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FORECASTING THE NUMBER OF AUDITORS FOR THE SPECIALIZED DENTAL CENTER IN BABYLON USING TIME SERIES

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Abstract:

The Specialized Dental Center in Babylon is considered one of the important centers in the urban time, and the rate of auditors for this center is remarkably high, and annual plans must be drawn up by those concerned to accommodate these numbers. This study aimed to develop standard models to predict the number of auditors expected to arrive at the specialized center to use the Box Jenkins methodology

Keywords:

1. INTRODUCTION

Prosthodontics: Is one of the branches of dentistry that deals with artificial replacements of missing teeth and oral tissues by Prostheses (crowns dentures, bridge It may be fixed or removable or support and retained by implants. In dental specialized center we deals with only removable partial and complete

Time series models have been the basis for any study of the behavior of a process or measure over a period of time. Applications of time series models are multifaceted, including sales forecasting, weather forecasting, inventory studies etc. In decisions involving the factor of future uncertainty, time series models have been found to be one of the most effective forecasting methods. Most often, the future course of actions and decisions for such operations will depend on the expected result. The need for these predictable outcomes has encouraged organizations to develop forecasting techniques to be more prepared to face the seemingly uncertain future. Also, these models can be combined with other data mining techniques to help understand data behavior and be able to predict future trends and patterns in data behavior.

2. THE AIM.

- To test the possibility of applying the modern method in time series analysis to predict the number of auditors to the Specialized Dental Center in Babylon
- Develop a standard model to predict the number of auditors for the Specialized Dental Center in Babylon Forecasting the number of students expected to be referred to the Specialized Dental Center in Babylon

3. THE IMPORTANCE.

the conclusion of a standard model used to predict the number of auditors to the Specialized Dental Center in Babylon using the methodology of modern analysis of time series by Box-Jenkins methodology and Forecasting the number of auditors until the year 2022.

4. MODELS USED IN THE RESEARCH

In this research, two time series models will be used

1. Double Exponential Smoothing

There are two models of Double Exponential Smoothing and we will rely in this paper on: Holt**'s Method** This model is derived as follows 1999) McGee, Yaffee:

Let $Z_1, Z_2, \dots, Z_{n-1}, Z_{n-2}$ such that $0 < a < 1$ ، $0 < y < 1$, we find the following:

$$S_t = aZ_1 + (1-a)(S_{t-1} + b_{t-1}), \quad t = 1,2,\dots,n$$
$$b_t = y(S_t - S_{t-1}) + (1-y)b_{t-1}, \quad t = 1,2,\dots,n$$

We calculate the applicable values from

$$\hat{Z}_t = S_t + b_t t, \quad t = 1,2,\dots,n$$

and predictions for future values from

$$Z_n(l) = S_n + b_n l, \quad l > 0$$

compute initial values S_0 and b_0 from

$$S_0 = Z_1$$
$$b_0 = Z_2 - Z_1 \text{ or}$$
$$b_0 = \frac{(Z_2 - Z_1) + (Z_3 - Z_2)}{2} = \frac{(Z_3 - Z_1)}{2} \quad or$$
$$b_0 = \frac{(Z_2 - Z_1) + (Z_3 - Z_2) + (Z_4 - Z_3)}{3} = \frac{(Z_4 - Z_1)}{3}$$

2. Autoregressive-Integrated-Average Models (ARIMA)

They belong to a large family of models called **-**Moving Average Models, invented by Box and Jenkins, which has been proven by many researches in various fields. Applied for its tremendous superiority over the traditional methods of prediction (Ani,Ahmed Hussein**)**

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These models are used for unstable time series, where the degree of dispersal is given d, that is $W_t = \Delta^d t$, to convert it to a stable series) Bari 2002.**(**
The stable $W_t = \Delta^d t$ series can be modeled in the form of an autoregressive model -a moving average of degree (p, q) as follows) (Brockleban, Dickey 2003):

$$\varphi_p(B)W_t = \varphi_p(B)\nabla^d Z_t = \delta + \theta_q(B)a_t, \quad a_t \sim WN(0, \sigma^2)$$

or

$$\varphi_p(B)(1-B)^d Z_t = \delta + \theta_q(B)a_t, \quad a_t \sim WN(0, \sigma^2)$$

This model is called an autoregressive model integrative moving average of the degree (p, d, q) where $\delta \in (-\infty, \infty)$ the model is constant.

