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Forecast and Analyze the Revenue of Biman Bangladesh Airlines Limited Based on ARIMA Model

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Authors' contributions

This work was carried out in collaboration between all authors. Author SR performed the statistical analysis, managed the analyses of the study and the literature searches. Author SA wrote the first draft of the manuscript and Author TF designed the study. All authors read and approved the final manuscript.

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ABSTRACT

Background: As a public limited company in Bangladesh, Biman Bangladesh Airlines Limited has been struggling to establish itself as a profitable company after taking many initiatives. The work presented in this article constitutes a contribution to modeling and forecasting the financial position of Biman Bangladesh by using a time series approach.
Methodology: The article demonstrates how the income and expenditure data could be utilized to forecast future profit scenarios by developing several Autoregressive Integrated Moving Average (ARIMA) time series with the regression model. Utilizing the Akaike Information Criterion (AIC) values, we identify the best fit ARIMA model and use this to forecast the financial scenarios for the subsequent years. To successfully build the model we use R Programming.

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Results and Conclusion: The model predicts future values of income, expenditure and using these two, the profit or loss scenarios can be used for forecasting from year 2018 to 2025. The results forecast that Income would increase or decrease in contest of the Expenditure. As a result Biman Bangladesh may have face significant losses in the years 2020, 2021 and 2024.

Keywords: Forecasting; Time series; ARIMA model; revenue analysis.

2010 Mathematics Subject Classification: 37M10, 91B84, 91G70.

1 INTRODUCTION

Biman Bangladesh Airlines Limited (BBAL), the national flag carrier of Bangladesh provides international passenger and cargo services to multiple destinations and has air service agreements with 42 countries. It came into operation immediately after the war of independence, 1971. Despite many odds on its journey towards a long and challenging way to progress, Biman has been able to establish its reputation as an airline of a welcome smile and an ocean of hospitality. On 23 July 2007, BBAL came into existence as a public limited company with 100% government ownership and made a remarkable financial recovery that failed to last. According to reports in The Financial Express in June 2011, BBAL was on the verge of bankruptcy due to its large debt burden, after sliding from profitability to losses year 2010. Bangladesh Biman has entered a new era with the inauguration of its first Boeing 787-8, known as the Dreamliner in September 2018 to dignify its glory in the aviation industry [1]. The carrier, the largest airline in Bangladesh by seat capacity, has been plagued by corruption allegations, a lack of planning, mismanagement, operational inefficiency, an aging fleet, constant aircraft groundings, and persistent operational delays, with the carrier finding profitable growth a challenge. In fact, growth of any kind appears to be a challenge. Biman Bangladesh is shrinking while other airlines are expanding.

Several qualitative studies have been conducted on the external and internal management scenarios of Bangladesh Biman. A study by Md. Shahidul Islam [2], covers the organizational structure, background, functions and the performance of Bangladesh Biman using information both from primary and secondary sources during the year 2010 to 2012. In [3], different type of marketing strategies of Biman Bangladesh Airlines has been demonstrated, concentrate on the 4 p's (Product, Price, Promotion & place/distribution) strategy of Biman, what are the products of Biman, how do they fix the price, what are the promotional activities taken by them and the distribution system of Biman Bangladesh Airlines. A similar type of research in [4] & [5], studied the level of service quality of Biman Bangladesh Airlines for their passengers travel to various destinations like a domestic destination as well as an international destination. To identify the probable remedies of the existing problems, a study conducted by Transparency International Bangladesh (TIB) [6] explore current business and operational status, different allegations of corruption and mismanagement, to identify the reasons behind its problems.

The aim of the present study is to investigate the changes in some key performance indicators (KPI) to assess the financial position of Biman Bangladesh Airlines from present to future by using Box-Jenkins time series approach, especially the ARIMA. Several ARIMA models were developed and evaluated by the performance of Akaike criterion (AIC). The novelty of this work is to develop a time series model to predict the revenue condition of Biman Bangladesh Airlines up to the fiscal year 2025-2026. In this article, the second section presents materials and methods about forecasting studies. The third section is consecrated to the results and discussions of our case study. Finally, the article concludes with a summary and the future work.

