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FORECASTING OF (DEAD AND NON DEAD, DEATHS AND INJURIES) FOR TRAFFIC ACCIDENTS IN IRAQ USING AN OPTIMAL STATISTICAL MODELS

Dr. Nahla Hafidh Jawad

Lecture, Highway and Transportation Engineering Department, Al-Mustansiriyah University, Baghdad, Iraq.

Abstract: Objective: This research aimed to forecasting of an expected outcomes for the planning periods (2014-2026) based on the numbers of traffic accidents, as well as projection long term trend graphically for (Dead and non dead accidents, numbers of deaths, and numbers of injuries), in Iraq throughout applying an optimal statistical models. Methodology: Data are selected from annuls statistical reports of traffic accidents registered and published by Ministry of Planning for the time periods (2002-2013). Five criteria had been applied, such that (MSE, MAE, MAPE, ME, and MPE), the first three statistics measuring the magnitude of the errors. A better model will give a smaller value. The last two statistics measure bias. A better model will give a value close to zero. Results and Findings: Several forecasting models are suggested, and among that are nominated (Linear trend, Brown's Linear Exponential Smoothing, and Moving Average of order (1) i.e. MA(1)), since recorded significant autoregressive, and goodness of fit tests. Conclusions: For the three time series, (Dead accidents, no. of deaths, and no. of injuries), it will be increases significantly at the projection of planning periods, while time series, concerning (Non Dead accidents) according to the magnitude of residuals by applying studied indicators, shows stability status along the projection periods at the general mean line.

Keywords: *Traffic Accidents, Forecasting Methods, Linear & Non Linear Time Series Analysis, Goodness of Fit, Future Projection.*

التنبؤ بحوادث المرور (المميتة، وغير المميتة، وأعداد حالات الوفاة، وأعداد الجرحى) في العراق باستخدام النماذج ألأمثليه

الخلاصة: الهدف: يهدف البحث إلى التنبؤ عن النتائج المتوقعة للفترة المخطط لها (2014-2026)، بالإضافة الى بيان خط الاتجاه العام لإعداد الحوادث المرورية (الحوادث المميتة وغير المميتة وأعداد القتلى، وأعداد إصابات الجروح) في العراق من خلال تطبيق النماذج الإحصائية المثلى. إجراءات البحث: تم اختيار البيانات من التقارير الإحصائية السنوية لحوادث المرور المسجلة، والمنشورة من قبل وزارة التخطيط للفترة الزمنية (2002-2013). وقد طبقت خمسة معايير، هي (MSE، MAE، MAPE، ME، وMPE)، حيث أن الإحصاءات الثلاثة الأولى تختص بحجم الأخطاء. في حين يعكس المؤشرين الآخرين مقياس التحيز، حيث أن النموذج الأفضل هو النموذج الذي يعطي قيمة تقترب من الصفر. النتائج وعرضها: تم اقتراح العديد من نماذج التنبؤ، وجاء من بينها ترشيح النماذج (الخطي الاتجاه، الممهد الأسي الخطي لبراون، والمتوسط المتحرك من الرتبة (1))، حيث معنوية نتائج الانحدار الذاتي، واختبارات جودة المواءمة. الاستنتاجات: سجلت نتائج السلاسل الزمنية الثلاث (الحوادث المميتة، وأعداد الوفيات، وأعداد الإصابات)، زيادةً كبيرة بتقادم فترات الإسقاط الزمني المخطط لها، بينما جاءت نتائج إسقاطات السلسلة الزمنية (أعداد الحوادث غير المميتة) وفقا لتحليل الأخطاء على امتداد فترات الإسقاط عند خط المتوسط العام.

nahlahafidh@yahoo.com

1. Introduction

The mass transport of different kinds one cultural manifestations that reflect the growth of economic and social activities, evolution and against the expansion of the numbers and types of these media highlights the issue of traffic accidents and the resulting human and material losses exacerbated danger to the national economy, the increase in number and severity, and to find out the causes and develop appropriate solutions to reduce them [1].

