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Distribution Function Similarity of Commercial Drivers and their Willingness to Take Examinations and Training Courses (Case Study: Iran)

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Abstract

In the process of training and examining professional drivers who serve as commercial trucks and coaches' drivers, studying the willingness of taking training courses is a crucial concern for transport authorities for developing training programs on transportation. To this purpose, an adapted version of the statistical method of Kolmogorov-Smirnov, three sample, has been utilized to investigate the similarity of distribution functions for three types of drivers who receive permission with taking training courses and examinations, taking examinations without training courses, and receiving permissions without examination and training courses. Data, for those received permissions across the West-Asian country of Iran, has been collected for a year through the system used for issuing drivers' permissions for commercial transportation followed by categorizing into thirty-one provinces and analysis. The results revealed that their distribution functions are different for three types of drivers over the provinces. Therefore, transport authorities should design driver's exams and training courses different province to province.

Keywords
Commercial Drivers, Inter-city Transport,Drivers' Training,Distribution Function, Statistical Similarity.

Introduction
Compliance with laws is one of the most prominent manifestations of civic rights in the social sphere nowadays (Nwagwu et al. 2020). This commitment is discussed in various fields, some of which are neglected in certain areas such as transportation, leading to traffic violations (Ako2019). One of the major contributors to traffic issues and accidents across all communities is driving offenses that believed that is preventable if drivers are under comprehensive and efficient training courses (Gichaga2017). The prevalence of such offenses differs based on the cultural, social, economic, and geographic characteristics of each society (Kelacha2021). While various environmental, regulatory, and enforcement factors contribute to driving offenses, human factors are considered to be the main cause (Lee and Al-Mansour2020). The identification of human factors and the use of education to address and improve driving behaviors have been found to play a significant role in preventing and managing traffic accidents, according to studies conducted in developed countries (Nancy2021). So, the Global Plan for the Decade of Action for Road Safety places emphasis on the driver as a crucial element in their approach to reducing driving-related accidents and injuries worldwide (Timmermans et al. 2020). Education is additionally acknowledged as a sustainable competitive advantage for enhancing the awareness and skills of the workforce in modern times (Farooq and Juhasz 2020), so in terms of road safety, providing driver education is regarded as the topmost priority for investment in human capital (Timmermans et al. 2019). One of the important concerns of transportation authorities who are dealing with developing training programs for commercial drivers is to study their inclination toward taking training courses. This is because the effectiveness of training programs depends on the individual's willingness to engage in the activities and follow the guidelines provided in this regard (Nwakaire and Kobani 2022). Therefore, managing the training process and developing driver education programs require careful consideration of individuals' motivations

and desires to participate. By evaluating educational programs, decision-makers are empowered to devise tailored educational systems for each region, resulting in better enhancement of the knowledge and skills of the human resources involved in traffic and transportation. While maintaining productivity, an approach can be adapted to create desirable behavioral changes for both individual and societal needs, facilitating the achievement of organizational goals. On the other hand, it is important to design training courses according to the tangible needs of participants to ensure their usefulness and ensure that they lead to behavioral changes during and after these courses (Mahmoudabadi and Moghadam 2020). In the countries such as Iran where there are significant differences between provinces in terms of social, economic, and geographic specifications, it is crucial to take care of developing drivers' training courses so the main aim of the present research work is to ensure that the willingness of drivers on taking training courses are the same of different.

Following the above-mentioned, the study has been conducted to investigate the similarities and dissimilarities between the distribution functions of drivers who receive commercial driving permissions in three forms taking examination and training courses, examination without training courses, and drivers who receive permission without examination. The results would support transport authorities to make decisions on training commercial drivers based on their willingness to take training courses. In other words, in a country where drivers can optionally select the way of receiving permission with or without examination and taking training courses, the study investigates if the driving training programs would be successful or not.

