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Research Article

Increasing Number of Vehicles and Traffic Accidents in Turkey: Current Situation and Future Predictions

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Abstract

Statistics on road safety and traffic accidents show that the increasing number of vehicles causes a significant increase in the number of accidents. As a result of urbanization and population growth, the number of vehicles using the roads is increasing rapidly. This increase increases traffic congestion and therefore the risk of accidents, especially in big cities and heavy traffic areas. This study aims to comprehensively examine the effects of vehicle excess on traffic accidents and make predictions on possible future scenarios. Within the scope of the study, existing traffic data will be analyzed and changes in accident rates will be evaluated as the number of vehicles increases.

Keywords: *Traffic Accident, Prediction, Vehicle Rates, Exponential Smoothing Method, Holt-Winters*

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Türkiye'de Artan Araç Sayısı ve Trafik Kazaları: Mevcut Durum ve Geleceğe Dair Tahminler

Öz

Yol güvenliği ve trafik kazaları konusundaki istatistikler, artan araç sayısının kaza sayılarında belirgin bir artışa neden olduğunu göstermektedir. Şehirleşmenin ve nüfus artışının sonucu olarak, yolları kullanan araç sayısı hızla artmaktadır. Bu artış, özellikle büyük şehirlerde ve yoğun trafik bölgelerinde trafik sıkışıklığını ve dolayısıyla kaza riskini artırmaktadır. Bu çalışma, araç fazlalığının trafik kazalarına olan etkilerini kapsamlı bir şekilde inceleyerek, gelecekte olası senaryolar üzerine tahminlerde bulunmayı amaçlamaktadır. Çalışma kapsamında, mevcut trafik verileri analiz edilerek, araç sayısının artmasıyla birlikte kaza oranlarındaki değişimler değerlendirilecektir.

Anahtar kelimeler: *Trafik Kazası, Tahmin, Araç Oranları, Üstel Düzeltme Yöntemleri, Holt-Winters*

1. Introduction

In recent years, the significant development of technology has increased the quality of life depending on positive developments such as the increase in the transportation level, transportation demand has increased. With all these developments, the efficiency and number of transportation networks are also a natural consequence of increasing comfort demands. The number of vehicles increasing day by day increases the traffic density on the highways (Parsa et al., 2020). In parallel with this situation, traffic in many countries. The increase in accidents poses a serious problem (Deb & Liew, 2016). The number of vehicles and usage rates have also increased. In traffic density due to not being adequately prepared for this increase and not being able to take precautions. Therefore, an increase in accidents has been observed. The World Health Organization in 2010 According to the statistics published by the world, an average of 1,240,000 people are trafficked every year and die in accidents. Damage caused by traffic accidents reaches an average of $518 billion annually (Karayolları Trafik Kanunu, 1983; World Health Organization, 2013).

In recent years, the significant development of technology has increased the quality of life depending on positive developments such as the traffic problem, which has become the biggest problem in our country. Also it compares favorably with other countries in terms of death rates in traffic accidents. Traffic accident occurred while on the highway and in motion; one or more vehicles. It is an incident that resulted in death, injury, and material damage (KGM). Traffic accidents There is a direct proportion of the increase in the number of accidents to increasing and developing roads and vehicles. Considering the accidents in our country, to ensure traffic safety, traffic the causes of accidents should be carefully identified. Number of vehicles, number of drivers and in direct proportion to the increase in population, there was an increase in road traffic accidents between 1980 and 2000. A continuous increase is observed (Erdoğan, 2006; Türkiye Makina Mühendisleri Odası, 2016). Accident analysis should be used more in detecting problems in Turkish traffic. Analyzing these accidents has many benefits for the country. It is thought that considering it would be beneficial. First of all, the factors that caused the accident traffic accident analyses should be carried out and the real causes of accidents should be determined and the necessary work should be done to prevent these detected problems. Accident analysis is to be carried out in detail and according to different reasons, without wasting time in preventing accidents and taking corrective actions. It is thought that it would be beneficial to identify the information needed (Öztürk, 2013). The causes of traffic accidents or the defects that cause accidents are very diverse. Defects general aspect; driver faults, pedestrian faults, passenger faults, vehicle faults, and road faults ıt can be counted as (Fallon et al., 2005). It was mentioned that the driver, pedestrian, or vehicle

must be harmed in a traffic accident. On the other hand, participants participating in highway traffic damage as a result of traffic accidents are among the factors that cause accidents. Apart from these, the type of transportation itself may also be due to the geometric structure of the highway.