The injuries of the traffic accidents of great seriousness and comparable to the current-terrorism operations, as it constitutes an obsession and concern for all members of the community and has become one of the problems that drain material resources and incur social problems and loss of human energies which affects the necessities of life in which the human element is the foundation of society and has become the work necessary to find solutions and suggestions and put them into practice to reduce these accidents or at least address the causes and mitigate the negative effects and to identify the most important elements that share and caused traffic accidents, which are the driver and the road and the vehicle ... etc [2].

The World Health Organization seeks to provide indicators for the total death cases and performed this report contain death accidents during accident only [3]. But there are cases of death after the accident occur in the hospital for serious injuries, and so "Central Bureau of Statistics (NBS)" as the issuer of the data, and by cooperation with the Ministry of Health starting for recorded that cases under classification of " No. of death, and No. of Injuries".

The current study singled to adjust optimization models to analyze data of car accidents and numbers of fatal and non- fatal cases, in addition to the number of deaths and the number of cases of various injuries resulting from car accidents during the years of the time series (2002-2013) years. As well as making future projections process for those incidents, and that are for the first time as for (as we know).

2. Objectives and Scope of Work

1. To find out long term trend graphically based on traffic's projection accidents, such that (Dead and non dead accidents), and (numbers of deaths, and numbers of injuries) in Iraq throughout applying an optimal statistical models.
2. Forecasting of an expected numbers based on traffic accidents, such that (Dead' and non dead accidents), and (numbers of deaths, and numbers of injuries) in Iraq throughout applying an optimal statistical models.

3. Definitions of studied modes [4, 5, 6, 7, 8]:

1. The Brown's Linear exponential smoothing function (F_{T+m}) is defined as:

$$S_1' = X_1$$
$$S_1'' = X_1$$

$$S'_{tgt:1} = \alpha X_t + (1+\alpha) S'_{t-1}$$
$$\alpha_t = 2S'_t - S''_t$$
$$b_t = \frac{\alpha}{1-\alpha} (S'_t - S''_t)$$
$$F_{T+m} = \alpha_T + m \times b_T$$

where : X_t is the value of the time series t.

T is the time of the latest observation in the sample data.

α is the smoothing factor.

2. The Simple Linear trend function (y'_t) is defined as:

$$Y'_t = a + bY_{t-1}$$

where: Y' **:** read Y prime, is the projected value of the Y variable for a selected value of t.

a **:** is the Y-intercept. It is the estimated value of Y when y_{t-1} = 0. Another way to put it is the estimated value of Y where the line crosses the Y-axis when t is zero.

b **:** is the slope of the line, or the average change in Y' for each change of one unit in t.

t **:** is any value of time that is selected

3. The Moving Average trend function of order (1) is defined as:

$$w_t = \mu + \theta_1 w_{t-1}$$

where **:** w_t are identically, independently distributed, each with a normal distribution having mean 0 and the same variance.

4. Results and Finding

This procedure will forecast future outcomes for studied parameters, such that (dead's and non dead numbers of car accidents, as well as forecasting deaths, and injuries numbers) along (2014-2026) periods of years. The studied of parameter's series cover 13 time periods (2002-2013).

Currently, three statistical models, linear trend, quadratic exponential smoothing, and moving average of order (1) has been selected, since are accounted significant autoregressive, as well as goodness of fit in at least at P<0.05. These models assumes that the best forecast for future outcomes are given by linear trend estimated for dead accidents, and for deaths, injuries numbers, while Brown's Quadratic exponential smoothing are fitted for non dead accidents, and finally ARIMA(0,0,1) mode of moving average are fitted for total numbers for dead and non dead' accidents.

Table (1) summarizes the performance of the currently selected models in fitting the previous data. It displays:

(1) the mean squared error (MSE)

(2) the mean absolute error (MAE)

(3) the mean absolute percentage error (MAPE)
(4) the mean error (ME)
(5) the mean percentage error (MPE)

Table(1) Summarizes the performance of the currently selected models in fitting of the studied data for obtaining a forecast outcomes at the planning periods.

