# Forecasting of YG Entertainment Stock Prices February 2022-August 2022 Using Arima Model

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*Abstract*— The stock price in investing is the main factor in determining whether an investor will invest there. With stock price prediction research, investors have an idea of whether to invest in the company. YG Entertainment is a public company in the entertainment sector with many artists and entertainment projects that have fluctuating prices. With the ARIMA (Autoregressive Integrated Moving Average) forecasting method, we can predict YG Entertainment's stock price. In this article, YG Entertainment's prediction using the ARIMA model results in a MAPE error rate of 11% with the best model being ARIMA (0,1,0). The error of the model are 33160 x10$^3$ MSE, 5758.543 RMSE, and 4366.446 MAE. This forecast will produce good output as consideration for investor who interesting buy YG Entertainment stock price.

*Keywords*— ARIMA; Forecasting; Stock Price; MAPE.

## I. INTRODUCTION

YG Entertainment is an entertainment company based in South Korea. The company publishes and distributes digital music and other materials. It also trains and offers artists, as well as provides content services. YG Entertainment Inc. was founded in 1996 and based in Seoul, South Korea. The company was previously known as Hyun Entertainment and changed its name to YG Entertainment Inc. in April 2001. Assessing YG Entertainment's stock is extremely difficult, and any metric should be seen as part of the bigger picture of YG Entertainment's overall performance. YG Entertainment shares were divided on a basis of 93773:7213 on May 1, 2014. So, if one owned 7213 shares the day before the split, the following day would have 93773 shares. This will not directly change the overall value of YG Entertainment's shareholders – only the amount. However, indirectly, the new 92.3% drop in share price could impact the market appetite for YG Entertainment shares which in turn could impact YG Entertainment's stock price.

Research on forecasting accuracy using the ARIMA model has been proven by several journals. In [2], Mondal *et al.* conducted a study on the effectiveness of the Autoregressive Integrated Moving Average (ARIMA) model on fifty-six Indian stocks from various sectors. The comparison and parameterization of the ARIMA model was carried out using the Akaike Information Criteria (AIC) resulting in an analysis of prediction accuracy based on the data range of the previous period which varied with an accuracy rate of 85%. In addition, ARIMA model is used to predict stock prices of selected pharmaceutical companies in India, which are listed under NIFTY100 with the help of the above model developed for each selected company in this study, stock prices have been predicted from October 1, 2019 to December 31, 2019 [2]. Another study that determines the ARIMA model for forecasting the JSE stock price index. This study uses a three-step iterative quantitative approach to determine the optimal ARIMA model to be used in stock price index forecasting [3]. After that, the best 5 models have been selected, and the embedding of various necessary AR and MA terms has been made to fit the model and select a customized ARIMA model for each company based on Volatility, adjusted R-squared, and Akaike Information Criteria. The results can be used to analyze stock prices and their predictions in depth in future research efforts.

When investing in the stock market, making sound economic and financial decisions remains the main focus of every investor and market participant. While this goal involves applying skills, information, and some technical prowess, the ability to predict the future performance of a stock index or market remains a skill that is highly sought after by many markets. The forecasting method commonly used is Autoregressive Integrated Moving Average (ARIMA). Integrated Moving Average Autoregressive Model (ARIMA) is a model that uses the dependent variable or data from the past and completely ignores the independent variables. This method has several advantages, namely it does not require a stationary data pattern and can be used on data that forms a seasonal pattern. ARIMA model is a statistic that is suitable for predicting a number of variables quickly, simply, and accurately because it only requires variable data to predict. Therefore, this study uses the ARIMA model for time series data analysis and forecasting using YG Entertainment stock price data from February 2019 to January 2022.

