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Distribution Function Similarity of Overloaded Commercial Trucks Detection (Case Study: Iran)

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Abstract: Monitoring overloaded vehicles is an operational aspect of ensuring the safe operation of vehicles and mitigating damages to road pavement. Since, the concentration on overloading is claimed to differ for the type of trucks, where trailers are more allegedly engaged under enforcement, this research aims to explore the differences in overload monitoring among various kinds of vehicles, including trailers, heavy trucks, and light trucks in intercity transportation. To this purpose, at the first stage, the effect of the number of weighing stations and cargo trips on overloading detection has been investigated through analysis of variance. It is followed by considering the number of registered trucks as an exposure factor to standardize the enforcement rate in the second stage. An adapted version of the statistical method of Kolmogorov-Smirnov, known as three samples, is finally utilized to investigate the similarity of distribution functions of overloading detection for three types of trucks including trailers, heavy trucks, and light trucks. Data, for registered trucks as well as detected trucks as overloading across the road network in the West-Asian country of Iran, has been collected for a year followed by categorizing into thirty-one provinces. The results revealed that whereas the number of weighing stations and cargo trips do not have significant effects on overloading detection, the similarity of distribution functions for overloading detection is different for three types of trucks over the provinces. Therefore, all types of trucks are not equally under overloading control and transport authorities should redesign overloading detection approaches throughout the enforcement instruction applied in intercity transportation.

Keywords: Trucks' Overloading, Traffic Enforcement, Similarity Distribution Functions, Intercity Transportation.

I. INTRODUCTION

Overload monitoring is an operational aspect of ensuring the safe operation and longevity of vehicles due to the importance of enhancing the intercity traffic safety and maintaining the road pavement in good condition. It continuously involves monitoring the weight and load distribution of a vehicle to prevent it from exceeding its maximum capacity. Since commercial trucks, trailers, buses and passenger cars have different weight limits, load configurations, and structural considerations, specific monitoring systems are designed and implemented to cater to each vehicle category's unique requirements [1].

As result, the methods and technologies adopted for overload monitoring can vary significantly between various types of vehicles. The studies in this filed highlight the variations in design, size, and purpose of these vehicles necessitate distinct approaches to overload monitoring.

For cars, overload monitoring is typically focused on passenger safety and vehicle performance in which modern cars are equipped with sensors that measure the weight distribution and compare it with the manufacturer's specifications. If an overload or unbalancing is detected, the system may notify the driver or adjust the suspension to comply with factory instructions in order to maintain vehicles' stability [2] In contrast, trucks are primarily designed for transporting goods and often operate under heavy loads, so overload monitoring systems in trucks are more advanced and sophisticated. The above-mentioned systems may include load cells integrated into the suspension or axle, which provide real-time data on the weight distribution. Additionally, truck overload monitoring systems may incorporate GPS technology to track the vehicle's location and ensure compliance with weight regulations.

In terms of regulation and traffic enforcement, overload distribution in vehicles is a critical aspect of ensuring road safety, preventing damage to infrastructure, and complying with weight regulations. Monitoring the amount of overload distribution is essential for maintaining vehicle stability, optimizing fuel efficiency, and preventing excessive wear and tear on components as well [3]. Regional regulations are also important concerns where vehicle weight limits and overload monitoring regulations can vary from region to region or country to country. Stringent weight enforcement policies in certain areas may necessitate the widespread use of advanced overload monitoring systems. These regulations ordinarily require authorities to employ Weigh-In-Motion systems (WIM) that measure vehicle weight while in motion, allowing for efficient enforcement and minimizing traffic disruptions [4]. However, the approach to monitoring overload distribution can vary significantly depending on the type of vehicle involved. Studies in this field typically targeted the roles of the performance of weighing stations on overloading detection and concluded that the stations have significant effects on detection overloads and suggested the stations' performance ranking should be more carefully applied over the country [5].

From the view of industry-specific requirements, industries such as

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construction, logistics, and transportation have specific needs for monitoring overload distribution in their respective vehicles. For example, the construction industry frequently employs heavy-duty trucks equipped with on board weighing systems to ensure compliance with weight limits and prevent damage to roads and bridges [6]. In contrast, logistics companies may rely on Weigh-In-Motion systems at checkpoints or toll plazas to monitor vehicle weight distribution accurately may be also followed with determining the most suitable locations for improving efficiency [7]. Overloading equipment and their performances are also known as concerns where performance evaluations of different overload monitoring systems play a crucial role in determining their effectiveness across various vehicle types. Researchers have proposed and assessed factors like accuracy, reliability, real-time monitoring capabilities, ease of installation and cost-effectiveness. Comparative studies help identify the most suitable monitoring systems for each vehicle category, ensuring accurate measurement and distribution of overload [8] In terms of systems, monitoring the amount of overload distribution in vehicles is essential for maintaining road safety and complying with weight regulations.

