Forecasting Inflation Using Seasonal Autoregressive Integrated Moving Average Method for Estimates Decent Living Costs

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Abstract. This research purposes to forecast inflation data. The forecasting results can be used as a reference for the determination of decent living costs for a single worker in one month. The method used in this study is the SARIMA method, in forecasting the inflation rate where the data is time series. SARIMA method can show forecasting results that are able to follow the movement of the actual data from the inflation rate. Based on the comparison of overall SARIMA model and with a value of MAD, MSE and MAPE smallest, it shows the results of forecasting the SARIMA method on inflation values are very feasible and accurate. The result KHL value with calculation results of inflation forecasting has a value close to actual data so that the value can be used as a reference for decision making a single worker in needing one month.

1. Introduction
Inflation was instrumental in determining the condition of the economy [1], so it needs a serious attention from various circles, especially the monetary authorities responsible for controlling inflation. The inflation rate cannot be underestimated in the economic system of a country and business people in general. Based on Republic of Indonesia Minister of Manpower and Transmigration Regulation No.17 of 2005 about Components and Implementation of Stages of Achieving Decent Life Needs states that the need for decent living is a standard of needs that must be met by a single worker to live properly both physically, non-physically and socially for the needs of one month [2]. The indicator that is often used to measure inflation is the Consumer Price Index (CPI). Adjustment of the value of decent living needs is directly corrected through the calculation of the current year's minimum wage with the national inflation rate for the current year. The number of types of needs initially 46 types in the Minister of Manpower Decree No. 17 of 2005 becomes 60 types of Decent Living Costs in the Minister of Manpower Decree No. 13 of 2012 [3].

Forecasting is a method for estimating value in the future by using past data [4]. Inflation data is one of the time series data [5]. By modeling past time data, it can be used to forecast future time data. One method for modeling time series data is parametric methods, namely parametric models such as the Autoregressive (AR) model, the Moving Average (MA) model or the mixed model (ARIMA) that has been developed by Box and Jenkins since 1970 [6]. However, for modeling with the parametric model has assumptions that must be met, data must be stationary, and errors are white noises. The best forecasting method is seen by comparing the smallest error value. Forecasting error rates obtained based on the results of calculations using Mean Absolute Deviation (MAD), Mean Square Error (MSE) or Mean Absolute Percentage Error (MAPE) [7].
Based on Republic of Indonesia Minister of Manpower and Transmigration Regulation No. PER 17 No.17 of 2005 states that decent living costs must be fulfilled. Based on this rule, researchers have the assumption that there is a need for forecasting inflation values to determine the Decent Living Costs that every single worker must fulfill in one month. Through this research, the researcher aims to see the accuracy of the forecasting results of the SARIMA method in the case of inflation forecasting in the city of Bandung and determine the Decent Living Costs from the results of calculations with the inflation value generated by the SARIMA model. With the expectation of the results of forecasting inflation values and Decent Living Costs, values can be used as a reference for a single worker in meeting the needs of a decent life [2].

2. Method

Time series is a set of data based on specific intervals, such as: daily, weekly, monthly, and yearly. Forecasting is an attempt to predict future events. Forecasting has two properties, which are based on existing data (quantitative) and based on the opinions of experts (qualitative) [8].

2.1 Seasonal Autoregressive Integrated Moving Average Model (SARIMA)

This study uses the SARIMA model to forecast inflation values that display seasonal patterns. Seasonal Autoregressive Integrated Moving Average or also known as SARIMA is a time series forecasting method for stochastic data models with seasonal data patterns [9].

In general, SARIMA notations are:

\[
\text{SARIMA (p, d, q) (P, D, Q) }^{s} \tag{1}
\]

with:

- \(p, d, q\) : Parts are not seasonal from the model
- \(P, D, Q\) : Seasonal section of the model
- \(s\) : Number of periods per season

The general formula of SARIMA \((p, d, q) (P, D, Q) \) \(s\) is as follows:

\[
\Phi_{p}B^{S}\phi_{p}(B)(1 - B)^{d}(1 - B^{S})^{D}Z_{t} = \theta_{q}(B)\Theta_{q}(B^{S})\alpha_{t} \tag{2}
\]

with:

- \(\Phi_{p}B\) : AR Non-Seasonal
- \(\phi_{p}B^{S}\) : AR Seasonal
- \((1 - B)^{d}\) : differencing non seasonal
- \((1 - B^{S})^{D}\) : differencing seasonal
- \(\theta_{q}(B)\) : MA non seasonal
- \(\Theta_{q}(B^{S})\) : MA seasonal