Optimal Models Selection					
Forecast model selected:	Linear trend (α=0.0008) (*)	Brown's Quadratic exp. Smoothing (α =0.0074) (*)	ARIMA (0,0,1) with constant (α =0.0000) (*)	Linear trend (α=0.0003) (*)	Linear trend (α=0.0140) (*)
Studied Parameters					
Indicators	Dead accidents	Non Dead Accidents	Total no.	No. of deaths	No. of Injuries
MSE	152804.0	3.75362E6	1.93E6	144089	4.04E6
MAE	269.136	1458.65	1020.42	275.816	1525.86
MAPE	19.9523	39.8067	18.6979	16.6521	29.2448
ME	3.498E-14	-222.686	-383.291	5.25E-14	-7.00E-14
MPE	-5.93641	-22.9035	-1.17E1	-3.93357	-10.9652

(*) *(α < 0.05: Significant)*

Each of the statistics is based on the one-ahead forecast errors, which are the differences between the data value at time t and the forecast of that value made at time t-1. The first three statistics measure the magnitude of the errors. A better model will give a smaller value. The last two statistics measure bias. A better model will give a value close to 0.0.

Table (2) shows the real observation and expected responses by applying of fitted models at the planning of the studied periods (2002-2013) years.

Table 2. Real observation and Responses by selected fitted models at the planning of the studied periods.

Responses Periods	Response's Estimates									
	Dead accidents		Non dead accidents		Total no.		No. of deaths		No. of Injuries	
	Real	Resp.	Real	Resp.	Real	Resp.	Real	Resp.	Real	Resp.
2002	1542	1043	6993	6168	8535	8734	1693	1184	7072	4859
2003	1233	1176	5593	6185	6826	8282	1355	1331	5657	5294
2004	1480	1309	6711	6171	8191	6575	1626	1479	6788	5729
2005	1628	1442	7382	6182	9010	10749	1789	1627	7467	6164
2006	932	1575	2457	6208	3389	6190	1151	1774	3303	6599
2007	945	1709	2190	6124	3135	4746	1210	1922	3252	7034
2008	1628	1842	3874	6036	5502	6363	1863	2069	5499	7469
2009	1955	1975	5497	5986	7452	7382	2151	2217	7955	7904
2010	2194	2108	6667	5973	8861	8647	2508	2364	8996	8339
2011	2372	2241	7710	5986	10082	8843	2703	2512	10198	8774
2012	2900	2374	7809	6022	10709	10235	3132	2660	11009	9209
2013	2601	2507	7124	6060	9725	9196	2951	2807	10694	9644

Figure (1) shows the projection of long term trend graphically for (Dead and non Dead Accidents, as well as total numbers) of cars accidents for studied and forecasting of planning periods in Iraq throughout applying an optimal of statistical

models by applying of fitted models at the planning of the studied periods (2002-2013) years, and planning of projection periods (2014-2026) years [9].

