Urban Studies and Public Administration
Vol. 8, No. 1, 2025
www.scholink.org/ojs/index.php/uspa
ISSN 2576-1986 (Print) ISSN 2576-1994 (Online)

Original Paper

Randomness Exploration in Daily Detected Overloaded Trucks (An Experimental Study)

Abbas Mahmoudabadi[1] & Fatemeh Pourhossein Ghazimahalleh[2]

[1] Director, Master Program in Industrial Engineering, Department of Industrial Engineering, MehrAstan University, Gilan, Iran

[2] Ph.D. Student, Department of Information Technology, University of Tehran, Tehran, Iran

Received: December 15, 2024 Accepted: December 29, 2024 Online Published: January 6, 2025

doi:10.22158/uspa.v8n1p1 URL: http://dx.doi.org/10.22158/uspa.v8n1p1

Abstract

Since the overload detection program is a main concern for transport authorities to prevent road damage and enhance road safety, this paper investigates the randomness in the number of daily overloaded vehicles detected throughout the month. The concern is crucial where it is said that detected overloaded vehicle drops over the month. For this purpose, the randomness of daily detected overloaded vehicles has been tested by utilizing the familiar statistical method of "Runs Test", in which the numbers of daily detected vehicles are considered observation. Data, for detecting trucks as overloading across the intercity roads in the West-Asian country of Iran, has been collected for a year followed by categorizing into thirty days to check the randomness pattern. The results revealed that, despite fluctuating stats, the number of detected overloaded vehicles follows a random pattern instead of a specific pattern in increasing or decreasing trends believed in the rumours. Since the number of daily overloaded vehicles exhibits randomness during a month and all types of trucks including trailers (detachable trucks), heavy trucks, and light trucks have been investigated, transport authorities are recommended to focus more on the methods of weighing enforcement to ensure that sufficient overloading enforcement activities are performed.

Keywords

traffic enforcement, intercity transportation, trucks overloading, randomness testing, statistical analysis

1. Introduction

In today's fast-paced world, overloaded vehicles are common sights on the roads and transport infrastructures. These instances occur when the weight or volume of goods being transported exceeds the permissible limits, posing risks to road safety and damage to infrastructure as well (Saad et al., 2021).

While efforts are required to enforce regulations and prevent overloading, and the frequency of overloading can fluctuate and be influenced by various factors such as supply and demand dynamics, operational aspects, and enforcement efforts (Hou et al., 2020), it is intriguing to investigate the randomness characteristic for the number of overloaded vehicles detected during the days of a month. The concern arises when it is claimed that the rate of overloading enforcement smoothly decreases throughout the month from the beginning to the end. Therefore, this paper delves into the fascinating phenomenon of the random occurrence of the daily detected overload vehicles throughout the month. Before delving into the randomness of overloaded vehicles, it is important to recognize the risk of overloaded vehicles. In transportation, overloading refers to exceeding the maximum weight or volume limits approved for vehicles (Hameed & Prathap, 2018). This can equally occur in various industries, including transportation, logistics, and construction, where goods are often transported in large quantities (Jacob & Cottineau, 2016). The number of overloaded vehicles can vary depending on supply and demand dynamics within different industries. For example, during peak seasons or periods of excessive demand, there may be considerable interest in overloading as companies strive to meet customer needs. Conversely, during interminable periods, the number of overloaded vehicles may decrease. Despite efforts to regulate and prevent overloading, the number of overloaded vehicles experienced during separate days of a month should exhibit a certain degree of randomness (Islam, 2015). This randomness can be attributed to several factors that affect transportation patterns and industry practices. Operational factors within industries can also contribute to the randomness of overloaded vehicles. Factors like production schedules, delivery deadlines, and unforeseen events can impact the volume of goods transported and increase the likelihood of overloading on specific days (Lu et al., 2023). Enforcement efforts by regulatory bodies carry out a crucial role in managing overloading. Unexpected inspections and enforcement activities lead to fluctuations in the number of overloaded vehicles observed during separate days of the month. This randomness stems from the unpredictable nature of enforcement efforts and the varying compliance levels within the industry (Ahmed et al., 2022). Given the inherent randomness of overloaded vehicles, transport authorities, regulatory bodies, and industry stakeholders need to implement effective strategies for managing and preventing overloading. The above concern prompts the researchers to investigate the randomness of overloading detection and rumours declaring the importance of overloading enforcement decreases throughout the month.