In setting the \(p\) and \(q\) values can be helped by observing the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) patterns concerning the following Table 1[9]:

| Model        | Pola ACF                              | Pola PACF                              |
|--------------|---------------------------------------|----------------------------------------|
| AR (p)       | Declining rapidly (dies down)         | Significant spike appears until the lag is \(p\) and the cut off after the \(p\)-lag |
| MA (q)       | Significant spike appeared until the \(q\) lag and cut off after the \(q\)-lag   | declining rapidly (dies down)          |
| ARMA (p,q)   | Declining rapidly (dies down)         | Declining rapidly (dies down)          |
| AR (p) or MA (q) | Significant spike appeared until the \(q\) lag and cut off after the \(q\)-lag | Significant spike appeared until the \(p\)-lag and cut off after the \(p\)-lag |
2.2 Decent Living Costs

Based on Republic of Indonesia Minister of Manpower and Transmigration Regulation No. 17 of 2005 concerning Components and Implementation of Stages of Achieving Decent Living Needs [2], stating that Decent Living Needs is a standard of needs that must be met by a single worker to live properly both physically, non-physically and socially for the needs of one month. The number of types of needs initially 46 types in the Minister of Manpower Decree No. 17 of 2005 becomes 60 types of Decent Living Costs in the Minister of Manpower Decree No. 13 of 2012 [3].

In addition to the addition of 14 new types of Decent Living Costs, there are also adjustments/additions to the type of quality and quantity of Decent Living Costs and changes in the types of needs. The following are components of the food and beverage component of the Decent Living Costs standard based on Minister of Manpower Decree No. 13 of 2012 [3] (see Table 2):

| No. | Components | Quality / Criteria | Needs |
|-----|------------|--------------------|-------|
| 1   | Medium Rice | Medium             | 10 kg |
| 2   | Protein Source: |                   |       |
| a. | Meat       | Medium             | 0.75 kg |
| b. | Fresh fish | Good               | 1.2 kg |
| c. | Chicken eggs | Good              | 1 kg  |
| 3   | Nuts: tempeh / tofu | Good                | 4.5 kg |
| 4   | Milk powder | Medium             | 0.9 kg |
| 5   | Sugar       | Medium             | 3 kg  |
| 6   | Cooking oil | Bulk               | 2 kg  |
| 7   | Vegetables  | Good               | 7.2 kg |
| 8   | Fruits (equivalent to banana / papaya) | Good | 7.5 kg |
| 9   | Other carbohydrates (equivalent to flour) | Medium | 3 kg |
| 10  | Tea or Coffee | Dip / Sachet     | 2 Box 25 |
| 11  | Spices      | Value 1 to 10      | 15%   |

Table 2. Decent Living Costs Standards (Food and Drink Components)

For more information on the components of the Decent Living Costs component, on the Minister of Manpower Decree No. 13 the year 2012 [3].

2.3 Evaluation of forecasting results

Evaluation of forecasting results is used to determine the accuracy of the forecasting results that have been made on the actual data. There are many methods for calculating forecasting errors [11]. Some of the methods used are:

Mean Absolute Deviation is a measure of the overall forecast error for a model. The MAD value is calculated by taking the absolute number of forecast errors divided by the number of periods of data (n).

\[
MAD = \frac{\sum |\text{actual} - \text{forecast value}|}{n}
\]  

(3)

with:

n = number of data periods

Mean Squared Error is the average of the squared difference between the predicted and observed values. The disadvantage of using MSE is that this evaluation method tends to accentuate a large deviation value due to the adherence to it.

\[
MSE = \frac{\sum (\text{error forecast})^2}{n}
\]  

(4)

with:

n = number of data periods

Mean Absolute Percentage Error is the average value of the absolute difference between the value of the forecasting result and the actual value; the value is shown as a percentage [12].

\[
MAPE = \frac{\sum_{t=1}^{T} |\text{forecast value} - \text{actual}|}{\text{actual}} \times 100\%
\]  

(5)
2.4 Research Phase
The research phase to be carried out is as follows:
1. Collection of historical inflation data from January 2011 to December 2017.
2. Identifying the pattern shown by data.
3. Customer inflation forecasting using the SARIMA method
4. Comparing forecasting results with actual data in 2018
5. Checking the error value using MAD, MSE or MAPE.
6. Calculating the minimum monthly living costs from data forecasting inflation.
(See Figure 1).

![SARIMA Diagram](image)

**Figure 1. Research Phase**

3. Results and Discussion
Bandung City inflation data is obtained from the Bandung City Central Bureau of Statistics, data in the form of monthly data period for the January 2011 - December 2017. While the costs of living are based on the Decree of the Minister of Manpower No. 13 of 2012 concerning Changes in Decent Living Costs Calculations. To be able to analyze the time series from the data, the original plot is needed first so that the next step can be done correctly. From the data obtained, it is obtained a time series graph which is known that inflation data in Bandung City has a seasonal pattern. (See Figure 2).