The choice of monitoring systems varies depending on the vehicle type, industry requirements, regional regulations, and performance evaluations. Understanding these differences can help policymakers, transportation authorities, and vehicle manufacturers make perfect decisions about implementing the most appropriate overload monitoring systems. By ensuring accurate and reliable monitoring of overload distribution, we can enhance road safety, preserve infrastructure, and optimize vehicle performance across different types of vehicles [9].

Following the above-mentioned, the study has been conducted to investigate the similarities and dissimilarities between the distribution functions of detected overloading for three types of trucks that are basically different in terms of enforcement including trailers, heavy trucks and light trucks. Since the study focuses on provinces as observations, the results would support transport authorities to adapt overload enforcement instructions to ensure that all types of trucks are similarly under enforcement.

II. SCIENTIFIC BACKGROUND

A. Distribution Similarity for Three Samples

Checking the similarity of distribution functions is one of the practical methods to examine relevancy between two variables. In this case, two data sets are commonly compared based on the similarity of their distribution functions through statistical tests [10]. There are many measures to check the similarity of two distribution functions [11], and all are dependent on which method is used. The Kolmogorov-Smirnov test, known also as the KS test and primarily utilized in non-parametric hypothesis testing [12], is one of the statistical tests that compare the behavior of two samples. It is a goodness of fit non-parametric test of the equality for continuous or discrete one-dimensional probability distributions to compare the statistical probabilities of two samples [13], so it is conventionally utilized to compare a real distribution sample with a reference probability distribution [14]. The overall concept behind the KS test is to investigate the maximum distance between the cumulative distribution functions of two samples which represent the unlikeness of two distribution shapes [15]. It is utilized to assess the similarity between the expected and the experimental or observational distribution functions for checking the fitness of the experimental data to the expected distribution function [16].

Although this ability commonly supports data analysers for testing normality, where the existing normality is necessary to perform analyzing procedures [17], but it can be also utilized in other distribution functions and existing similarities for two data sets [18]. In the case of comparing two samples, each record or sample in one population is compared individually to the same observation in the other population. It can be likely developed where the difference between two distribution functions is formulated to check if they are the same or different [19]. The test that was initially introduced by, on the maximum discrepancy between two empirical distributions [20]. The method proposed in 1951 was later developed it to check the similarity functions for three samples by for testing a three-sample Kolmogorov-Smirnov test in 1958 followed by developing for assessing the similarity functions for “k” (k≥2) by [21], and eventually simplified for understanding by [22]. The statistical measure is obtained by equation (1), where $\delta_{i,j}(n) = Sup_x\left|F_{n,i}(x) - F_{n,j}(x)\right|$ and $F_{n,i}(x); i = 1, 2, \dots, r \; and \; j = 1,2, \dots, r$denote the empiricaldistribution functions of these samples.In the case of $r = 3$, equation (1) is developed by equation (2).

$$\delta_r(n) = max\left|\delta_{1,2}(n), \delta_{2,3}(n), \dots, \delta_{r-1,r}(n), \delta_{r,1}(n)\right| \quad \dots \quad (1)$$

$$\delta_3(n) = max\left|\delta_{1,2}(n), \delta_{2,3}(n), \delta_{3,1}(n)\right| \quad \dots \quad (2)$$

B. Relevant Studies

There are many studies in the literature that investigated the concerns and issues related to overloading. In addition to attributes studied in this field, techniques and approaches, as well as recommendations are also highlighted in this manner. Since the weighing technology are being improved these days, the recent studies mainly focus on advanced tools such as Weigh-In-Motion technology even the economic aspects are under study to ensure that the cost will be generated enough revenue during the usage [23]. The overloading is a primary concern in pavement management, where Chen, et al. made a research work to evaluate the impact of overload on road infrastructure by comparing different vehicle types and assessed the extent of pavement damage caused by overloaded vehicles and provides recommendations for infrastructure preservation [24].