3. Predictive accuracy tests

In this research, we will rely on these tests in order to compare the two models used in the research, which one is more accurate in Forecasting and these tests are

I. **Root Mean Square Error (RMSE)** can be found by the following formula:

$$RMSE = \sqrt{\sum_{t=1}^{n} a_t^2/n}$$

II. Mean absolute error **(MAE)** can be found by the following formula:

$$MAE = \sum_{t=1}^{n} |a_t|/n$$

Tests I and II used to find out the predictive power of the model used

III. **Mean Absolute Percentage Error (MAPE)** can be found by the following formula:

$$MAPE = \sum_{t=1}^{n} (|a_t|/Z_t)/n$$

5. APPLICATION SIDE

Data collection:

The study sample represented the number of auditors to the Specialized Dental Center in Babylon from January 2019 to December 2021 as shown in the following table:

Table (1) represents the auditors to the Specialized Dental Center in Babylon from January 2019 to December 2021

	2019	2020	2021
January	105	358	1265
February	153	352	1300
March	192	388	1464
April	289	427	1179
May	404	355	1496
June	360	691	1316
July	347	717	1642
August	391	499	1328
September	364	558	1290
October	369	768	1239
November	374	769	863
December	366	1028	810

The stability of the series

After collecting the data, which is the first stage of the Jenkins Box methodology, we draw data for the number of auditors to identify the behavior of the series and Figure No. (1) represents the drawing of the series

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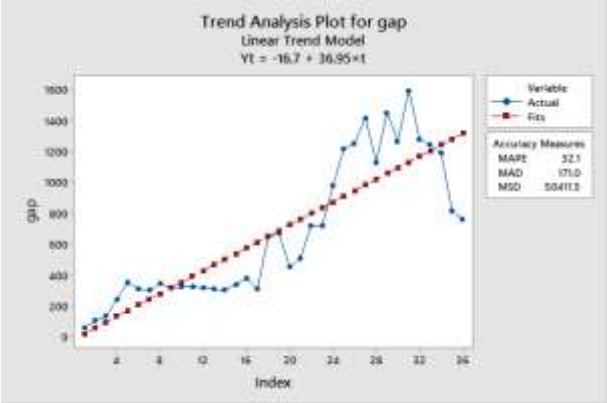
Figure (1) Charting a series of the number of auditors to the Specialized Center for Dental Industry in Babylon from January 2019 to December 2021



, through Figure No. (1), we note the instability of the time series, and for more accuracy, we draw the ACF and the partial autocorrelation PACF, respectively:

Figure (2) Autocorrelation Function ACF

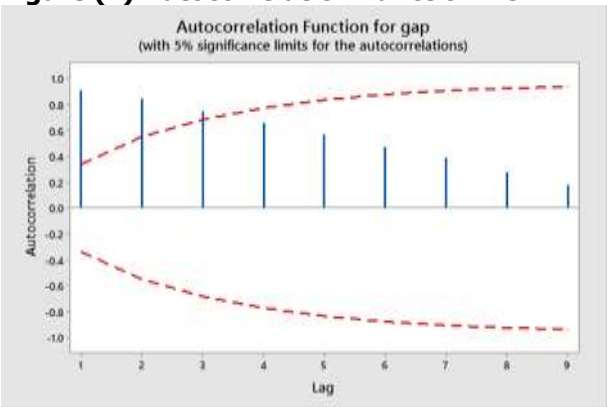
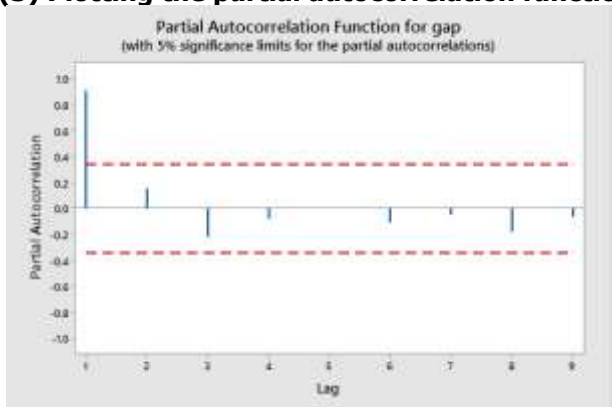


Figure (3) Plotting the partial autocorrelation function PACF



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where we notice from Figure (2) that the ACF autocorrelation coefficients are outside the confidence limits and the level of significance is 95%, as well as from Figure (3) regarding the behavior of the partial autocorrelation coefficients PACF that the first displacement is outside the confidence limits of the correlation coefficients The subjective part and this is an indication of the lack of stability in the series. Therefore, we take the differences where stability is achieved after taking the first difference, so the graph of the resulting series becomes as it appears in Figure (4), as it seems that the series has become stable, and the ACF and PACF functions are plotted after taking the first difference And its coefficients as shown in Figures (5) and (6) confirm this.