## II. LITERATURE REVIEW

### A. Time Series Modelling

Time series is a set of data observations ordered in time [4]. The time series method can be used to analyze

the pattern of relationships that occur in a time series so that they can know predictions about the future. Measures of time used can include years, months, days, seconds, and others as long as they have a time sequence. Time series can be used in various fields such as predicting stock prices in the market, death and birth rates, the level of sales of a company, and others. However, when we get time series data, it is very possible that the dataset does not meet the time series data pattern with the aim of decomposing or decomposing the data.
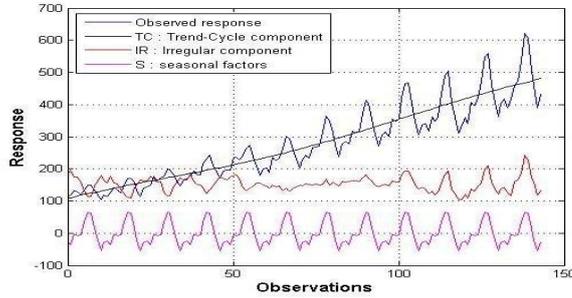


Figure 1. Time Series Illustration

There are 4 techniques in deciphering data in time series as shown in Figure 1 [5]. First, Base or level, namely the value in the data series has a straight line. Second, Trend is the rise and fall of data due to cyclic components in a time sequence. Third, Seasonality is a seasonal pattern that occurs at a data interval such as one month in a year or one hour in one day. Fourth, Error or Residual is a variation of abstract data. To find out the time series model or pattern, it is necessary to analyze using images when choosing a model.

*B.  Stationarity and differencing*

Stationary shows no drastic changes in the data, identified by the shape of the data distribution that fluctuates around a constant average value and does not depend on the time and variance of these fluctuations [5]. Stationary in time series analysis is needed to minimize model error [6]. A stationary dataset is data that has a stable mean and variance, and in turn is much easier to model. Figure 2 give us an illustration about the data. Non-stationary data are typically unpredictable and impossible to model or predict [7], for example can be seen in Figure 3. Results from non-stationary time series analysis could be false in the sense that they could suggest a relationship between two variables when none actually exists. The non-stationary data must be converted into stationary data in order to obtain repeatable, dependable findings. If a time series data is not stationary or has a unit root, there are several tricks that can be done to make the data stationary. One way is by using a stochastic difference process.
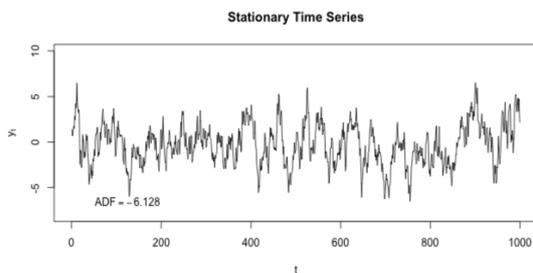


Figure 2. Stationary graphic illustration
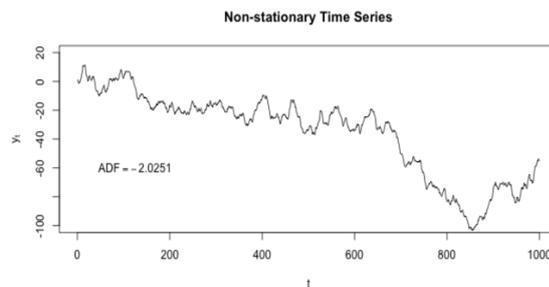
Figure 3. Non-stationary graphic illustration

Differencing is a popular and widely used data transformation to create stationary time series data. Transformations such as logarithms can help stabilize time series variances. The divergence can help stabilize the time series average by eliminating changes in the rate of the time series, and thereby eliminating (or reducing) trends and seasonality. To obtain stationarity, a new series consisting of differencing between the time series data set and its unit root can be created:

$$\Delta Z_t = Z_t - Z_{t-1} \qquad (1)$$

After using this formula, the data series has a value of n-1. If the first differencing does not show that stationary is achieved, then a second differencing can be done which will have a value of n-2:

$$\Delta^2 Z_t = \Delta Z_t - \Delta Z_{t-1} = Z_t - 2Z_{t-1} - Z_{t-2} \qquad (2)$$

Differencing will change the time series data that was not stationary into a time series data that is stationary and has a constant average and variance between periods. This process is a form of data transformation. The purpose of these other transformations is usually not to eliminate unit roots or to stationary the data, but to eliminate unit effects, normalize the data, and so on.