Especially in cities with high populations, many different activities interact with each other. They are very lively settlements. Home, workplaces, shopping malls, education, and travel demand between entertainment venues constitutes city traffic. This is the journey of the excess supply and demand between the producing and traveling regions leads to an increase in city traffic. It leads to the increase in automobile ownership increases the use of private vehicles. As a result, city traffic becomes inconvenient, especially in big cities. Trips made at peak hours due to congestion effects as a result of increased traffic people using private vehicles, shuttles, and buses increase their travel time. Construction on the road infrastructure of cities despite large investments, traffic congestion and, as a result, congestion increases further is becoming. When these increasing vehicle numbers combine with an unplanned transportation network, inevitable traffic accidents occur. Traffic congestion is a common problem in cities and areas with busy roads and significantly affects the likelihood of traffic accidents occurring. The impact of traffic congestion on crashes has a complex relationship with many factors, and these effects are shaped by variables such as traffic congestion, speed, driver behavior, and road design. The effects of the increasing number of vehicles in traffic on accidents can be listed as follows:

- Failure to Comply with Traffic Rules:

Heavy traffic can cause drivers to violate traffic rules. Especially when approaching traffic lights, impatient drivers may commit red light violations. Finding parking in busy areas can be difficult, leading to improper parking and resulting accidents.

Intensive use of highways brings accidents. Traffic accidents often result in death and injury. Increasing the transportation network on highways ıt also increases the number of accidents for the safety of passengers and cargo carried on highways.

It is necessary to reduce the number of accidents. To reduce the number of accidents that cause accidents. It is necessary to minimize the effects of these factors. In what proportion do the factors causing accidents depend on the number of vehicles, number of drivers, population, and travel destinations? Determining whether it depends on the vehicle mileage is important in reducing the risk of accidents. Also, this if it is known to what extent the factors affect the number of accidents, the number of accidents that will occur can be predicted and transportation policies can be developed accordingly. The objectives of the study are:

- Analyzing the relationship between number of car and accident rates
- To determine the effects of the increase in the number of vehicles on accident frequency and severity, using existing traffic data. • Predicting future scenarios: Making predictions about how traffic accidents will follow in the future
- To develop policy recommendations, to develop strategies and policies to reduce traffic accidents, and to offer suggestions in the fields of urban planning and traffic management in this context
- This research will be an important reference point for measures to be taken and policies to be developed to reduce traffic accidents.

2. Materials and Methods

SPSS 21.0 software was used to analyze the data. Exponential smoothing methods were utilized to predict traffic accident data in 2025. This time series method is widely preferred due to its clarity and transparency. Series that have variables that vary depending on time and can be explained by more than one regression curve because they do not have the return to a regression curve or line are called series with a stochastic tendency (Yağımlı & Ergin, 2017). Holt-Winters exponential smoothing model can be applied when both trend and seasonality are present, with the two components being either additive or multiplicative. Winters additive and multiplicative models was extremely high and both additive and multiplicative models. Time series data often includes periodic changes (seasonality) and long-term trends (trend). The Holt-Winters method allows making accurate predictions by analyzing these two components separately.The Holt-Winters method is an extension of the simple and double exponential smoothing methods. The simple smoothing only takes into account changes in level, while the double exponential smoothing takes the trend into account. The Holt-Winters method provides more complex and more accurate forecasts by modeling both trend and seasonality. Also this method is successful not only in short-term but also in long-term predictions because it identifies seasonal patterns in time series. The Holt-Winters method can quickly adapt to possible changes in the time series. (Djakaria & Saleh, 2021; Konarasinghe, 2021a).

After more than 50 years of widespread use, the exponential smoothing method is still one of the most practically used forecasting methods (Goodwin, 2010). Being the most used method.