Road safety is another main concern for transport authorities in the manner of overloading. Singh and Srivastava investigated the impact of overloading on the wear and tear of critical components in trucks, such as tires, suspension systems and brakes [25]. The research examines how exceeding legal weight limits affects the performance and durability of these components, leading to increased maintenance costs and potential safety hazards. The findings also highlight the

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importance of adhering to permissible limits and implementing effective overload monitoring systems to mitigate excessive wear and tear, optimize fuel efficiency and ensure road safety.

Following the above mentioned, improving technologies are also being studied. For example, Lin et al. studied the utilization of Weigh-In-Motion data to analyse the distribution of overload among different vehicle types and provide insights into the specific vehicle categories those are more prone to overloading, aiding in targeted interventions to improve overloading control [26].

Enforcement strategy is moreover under study as a very important issue in the field of pavement management, where Dolcemascolo et al. compare overload monitoring and enforcement strategies implemented in different countries for heavy vehicles and examine the effectiveness of various approaches and highlights best practices for mitigating overload risks [27]. Another example is to improve predicting the rate of trucks may be put under enforcement not only by utilizing the conventional methods but also by modelling the prediction in chaos theory context [28]. It is also combined in the studies with traffic congestion whereas Gaira et al. 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 proposes strategies to alleviate congestion where traffic congestion has significant effect of pavement conditions [29].

The role of transport companies is also perceived as a critical attribute where in a case study Qiao et al. put a light on a collaborative approach to overload monitoring between regulatory bodies and transportation companies and highlights the benefits of stakeholder engagement in implementing effective monitoring systems and reducing overloading practices [30]. Although passenger cars maybe under overloading control by various factors investigated by Gezahegn [31], improved by Yassenn et al. [32] for vans and SUVs as well, but commercial vehicles are more under overloading control comparing to other types of vehicles. For example, in the field of improving technologies, Odonkor et al. focus on the development of an overload monitoring system specifically designed for commercial vehicles and discuss the importance of weight distribution monitoring and proposes a sensor-based system for accurate measurement [33].

Heavy-duty vehicles are also investigated where Nassif et al. [34] compares different overload monitoring systems used in heavy-duty vehicles, including construction equipment and mining trucks operating in extreme conditions. The research evaluates the effectiveness of these systems in measuring real-time cargo weight and preventing structural damage caused by overloading and explores 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 extraordinary operating conditions. It is also improved in the further studies where Alkhoori et al. [35] focuses on optimizing overload distribution in heavy-duty vehicles and proposes strategies to achieve optimal weight distribution, considering factors like cargo weight, vehicle characteristics, and handling capabilities. They additionally 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.

The further studies have also examined the distribution of overload in different types of vehicles, specifically focusing on passenger cars and trucks and analyse various factors such as weight distribution, maximum load capacity, handling, braking, and stability to determine how these characteristics affect the distribution of overload [36]. Their findings provide insights into the differences between passenger cars and trucks in terms of their ability to handle and distribute excess weight, highlighting the importance of considering these factors for passenger safety and vehicle performance optimization [37].

In summary, many studies have been conducted in overloading so it is not a novel topic in transportation but it requires more studies to improve the procedures applied in overloading enforcement to ensure heavy vehicles do not destroy transport infrastructures [38]. The present research work accordingly focuses on the importance of freight vehicle type on enforcement to investigate if all types of trucks are systematically under control or not [39].

III. RESEARCH METHODOLOGY AND IMPLEMENTATION

As stated in the previous section, the comparison of distribution similarities between three types of commercial trucks detected as overloading is directly investigated in all provinces in the West-Asian country of Iran. At the first stage, data collection process is conducted to gather relevant data. Data will be gathered in records, but analysing will be done in provinces that attributed as observations. The second stage is to check the necessity of data standardization. This step ensures if the number of detected overload vehicles depends on the number of weighing stations and the number of freight trips or not. If so, the data should be normalized, otherwise, no normalization is needed. The dependency will be checked by analysing of variance one of the most well-known test in this area. The third stage is to normalize data using exposure in which the number of registered trucks for each type is considered as exposure factor. The fourth stage is to utilize the well-known statistical testing method of the Kolmogorov-Smirnov. Since the specifications of three types of trucks are studied, the updated version of the test, known as three sample Kolmogorov-Smirnov test is performed to check the similarity between the three types of trucks named here as samples in the literature context. Each sample includes thirty-one observations attributed to each province accordingly. In this stage the relevant hypotheses are defined, and comparison is performed based on the maximum difference between the cumulative proportions calculated for each type of trucks. The final stage is to conclude what has been

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outlined as research findings.