Figure (4) Drawing of the series of reviewers after taking the first difference

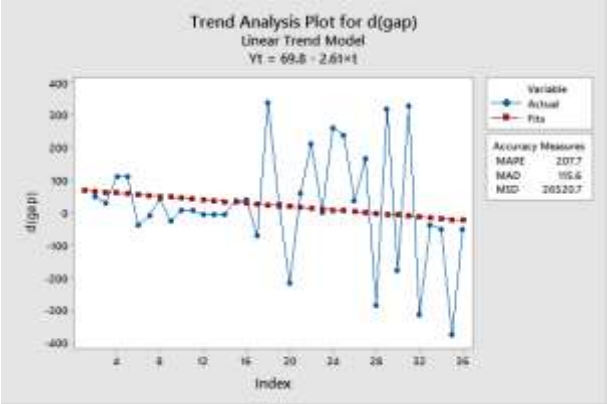

Figure (5) Drawing ACF after taking the first difference

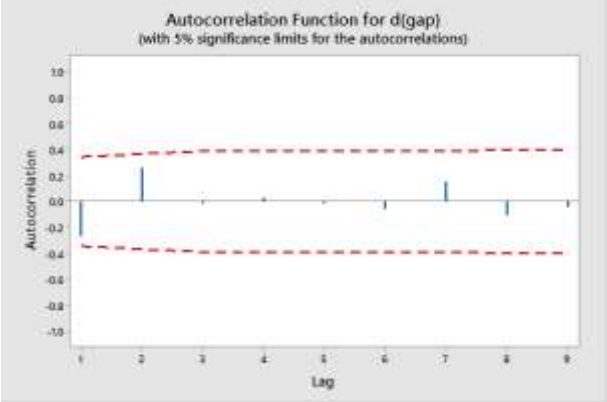

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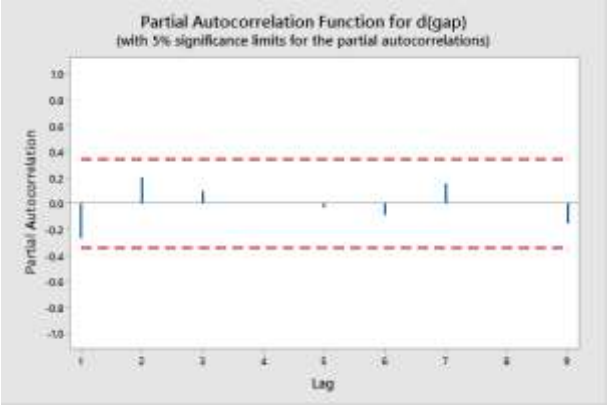
Figure (6) Drawing PACF after taking the first difference



Diagnosing and estimating the model and choosing the best

model to more accurately determine the model's rank. A number of models were reconciled and the best model was selected according to the criteria for differentiation and the proposed models. It was found that the best model from the Jenkins Box models is ARIMA(1,1,0) being standard values (BIC criterion and The AIC criterion that is used to differentiate between models is of less value.

Accuracy Of The Model

After diagnosing the model, determining its degree and estimating it, it is necessary to ensure the correctness of the model's suitability and efficiency, and this was done through

1. The (Liung-Box) test

by applying the properties of (Liung-Box) to check the fit of the model and it appeared that $(Q = 11.37)$ at the displacement $K = 12$ and through the value of P-Value and this indicates that the errors are not related to each other and the value of the P-Value increases as the number of displacements increases and this Indicates that the model is good, appropriate and efficient, as shown below.

Modified Box-Pierce (Ljung-Box) Chi-Square Statistic

Lag	12	24	36	48
Chi-Square	11.37	15.42	20.52	24.91
DF	10	22	34	46
P-Value	0.329	0.844	0.921	0.991

2. Residuals test

The autocorrelation coefficients and partial residuals (errors) of the estimated model were extracted and plotted. We note from the figure that all the autocorrelation coefficients of the residuals are within confidence limits, which means that the series for residuals is random and the model used is good and appropriate.

