Time Series Analysis of Number of Road Motor Vehicles in Turkey

KARACASU Murat, AKALIN Kadir Berkhan, ERGÜL Barış

Abstract— **Recently there has been an increased interest in number of road motor vehicles in Turkey. Number of road motor vehicles in Turkey is increasing at an alarming rate and has raised major concerns. There is a feeling that the rapid growth of traffic should be accompanied by additional efforts to improve traffic safety, in order to stop the corresponding increase in number of road motor vehicles. In this study the developments of traffic and number of road vehicles are investigated and forecasts are made. Time series with Box – Jenkins method was applied to 47 years of annual number of road motor vehicles data from 1966 to 2013 to determine patterns of road traffic safety cases. Models were subsequently developed for number of road motor vehicles in Turkey. ARIMA(0,2,1) was used to model the number of road vehicles data from 1966 to 2013. Model showed that number of road motor vehicles in Turkey would continue to increase.**

Keywords— **transportation, ARIMA, Turkey, road motor vehicle**

I. Introduction

Transportation is the movement of people or goods from one location to another. Transporter is natural or legal person who has an authorization for transportation and undertake transportation on its own behalf.

Road transport has become the most widely used transportation system in many developed and developing countries in the 2000s. As a natural result of unplanned applications in previous years, serious imbalances have occurred between modes of transportation and road transportation have become prominent for both passenger and freight transport. According to recent data, about 98% of passenger and 92% of freight transport are done by highway in Turkey. This situation leads traffic to be massive on the highway in Turkey. [1].

The aim of this study is to estimate the number of road motor vehicles in traffic in the future by using the number of motor vehicles we know.

KARACASU Murat, AKALIN Kadir Berkhan
University of Eskişehir Osmangazi, Engineering and Architecture Faculty
TURKEY

ERGÜL Barış
University of Eskişehir Osmangazi, Faculty of Science and Letter
TURKEY

In this study, the number of road motor vehicle in Turkey in the period between 1966 and 2013 is taken annually data from Turkey Statistical Institute.

In the second part of the study Box-Jenkins or ARIMA technique is described. In the third chapter, the number of motor vehicle is predicted by using Box-Jenkins technique for the period between 1966 and 2013 in Turkey and the obtained results are given. In the fourth part there is conclusion and general comments.

II. Material and Method

If time series contain discrete, linear and stochastic processes, it is called Box-Jenkins or ARIMA model [2]. AR-Autoregressive models was introduced by Yule. The other model, MA-Moving Average, is considered by Slutsky. ARMA-Autoregressive Moving Average which is a mixture of AR and MA models is developed by Wold [3]. The models applied to the series which is not stable at first but stabilized in the result of getting difference, called ARIMA-Autoregressive Integrated Moving Average model. This model also called as Box-Jenkins technique. The aim of the Box-Jenkins models; determining the linear model which fits best to the time series and includes least parameters [4].

The mean of the times series and variance must be stationary for the ARIMA models to be implemented. So in the first stage, it must be examined whether the series is stationary. For a stationary series, mean, variance and autocovariance must be independent from time variable. Therefore, to make the series stationary, number d is subtracted from the previous values of the series [5].

The functions of autocorrelation and partial autocorrelation of the series are utilized to determine which of ARIMA(p,d,q) processes is appropriate for subtracted series. The next stage is to test the suitability of the temporary model.

The goodness of fit is determined by BIC (Bayesian information criterion) value which is based on the total of the square of discards. It is desired for BIC value to be as small as possible [6].