### C.   Autoregressive Integrated Moving Average (ARIMA)

ARIMA model is one of forecasting using a dataset that predicts certain patterns from historical data. A 'non-seasonal' time series showing a pattern instead of random white noise can be modeled with the ARIMA model. The ARIMA model is characterized by 3 terms: *p, d, q*. For *p* is a sequence of 'Auto Regressive' (AR) terms. This refers to the amount of lag of Y that will be used as a predictor. For *q* is a sequence of terms 'Moving Average' (MA). This refers to the number of lagging forecast errors that must be entered into the ARIMA Model. For *d* is the number of differentials required to make the time series stationary. Therefore, the value of d is the minimum amount of differencing required to make the series stationary. If the time series is stationary, then d is 0. A value of 0 can be used for the parameter, which indicates not to use the model element.

ARIMA model is obtained from combining AR and MA formulas with differentiation.
For AR can be formulated:

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_1 Y_{t-2} + \cdots + \beta_p Y_{t-p} + \varepsilon_t \tag{3}$$

For MA can be formulated:

$$Y_t = \alpha + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_1 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} \tag{4}$$

The ARIMA method with degrees AR (p), degrees of difference d and degrees MA (q), then the model is written ARIMA (p, d, q) which has the following general form [7]:

$$Y_t = \alpha + (\beta_1 + 1)Y_{t-1} + (\beta_2 - \beta_1)\,Y_{t-2} + \cdots + (\beta_p - \beta_{t-p})\,Y_{t-p} - \beta_p Y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} \tag{5}$$
$$- \cdots - \theta_q \varepsilon_{t-q}$$

| | |
|---|---|
| $Y_t$ | : *t*-period data |
| $\alpha$ | : model constant |
| $\theta_2, \ldots, \theta_q$ | : moving average parameter coefficient |
| $\beta_1, \ldots, \beta_p$ | : autoregressive parameter coefficient |
| $Y_{t-p}$ | : time data period *t-p* |
| $\varepsilon_t$ | : error value at time *t* |
| $\varepsilon_{t-q}$ | : error value at time *t-p* |

In this way, ARIMA models can be configured to perform the functions of ARMA models, and even simple AR, I, or MA models. Adopting the ARIMA model for time series assumes that the basic process that generates observations is the ARIMA process.

### D.   Forecasting

Forecasting process is a series of steps that define the problem to the result of having a time series forecast model or a series of predictions. Forecasting has a wide range of applications in various industries. It has many practical applications including: weather forecasting, climate forecasting, economic forecasting, financial forecasting, business forecasting, environmental studies forecasting, social studies forecasting, and many more. Basically, anyone who has consistent historical data can analyze that data with time series analysis methods and then model, forecast, and predict.

The forecasting method used to model data that continues to grow is called the time series forecasting method. This method performs the forecasting process by analyzing the relationship between the variable to be estimated and the time variable [8]. The time series model assumes that some pattern or combination of patterns will be repeated all the time. So, by identifying and extrapolating these patterns, it can be predicted. Time series forecasting methods focus on the type or pattern of data.

To determine the appropriate forecasting model, several steps are needed. First, check for stationarity, If the time series has a trend or seasonal component, it must be made stationary before we can use ARIMA to forecast. Second, check the difference with the state if the time series is not stationary, the time series needs to be stationary through differencing. Take the first difference, then check for stationarity. Third step, filter validation samples: This will be used to validate how accurate our model is. Use test train validation splits to achieve this. After that, select the AR and MA terms: to determine this you can use ACF and PACF to decide whether to include AR terms, MA terms, or both.

Selection of candidate Auto Regressive Moving Average (ARMA) models for time series analysis and forecasting, understanding the Autocorrelation function (ACF), and Partial autocorrelation function (PACF) plots of the series are needed to determine the order of AR and/or MA terms. ACF describes how the present value of a given time series is correlated with past values (1 past unit, past 2 units, …, n past units). PACF is a partial autocorrelation function that describes the partial correlation between the series and the lag itself.