The occurrence of overloaded vehicles on the roads can have severe implications for road safety, infrastructure damage, and traffic congestion (Rasool & Kaushal, 2022). To effectively manage this issue, it is essential to understand the efficiency and the permanency of the enforcement programs implemented in intercity transportation. It can be verified by checking the randomness associated with the number of overloaded vehicles detected during different days of the month. In this article, we will explore the application of the “Runs Test” to evaluate the randomness. The “Runs Test” is a statistical test used to assess the randomness of data sequencing. In the context of the number of overloaded vehicles detected during the days of the month, the above test examines whether there are significant deviations from randomness in the sequence of these numbers associated with the sequence of days. In this case, we will apply the "Runs Test" to determine if the number of overloaded vehicles detected during separate days of the month follows a random pattern or exhibits systematic behaviours.

The rest of the paper is organized by explaining the scientific background, randomness testing, and the relevant studies followed by illustrating the research methodology to explain how the daily detected overloaded vehicles are examined. The calculation process and its outcomes will be explained in the numerical analysis section to show the research results followed by a summary and conclusion as well as recommendations for further studies.

2. Scientific Background

2.1 Randomness Testing

"Runs Test" is a statistical tool used for analysing a sequential arrangement of data points in a dataset. In theory, observations in a variable can be represented by a data sequence. The sequence is denoted as $X = (X_1, X_2, \ldots, X_3)$where X_i represents the observation. In a random data set, the probability that the (i+1)th value is larger or smaller than the ith value follows a binomial distribution, which forms the basis of the "Runs Test". One of the well-known tests for randomness is the "Runs Test" in which the null hypothesis (H_0) and the alternative one (H_1) are defined as follows (Vovk, 2021):

- Null hypothesis (H_0): The sequence of data series follows a random process.
- Alternative hypothesis (H_1): The sequence of data series does not follow a random process.

Defining the hypotheses is followed by observing the number of Runs (R) which may define case differently to case. A Run is defined as consecutive increasing or decreasing values in the data sequence or number of observations sequenced each other and come from the same population. There are several ways to define runs in the literature, however, in all cases the formulation must produce a dichotomous sequence of values or elements. In the case of existing values, the values above the median are coded as positive and values below the median as negative. A run is defined as a series of consecutive positive (or negative) values as well as N_1 and N_2 denote the number of positive and negative values in the series, respectively (Luengo et al., 2022). For a small-sample runs test, there is a table to determine critical values that depend on values of N_1 and N_2 (Mendenhall, 1982). For a large-sample runs test (where N_1>10 and N_2>10), the test statistic is compared to the standard normal table. Therefore, the test statistic is formulated by equation (1) where $\bar{R}$ and $S_R^2$are respectively defined as the expected value of the Runs and its variance formulated by equations (2) and (3), respectively. The test statistic (Z) is compared to critical values from the standard normal table. If Z is greater than the critical value, we reject the null hypothesis and if Z is less than or equal to the critical value, we fail to reject the null hypothesis (Karell-Albo et al., 2020). Rejecting the null hypothesis means the data series does not follow a random process.

$$Z = \frac{R - \bar{R}}{S_R} \tag{1}$$

$$\overline{R} = \frac{2N_1N_2}{N_1 + N_2} + 1 \quad (2)$$

$$s_R^2 = \frac{2N_1N_2\,(2N_1N_2 - N_1 - N_2)}{(N_1 + N_2)^2(N_1 + N_2 - 1)} \quad (3)$$

2.2 Relevant Studies

Many studies, in the literature, have investigated the concerns and issues related to trucks' overloading in transportation. In addition to attributes studied in this field, techniques, approaches, and preventive countermeasures are also being studied in this manner. Since weighing technology is being gradually improved these days, recent studies mainly focus on advanced tools such as weigh-in-motion technology whereas the economic aspects are under study to ensure that the operations gain enough revenue during the usage (Mahmoudabadi & AkbariLalaei, 2017). Overloading is a primary concern in pavement management, where Chen et al. (2020) conducted a research work to evaluate the impact of overloading on road infrastructure by comparing different vehicle types and assessed the extent of pavement damage caused by overloaded vehicles to provide recommendations for infrastructure preservation.