The most important reasons are; The method is clear, understandable, transparent and has the ability to adapt to many different situations. error, tendency and seasonality variables are the three basic components of this method (Hyndman & Athanasopoulos, 2013) The working principle of the method is based on very old observations or recently obtained data depending on the impact of the data and

observations are more important (Bergmeir et al., 2016). Accordingly, exponential the smoothing method uses predominantly moving average data that decays exponentially. The basic idea behind exponential smoothing is to enhance the modeling of various components such as seasonal changes, trends, and long-term changes in a series, along with detecting recurring components and forecasting over periods. These components cannot be determined by other means. The method combines the duration and growth of the current condition.

For the study conducted using annual data from 2012 to 2023 (without seasonal data), the Holt-Winters exponential smoothing method for non-seasonal data with two parameters was utilized. This method is suitable for series with a linear time trend and no seasonal variation.

3. Results

Table 1 includes traffic accident data between 2012 and 2023. According to the data in Table 1, the number of traffic accidents follows a fluctuating trend between 2012 and 2023 (Figure 1). These results show a general increase trend in traffic accidents over the last 11 years. Figure 1 shows the view of the number of traffic accidents between 2012 and 2023.

Table 2 shows the data on the number of vehicles per capita between 2012 and 2012.

Table 1. Traffic accident data (2012-2023).

Year	Number of traffic accident
2012	1.296.634
2013	1.207.354
2014	1.199.010
2015	1.313.359
2016	1.400.491
2017	1.450.716
2018	1.500.364
2019	1.900.144
2020	1.983.808
2021	2.050.353
2022	2.100.957
2023	2.200.071

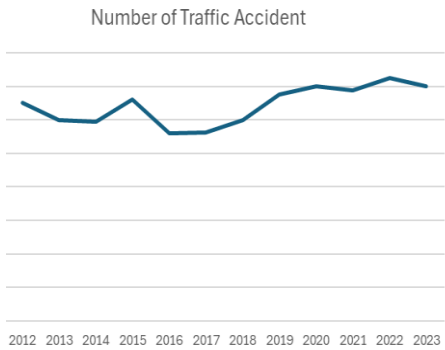

Figure 1. The course of the number of traffic accidents (2012-2023).

When the number of vehicles per thousand people in Table 2 is examined, it is seen that there is a continuous increase in the number of vehicles per thousand people between 2012 and 2023 (Figure 2). Compared to the starting year of 2012, there is a 49.3% increase in the number of vehicles per thousand people in 2023. These results show an increasing trend in the number of vehicles per thousand people in the last 11 years. Figure 2 shows the trend of the number of vehicles per thousand people between 2012 and 2023.

Table 2. Number of vehicles per capita (2012-2023).

Year	Number of Vehicles per Thousand People
2012	225
2013	234
2014	242
2015	254
2016	264
2017	275
2018	279
2019	278
2020	289
2021	298
2022	311
2023	336

Table 3 shows the 2023-2025 forecast results for the number of traffic accidents and the number of vehicles per thousand people. The non-seasonal Holt-Winters (No Seasonal) method was used as the forecasting method.

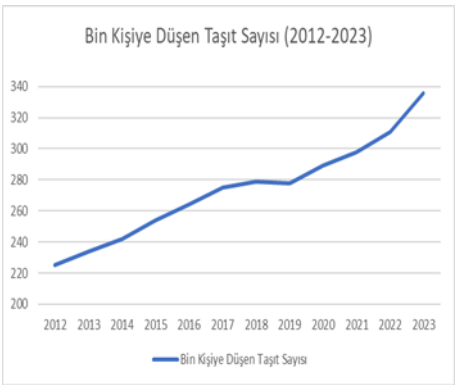

Figure 2. The course of the number of vehicles per thousand people (2012-2023).

When the prediction results for the number of traffic accidents in Figure 3 are examined according to the Holt-Winters correction, it is seen that the number of traffic accidents will reach 2.310.952 in 2026.

Table 3. Estimation results of traffic accidents and number of vehicles per thousand people.