ACF and PACF plots should be considered together to define the process. For the AR process, we expect the ACF plot to decrease gradually and simultaneously the PACF to experience a sharp decline after a significant p lag. To define the MA process, we expect the inverse of the ACF and PACF plots, which means that: ACF should show a sharp decline after a certain number of q lags while PACF should show a geometric or gradual downward trend. On the other hand, if the ACF and PACF plots show a gradual decreasing pattern, then the ARMA process should be considered for modeling. After determining ACF and PACF build a model and set the number of periods to be forecast to N and compare the predicted value with the actual in the validation sample.

*E.    Box Jenkins Method*

The Box-Jenkins method is a time series forecasting method. This method uses the past value as the dependent variable and the independent variable is ignored [8]. The Box-Jenkins method has the advantage that it can be used on non-stationary data and can be used on all data patterns so that this method can be used to forecast the daily stock of YG Entertainment.

The first stage is to find and examine the pattern of the dataset that we want to analyze. The second stage is to test the stationarity of the data by analyzing the ACF graph if the data is stationary and the ADF test at R. The data is said to be stationary if the p-value is less than 0.05. If the data is stationary then we can proceed to the next stage, namely temporary identification. However, if the data is not stationary at the average value, then the difference process is carried out. The next step is temporary identification or establishing a temporary model of ARIMA (p, d, q). If the data does not experience a difference, then the value of d in the model is 0 and if it is stationary after the 1st difference, then d = 1 and so on.

The next stage is to estimate the parameters of the AR and MA models and then perform diagnostic tests to test whether the model is good or adequate to use. We can see whether the model is adequate or not by looking at the residuals. Furthermore, testing through the ACF and PCAF correlogram of the residuals. If ACF and PCAF are not significant, then this indicates residual white noise, meaning that the model is adequate or suitable. We can also do the Ljung-Box test by testing the residual white noise. The residual is said to be white noise if the p-value is more than alpha (α), which is more than 0.05. If you have got the best ARIMA model, it will be used for the forecasting process. The best model is the model that has the smallest error value. The explanation presented is taken from the blog [9] and math journal [10]. This stage uses the Jenkins box method with a flowchart sourced as shown in Figure 5 [11].

*F.    Error Estimation*

Error estimation is one way to measure the level of accuracy of a method or algorithm. Mean Square Error (MSE) is a way of finding errors for the RMSE formula. Root Mean Square Error (RMSE) is the difference between the actual value and the predicted value generated by the algorithm. Mean Absolute Error (MAE) is the average error value of the actual value in time series analysis. Mean Absolute Percentage Error (MAPE) is the percentage generated by MAE.

1)    *Mean Square Error* (MSE)

$$MSE = \sum \frac{(y' - y)^2}{n} \tag{6}$$

2)    *Root Mean Square Error* (RMSE)

$$RMSE = \sqrt{\sum \frac{(y' - y)^2}{n}} \tag{7}$$

3)    *Mean Absolute Error* (MAE)

$$MAE = \sum \frac{|y' - y|}{n} \tag{8}$$

4)    *Mean Absolute Percentage Error* (MAPE)

$$MAPE = \frac{1}{2} \sum_{t=1}^{n} \left| \frac{y - y'}{y} \right| \times 100\% \tag{9}$$