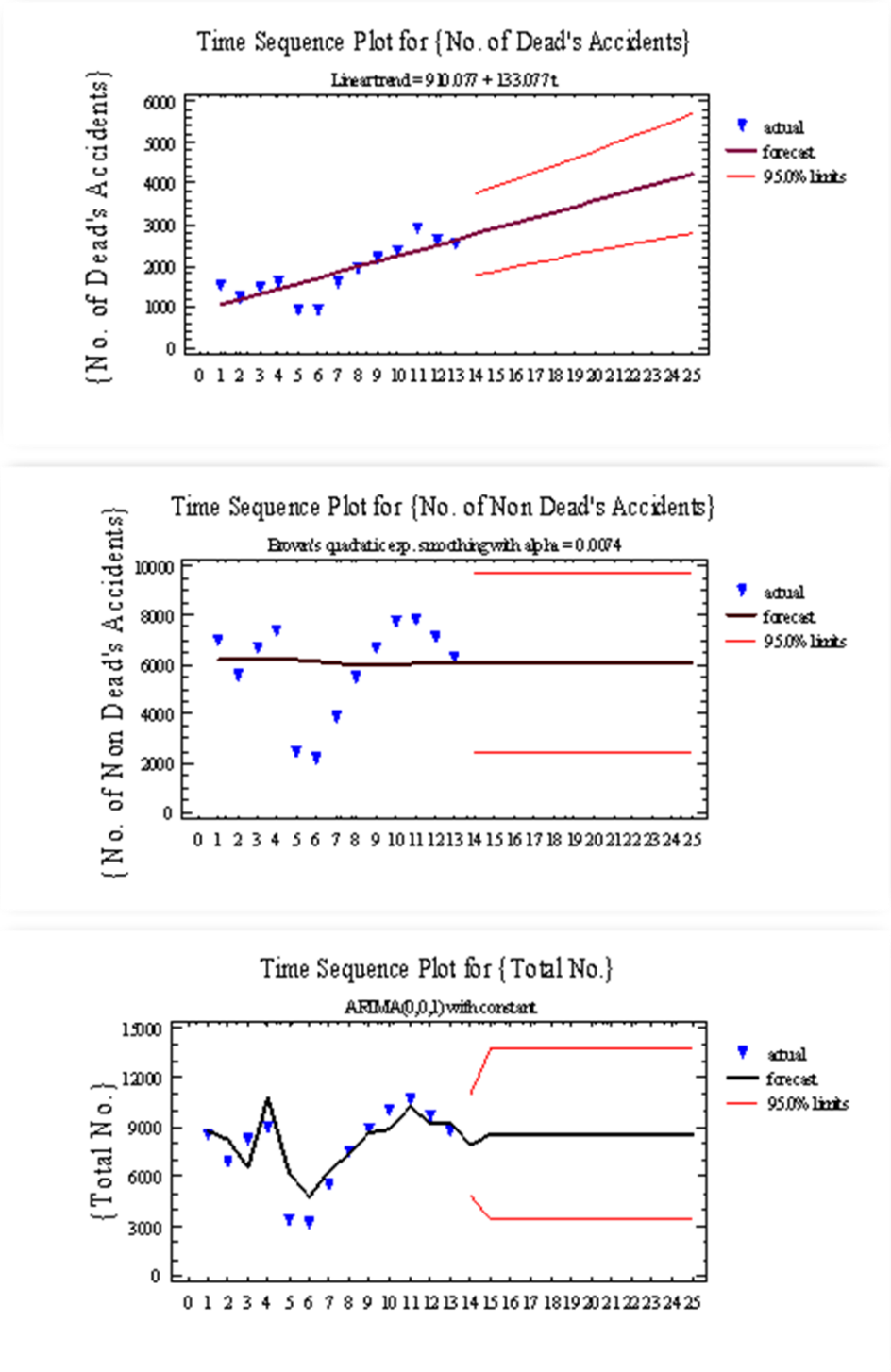

Figure 1. Projection of long term trend graphically for (Dead and non dead accidents, as well as total numbers) of cars accidents for studied and forecasting of planning periods in Iraq throughout applying an optimal of statistical models

Figure (2) shows the projection of long term trend graphically for (No. of Deaths and Injuries) of cars accidents for studied and forecasting of planning periods in Iraq throughout applying an optimal of statistical models by applying of fitted

models at the planning of the studied periods (2002-2013) years, and planning of projection periods (2014-2026) years [9].