III. Road Motor Vehicles Forecast

In the first stage in order to find a temporary model, autocorrelation and partial autocorrelation graphs with series graph are drawn.
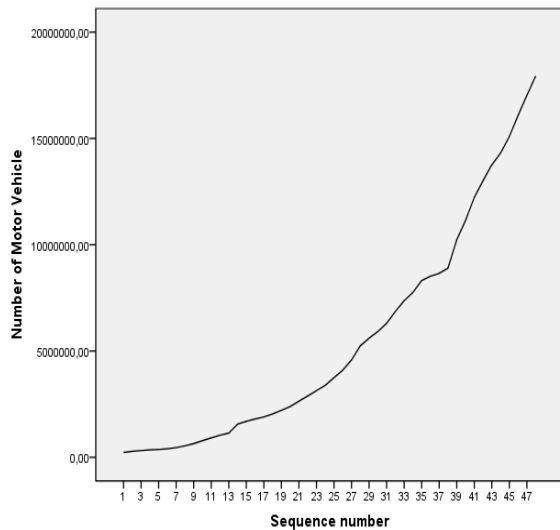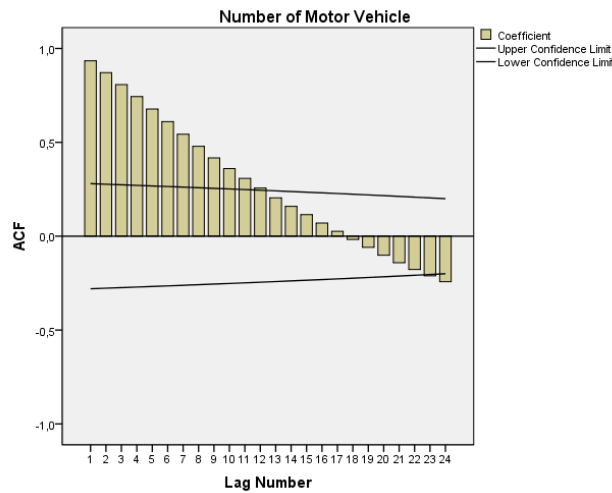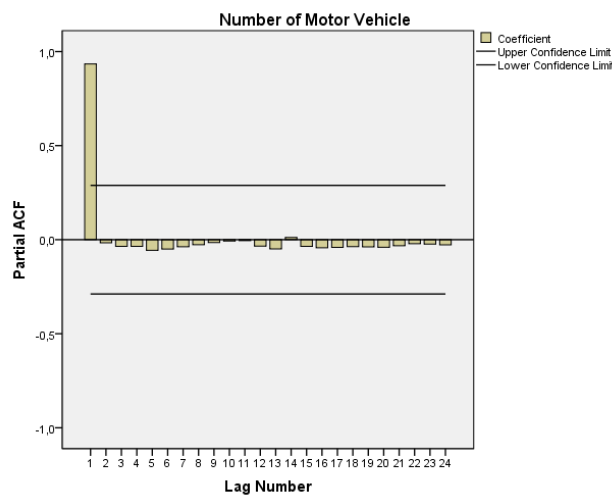
Figure 1. NUMBER OF THE MOTOR VEHICLE

When autocorrelation and partial autocorrelation graphs of the series are analyzed, the first few autocorrelation and partial autocorrelation values take place outside the limits and other delay values take place within the limits. In the following stage, various ARIMA models are tested for this series.

TABLE 1. DIFFERENT ARIMA MODELS AND BIC

ARIMA Models	BIC Values
ARIMA(1,0,0)	28.060
ARIMA(1,1,0)	24.728
ARIMA(1,0,1)	28.548
ARIMA(1,1,1)	24.606
ARIMA(1,0,2)	28.413
ARIMA(0,1,1)	25.154
ARIMA(0,2,1)	**24.559**

TABLE 2. MODEL PARAMETERS FOR ARIMA(0,2,1)

Parameters	Estimate	SE	t	Sig.
Constant	19748.392	3638.083	5.428	0.000
Difference	2			
MA	0.916	0.090	10.222	0.000

When Table 1 and Table 2 are analyzed, ARIMA(0,2,1) is the model where model has the lowest value according to BIC criteria. In addition, the probability value (Sig.) which is calculated to test significance of the estimation parameters of the model is significant because of being less than significance level a=0.05. So thinking that the ARIMA(0,2,1) is the appropriate temporary model, processes are continued.