Where *y'* is prediction value, *y* is actual value and *n* is number of observations.
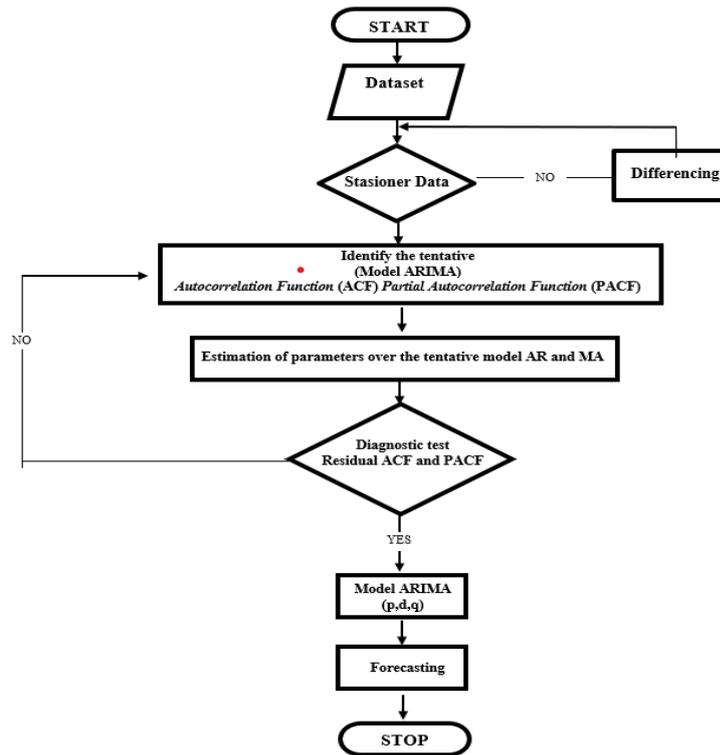
Figure 4. box Jenkins flowchart

III. RESULT AND DISCUSSION

A. *Data Preparation*

This work uses the secondary data of YG Entertainment monthly stock data from January 2019 to January 2022 taken from Investing.com [12] as can be seen in TABLE 1.

TABLE 1
YG ENTERTAINMENT STOCK PRICE

| Date | Price (KRW) | Date | Price (KRW) |
|---|---|---|---|
| February 2019 | 42050 | August 2020 | 46650 |
| March 2019 | 37700 | September 2020 | 58000 |
| April 2019 | 36000 | October 2020 | 43800 |
| May 2019 | 30600 | November 2020 | 38700 |
| June 2019 | 28950 | December 2020 | 44700 |
| July 2019 | 25000 | January 2021 | 45350 |
| August 2019 | 21200 | February 2021 | 45700 |
| September 2019 | 23050 | March 2021 | 44500 |
| October 2019 | 26750 | April 2021 | 41550 |
| November 2019 | 24850 | May 2021 | 50900 |
| December 2019 | 27350 | June 2021 | 51200 |
| January 2020 | 31600 | July 2021 | 52700 |
| February 2020 | 30300 | August 2021 | 60600 |
| March 2020 | 24050 | September 2021 | 61800 |
| April 2020 | 29650 | October 2021 | 70300 |
| May 2020 | 29600 | November 2021 | 55700 |
| June 2020 | 37250 | December 2021 | 55700 |
| July 2020 | 40700 | January 2022 | 49000 |

*B.    Stationary and differencing data*

Enter the data set with the name data and convert it to time series data with the name data2. After determining the dataset that we want to use, then we must check whether the dataset is stationary or not by using the ADF test in R. The data is said to be stationary if the p-value is less than 0.05. The results of ADF test before differencing do not look stationary because the p-value is 0.264 more than 0.05. For that we do differencing the data so that it becomes data stationary. The differencing process give a p-value of 0.01< 0.05. Thus, the data can be said to be stationary. Below is a comparison of time series plots for data that have not been differencing or not stationary and plots that have been differencing or are stationary.
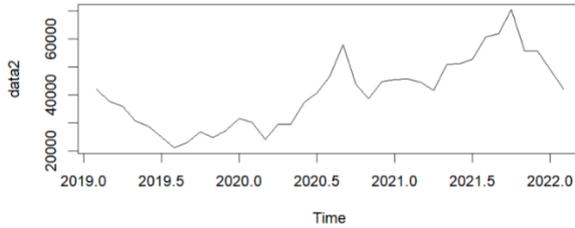