Scientific Background

Distribution Similarity for Three Samples

Checking the similarity of distribution functions is one of the practical methods to examine the relevancy between two variables. In this case, two data sets are commonly compared based on the similarity of their distribution functions through statistical tests (Pastore and Calcagnì 2019). There are many measures to check the similarity of two distribution functions (Lee1999), 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 (Sahinturk and Özcan 2017), 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 (Vrbik 2018), so it is conventionally utilized to compare a real distribution sample with a reference probability distribution (Arnold and Emerson 2011).The overall concept behind the KS test is to investigate the maximum distance between the cumulative distribution functions of two samples which represents the unlikeness of two distribution shapes (Lopes et al. 2007). 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 (Simard and L'Ecuyer 2011).Although this ability commonly supports data analyzers for testing normality, where the existing normality is necessary to perform analyzing procedures (Drezner et al. 2010), it can be also utilized in other distribution functions and existing similarities for two data sets (Mahmoudabadi and Abdous 2020).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. The test that was initially introduced by (Gnedenko and Korolyuk 1951), on the maximum discrepancy between two empirical distributions. The method proposed by Doklady et al. in 1951 was later developed it to check the similarity functions for three samples by (David 1958) for testing a three-sample Kolmogorov-Smirnov test. The Annals of Mathematical Statistics, 29, 842–851.) (Herbert, 1958) in 1958 followed by developing for assessing the similarity functions for "k" (k≥2) by (Kiefer 1959), simplified for understanding by (Bohm and Hornik 2010). 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 $F_{n,i}(x); i = 1,2,\dots,randj = 1,2,\dots,r$ denote the empirical distribution functions of these samples. In the case of $r = 3$, equation (1) is described as equation (2).

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

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

Relevant Studies

Due to the importance of training programs for promoting road safety in traffic and enhancing transport productivity, many studies have been conducted in this area. In a study conducted by Nwadinigwe et al. (2018), the effectiveness of road safety education on the knowledge and behavior of commercial drivers was evaluated. The results of the study

suggested that the educational program had a significant impact on the behavior of commercial drivers. Furthermore, the study also observed the joint influence of factors such as the educational background of commercial drivers, the duration of their road safety learning, their behavior and knowledge, and eventually their perception of the road safety education program on road safety (Nwadinigwe et al. 2018). The efficacy of training courses on transportation drivers was also investigated by Koushki et al. (2022). According to their findings, attending these courses results in improving driver skills, increasing levels of learning, and reduction in accidents (Koushki et al. 2020). In Mexico, a study was conducted by Bergoffen et al. (2022) to examine driver training for commercial vehicle operators. Their research showed that individuals who receive technical knowledge and skills training and undergo testing should undergo periodic validation and monitoring. The study also revealed the necessity for a standardized national curriculum for each LFC class in the country, with certification granted to LFC drivers upon meeting national standards (Bergoffen et al. 2022).

Training progressive approach is another contributing factor studied frequently. In a study, the effectiveness of a traffic safety education program for the Oman Traffic Safety Administration was examined through program design and implementation. The study's findings demonstrated that implementing multiple educational systems for residents was highly desirable, but the program also required continuous planning, monitoring, and improvement (Hamdania et al. 2019). The results of another study conducted by a group of researchers demonstrate a significant difference in risky behavior in road accidents between commercial vehicle drivers who have participated in training programs and those who have not. The executive summary of the study suggests that the government and other relevant organizations, such as the National Road Safety Corps and vehicle inspection officers, collaborate to organize a program that educates commercial vehicle drivers about behaviors that make them more prone to road accidents. Eventually, qualified drivers should be hired from among those who have received training (Yahaya and Abubakar2022). Nwadinigwe et al. evaluated commercial drivers' understanding of traffic safety training. The results of their study indicate that the road traffic safety training program has a significant impact on drivers' compliance with road traffic laws and regulations. Additionally, it was observed that drivers' experience will affect their adherence to road traffic laws and regulations (Nwadinigwe et al. 2019).Garcia and colleagues conducted a study in which they examined the effectiveness of training techniques for vehicle operators in their reviewing study. In this review, some of the topics of the theoretical lessons and others completely practical were taught to the operators, and in the end, they were asked to participate in a test to evaluate the impact of the techniques learned in the classes on the performance of individuals. The test results showed that the selected plan was very successful as a desired short-term effect and required the continuation of the course in the long run (Garcia et al. 2019).

To summarize, what can be obtained from the above studies is that taking and examining training drivers' courses have a significant influence on road safety and transportation as well. In addition, developing appropriate training courses is so crucial to manage drivers who take examination and training courses, in particular, commercial truck drivers whose exposure to traffic is higher rather than the other road users.