2 MATERIALS AND METHODS

2.1 Data Collection

In this study, we mainly collected the secondary data from the Bangladesh Statistical Year Book

and Economic review of Bangladesh from the fiscal year 2006-2007 to 2017-2018 [7]. The variables in the datasets are:

- FARE: Fare in tk per person per kilometer distant travelled.
- FREIGHT: Freight in tk per person per kilometer distant travelled.
- N. PASS: Number of passengers.
- INCOME: Income earned by Biman Bangladesh in crore tk.
- EXPENDITURE: Expenditure by Biman Bangladesh in crore tk.

From Fig. 1, we see that the Fare and Freight are approximately same during the fiscal year 2006-2007 to 2017-2018. However, No of Passengers, Income and Expenditure has increased day by day. The aim of the present study is the modelling quantitative data by using the Box–Jenkins time series approach [8]. The data were analyzed to forecast over the period of 2018 to 2025 by using R language.

2.2 ARIMA (p, d, q) Model

Autoregressive Integrated Moving Average Model (ARIMA model) [9] is commonly used on fitting stationary random series. It is proposed by Box and Jenkins, thus it is also called Box-Jenkins model. Its basic idea can be stated as follows: treat the data series formed by the prediction target with time as a random series, and describe the series with a mathematical model approximately. It can be used to forecast desired values from the past and present values once the model is identified. This model specifies three parameters to analyze the time series: autoregressive order (p), moving average order (q) and the number of differentials made to be a stationary series (d), generally called ARIMA (p, d, q). The form can be written as follows:

$$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots + \phi_p Y_{t-p} + e_t - \theta_1 e_{t-1} - \theta_2 e_{t-2} - \cdots - \theta_q e_{t-q} \quad (2.1)$$

where Y_t is the observed value of time series at the stage of t, e_t is the deviation of time series at the stage of t, $(\phi_1, \phi_2, \cdots, \phi_p)$ are the autoregressive coefficients, and $(\theta_1, \theta_2, \cdots, \theta_q)$ are the moving average coefficients. When $p = 0$, the model is called the moving average model, denoted as MA(q); when $q = 0$, the model is called autoregressive model, denoted as AR(p). Fig. 2 shows the general modeling process of ARIMA. First, smooth the data, and then identify the model, followed by estimating the parameters. After the residual test and data fitting, the forecast will start.