Figure 5. before differencing                    Figure 6. After differencing
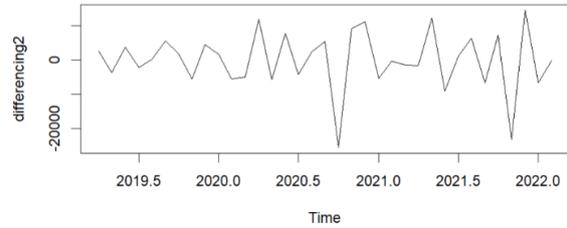
*C.    Determine the model from ARIMA with ACF and PACF*

Determine the ACF (q) and PACF (p) by looking at the ACF and PACF graph above. We can see that in ACF there is a cut off in lag 1 so that the ARIMA model's q value is 1 and in PACF there is a cut off at lag 3 so that the ARIMA model's q value is 1 and because we differencing 1 time, the d value we have is 1. So, the model specifications for the ARIMA (1,1,1) model are as follows.
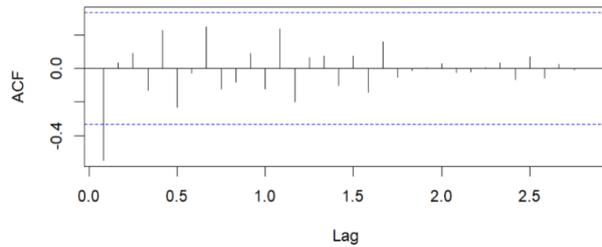


Figure 7. Series ACF value 1                    Figure 8. Series PACF value 1
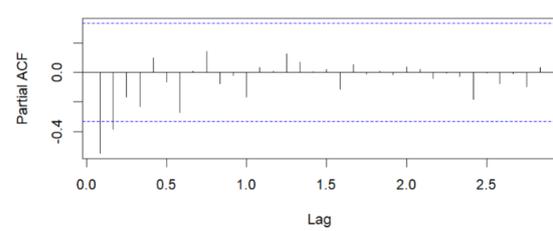
TABLE 2
ARIMA MODEL

| Model ARIMA | p | d | q |
|---|---|---|---|
| ARIMA (0,1,1) | 0 | 1 | 1 |
| ARIMA (0,1,0) | 0 | 1 | 0 |
| ARIMA (1,1,1) | 1 | 1 | 1 |
| ARIMA (1,1,0) | 1 | 1 | 0 |
| ARIMA (0,2,1) | 0 | 2 | 1 |
| ARIMA (0,2,0) | 0 | 2 | 0 |
| ARIMA (1,2,1) | 1 | 2 | 1 |
| ARIMA (1,2,0) | 1 | 2 | 0 |

*D.    Parameter Estimation*

After getting the ARIMA model, we then determine an estimate consisting of AR1, AR2, MA1, Log likelihood and AIC which we will consider later for forecasting as seen on table 3.

TABLE 3
COEFFICIENT ESTIMATION

| Model ARIMA | Coefficient of Estimation Result | | | |
| --- | --- | --- | --- | --- |
| | AR1 | MA1 | Log likelihood | AIC |
| ARIMA (0,1,1) | | -0.0826 | -353.08 | 710.16 |
| ARIMA (0,1,0) | | | -353.20 | 708.40 |
| ARIMA (1,1,1) | 0.9202 | -0.1000 | -352.81 | 711.62 |
| ARIMA (1,1,0) | -0.0876 | | -353.07 | 710.14 |
| ARIMA (0,2,1) | | -0.999 | -345.36 | 694.72 |
| ARIMA (0,2,0) | | | -356.36 | 714.71 |
| ARIMA (1,2,1) | -0.0638 | -1.000 | -345.30 | 696.59 |
| ARIMA (1,2,0) | -0.5433 | | -350.31 | 704.63 |

### E. Residual Analysis

If you have estimated the parameters, then the next step is to carry out a diagnostic test, which is to test whether the model is good or adequate to use. We can see whether the model is adequate or not by analyzing the residuals. This analysis uses the Saphiro and Ljung test, if the *p*-value is more than 0.05, it can be said that the model will be the best or adequate model.