![Time Series Plot](image)

**Figure 2. Inflation Data 2011-2017 Bandung City**

From Figure 2, it can be seen that the data has a seasonal pattern that recurs every year with the peak of the recurrence occurring in the month of the month approaching Eid [13]. So that it can be seen that the seasonal pattern is following the 11 monthly seasonal patterns. SARIMA forecasting method is a method used to predict data that has a seasonal pattern.

3.1 Application SARIMA Model
The first step is the process of identifying the model. The model identification process was first tested whether the data was stationary or not, namely by looking at the ACF and PACF plots from the original data. This step is used to view data patterns. Figure 2 shows that the data has a recurring pattern every year.
Furthermore, the data were analyzed using the SARIMA method; time series data were first identified as stationary invariants and mean. From the results of the analysis, the original data plot of Bandung City’s inflation value is stationary in the variant, so there is no need to do a transformation (See Figure 3 and 4).

![Figure 3. Plot ACF](image1)

![Figure 4. Plot PACF](image2)

Figures 3 and 4 show ACF and PACF plots, in the ACF plot it appears that in the 1st lag the vertical lines pass through the dashed lines [10]. Likewise, the PACF plot is found in the lag of the 1st bar that passes through the dashed line so that it can be said that the ACF and PACF values are significant in the 1st lag. If ACF and PACF show dies down, which means that both the ACF pattern and PACF pattern has decreased dramatically at each lag, it can be said that the SARIMA model is a combination of AR and MA.

3.2 Parameter Estimation

After the processed time series data is stationary, the next is the application of the SARIMA model \((p, d, q) (P, D, Q)^{11}\) while the corresponding (see Table 3).
### Table 3. SARIMA Candidate Model

| SARIMA Model (p,d,q)(P,D,Q) | MAD   | MSE   | MAPE  | Information     |
|-----------------------------|-------|-------|-------|-----------------|
| (1,1,1)(1,1,0)              | 0.364 | 0.214 | 1.04% | Not Significant |
| (1,1,1)(1,1,1)              | 0.369 | 0.155 | 1.03% | Not Significant |
| (1,1,0)(1,1,0)              | 0.308 | 0.152 | 0.81% | Not Significant |
| (1,0,1)(1,1,1)              | 0.142 | 0.025 | 0.45% | Significant     |
| (1,0,1)(1,0,1)              | 0.141 | 0.025 | 0.42% | Significant     |

From Table 3, it can be concluded that the best SARIMA model for forecasting inflation in Bandung is SARIMA (1,0,1)(1,0,1) because it has the smallest error value with MAD 0.141, MSE 0.025 and MAPE 0.42%. Table 4 shows the forecasting results with the SARIMA model (1,0,1)(1,0,1) from January to June 2018. The results show that the SARIMA model can predict the inflation value of Bandung City with good accuracy, while other studies have limitations. For example, in some existing literature, inflation values can be predicted but very low accuracy for long-term predictions (See Figure 5 and Table 4).

### Table 4. Forecasting 6 Months

| Period 2018 | Actual Value (a) | Hasil Peramalan (i) | Error | Absolut | Square Of Error | Absolute Values of Errors |
|-------------|------------------|---------------------|-------|---------|-----------------|--------------------------|
| January     | 0.83             | 0.68                | 0.15  | 0.021   | 0.021           | 0.18                     |
| February    | 0.22             | 0.30                | -0.08 | 0.006   | 0.006           | 0.35                     |
| March       | 0.21             | 0.17                | 0.04  | 0.002   | 0.002           | 0.21                     |
| April       | 0.27             | 0.09                | 0.18  | 0.033   | 0.033           | 0.67                     |
| May         | 0.22             | 0.34                | -0.12 | 0.014   | 0.014           | 0.54                     |
| June        | 0.48             | 0.76                | -0.28 | 0.076   | 0.076           | 0.57                     |

**Error Value**
- **MAD** = 0.141
- **MSE** = 0.025
- **MAPE** = 0.42%

Figure 5 shows a comparison chart of estimated data with actual data. The graph uses estimates with the SARIMA model (1,0,1)(1,0,1). The comparison shows good performance seen from its proximity to the actual data.
3.3 Decent Living Costs (Food and Drink Components)

Based on the Minister of Manpower Decree No. 13 of 2012 concerning Changes in Decent Living Costs Calculations, decent living needs are the standard of living needs of a single worker/laborer to be able to live physically in one month. There are 60 items calculated in HKL which are grouped in 7 components, among them: food and drinks (11 items), clothing (13 items), housing (26 items), education (2 items), health (5 items), transportation (1 item), recreation and savings (2 items). However, in this study, the author will focus more on food and beverage components with 11 items. Food data is obtained from the average commodity consumer prices in the city of Bandung from the Food Price Information Portal [14]. Table 5 shows food data for December 2017 in Bandung City with 11 items stipulated by Minister of Manpower Decree No. 13 of 2012 to become a standard for decent living needs.