Road safety is another concern for transport authorities in this field. Singh and Srivastava (2022) investigated the impact of overloading on the wear and tear of critical trucks' components, such as tires, suspension, and brake systems. They examine how exceeding weight limits affects the performance and durability of trucks' components, leading ultimately to increased maintenance costs and potential safety hazards. The findings also highlight the importance of adhering to legal limits and implementing effective overload monitoring systems to mitigate excessive wear and tear, optimize fuel efficiency, and ensure road safety. Improving technologies is moreover under study where Lin et al. (2022) studied the utilization of weigh-in-motion data to analyse the distribution of overload among different vehicle types and provide insights into the specific and more prone vehicle categories to overloading, aiding in targeted interventions to improve overloading control. Under focusing in this study, Borucka et al. (2020) analyzed the randomness of overloaded vehicle incidents during separate days of the month in a metropolitan area. They collected data on the number of overloaded vehicles detected over 12 months and utilized statistical methods, including the KS test and Chi-square test, to compare the distribution of incidents across different days. Compared to weekdays, the results indicated significant differences in distribution, with more significant incidents observed on weekends (Borucka et al., 2020). Heshami and Kattan (2022) have examined the temporal patterns and randomness of overloaded vehicles in a highway network. They collected data on the number of overloaded vehicles stopped a day for two years and applied statistical tests, including the KS and Chi-square tests, to analyze the distribution similarity across different days. The study revealed no significant differences in distribution and indicated that overloaded vehicle incidents occurred randomly throughout the month. The incidents associated with overloading are additionally a topic under study where Prochowski (2013) investigated the impact of the day of the week on overloaded vehicle incidents. He collected data on the number of overloaded vehicles discovered during weekdays and weekends over six months and employed statistical methods to compare the distribution of incidents. The results demonstrated a significant difference in the distribution, with higher incidents observed on weekends compared to weekdays, resulting in a non-random pattern in overloaded vehicle occurrences.

Enforcement strategy is also under study as an essential component in pavement management where Dolcemascolo et al. (2015) compared overload monitoring and enforcement strategies implemented in various countries for heavy vehicles. They examined the effectiveness of approaches and highlighted the best practices for mitigating overload risks. Another example is to improve the prediction rate of trucks under enforcement, not only by utilizing the conventional methods but also by modelling the prediction methods such as the context of chaos theory (Mahmoudabadi & Abolghasem, 2013). It is also combined in the studies with traffic congestion whereas Gaira et al. (2020) explore the relationship between overload distribution among different vehicle types and traffic congestion. They provided an analysis of the impact of slow-moving overloaded vehicles on overall traffic flow and proposed strategies to alleviate traffic congestion because it has a significant effect on pavement conditions. The role of transport companies is also perceived as another attribute such that in a case study, Qiao et al. (2018) showed a collaborative approach to overload monitoring between regulatory bodies and transportation companies. It highlights the benefits of stakeholder engagement in implementing effective monitoring systems and reducing overloading practices.

Although passenger cars may be under overloading control by distinct factors investigated by Gezahegn (2021), improved by Yassenn et al. (2015) for vans and SUVs, commercial vehicles are more under overloading control. For example, to improve technologies, Odonkor et al. (2020) focused on developing an overload monitoring system specifically designed for commercial vehicles, discussing the importance of weight distribution monitoring and proposing a sensor-based system for accurate measurement. Heavy-duty vehicles are also investigated when (Nassif et al., 2018) compare different overload monitoring systems used in heavy-duty vehicles, including construction equipment and mining trucks operating in oppressive conditions. The research evaluates the effectiveness of the systems in measuring real-time cargo weight and preventing structural damage caused by overloading followed by indicating the impact of overload on components and structures, emphasizing the need for accurate monitoring systems to ensure safety optimization and prolong the lifespan of vehicles under such extreme operating conditions. It has also been improved in further studies where Alkhoori et al. (2021) focus on optimizing overload distribution in heavy-duty vehicles and propose strategies to achieve optimal weight distribution, considering factors such as cargo weight, vehicle characteristics, and handling capabilities. They also emphasize the importance of balancing load distribution to minimize stress on components and structures, reduce accidents caused by instability, and enhance overall vehicle performance and safety.