TABLE 4
RESIDUAL ANALYSIS SHAPIRO TEST AND LJUNG

| Model ARIMA | Shapiro Test | Ljung | AIC |
| --- | --- | --- | --- |
| ARIMA (0,1,1) | 0.7260 | 0.9662 | 710.16 |
| ARIMA (0,1,0) | 0.3570 | 0.5827 | 708.40 |
| ARIMA (1,1,1) | 0.7109 | 0.7269 | 711.62 |
| ARIMA (1,1,0) | 0.7249 | 0.9918 | 710.14 |
| ARIMA (0,2,1) | 0.0103 | 0.4434 | 694.72 |
| ARIMA (0,2,0) | 0.0164 | 0.0006 | 714.71 |
| ARIMA (1,2,1) | 0.0249 | 0.6905 | 696.59 |
| ARIMA (1,2,0) | 0.0368 | 0.1855 | 704.63 |

From the table 4, it is known that the ARIMA models that meet the p-value requirements of more than 0.05 in the Ljung and Shapiro tests are ARIMA (0,1,1), ARIMA (0,1,0), ARIMA (1,1,0) and ARIMA (1,1,1). To determine the best results that will be used in forecasting is to look at the minimum value of AIC, namely the ARIMA 4 model (0,1,0). The ARIMA equation (0,1,0) which will be generated is as follows:

$$Y_t = e_t \tag{10}$$
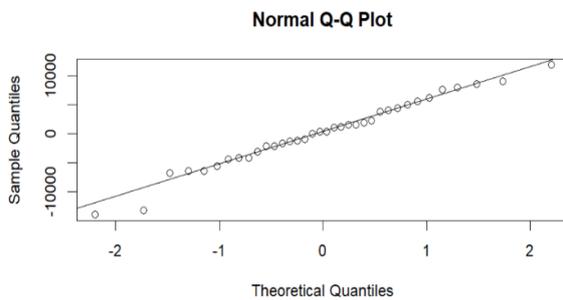


Figure 9. Plot ARIMA (0,1,0)
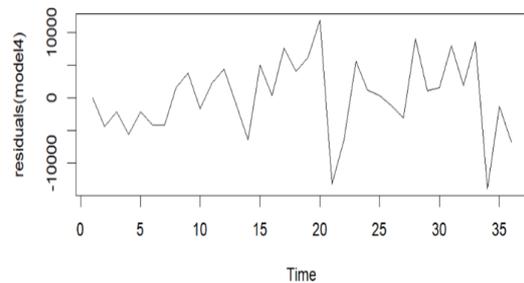


Figure 10. ARIMA (0,1,0) Model Residuals

With the QQ plot above, it can be concluded that the data is in a straight line and only a few are out. Thus, normality is considered valid.
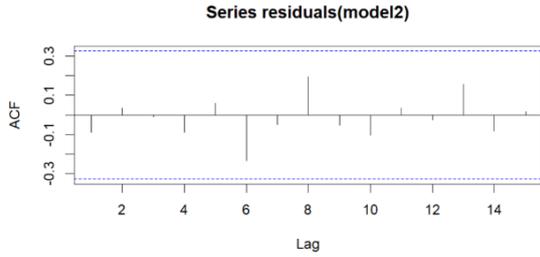
Figure 11. ARIMA (0,1,0) ACF series       Figure 12. PACF ARIMA (0,1,0) Series
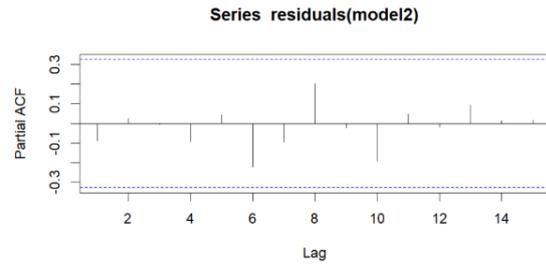
*F. Forecasting*