Table 5. Decent Living Costs Standard for December 2017 Based on Food and Drink Components

| No. | Components                      | Quality / Criteria | Needs | Components  |
|-----|---------------------------------|--------------------|-------|-------------|
| 1   | Medium Rice                     | Medium             | 10 kg | Rp126,240   |
| 2   | Protein Source:                 |                    |       |             |
|     | a. Meat                         | Medium             | 0.75 kg| Rp84,083    |
|     | b. Fresh fish                   | Good               | 1.2 kg | Rp85,082    |
|     | c. Chicken eggs                 | Good               | 1 kg   | Rp20,623    |
| 3   | Nuts: tempeh / tofu             | Good               | 4.5 kg | Rp51,156    |
| 4   | Milk powder                     | Medium             | 0.9 kg | Rp32,940    |
| 5   | Sugar                           | Medium             | 3 kg   | Rp40,104    |
| 6   | Cooking oil                     | Bulk               | 2 kg   | Rp23,168    |
| 7   | Vegetables                      | Good               | 7.2 kg | Rp72,000    |
| 8   | Fruits (equivalent to banana)   | Good               | 7.5 kg | Rp70,500    |
| 9   | Other carbohydrates (equivalent to flour) | Medium             | 3 kg   | Rp45,000    |
| 10  | Tea or Coffee                   | Dip / Sachet       | 2 Box 25| Rp11,000   |
| 11  | Spices                          | Value 1 to 10      | 1kg    | Rp35,700    |
|     | Total                           |                    |       | Rp697,596   |

3.4 Forecast Decent Living Costs Based on Inflation Forecast SARIMA Model

Following the stipulated Minister of Manpower Decree No. 13 of 2012, the adjustment of the Decent Living Costs value is directly corrected through the national inflation rate for the current year. It means that the inflation value can be used as a benchmark for forecasting the value of decent living needs for each particular period. The following is the Decent Living Costs forecasting result generated by the inflation value predicted using the SARIMA method. The initial value of Decent Living Costs is taken from the Decent Living Costs value in December 2017; then the value is corrected by the inflation value generated by the SARIMA method (see Table 6).

Table 6. Decent Living Costs Based on Inflation Forecast SARIMA Model

| Period 2018 | Decent Living Costs (Minimum/Month/Capita) | SARIMA |       |       |
|-------------|-------------------------------------------|--------|-------|-------|
|             | Actual                                    | Inflation | Decent Living Costs |
| January     | Rp 686,665                                 | 0.68    | Rp 687,572 |
| February    | Rp 690,973                                 | 0.30    | Rp 690,249 |
| March       | Rp 691,421                                 | 0.17    | Rp 691,157 |
| April       | Rp 687,742                                 | 0.09    | Rp 691,696 |
| May         | Rp 691,121                                 | 0.34    | Rp 689,957 |
| June        | Rp 689,053                                 | 0.76    | Rp 687,074 |
Table 6 is the result of forecasting the KHL value based on the inflation value generated by SARIMA forecasting. The KHL value based on SARIMA was obtained from the accumulation of KHL values in December 2017 with the inflation period of January 2018 - June 2018 resulting from forecasting the SARIMA \((1,0,1)(1,0,1)^{11}\) with the smallest error value, MAD 0.141, MSE 0.025 and MAPE 0.42%. (See Figure 6).

Figure 6 shows a graph of the comparison of Decent Living Costs actual and Decent Living Costs values based on the accumulated inflation value generated forecasting by SARIMA. Similar research was conducted by [15], forecasting using the ARIMA method is done to forecast inflation. However, this study focuses more on the seasonal patterns produced by inflation. So in this study, researchers used the SARIMA method to forecast inflation values where the SARIMA method is one method to forecast time series data with seasonal patterns. The results of forecasting the inflation value are then used as a reference for the determination of decent living needs for a single worker in one month.

4. Conclusion
The SARIMA model can be used for forecasting the inflation value of Bandung City based on CPI with MAD 0.141, MSE 0.025 and MAPE 0.42%. Using the SARIMA \((1,0,1)(1,0,1)^{11}\) model with the smallest error value in forecasting the inflation value. Moreover, based on the calculation of decent living needs based on the accumulated inflation value of the results of SARIMA forecasting produces accurate values. Based on the results of data analysis, the author uses the SARIMA method to forecast the inflation value of Bandung City and predicts the value of decent living needs based on the accumulation of inflation values from the forecasting results of the SARIMA model. Therefore, readers are expected to try to use other methods such as Holt-Winters, Exponential Smoothing and Naive models for forecasting inflation values, so that the reader can find out which method is the best and right to use.

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