Recent studies have also examined the distribution of overload in different types of vehicles, specifically by focusing on passenger cars and trucks, and analyzed various factors such as weight distribution, maximum load capacity, handling, braking, and stability to determine how these characteristics affect the overload distribution. Their findings provided insights into the differences between passenger cars and trucks based on their ability to handle and distribute excess weight, highlighting the importance of considering these factors for passenger safety and vehicle performance optimization (Chan, 2008).

In summary, many studies have been conducted in overloading, so it is not a novel topic in transportation but it requires more studies to investigate the efficiency and performance of enforcement and to improve the procedures applied in overloading enforcement to ensure heavy vehicles do not destroy transport infrastructures. The present research work accordingly focuses on the permanency of enforcement over trucks' overloading to ensure that the weighing stations spread across the country follow the enforcement procedures constantly throughout the month. The concept follows by utilizing the statistical test, the so-called "Runs Test" to check the randomness of the number of overloaded vehicles detected over the days of the month. Overall, while there is limited specific research on checking the randomness of overloaded vehicles during separate days of the month, studies on traffic patterns and vehicle overload detection suggest that systematic factors influence their occurrence. Conducting the "Runs Test" can support further investigation to check the randomness and identify any underlying patterns or deviations that can inform traffic management authorities.

3. Research Methodology and Implementation

The research methodology and implementation for studying the randomness of the number of daily detected overloaded vehicles on the month comprise collecting data, analyzing patterns, and re-drawing conclusions based on the findings. The following represents a possible approach in this research.

Data collection: The first step is to collect experimental data on the number of daily overloaded vehicles detected throughout the month. This data can be obtained from transport officials such as transportation departments, law enforcement agencies, or any other organization responsible for monitoring and reporting overloaded vehicles.

Data analysis: Once the data is collected, it should be analyzed to identify patterns or trends. Various statistical techniques can be employed in the dataset to determine if there is a random distribution in the data series or if certain days show higher detections of overloaded vehicles. The analysis is followed based on the required steps to utilize the "Runs Test" to investigate the randomness of the data series as the daily number of detected overloaded trucks throughout the month.

Hypothesis formulation: Based on the initial analysis, researchers can formulate hypotheses about existing the randomness characteristics on the daily overloaded vehicles detected throughout the month.

Statistical tests: To examine the hypotheses, a specific statistical test should be utilized. For instance, in the "Runs Test", the normal standard table is used to determine if the number of overloaded vehicles across different days significantly deviates from a random distribution. In a small sample size, it can also be performed by extracting critical values from statistical tables.

Interpretation of results: The results would support transport authorities to ensure that there is no out-of-place pattern in the trucks' overloading enforcement. If data series come from a random pattern, it would be a piece of good news, otherwise, they need to check the enforcement strategies employed for overloading.

4. Case Study and Data Collection

The first step in implementing the study is to identify the different vehicle types investigated in the analysis. This may include commercial detachable trucks of trailers and heavy and light trucks. Although vehicle fleets have been identified in the software for managing overloading data, all can be categorized into three types. Data collection provides data records attributed to each detected vehicle on the roads, that topped and forced the driver to pay a fine during a sonar Iranian year of 1399. It is the same time as 21st March 2020 to 20th March 2021. The overloading records have been categorized into thirty observations and tabulated as shown in Table 1. Each observation includes the number of trucks detected and recognized as overloaded trucks. It should be mentioned that although six months contain thirty-one days, to obtain the homogeneity of 12 records for each day, the 31st day has been removed from analyzing process.

5. Defining Hypotheses

When defining hypotheses, it is essential to make statements about the population or phenomenon under study. In this case, we are interested in the number of overloaded vehicles detected during the days of the month. Therefore, the statistical hypotheses are defined as follows:

The null hypothesis (H_0) states the number of overloaded trucks follows a random pattern. This means there is no specific trend over the month or, in other words, there is no relationship between the days of the month and the number of overloaded vehicles. For instance, any fluctuations or variations in the number of overloaded vehicles are due to chance, and nothing has an influence on it.

On the other hand, the alternative hypothesis (H_1) states that the number of daily detected overloaded trucks does not follow a random pattern. This suggests there is some underlying factor or factors that influence the number of overloaded trucks on different days of the month. These factors could be related to external factors, such as traffic volume, road conditions, or specific events during certain days.