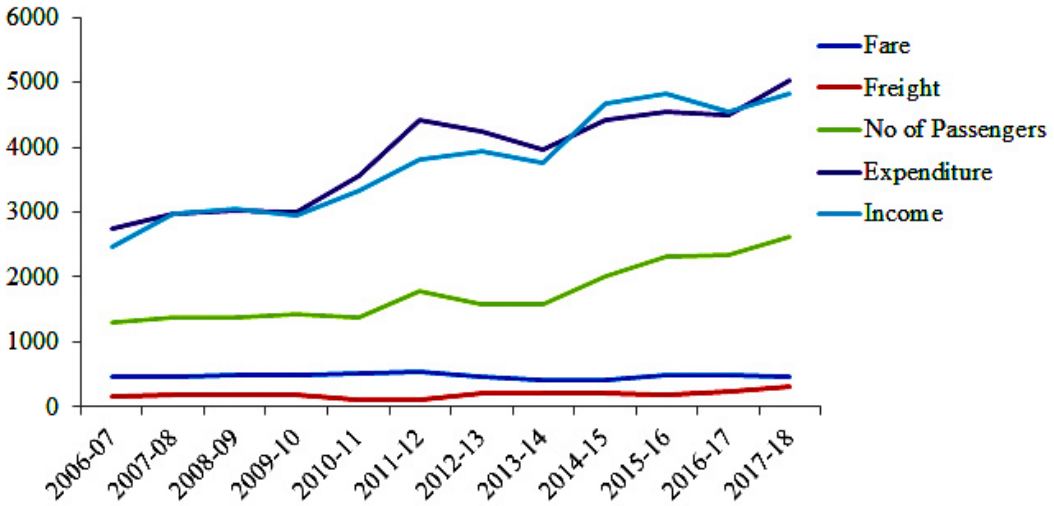


Fig. 1. Graphical representation of some KPI of Biman Bangladesh

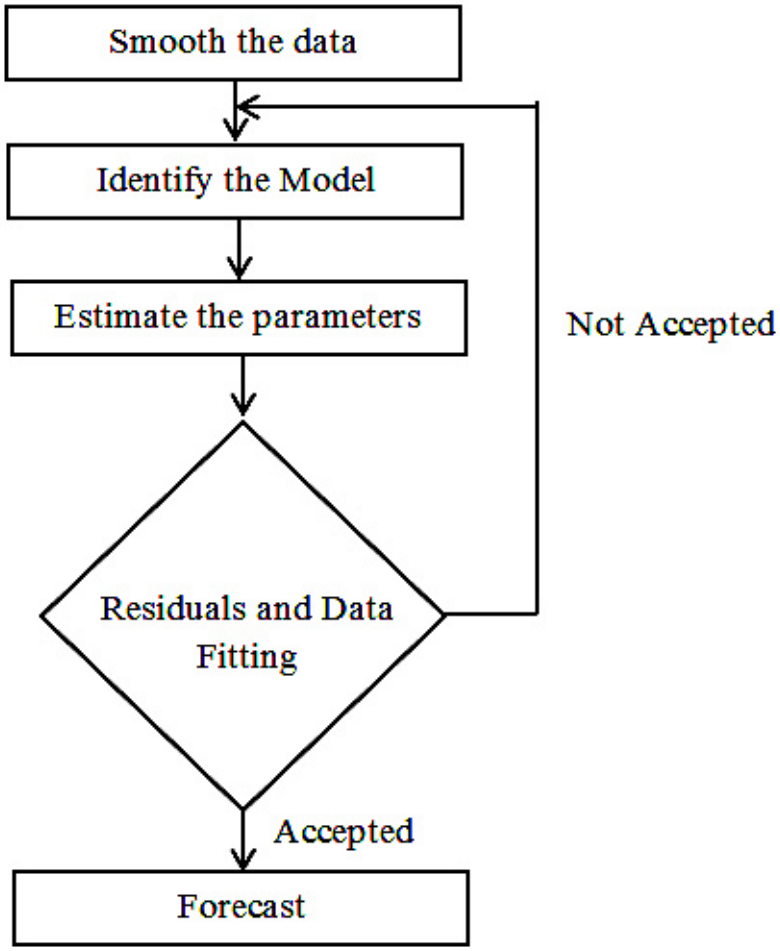


Fig. 2. The process of building ARIMA model [10]

3 RESULTS AND DISCUSSION

3.1 Data Smoothing

The prerequisite of the Box Jenkins ARIMA model is that the series should be stationary to estimate the parameter of the model. So it is necessary to test the time series on the following three aspects: zero average value, constant variance, and correlation coefficient only related to time interval and independent of specific time. ARIMA model can be used only when time series meets the above three conditions. It can be seen from Fig. 1 that income series is non-stationary in mean. After differencing the income data, we find that its stationary from Fig. 3.

Moreover, to assess whether the data come from a stationary process we can perform the Durbin-Watson test to check autocorrelation. The hypothesis is described as

H_0 : The series has no autocorrelation.

H_1 : The series has autocorrelation.

After carrying out the test, we have found p-value is 0.0104 which is greater than the level of significance 0.01. So we accept the null hypothesis and conclude that there is no autocorrelation in the data.

3.2 Identification of Model

Identification of the model involves two steps: first, determine which model should be adopted, AR(p) model , MA(q) model or ARIMA(p, d, q) model, and then determine the value of p, d, q in Eq. (2.1). The two identifications depend on the property of ACF and PACF, which is shown in Table 1.

Fig. 4 involve the analysis of autocorrelation and partial correlation stationary income series. It indicates that the ARIMA(p, d, q) model can be adopted as the two figures with tailing. As a result, the above analysis indicates that a differential of the original time series of income Y_t can obtain stationary series, thus parameter d equals to 1.