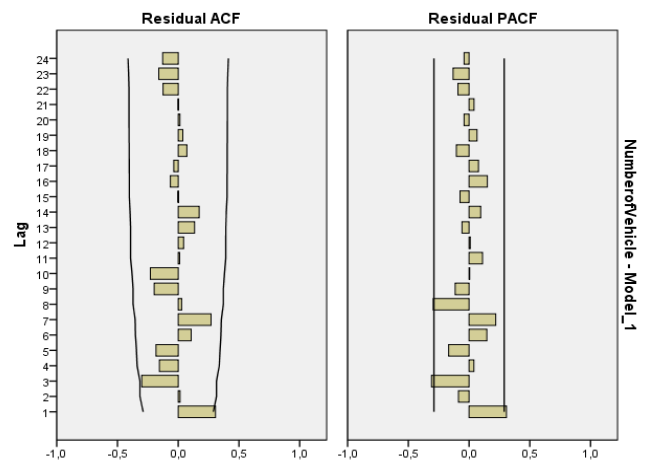Autocorrelation an partial autocorrelation function graphs for ARIMA(0,2,1) model are drawn in Figure 4.

Figure 2. ACF GRAPH

Figure 3. PACF GRAPH

Figure 4. ACF AND PACF GRAPH FOR ARIMA (0,2,1)

2

The suitability of provisional model is tested with Ljung-Box test.

TABLE 3. LJUNG-BOX STATISTICS FOR ARIMA(0,2,1)

Statistics	df	Sig.
26.918	17	0.059

To decide that temporary model is the appropriate one by Ljung-Box statistics (Sig. > 0.05).

Using the ARIMA(0,2,1) model, the number of motor vehicle predictions are made for the period between 2014 and 2020. Reason for making predictions for this period is ARIMA models give very satisfactory results for short term.

IV. Conclusion

In this study, the number of road motor vehicles in Turkey in the period between 1966 and 2013 is taken annually data from Turkey Statistical Institute. These data sets were analyzed by Box-Jenkins technique.

Predictions for road motor vehicles in Turkey for the period between 2014 and 2020 are made by the ARIMA model which is defined by analysis result shown in Table 4.

TABLE 4. FORECAST FOR MOTOR VEHICLES

Period	Estimate Value of Number of Motor Vehicles
2014	18816681
2015	19713663
2016	20630394
2017	21566874
2018	22523101
2019	23499077
2020	24494802

Model showed that number of road motor vehicles in Turkey would continue to increase.

References

[1] B. Çetin, S. Bakış, and S. Saroğlu, "Türkiye'de Karayollarının Gelişimine Tarihsel Bir Bakış," Çankırı Karatekin Üniversitesi İktisadi ve İdari Bilimler Fakültsi Dergisi, Cilt:1 Sayı:1, pp. 123-150, Güz 2011.

[2] A. Kutlar, Uygulamalı Ekonometri, 2nd ed., Nobel Yayınları. Ankara, 2005.

[3] M. B. Priestly, Non-Linear and Non-Stationary Time Series Analysis, Academic Press. London, 1991.

[4] C. Hamzaçebi and F. Kutay , "Yapay Sinir Ağları ile Türkiye Elektrik Enerjisi Tüketiminin 2010 Yılına Kadar Tahmini," Gazi Üniversitesi MMF Dergisi, Cilt:19, No:3, pp. 19-40, 2004.

[5] İ. Akgül, Zaman Serileri Analizi ve ARIMA Modelleri, Der Yayınları. İstanbul, 2003.

[6] C. Kadılar, SPSS Uygulamalı Zaman Serileri Analizine Giriş, Bizim Büro Basımevi. Ankara, 2005.

[7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

About Author (s):

KARACASU, Murat
Assoc. Prof. Dr. in civil engineering department transportation division at Eskişehir Osmangazi University, TURKEY
He was born in 1973 in Afyon, TURKEY.
He graduated from Eskişehir Osmangazi University Engineering and Architecture Faculty Civil Engineering Department and ranked first in department in 1994 and graduated from MSc. Transportation Engineering in 1996.
He finished his PhD. Degree education in Istanbul Technical University in 2007.

AKALIN, Kadir Berkhan
He was born on 02.06.1990 in İzmir TURKEY.
He graduated from Eskişehir Osmangazi University Engineering and Architecture Faculty Civil Engineering Department and ranked first among all students graduating from the university with 3.95/4.00 GPA in 2013.
He continues studying both in MSc. Transportation Engineering at Istanbul Technical University and MSc. Railway Engineering at Eskişehir Osmangazi University.

ERGÜL, Barış
He graduated from Eskişehir Osmangazi University Science and Letters Faculty Statistics Department in 1998.
He continues his PhD. education in Applied Statistics at Eskişehir Osmangazi University.