By defining the above hypotheses, a framework is set up for testing and analyzing data associated with the number of overloaded trucks. Data has been collected over a while, and we compare it to what would be expected under the null hypothesis. If the observed data significantly deviates from what would be expected by chance alone, the null hypothesis is rejected, and conclude that there is adequate evidence to support the alternative hypothesis. Otherwise, the null hypothesis is accepted and concludes the number of daily detected trucks follows a random pattern.

In summary, defining hypotheses allows researchers to investigate whether there is a non-random pattern in the number of overloaded trucks detected during the days of the month. It assists them in determining if any underlying factors contribute to variations in this number and provides a basis for statistical analysis and inference. The briefly stated sentences for the above hypotheses can be defined as follows:

Null Hypothesis (H_0): The number of overloaded trucks detected during the days of the month follows a random pattern.
Alternative Hypothesis (H_1): The number of overloaded trucks detected during the days of the month does not follow a random pattern.

6. Numerical Analysis

Numerical analysis should be conducted to study the randomness of the number of overloaded trucks detected during the days of the month. This analysis can help researchers determine if there are any patterns or trends in the occurrence of overloaded trucks, or if the occurrences are in a random pattern. To conduct the analysis, data on the number of overloaded trucks detected each day of the month over a certain period has been summarized. Let's assume data was collected for 12 months. So, data is attributed to each day as it has been recorded by the number of overloaded trucks on the 1st, 2nd, 3rd, ..., 30th day of each month. Data is now tabulated in Table 1 where the first column indicates the day of the month and the total number of detected trucks is tabulated in the fifth column titled as "Total in Day".
The second step is calculating the deviation from the mean or median for the number of detected trucks. The mean has been calculated as 2030 mentioned at the bottom of the column "Total in Day". The second step is calculating the deviation from the mean. For the first observation (the first day of the month), it is obtained $1766 - 2030.5 = -264.5$. The rest is obtained and tabulated in the sixth column. As shown, some are positive and the others negative assigned by a sign in the seventh column.
The third step is calculating the parameters N1, N2, and Runs (R). The number of positive and negative signs are respectively 16 ($N_1 = 16$), and 15 ($N_2 = 14$), while the number of the Runs is 12 ($R = 12$) as shown in Table 1. Referring to the table for critical values of Runs Test (Mendenhall, 1982), the lower and upper critical values are respectively 10 and 23 under 95% of the confidence interval. Since the number of Runs ($R = 12$) is greater than 10 and smaller than 23, the null hypothesis is accepted so we conclude that the number of daily overloaded trucks detected throughout a month follows a random pattern. On the other side, considering the large sample size, equations (4), (5), and (6) are adapted to calculate the expected value of Runs, Variance, and Z-Stat, respectively. As obtained, the absolute value of the Z-Stat is not greater than the critical value of normal standard distribution under 95% of the two-sided confidence interval ($Z_{0.975} = 1.96$). Therefore, the above decision is once more supported which means that the number of overloaded trucks detected in days follows a random pattern.

Table1. Overall Stats on Trucks Detected as Overloading in Days

Day	Trailer and Compound	Heavy Truck	Light Truck	Total in Day	Deviation to Mean	Sign	Runs
01	567	779	420	1766	-264.5	-	1
02	614	675	358	1647	-383.5	-	1
03	625	786	376	1787	-243.5	-	1
04	699	697	340	1736	-294.5	-	1
05	731	726	344	1801	-229.5	-	1
06	850	868	438	2156	125.5	+	2
07	866	828	344	2038	7.5	+	2
08	938	759	345	2042	11.5	+	2
09	1007	654	327	1988	-42.5	-	3
10	1308	821	360	2489	458.5	+	4
11	509	875	427	1811	-219.5	-	5
12	643	800	393	1836	-194.5	-	5
13	666	707	422	1795	-235.5	-	5
14	569	725	371	1665	-365.5	-	5
15	840	837	411	2088	57.5	+	6
16	886	780	394	2060	29.5	+	6
17	822	967	425	2214	183.5	+	6
18	1026	897	426	2349	318.5	+	6
19	802	881	403	2086	55.5	+	6
20	1297	858	446	2601	570.5	+	6
21	499	799	398	1696	-334.5	-	7
22	709	872	411	1992	-38.5	-	7
23	761	854	507	2122	91.5	+	8
24	771	884	380	2035	4.5	+	8
25	1031	968	481	2480	449.5	+	8
26	831	731	359	1921	-109.5	-	9
27	924	904	470	2298	267.5	+	10
28	950	682	355	1987	-43.5	-	11
29	987	860	420	2267	236.5	+	12
30	1043	723	396	2162	131.5	+	12
Total	**25317**	**24774**	**12150**	**62241**			
Mean				**2030.5**			