According to Box-Jenkins method, in ARIMA(p, d, q) the value of p and q should be 2 or less or total number of parameters should be less than 3 [11]. Therefore, for checking AIC of the model we have only checked for p and q values 2 or less. The model with the least AIC value is selected [11], shown in Table 2.

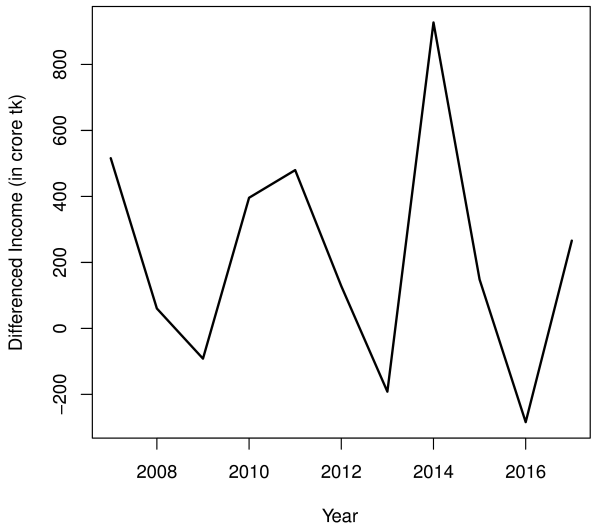
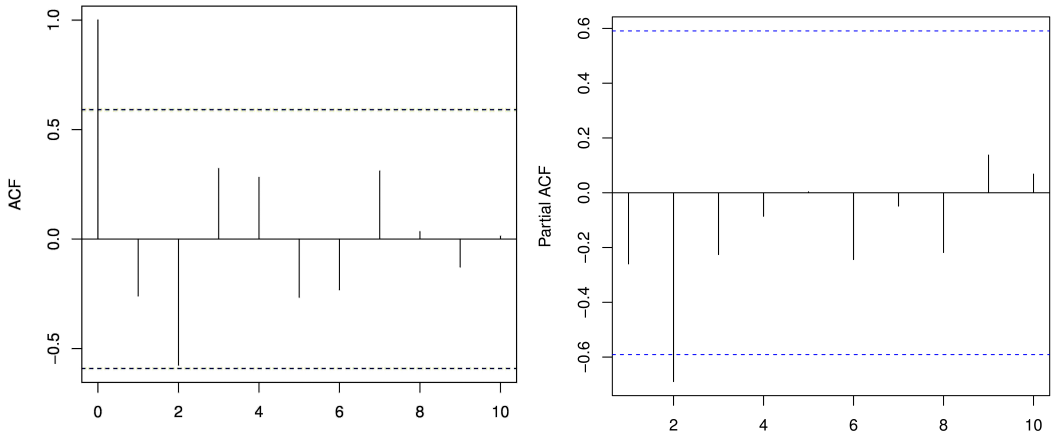


Fig. 3. Income after differencing



(a) ACF **(b) PACF**

Fig. 4. Autocorrelation and partial correlation series of income

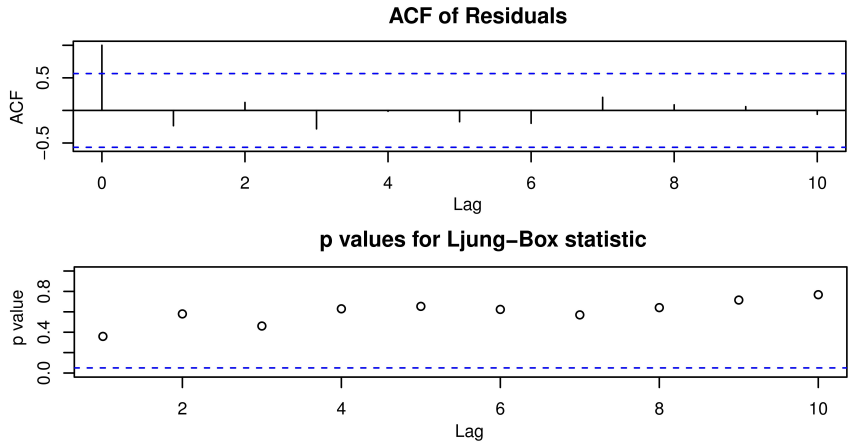


Fig. 5. Autocorrelation of residual series in ARIMA $(2,1,1)$ model for income

Table 1. Criteria of order determination of ARIMA model

ACF	PACF	Order Determination of Model
Tailing	Order p tailing	AR(p) model
Order q tailing	Tailing	MA(q) model
Tailing	Tailing	ARIMA(p,q) model