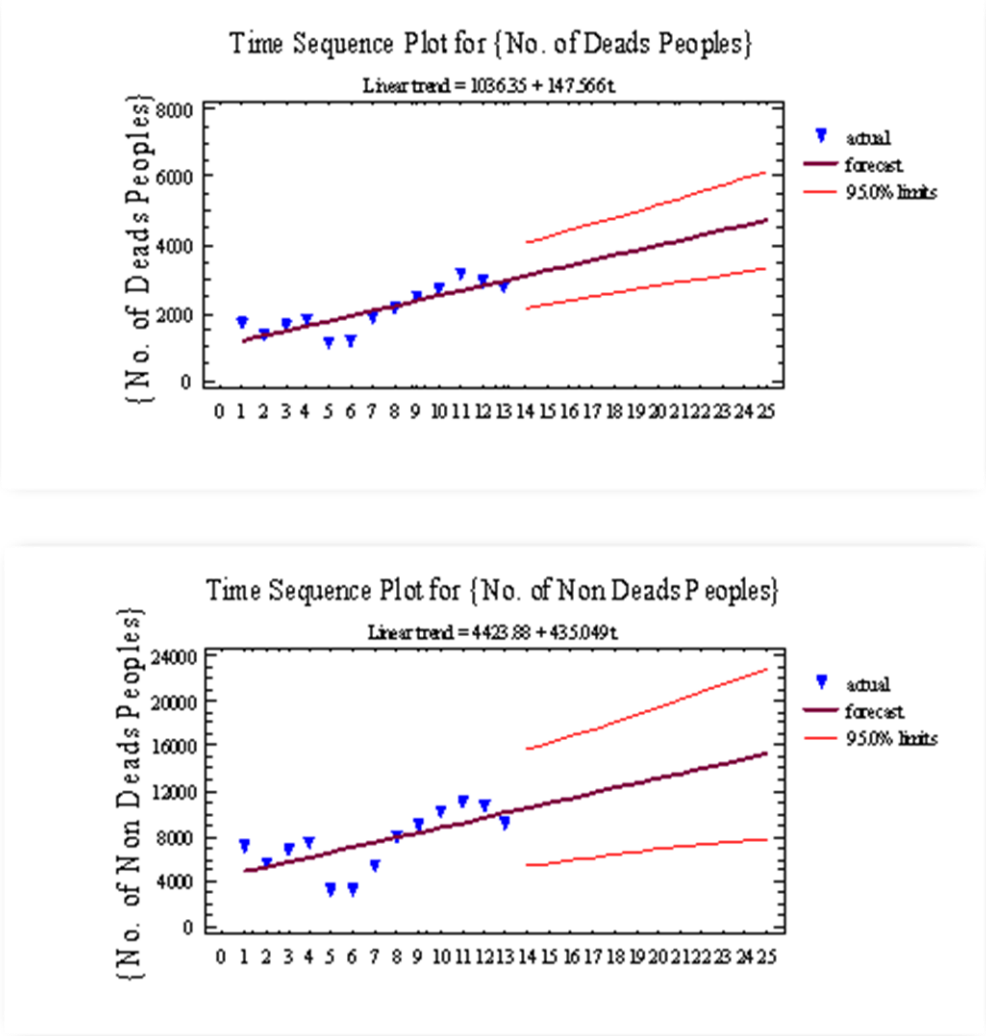

Figure 2. Projection of long term trend graphically for (No. of Deaths and Injuries) by cars accidents for studied and forecasting of planning periods in Iraq throughout applying an optimal of statistical models

Table (3) Shows the forecasting of an expected outcomes by selected fitted models at the planning of the future periods (2014-2026) years.

5. Conclusions

1. The three time series, (Dead accidents, deaths, and injuries numbers) according general to the magnitude of residuals by applying studied indicators, it will be increases significantly at the projection periods.
2. The time series, (Non Dead accidents) according to the magnitude of residuals by applying studied indicators, shows stability status along projection periods at the mean line.

Table3. Forecasting of expected outcomes by selected fitted models at the planning of the future periods.

Forecasting Years	Dead Accidents	Non Dead Accidents	Total No.	No. of deaths	No. of Injuries
	Forecast	Forecast	Forecast	Forecast	Forecast
2014	2640	6082	9271	2955	10080
2015	2773	6081	7931	3102	10515
2016	2906	6079	8552	3250	10950
2017	3039	6078	8552	3397	11385
2018	3172	6077	8552	3545	11820
2019	3305	6075	8552	3693	12255
2020	3439	6074	8552	3840	12690
2021	3572	6072	8552	3988	13125
2022	3705	6071	8552	4135	13560
2023	3838	6070	8552	4283	13995
2024	3971	6068	8552	4430	14430
2025	4104	6067	8552	4578	14865
2026	4237	6065	8552	4725	15300

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