$$\overline{R} = \frac{2 \times 16 \times 14}{16 + 14} + 1 = 15.933 \tag{4}$$

$$s_R^2 = \frac{2 \times 16 \times 14 \times (2 \times 16 \times 14 - 16 - 14)}{(16 + 14)^2 (16 + 14 - 1)} = 7.175 \tag{5}$$

$$Z = \frac{12 - 15.933}{\sqrt{7.175}} = -1.468 \tag{6}$$

The results are also depicted in better shape by a graph in Figure 1 composed of two lines. The solid line with square makers represents the number of daily detected overloaded trucks, and the dashed line represents their mean. As shown the number of daily detected overloaded trucks smoothly moves around the mean, so there is no descending or ascending throughout the month although a little fluctuation is observed.

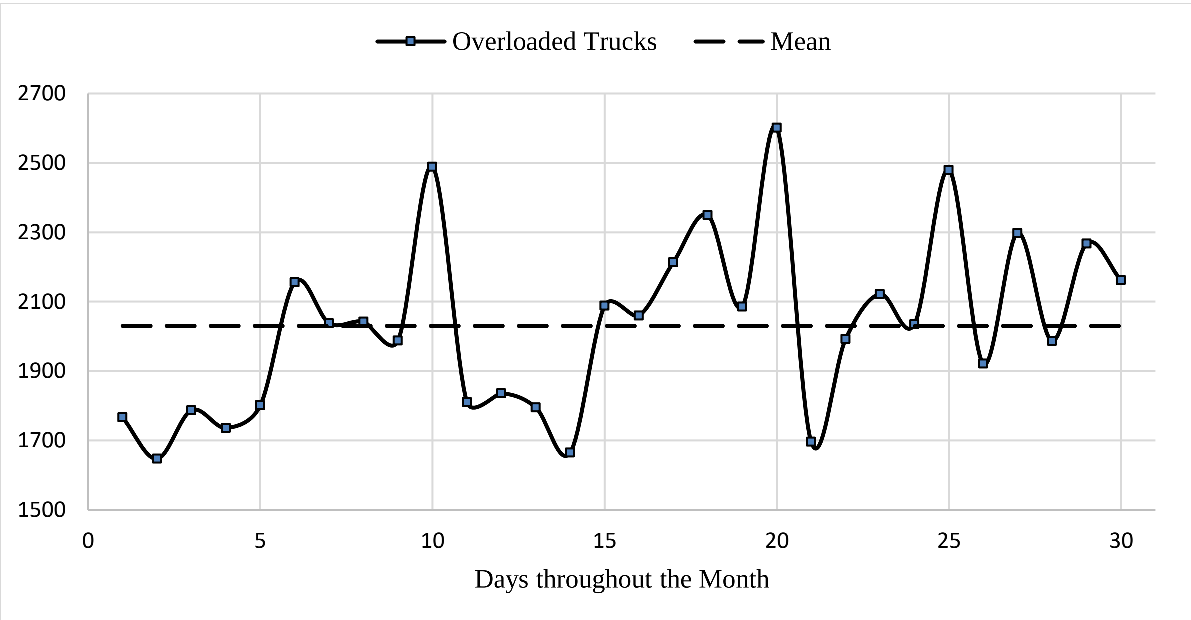

Figure 1. The number of Overloaded Trucks Detected throughout the Month

7. Conclusion

Since it is allegedly believed that the rate of overloading enforcement decreases throughout the month, the present research work studies the statistical behaviour of that in days from the beginning to the end of a month. To this purpose, the statistical characteristic of randomness for the number of overloaded trucks detected each day has been investigated to check if the number of daily overloaded trucks follows a random pattern. As an experimental study, the number of overloaded trucks' data recorded during a year has been studied using the well-known statistical "Runs Test". The test has been performed where the observations are ordered in occurrence and deviations obtained by subtracting the number of overloaded trucks, here as observations, from the average number of overloaded trucks. Performing the test revealed that the number of daily overloaded trucks followed a random pattern. It means that there is no specific pattern or trend throughout the month. The results support transport authorities to ensure there is not a trend in the rate of enforcement, but it does not mean that the enforcement should not be improved. Further research in this field is recommended to study the above measure in distinct provinces where the transport infrastructures, and geographical situations, are different from province to province.