Forecast year	Number of traffic accident	Number of Vehicles per Thousand People
2024	2.253.957	354
2025	2.295.602	371
2026	2.310.952	397
2023-2026 change (%)		18,15

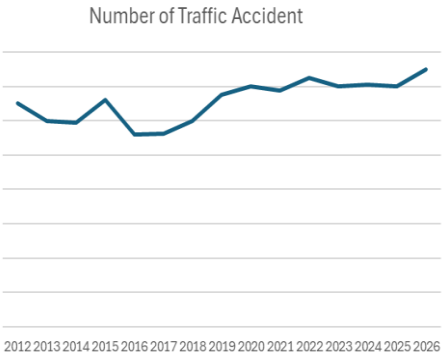

Figure 3. The course of the number of traffic accidents with 2024-2026 forecast results.

When the prediction results for the number of vehicles per thousand people in Figure 4 are examined according to the Holt-Winters correction, the number of vehicles per thousand people will reach 397 in 2026, and when compared to the 2023 data (336), this change is approximately 18%. It is seen that it represents an increase.

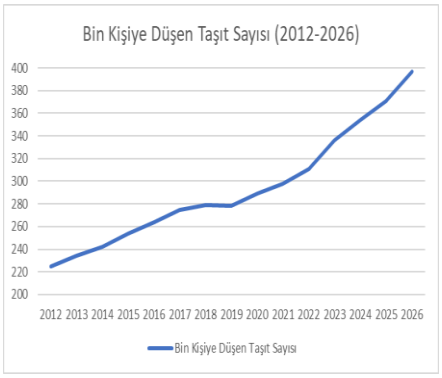

Figure 4. The course of the number of vehicles per thousand people with 2024-2026 forecast results.

4. Discussion and Conclusion

To address urban transportation issues such as accidents, inefficiency, and congestion, it is imperative to establish a safe, fast, and accessible transportation system. This necessitates comprehensive planning and coordination of various transportation elements within big cities. Developed countries prioritize urban transportation to facilitate movement within and between regions and central business areas. The increasing time spent in vehicles and traffic congestion negatively impacts the economy and people's well-being. Therefore, it is crucial to carefully select transportation modes that prioritize people's needs, are suitable for the region's topography, and are environmentally friendly and safe. Precautions to be taken to reduce accidents can be listed as follows:

- Traffic Management Systems: Smart traffic management systems can monitor traffic density and direct traffic more effectively and reduce congestion.
- Infrastructure Improvements: Increasing road capacity, building new roads and improving existing roads can reduce traffic congestion.
- Public Transport Incentive: Improving and encouraging public transport systems can reduce traffic density by reducing individual vehicle use.
- Driver Training: Stress management and attention-enhancing training for drivers can help them drive safer in heavy traffic.

The relationship between traffic density and traffic accidents is complex and multifaceted. However, with effective traffic management, appropriate infrastructure and social awareness, the negative effects arising from this relationship can be reduced and a safer transportation environment can be provided.

As a result, the increasing number of vehicles increases the frequency and severity of traffic accidents. This situation becomes especially evident in city centers and necessitates the implementation of various traffic safety measures. These implemented measures play an important role in reducing accidents and accident-related injuries. However, continuous improvements and innovative approaches are required to minimize traffic accidents. In line with the scope of the study, data on other factors that cause traffic accidents (driver training, road geometry features, speed restrictions and traffic management systems) may be limited.

However, the study may shed light on future studies, especially a more comprehensive analysis that includes the effects of driver training and road geometry.

More comprehensively, the study enables new studies to be carried out by including variables such as road geometry (including bends, intersections, viewing angles, cross slope condition, number of lanes and pavement widths) in future research.

Although my current study emphasizes the need to develop a safe and efficient transportation system in large urban areas, it can be more detailed. In this regard, future studies on the integration of various transportation safety policies and traffic management systems can be included.

Declaration of Ethical Standards

Compliance with all ethical standards.

Credit Authorship Contribution Statement

Author 1: Resources, Research, Experimentation, Writing – original draft Visualization, Writing – original.

Declaration of Competing Interest

The author has no conflicts of interest to declare regarding the content of this article.

Data Availability

All data generated or analyzed during this study are included in this published article.

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