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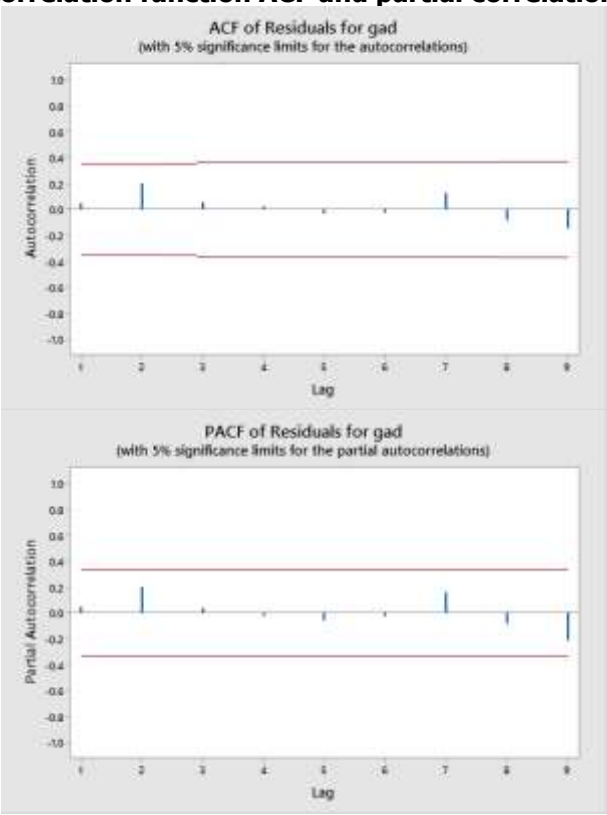
Figure (7) plotting the autocorrelation function ACF and partial correlation function PACF for residuals



FORECASTING

After the model has passed the diagnostic tests, it becomes possible to use the model for prediction and Table No. (2) represents the predictive value for the year 2022 and for all months of the number of auditors to the Specialized Center for the Dental Industry in Babylon, and Figure No. (8) represents the chart of the predictive value of the series with confidence limits. On this predictive value using the model
ARIMA(1, 1, 0).

Table (2) represents the predictive value of the number of visitors to the Specialized Dental Center in Babylon

time	Forecasting
Jan.2022	800
Feb.2022	815
Mar.2022	837
Apr.2022	857
May.2022	878
Jun.2022	898
Jul.2022	918
Aug.2022	939
Sep.2022	959
Oct.2022	980
Nov.2022	1000
Dec.2022	1021

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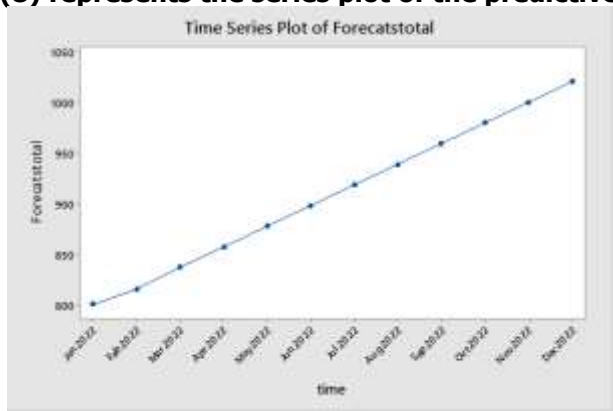
Figure (8) represents the series plot of the predictive values



CONCLUSIONS AND RECOMMENDATIONS:

First: Conclusions

A number of conclusions were reached based on the findings, the most important of which are:

1. The time series of the number of auditors is unstable on average, so the first difference was taken to achieve stability in it, and after taking the difference, the series became stable.
2. Depending on the criteria (BIC and AIC), the model ARIMA (1, 1, 0) was selected for the number of auditors by differentiating between a set of models.
3. The fit of the ARIMA (1,1,0) model for the number of auditors was a good fit after applying the Ljung-Bic test and the residual test.

Second: Recommendations

1. Ensure that data is recorded in an accurate and continuous manner for the number of auditors to the Specialized Center for Dental Industry in Babylon
2. Relying on the predicted value in this research according to the selected models to develop appropriate plans and policies
3. Conducting future studies that include the use of non-linear time-series models and binary models for the number of visitors to the Specialized Dental Center in Babylon.

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