Appreciation Note

The authors would like to gratefully thank Mr. Hassan Abdoos, deputy of the Traffic Safety Department at Road Maintenance and Transport Organization, who provided data on overloaded trucks stopped for taking fines. There is no doubt that conducting the research work would not have been possible if data was unavailable.

References

Ahmed, S. S., Alnawmasi, N., Anastasopoulos, P. C., & Mannering, F. (2022). The effect of higher speed limits on crash-injury severity rates: A correlated random parameters bivariate tobit approach. *Analytic Methods in Accident Research*, *34*, 100213. https://doi.org/10.1016/j.amar.2022.100213

Alkhoori, F. A., & Maghelal, P. K. (2021). Regulating the overloading of heavy commercial Vehicles: Assessment of land transport operators in Abu Dhabi. *Transportation Research Part A: Policy and Practice*, *154*, 287-299. https://doi.org/10.1016/j.tra.2021.10.019

Borucka, A., Kozłowski, E., Oleszczuk, P., & Świderski, A. (2020). Predictive analysis of the impact of the time of day on road accidents in Poland. *Open Engineering*, *11*(1), 142-150. https://doi.org/10.1515/eng-2021-0017

Chan, Y. C. M. (2008). *Truck overloading study in developing countries and strategies to minimize its impact* (Doctoral dissertation). Queensland University of Technology.

Chen, Y., Wang, K., Zhang, Y., Luo, R., Yu, S., Shi, Q., & Hu, W. (2020). Investigating factors affecting road freight overloading through the integrated use of BLR and CART: A case study in China. *Transport*, *35*(3), 236-246. https://doi.org/10.3846/transport.2020.12635

Gaira, A., Parveen, A., Dabral, D., Goyal, J., & Rani, M. R. (2020). Vehicle Overloading: A Review. *International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN*, 2321-9653. https://doi.org/10.22214/ijraset.2020.7002

Gezahegn, T. (2021). *DESIGN AND DEVELOPMENT OF AUTOMATIC VEHICLE OVERLOAD CONTROL SYSTEM* (Doctoral dissertation).

Hameed, S., & Prathap, R. C. (2018). Study on impact of vehicle overloading on National Highways in varying terrains. *Int. J. Eng. Res. Technol. (IJERT)*, *7*(1), 2278-0181. https://doi.org/10.17577/IJERTV7IS010135

Heshami, S., & Kattan, L. (2022). A stochastic microscopic based freeway traffic state and spatial-temporal pattern prediction in a connected vehicle environment. *Journal of Intelligent Transportation Systems*, 1-27.

Hou, Q., Huo, X., & Leng, J. (2020). A correlated random parameters to bit model to analyze the safety effects and temporal instability of factors affecting crash rates. *Accident Analysis & Prevention*, *134*, 105326. https://doi.org/10.1016/j.aap.2019.105326

Islam, M. (2015). Multi-vehicle crashes involving large trucks: A random parameter discrete outcome modeling approach. *Journal of the Transportation Research Forum*, *54*(1424-2016-117959), 77-104. https://doi.org/10.5399/osu/jtrf.54.1.4273

Jacob, B., & Cottineau, L. M. (2016). Weigh-in-motion for direct enforcement of overloaded commercial vehicles. *Transportation Research Procedia*, *14*, 1413-1422. https://doi.org/10.1016/j.trpro.2016.05.214

Karell-Albo, J. A., Legón-Pérez, C. M., Madarro-Capó, E. J., Rojas, O., & Sosa-Gómez, G. (2020). Measuring independence between statistical randomness tests by mutual information. *Entropy*, *22*(7), 741. https://doi.org/10.3390/e22070741

Lin, Y. H., Wu, F., Wang, R., Gu, S., &Xu, Z. (2022). Spatiotemporal Analysis of Overloaded Vehicles on a Highway Using Weigh-in-Motion Data. *Journal of Transportation Engineering, Part A: Systems*, *148*(1), 04021098. https://doi.org/10.1061/JTEPBS.0000616