A. 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 trucks of trailers, heavy and light trucks. Although there are many types of vehicle fleets, those have been identified in the software that manages overloading data, but all can be categorized into the three mentioned types. Data collection provides a history of data attributed to each detected vehicles on the roads, stopped and forced drivers to pay fine during a sonar Iranian year of 1401. It is the same time as 21st March 2022 to 20th March 2023. Since, the country (Iran) is divided into 31 provinces, politically and geographically, overloading records have been summarized to 31 observations as reported in Table 1. Each observation includes the number of weighing stations placed within the province, the number of freight trips, and the number of trucks detected as overloading categorized into trailer, heavy truck, and light truck.

Table 1: Overall Stats on Trucks Detected as Overloading

Row	Province (Observation)	Weighing Stations	Truck Trips (×1000 Trip)	Trailer (Compound)	Heavy Truck	Light Truck
1	Alborz	8	848	113	336	568
2	Ardabil	7	298	196	298	77
3	Bushehr	6	556	210	360	86
4	Chehar-Mahal-O-Bakhtiari	5	371	85	52	13
5	East-Azerbaijan	14	1583	944	1212	2987
6	Fars	22	2378	394	383	715
7	Golestan	10	729	220	1344	662
8	Guilan	8	628	91	889	670
9	Hamedan	7	697	156	779	201
10	Hormozgan	10	1481	530	166	237
11	Ilam	7	136	9	58	0
12	Isfahan	16	3206	1423	1235	1319
13	Kerman	20	1887	94	333	446
14	Kermanshah	10	602	168	589	265
15	Khouzestan	15	2386	528	124	169
16	Kohgiluye-Buyer-Ahmad	7	104	24	53	43
17	Kordestan	4	466	102	624	167
18	Lorestan	10	383	243	77	103
19	Markazi	19	1240	337	232	195
20	Mazandaran	17	1405	235	1883	1263
21	North-Khorasan	7	210	15	329	245
22	Qazvin	7	761	86	299	78
23	Qom	5	464	67	806	111
24	Razavi-Khorasan	26	1984	3890	172	385
25	Semnan	12	624	81	306	11
26	Sistan-O-Baluchestan	15	520	11908	539	194
27	South-Khorasan	8	393	1231	23	0
28	Tehran	18	3891	386	8044	116
29	West-Azerbaijan	14	867	912	1891	599
30	Yazd	7	1602	511	352	105
31	Zanjan	9	666	128	986	120
Total		**350**	**33366**	**25317**	**24774**	**12150**

B. Defining Hypotheses

The first step of performing the three-sample Kolmogorov-Smirnov test is to define its hypothesis. Since the test here is utilized to check the similarity between three types of trucks' attractions for overloading detection, the null and competitive hypotheses are defined as follows:

H_0: Trucks' attraction to be under control of overloading come from the same distribution functions.

H_1: Trucks' attraction to be under control of overloading come from different distribution functions.

IV. NUMERICAL ANALYSIS

A. Checking Variable Dependency

As stated in the previous section, the initial phase of data analysis is to check the dependency between the number of trucks detected as overloading with two leading contributing factors of the number of weighing stations and the number of truck trips. In this case, a two-variable linear regression model has been developed as equation (3) where Y is the number of total trucks detected as overloading, WS is the number of weighing stations located within the province, and eventually TT is the number of truck trips originated from the province over a year. For clarification in the regression model development, it should be mentioned that TT represents the sum of truck trips for all types of trailers, heavy and light trucks.

$$Y = -383.77 + 167.52WS + 0.465TT \quad \ldots \quad (3)$$

The ANOVA result test is also tabulated in Table 2 including parameters help readers to understand if the number of weighing stations and truck trips have significant effect on the number of detected overloading or not. "SS" and "df" represent the sum of squares and degree of freedom, respectively while F represents the value of F-test performed to the analysis. As shown, the statistical criterion of P-Value is greater than 0.05 for both independent variables, so it can be concluded that the number of weighing stations and the number of truck trips do not have significant effects on detected

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trucks. Therefore, data normalization is not necessary for data gathered in all provinces.