YG Entertainment's stock price forecast in the next 1 month (December 13, 2021 to January 13, 2022) with a confidence value of 90 can be depicted in Figure 14 with the black line as actual data while the blue line is predictive data.
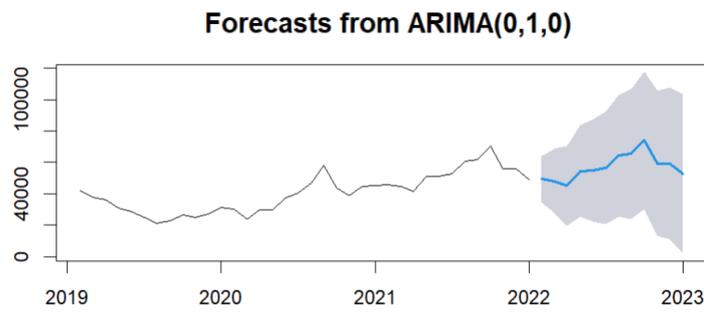


Figure 13. Forecast from ARIMA (0,1,0)

From the forecasting prediction, It can compare the actual data and the predicted data. The gap between the Actual and Prediction have the sum 34,850 KRW with average 4,979 KRW. The complete comparison can be seen on table 5 below.

TABLE 5
COMPARISON OF PREDICTED AND ACTUAL DATA

| Date | Prediction Data | Actual Data | Low Point | High Point |
|---|---|---|---|---|
| February 2022 | 49350 | 65700 | 34726.82 | 63973.18 |
| March 2022 | 48150 | 68400 | 27469.70 | 68830.30 |
| April 2022 | 45200 | 57000 | 19871.91 | 70528.09 |
| May 2022 | 54550 | 56600 | 25303.64 | 83796.36 |
| June 2022 | 54850 | 44150 | 22151.58 | 87548.42 |
| July 2022 | 56350 | 55100 | 20530.68 | 92169.32 |
| August 2022 | 64250 | 60600 | 25560.71 | 102939.29 |

*G. Calculating Estimation Error*

TABLE 6
ESTIMATION ERROR

| Model | ME | MSE | RMSE | MAE | MAPE |
|---|---|---|---|---|---|
| ARIMA (0,1,0) | 119.223 | $33160 \times 10^3$ | 5758.543 | 4366.446 | 11% |

From table 6, we can see that the lowest error is the ARIMA model (0,1,0) with an error rate of 11% which is the most accurate result among the others. The average of all the errors in a collection (Mean Error/ME) is 119.223. The degree of inaccuracy in statistical models is assessed by the mean squared error (MSE). The average squared difference between the values anticipated and observed is $33160e^3$ with its squared root (RMSE) value 5758.543. MAE computes the average magnitude of mistakes in a series of predictions without taking into

account their direction. It is the weighted average of the absolute discrepancies between forecast and actual observation and in this dataset MAE value is 4366.446. MAPE is often utilized since it is simple to interpret and explain. A MAPE number of 11% indicates that the average difference between the forecasted and actual value is 11%. This figure is considered a good result because it is in the 10%-20% range.

## IV. CONCLUSION

The ARIMA method is usually useful for short-term forecasting. The benefit of this method is that it accepts all forms of data models, despite the fact that the process must first be stationary. The data will be made stationary by utilizing the differencing function in the R software. We can forecast the stock price in the future using YG Entertainment's stock data from February 2019 to January 2022. Following the differencing and classification of the Shapiro and L-Jung methods, we obtain the ARIMA model (0,1,0) to forecast the stock price of YG Entertainment. After determining the optimal model, forecasting is performed on the dataset, the results of which are shown in table 5. YG Entertainment's stock is volatile according to the forecasting point data. The average gap between the actual data and the forecast data is 4,979 KRW. The estimated error of ARIMA (0,1,0) model produces the model with the lowest error, which is around 11% that consider a good result. However, seasonal data would increase forecasting accuracy even more. As is generally known, the entertainment industry has a season of ups and downs in stock, especially when their artists release their works and collaborate with third parties.

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