Lu, H., Sun, D., & Hao, J. (2023). Random traffic flow simulation of heavy vehicles based on R-vine Copula model and improved Latin hypercube sampling method. *Sensors*, *23*(5), 2795. https://doi.org/10.3390/s23052795

Luengo, E. A., Cerna, M. B. L., Villalba, L. J. G., & Hernandez-Castro, J. (2022). A new approach to analyze the independence of statistical tests of randomness. *Applied Mathematics and Computation*, *426*, 127116. https://doi.org/10.1016/j.amc.2022.127116

Mahmoudabadi, A., & Abolghasem, A. (2013). Application of Chaos Theory in Trucks' Overloading Enforcement. *Journal of Engineering*, *2013*. https://doi.org/10.1155/2013/245293

Mahmoudabadi, A., & AkbariLalaei, R. (2017). Developing a Breakeven Point Model Based on Enforce Rate for Installing Weigh in Motion System in Inter-City Transportation. *Journal of Intelligent Transportation and Urban Planning*, *5*(1), 1-7. https://doi.org/10.18005/ITUP0501001

Mendenhall, W., & Reinmuth, J. (1982). Statistics for Management and Ecomonics, Fourth Edition, Duxbury Press.Monitoring in France and applications. In *TheXXVth World Road Congress PIARC* (pp. 1-12).

Nassif, H., Ozbay, K., Na, C., Lou, P., Fiorillo, G., & Park, C. (2018). *Monitoring and Control of Overweight Trucks for Smart Mobility and Safety of Freight Operations*.

Odonkor, E. N., &Ofosu, W. K. (2020). Design and construction of vehicle loading monitoring system using load sensor and GSM. *International Journal of Applied Science and Technology*, *10*(1). https://doi.org/10.30845/ijast.v10n1p1

Prochowski, L. (2013). Analysis of the impact of road category and day of the week on accident hazard in the road transport of goods in Poland. *Journal of KONES*, *20*(1), 269-277. https://doi.org/10.5604/12314005.1136176

Qiao, X. X., & Zhao, Y. D. (2018, May). Vehicle overload detection system based on magnetoresistance sensor. In *2018 International Conference on Electronics Technology (ICET)* (pp. 102-105). IEEE. https://doi.org/10.1109/ELTECH.2018.8401434

Rasool, J., & Kaushal, M. (2022). *A STUDY ON IMPACT OF VEHICLE OVERLOADING ON JAMMU-SRINAGAR NATIONAL HIGHWAY*.

Saad, F. A. M., Ishak, S. Z., Sulaiman, S. A. H., & Awang, A. (2021, August). The Implication of Overloaded Truck to Developing Countries–A Review. In *2021 IEEE 12th Control and System Graduate Research Colloquium (ICSGRC)* (pp. 165-170). IEEE. https://doi.org/10.1109/ICSGRC53186.2021.9515215

Vovk, V. (2021). Testing randomness online. *Statistical Science*, *36*(4), 595-611. https://doi.org/10.1214/20-STS817

Yassenn, O., Endut, I., Hafez, M., Ishak, S., &Yaseen, H. (2015). Overloading of heavy vehicles around the world. *Int. J. Eng. Sci. Res*, 34-45.

Biographies

Dr. Abbas Mahmoudabadi is a faculty member and director of the master's program in Industrial Engineering at MehrAstan University, Gilan, Iran. He received his Ph.D. in optimization in Hazmat transportation in January 2014, obtained the Thesis Dissertation Award from the IEOM Society in 2015. He has around 100 papers published in Industrial Engineering, transportation and traffic safety, and e-commerce. He teaches transportation and industrial engineering courses and has around 30 years of executive experience in traffic and road safety planning in developing countries. He has cooperated with national and international agencies on traffic safety and industrial engineering.

Fatemeh Pourhossein Ghazimahalleh graduated in Information Technology at Mehrastan University, Gilan, Iran and she is currently a Ph.D. student in the same field at Tehran University. She received her MSc in March 2019 by conducting her research work titled "Developing smart advertising pattern in urban streets using Internet of Things". She published her thesis as a research paper in the Journal of Urban Studies and Public Administration. She works in an academic institute as a trainer on ICDL skills. She is also continuing her research on developing advertising patterns in urban areas and conducting statistical analysis on different topics.