Table 2: ANOVA Test for Two-Variable Linear Regression Model

Source	df	SS	F	Significance F
Regression	2	48748886	4.066778	0.028149
Residual	28	167819443		
Total	30	216568329		
Parameter	**Coefficients**	**t Stat**	**P-value**	
Intercept	-383.771	-0.3789	0.70762	
WS	167.5185	1.50388	0.14381	
TT	0.46474	0.68492	0.49903	

B. Exposure Fitting

The following stage is to normalize data according to exposure factor which is the number of trucks and trailers registered in the province. In this case, the uniform rate of detection for each type of truck in every province is calculated by dividing the number of detected trucks (extracted from Table 1) to the number of registered trucks. Table 3 represents the uniform rate of detections. For instance, the uniform detection rate for the trailer in the first observation, Alborz province, is calculated as $\frac{113}{2567} = 0.04402$. The rest have also been calculated and set in Table 3. From now on, the uniform rate of detection is considered as the statistical measure for checking the similarity utilizing the adapted version of Kolmogorov-Smirnov test. However the exposure usually comes from the real traffic volume of trucks passing through each provinces' roads and registered numbers do not necessarily represents the operational fleet carrying loads, but in shortage of data maybe better than absolute number of detected overloading.

Table 3: The Number of Registered Trucks and Uniform Detection Rates for Three Types of Vehicles

		Trucks Registered				Uniform Detection Rate		
Row	**Province**	**Trailer**	**H-Truck**	**L-Truck**	**Total**	**Trailer**	**H-Truck**	**L-Truck**
1	Alborz	2567	2329	4700	9596	0.044020	0.144268	0.120851
2	Ardabil	3999	2943	1838	8780	0.049012	0.101257	0.041893
3	Bushehr	1440	917	969	3326	0.145833	0.392585	0.088751
4	Chehar-Mahal	4449	2528	2268	9245	0.019105	0.020570	0.005732
5	E-Azerbaijan	14877	8728	5227	28832	0.063454	0.138863	0.571456
6	Fars	18365	15413	9792	43570	0.021454	0.024849	0.073019
7	Golestan	2194	2447	1856	6497	0.100273	0.549244	0.356681
8	Guilan	6291	2291	3094	11676	0.014465	0.388040	0.216548
9	Hamedan	3238	5872	3407	12517	0.048178	0.132663	0.058996
10	Hormozgan	24554	9935	2731	37220	0.021585	0.016709	0.086781
11	Ilam	1377	743	584	2704	0.006536	0.078062	0.000000
12	Isfahan	20259	12084	8103	40446	0.070240	0.102201	0.162779
13	Kerman	9953	4904	6081	20938	0.009444	0.067904	0.073343
14	Kermanshah	8086	4694	2416	15196	0.020777	0.125479	0.109685
15	Khouzestan	16956	5557	3319	25832	0.031139	0.022314	0.050919
16	Kohgiluye	249	508	236	993	0.096386	0.104331	0.182203
17	Kordestan	3353	2454	2515	8322	0.030421	0.254279	0.066402
18	Lorestan	5106	2866	3927	11899	0.047591	0.026867	0.026229
19	Markazi	4312	1845	2672	8829	0.078154	0.125745	0.072979
20	Mazandaran	2502	6728	3607	12837	0.093925	0.279875	0.350152
21	N-Khorasan	2317	1095	1565	4977	0.006474	0.300457	0.156550
22	Qazvin	4555	3542	3051	11148	0.018880	0.084416	0.025565
23	Qom	931	1512	1378	3821	0.071966	0.533069	0.080552
24	R-Khorasan	15378	10920	7027	33325	0.252959	0.015751	0.054789
25	Semnan	955	1542	806	3303	0.084817	0.198444	0.013648
26	Sistan	10804	7074	2107	19985	1.102184	0.076195	0.092074
27	S-Khorasan	3155	1680	933	5768	0.390174	0.013690	0.000000
28	Tehran	11492	4299	12832	28623	0.033589	1.871133	0.009040
29	W-Azerbaijan	9501	6092	2511	18104	0.095990	0.310407	0.238550
30	Yazd	5905	2027	1357	9289	0.086537	0.173656	0.077377
31	Zanjan	1975	2491	1717	6183	0.064810	0.395825	0.069889
Total		**221095**	**138060**	**104626**	**463781**	**3.22037**	**7.06915**	**3.53343**