Table 2. AIC values of different models for income

Model	(1,1,1)	(1,1,0)	(0,1,1)	(0,1,0)	(2,1,1)	(2,1,0)	(2,1,2)	(0,1,2)	(1,1,2)
AIC	161.16	164.48	159.18	163.24	154.44	157.44	155.16	161.18	161.66

3.3 Estimation of Model's Coefficients

Depending on AIC, model ARIMA(2,1,1) is selected for future income forecasting. The parameters estimated as per the model identified are as follows:

Table 3. Estimated parameters for ARIMA (2,1,1)

Coefficients	ar1	ar2	ma1	drift
	-0.2543	-0.8111	-1.0000	231.4152
S.E.	0.1825	0.1529	0.3078	7.0344

The coefficients show the AR and MA terms of the particular ARIMA model. S.E. denotes the standard error.

3.4 Model Validation

It needs to test the residual series to determine whether the model has reached the optimum. The Fig. 5 shows that the ACF plot of the residuals of income has no significant pattern among the residuals of the fitted ARIMA (2,1,1) model within the confidence band. Hence it has been suggested that the residuals are free from autocorrelation.

Moreover, Ljung-Box test is also used to check the autocorrelation in the residuals of the fitted ARIMA model. From the graph of "p values

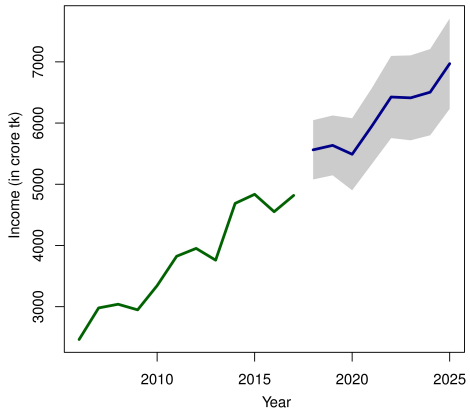
for Ljung-Box statistics", we see that, all p-values > 0.05, so null hypothesis is accepted. Which strongly suggested that there is no autocorrelation among the residuals of the fitted ARIMA (2,1,1) for income.

3.5 Forecasting

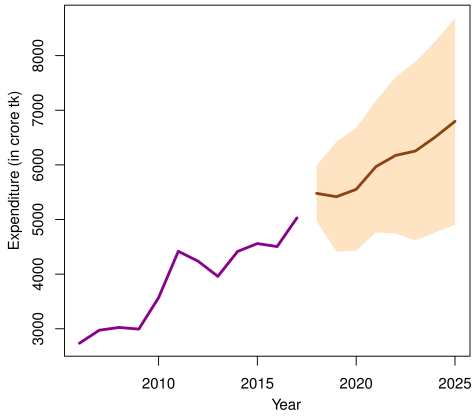
After we have defined the most appropriate model of income in our case ARIMA (2,1,1), we also make the forecast of expenditures. The procedure is the same one which we have used to forecast the income. Fig. 6 and Table 4 present the forecasted results of income and expenditure of Bangladesh Biman for the year from 2018 to 2025. Clearly we see that, both will increase with time. The income and expenditure of BBAL will increase from 5562.431 crore and 5478.516 crore in 2018 to 6970.038 crore and 6796.852 crore in 2025 respectively.