Research Methodology and Implementation

As stated in the previous section, the comparison of distribution similarities between three types of drivers who receive commercial driving permission with examination and training courses, examination without training courses, and without examination and training courses are now being investigated in all provinces in the West-Asian country of Iran. In the present research work, the well-known statistical testing method of the Kolmogorov-Smirnov test is utilized. Since the specifications of three types of drivers are studied, the updated version of the test, three sample Kolmogorov-Smirnov test is performed to check the similarity between the three samples. Each sample has thirty-one observations attributed to each province. The main stages of this research work include descriptions of how the data was collected and the hypotheses defined followed by utilizing the three sample Kolmogorov-Smirnov throughout this section.

Case Study and Data Collection

To implement the research study, the first step is to collect appropriate data. Data, in three types, composes of drivers who receive driving permission with examination and training courses, examination without training courses, and without examination and training in each province in the country where there are 31 provinces. Each province is a so-called observation in this study. Data has been received from the "Research, Training, and Innovation Center" the responsible branch directed by the Road Maintenance and Transportation Organization (www.rmto.ir). It composes of all drivers' certificates issued in the 1401 Sonar calendar (March 21, 2022, to March 20, 2023). Table 1 tabulates the number of three types of aforementioned drivers ordered alphabetically by the name of a province. Population size

and surface area are also tabulated in the third and fourth columns to make sense for readers to compare the scale of population and area in each province. The population for each province is derived from stats published by the Statistical Centre of Iran (https://amar.org.ir), which typically publishes the population survey stats once a five-year period. According to the stats, the population has been collected in a national survey in 2016 but it halted later due to Covid-19. The surface area is also available in the report.

Table1.Drivers who received driving commercial permission during a year

Row	Province	Population	Area (KM^2)	Unexamined	Trained	Untrained
1	Alborz	2712400	5833	203	0	590
2	Ardabil	1270420	17800	262	610	804
3	Bushehr	1163400	22713	70	96	473
4	Chehar-Mahal-O-Bakhtiari	947763	16328	172	1499	89
5	East-Azerbaijan	3909652	45650	560	208	6729
6	Fars	4851274	122068	1161	2331	2939
7	Golestan	1868819	20363	131	646	470
8	Guilan	2530696	14042	107	256	851
9	Hamedan	1738234	19368	274	821	1606
10	Hormozgan	1776415	70697	552	0	1544
11	Ilam	580158	20113	410	0	177
12	Isfahan	5120850	107018	1681	79	2693
13	Kerman	3164718	183285	1012	411	1792
14	Kermanshah	1952434	24998	175	2332	11
15	Khouzestan	4710509	64055	420	0	1232
16	Kohgiluye-Buyer-Ahmad	713052	15504	5	218	169
17	Kordestan	1603011	29137	378	1821	465
18	Lorestan	1760649	28294	916	0	1891
19	Markazi	1429475	29127	189	163	597
20	Mazandaran	3283582	23756	202	1377	107
21	North-Khorasan	863092	28434	94	500	627
22	Qazvin	1273761	15567	150	31	1308
23	Qom	1292283	11240	33	0	18
24	Razavi-Khorasan	6434501	118018	3376	1223	9
25	Semnan	702360	97491	388	0	71
26	Sistan-O-Baluchestan	2775014	180726	313	1574	130
27	South-Khorasan	768898	151193	212	982	371
28	Tehran	13267637	12981	2423	0	1688
29	West-Azerbaijan	3265219	37411	329	1610	2689
30	Yazd	1138533	73477	330	0	643
31	Zanjan	1057461	19164	187	0	841
Total				**16715**	**18788**	**33624**

Defining the 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 drivers and their willingness for taking training courses, the null and competitive hypotheses are defined as follows:

H_0: Drivers' willingness to serve as commercial drivers without exams, take exams, and training courses come from the same distribution functions.

H_1: Drivers' willingness to serve as commercial drivers without exams, take exams, and training courses come from different distribution functions.