C. Similarity Test Utilization

For utilizing the three-sample Kolmogorov-Smirnov test, the first step is to calculate the proportion for each observation so-called here as a province. The summation of total uniform detection rates for trailers is 3.22037 and for heavy and light trucks are 7.06915 and 3.53343, respectively. The trailer proportion for the first observation of Alborz province is calculated as $\frac{0.044020}{3.22037} = 0.01367$.The proportion for heavy trucks is also calculated as $\frac{0.144268}{7.06915} = 0.02041$, followed by calculating the light trucks proportion as $\frac{0.120851}{3.53343} = 0.03420$. The rest is also tabulated in columns three to five in Table 4 for all types of

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trucks. The second step of the test is to calculate the cumulative proportion for each observation. The cumulative proportion of three types of vehicles is calculated and represented in the sixth to eighth columns of Table 4. The third step is to calculate the absolute difference between the cumulative proportions based on equation (2) and its components. To simplify understanding the calculation process, trailer is identified by index Tr, heavy truck by index Ht, and light trucks by index Lt.

To understand easily, for each observation the maximum difference has also been calculated and tabulated in the last column of table 4. For example, the maximum pair-wise difference between three types of trucks

for the first observation, Alborz, is calculated as equation (4). Therefore, the absolute values for differences for all pair comparisons are obtained by equations (5) to (7).

$$MD(Alborz) = Max\,\{|0.01367 - 0.02041|, |0.01367 - 0.0342|, |0.02041 - 0.0342|\} = 0.0205 \quad \dots \quad (4)$$

$$\delta_{Tr,Ht}(31) = Sup_x\left|F_{31,Tr}(x) - F_{31,Ht}(x)\right| = 0.30192 \quad \dots \quad (5)$$

$$\delta_{Tr,Lt}(31) = Sup_x\left|F_{31,Tr}(x) - F_{31,Lt}(x)\right| = 0.49836 \quad \dots \quad (6)$$

$$\delta_{Ht,Lt}(31) = Sup_x\left|F_{31,Ht}(x) - F_{31,Lt}(x)\right| = 0.33232 \quad \dots \quad (7)$$

Following the test by calculating equation (2), the test stat is now obtained by equation (8).

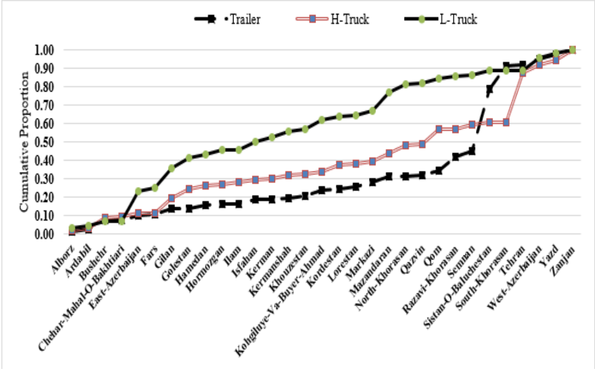
$$\delta_3(31) = max\left|\delta_{Tr,Ht}(31), \delta_{Tr,Lt}(31), \delta_{Ht,Lt}(31)\right| = max[0.30192, 0.49836, 0.33232] = 0.49836 \quad \dots \quad (8)$$

The test here is applicable in 31 groups with confidence probability 95% and the critical value of KS(0.95%, 31)=0.234 is less than the obtained value of 0.49836. It means that the null hypothesis is rejected, and it is concluded that the overloading detection for three types of truck come from different distribution functions. In practice, the result means the concentration for overloading detection is different, so some types of truck may put under more pressure for overloading detection rather than the other types.

The results are depicted better by a graph as Fig. 1 composes of three lines. The line with square makers represents trailers, and the dashed line represents heavy trucks and eventually the doubled line represents the cumulative proportion of light trucks according to the summation of detection rates. The most significant difference between the tree lines is detected in the observation of Qom province known as KS stat. In the figure, it represents the maximum difference between cumulative proportions of three samples under study.

