep the model equal to the cost of holding stock and the cost of ordering it. The retailer just keeps the based stock condition when the stock falls into the safety stock, and they start to reorder. Generally, in this area, they keep the safety stock around 10%-25% to reorder of stock. The result of the EOQ result can be seen in figure 6.
Figure 6. The stock inventory system in the retailer.

The figure 6 illustrates that the demand is 500 sacks per 2 weeks but have the variation demand in probabilistic with the max 581 sacks, and average demand is 229 sacks, from 500 sacks of demand. Average during lead-time is 212; reorder point is 298, the base stock level is 441. Order quantity (EOQ) is 276, variance order 276 sacks; the starting of the bullwhip effect is 0.0222. The calculation uses the $z$ factor 97% service level ($z = 1.88$), and the safety stock for this level is 212 (it is around 45%). Average inventory level 102, the average demand during the period is 229 sacks [12].

The safety stock indicates the high because influenced by the variance demand of high fluctuation. Then the retailer keeps more the safety stock to anticipate the unpredicted demand from consumers.

4. Conclusion
This study is the initial identification of the retailer’s competitiveness based on the distance relationship. The models are the distance relationship for cement retailer in the Banda Aceh province of Indonesia. It concludes that the retailers have the strong competitiveness in the closest distance between retailers, means that the locations have many populations in the area. The mathematical models of spline and polynomials can be used to compare the accuracy deviation with the MSE of the retailer based on the distance. These models can be applied for identification; the new location for the new retailer’s business with the assumption is the closest relationships have the high density of population. Other assumptions can be determined to obtain the good location-based on infrastructure activities. The MSE from the four methods indicates that spline is outperformed than the others where it is followed by the fourth, cubic and quadratic polynomial. The characteristic of models influences the inventory policy for the retailer. This policy influence the economic order quantity of retailer where from this study has the value of 276 sacks with the safety stock in 97% service level ($z = 1.88$) has the value of 212 (42%) to keep the inventory for the unpredicted high demand. The policy uses the periodic review policy. The demand fluctuates with the maximum high range 581 sacks. However, this study concludes that the closer of retailers indicate that the area has the high population and many infrastructure projects in that area. The locations are promising the good condition of investment to the business of retailer. Recently, the retailers could get the more revenue on the subsidized housing project in the area. Moreover, the retailers must manage the inventory policy management on the right track to obtain the maximum revenue from their supply chain; otherwise, it will be lost the opportunity to the retailers to get the more revenue. The additional conclusion that the marketing strategy must be applied refers to the situation to make more advantage to the retailer.
Future Work
The suggestion for the future work is trying to develop more models of inventory in the cannibalism retailers, identify the behavior of the customer when they choose the shop to buy, identify the variety of services quality, investment strategic and the marketing strategic, etc.

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References
[1] E. Fradinata, S. Suthummanon, and W. Suntiamorntut, "Forecasting Determinant of Cement Demand in Indonesia with Artificial Neural Network," Journal of Asian Scientific Research, vol. 5, p. 373, 2015.
[2] I. N. Pujawan, "The effect of lot sizing rules on order variability," European Journal of Operational Research, vol. 159, pp. 617-635, 2004.
[3] http://aceh.tribunnews.com/2017/08/26/suplai-semen-andalas-mulai-lancar, collected on 23 sept 2017
[4] B. Santosa, Data mining teknik pemanfaatan data untuk keperluan bisnis vol. 978, 2007.
[5] W. Gnad, "Regression by spline functions," Empirical Economics, vol. 2, pp. 69-77, 1977.
[6] E. Fradinata, S. Suthummanon, N. Sirivongpaisal, and W. Suntiamorntuthq, "ANN, ARIMA and MA timeseries model for forecasting in cement manufacturing industry: Case study at lafarge cement Indonesia—Aceh," in Advanced Informatics: Concept, Theory and Application (ICAIICTA), 2014 International Conference of, 2014, pp. 39-44.
[7] V. F. Jones, "A polynomial invariant for knots via von Neumann algebras," Bulletin of the American Mathematical Society, vol. 12, pp. 103-111, 1985.
[8] U. Ciptomulyono, "Fuzzy goal programming approach for deriving priority weights in the analytical hierarchy process (AHP) method," Journal of Applied Sciences Research, vol. 4, pp. 171-177, 2008.
[9] E. Fradinata, "Stock Market Prediction with Neural Network Method," in ASEAN/Asian Academic Society International Conference Proceeding Series, 2012.
[10] D. Simchi-Levi, E. Simchi-Levi, and P. Kaminsky, Designing and managing the supply chain: Concepts, strategies, and cases: McGraw-Hill New York, 1999.
[11] E. Murakami and D. P. Wagner, "Can using global positioning system (GPS) improve trip reporting?," Transportation research part c: emerging technologies, vol. 7, pp. 149-165, 1999.
[12] E. Fradinata, S. Suthummanon, and W. Suntiamorntut, "Reducing the bullwhip effect from signal demand of hybrid artificial neural network models of supply chain in Indonesia," International journal of advanced and applied sciences, vol. 4, pp. 64-75, 2017.