We can clearly see that the model chosen can be used for forecasting the future of Biman Bangladesh in the context of financial position. By predicting future values of income, expenditure and using these two, we have also got the profit or loss scenarios from year 2018 to 2025 in Fig. 7. After forecasting we see that Income would increase but Expenditure would also increase. As a result Biman Bangladesh may have face significant losses in the years 2020, 2021 and 2024.

The forecasts on income and expenditure obtained after modeling facilitated the decision on profit in this Airlines company. In fact, the model enabled us to forecast the profit and help to make predictions on revenue as well. Once we obtain a profit forecast, it will be much easier end very clear to make the right business planning and thus eliminate big losses.



(a) Income forecast from ARIMA (2,1,1)



(b) Expenditure forecast from ARIMA (2,2,2)

Fig. 6. Forecasting of income and expenditure

Table 4. Forecasted values of income and expenditure at 95% confidence interval

Year	Income (in crore tk)		Expenditure (in crore tk)		Profit
	Forecasted values	Confidence Interval (95%)	Forecasted values	Confidence Interval (95%)	
2018	5562.431	(5224.601, 5900.262)	5478.516	(4972.722, 5984.309)	83.915
2019	5635.268	(5294.212, 5976.323)	5417.037	(4413.864, 6420.21)	218.231
2020	5490.457	(5079.917, 5900.997)	5551.884	(4429.458, 6674.31)	-61.427
2021	5946.159	(5514.374, 6377.945)	5968.027	(4764.438, 7171.615)	-21.868
2022	6425.69	(5957.094, 6894.286)	6173.338	(4741.965, 7604.71)	252.352
2023	6412.101	(5927.963, 6896.238)	6253.556	(4619.712, 7887.4)	158.545
2024	6504.575	(6013.036, 6996.114)	6509.156	(4763.013, 8255.299)	-4.581
2025	6970.038	(6455.193, 7484.883)	6796.852	(4908.441, 8685.262)	173.186

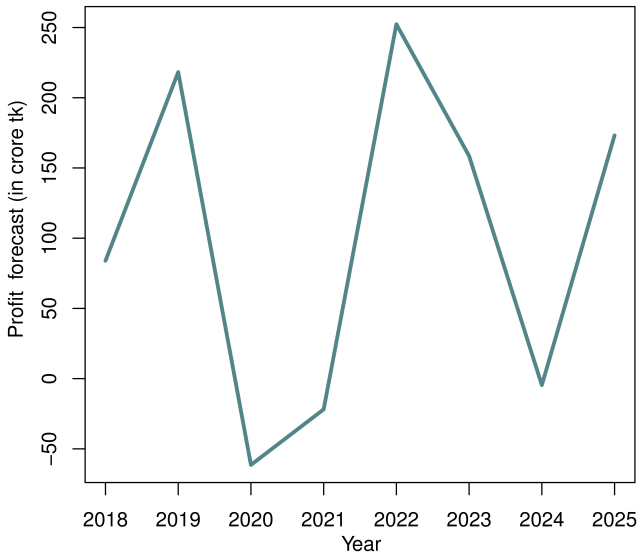


Fig. 7. Profit forecasting

4 CONCLUSION

Bangladesh Biman is one of the first choices for fly to many customers but in many aspects it lags behind. To help Biman move out from its old fashioned way of management, to accommodate the future opportunities and to avert the current crisis and threats, it is extremely essential for Biman to undertake the following steps set forth as recommendations:

- Biman should consider closing down the loss-making routes and divert the flights entirely to the profit-making ones.
- Analyzing current staff size and performing cost effective analysis, Biman should cut down its staff.
- Biman needs to purchase new generation aircraft to save operation cost significantly. Modem cost effective inventory control system should be introduced.
- During procurement of spare parts, technical experts must be included in the process. Consultants should be hired with regard to finance, store and purchase.
- In-flight service must be improved. Steps may be undertaken to ensure full complement of cabin crew, professionalism among the cabin crew, and provision of proper flight crew training to ensure that quality service can be rendered by the cabin crew at all times.

In the last but not the least, the experienced and dedicated manpower of Biman along the proper direction of management can lead Biman to be the market leader in South Asian Regions. More rigorous study can be done in future including fare, freight and no of domestic and international trips.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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