Table 4: Proportion and Cumulative Proportion for Uniform Detection Rate of Trucks

		Proportion			Cumulative Proportion			Maximum
Row	**Province**	**Trailer**	**H-Truck**	**L-Truck**	**Trailer**	**H-Truck**	**L-Truck**	**Difference**
1	Alborz	0.01367	0.02041	0.03420	0.0137	0.0204	0.0342	0.0205
2	Ardabil	0.01522	0.01432	0.01186	0.0289	0.0347	0.0461	0.0172
3	Bushehr	0.04528	0.05553	0.02512	0.0742	0.0903	0.0712	0.0191
4	Chehar-Mahal	0.00593	0.00291	0.00162	0.0801	0.0932	0.0728	0.0204
5	E-Azerbaijan	0.01970	0.01964	0.16173	0.0998	0.1128	0.2345	0.1347
6	Fars	0.00666	0.00352	0.02067	0.1065	0.1163	0.2552	0.1487
7	Golestan	0.03114	0.07770	0.10094	0.1376	0.1940	0.3561	0.2185
8	Guilan	0.00449	0.05489	0.06129	0.1421	0.2489	0.4174	0.2753
9	Hamedan	0.01496	0.01877	0.01670	0.1571	0.2677	0.4341	0.2771
10	Hormozgan	0.00670	0.00236	0.02456	0.1638	0.2701	0.4587	0.2949
11	Ilam	0.00203	0.01104	0.00000	0.1658	0.2811	0.4587	0.2929
12	Isfahan	0.02181	0.01446	0.04607	0.1876	0.2956	0.5047	0.3171
13	Kerman	0.00293	0.00961	0.02076	0.1905	0.3052	0.5255	0.3350
14	Kermanshah	0.00645	0.01775	0.03104	0.1970	0.3229	0.5565	0.3596
15	Khouzestan	0.00967	0.00316	0.01441	0.2067	0.3261	0.5710	0.3643
16	Kohgiluye	0.02993	0.01476	0.05157	0.2366	0.3408	0.6225	0.3859
17	Kordestan	0.00945	0.03597	0.01879	0.2460	0.3768	0.6413	0.3953
18	Lorestan	0.01478	0.00380	0.00742	0.2608	0.3806	0.6487	0.3879
19	Markazi	0.02427	0.01779	0.02065	0.2851	0.3984	0.6694	0.3843
20	Mazandaran	0.02917	0.03959	0.09910	0.3142	0.4380	0.7685	0.4542
21	N-Khorasan	0.00201	0.04250	0.04431	0.3163	0.4805	0.8128	0.4965
22	Qazvin	0.00586	0.01194	0.00724	0.3221	0.4924	0.8200	0.4979
23	Qom	0.02235	0.07541	0.02280	0.3445	0.5678	0.8428	0.4984
24	R-Khorasan	0.07855	0.00223	0.01551	0.4230	0.5701	0.8583	0.4353
25	Semnan	0.02634	0.02807	0.00386	0.4494	0.5981	0.8622	0.4128
26	Sistan	0.34225	0.01078	0.02606	0.7916	0.6089	0.8883	0.2793
27	S-Khorasan	0.12116	0.00194	0.00000	0.9128	0.6108	0.8883	0.3019
28	Tehran	0.01043	0.26469	0.00256	0.9232	0.8755	0.8908	0.0477
29	W-Azerbaijan	0.02981	0.04391	0.06751	0.9530	0.9194	0.9583	0.0389
30	Yazd	0.02687	0.02457	0.02190	0.9799	0.9440	0.9802	0.0362
31	Zanjan	0.02013	0.05599	0.01978	1.0000	1.0000	1.0000	0.0000
Maximum								**0.4984**



[Fig.1: Difference Between Cumulative Proportions of Trucks Over Observations]

V. CONCLUSION

Since in controlling overloading, it is necessary to assess the distribution functions upon the vehicle types, the trucks' attraction for overloading control has been investigated in this study. The overall concept behind the research work is to check the similarity between all types of trucks that have been enforced for overloading. Data for all types of trucks registered and detected as overloading have been collected in 31 provinces in the west-Asian country of Iran and the adapted version of the well-known goodness of fit test of Kolmogorov-Smirnov has been utilized to check if detected distribution functions for all types of trucks are the same or different.

In order to check the dependency between detected overloading cases and two contributing factors of the number of weighing stations and truck trips, ANOVA test has been utilized as showed that there is no significant dependency. The exposure factor of registered trucks has also been considered in the process for obtaining uniform detection rate. Therefore, the data have been solely manipulated in the analysing process by applying exposure fitting. The results revealed that their distribution functions are different means that trucks are not equally under the control of overloading enforcement. It means that transport authorities should revise control instruction to ensure all types of truck would be under control.

Further research in this field is recommended to focus more on specific measures that lead truck drivers to overload in particular where mining and construction industries are in high performances or incomes. The role of weighing stations should also be investigated in overloading control to make appropriate decisions on how they are working in deterrence of overloading.

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After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

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