Numerical Analysis

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 total number of drivers who received commercial driving permission without examination is 16715, while the number of drivers examined with and without taking training courses are 18788 and 33624, respectively. The unexamined driver proportion for the first observation of Alborz province is calculated as $\frac{203}{16715} = 0.01214$.The total number of trained and examined drivers over the period is 17788, so the trained drivers' proportion for the above province is calculated as $\frac{0}{18788} = 0$, followed by calculating the untrained drivers' proportion as $\frac{590}{33624} = 0.01755$.The rest is also shown in columns three to five in Table 2 for all types of drivers. The second step is to calculate the cumulative proportion for each observation. For each province, the cumulative proportion of three types of drivers is calculated and represented in the sixth to eighth columns of Table 2. 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, unexamined drivers are identified by index Ue, trained drivers by index Tr, and examined but untrained drivers by index Ut. Therefore, the absolute values for differences of all pair comparisons are obtained by equations (3) to (5).

$$\delta_{Ue,Tr}(31) = Sup_x\left|F_{31,Ue}(x) - F_{31,Tr}(x)\right| = 0.17464 \quad (3)$$

$$\delta_{Ue,Ut}(31) = Sup_x\left|F_{31,Ue}(x) - F_{31,Ut}(x)\right| = 0.26976 \quad (4)$$

$$\delta_{Tr,Ut}(31) = Sup_x\left|F_{31,Tr}(x) - F_{31,Ut}(x)\right| = 0.24704 \quad (5)$$

Following the test by calculating equation (2), the test stat is now obtained by equation (6).

$$\delta_3(31) = max\left|\delta_{Ue,Tr}(31), \delta_{Ue,Ut}(31), \delta_{Tr,Ue}(31)\right| = max[0.17464, 0.26976, 0.24704] = 0.26976 \quad (6)$$

The test here is applicable in 31 groups and the critical value of KS(0.95%, 31)=0.234 is less than the obtained value of 0.26976. It means that the null hypothesis is rejected and drivers' willingness to serve as commercial drivers without exams, take exams and training courses come from different distribution functions.

The results may be depicted better by a graph as Figure 1 composes of tree lines. The line with square maker represents the drivers who serve as commercial drivers without taking examination, the dashed line represents drivers who take exam with training courses and eventually the doubled line represents the proportion of drivers who have taken exam without training courses. The biggest difference between the tree lines is detected in the observation of Hormozgan province, for tenth observation, known as KS stat. In the figure, it represents the maximum difference between cumulative proportions of three samples under study.

Table 2. Proportion and cumulative proportion for three types of drivers in each province

		Proportion			Cumulative Proportion		
Row	**Province**	**Unexamined**	**Trained**	**Untrained**	**Unexamined**	**Trained**	**Untrained**
1	Alborz	0.01214	0.00000	0.01755	0.01214	0.00000	0.01755
2	Ardabil	0.01567	0.03247	0.02391	0.02782	0.03247	0.04146
3	Bushehr	0.00419	0.00511	0.01407	0.03201	0.03758	0.05553
4	Chehar-Mahal	0.01029	0.07978	0.00265	0.04230	0.11736	0.05817
5	E-Azerbaijan	0.03350	0.01107	0.20012	0.07580	0.12843	0.25830
6	Fars	0.06946	0.12407	0.08741	0.14526	0.25250	0.34571
7	Golestan	0.00784	0.03438	0.01398	0.15310	0.28689	0.35968
8	Guilan	0.00640	0.01363	0.02531	0.15950	0.30051	0.38499
9	Hamedan	0.01639	0.04370	0.04776	0.17589	0.34421	0.43276
10	Hormozgan	0.03302	0.00000	0.04592	0.20891	0.34421	0.47868
11	Ilam	0.02453	0.00000	0.00526	0.23344	0.34421	0.48394
12	Isfahan	0.10057	0.00420	0.08009	0.33401	0.34841	0.56403
13	Kerman	0.06054	0.02188	0.05330	0.39456	0.37029	0.61733
14	Kermanshah	0.01047	0.12412	0.00033	0.40503	0.49441	0.61765
15	Khouzestan	0.02513	0.00000	0.03664	0.43015	0.49441	0.65429
16	Kohgiluye	0.00030	0.01160	0.00503	0.43045	0.50601	0.65932
17	Kordestan	0.02261	0.09692	0.01383	0.45307	0.60294	0.67315
18	Lorestan	0.05480	0.00000	0.05624	0.50787	0.60294	0.72939
19	Markazi	0.01131	0.00868	0.01776	0.51917	0.61161	0.74714

		Proportion			Cumulative Proportion		
Row	**Province**	**Unexamined**	**Trained**	**Untrained**	**Unexamined**	**Trained**	**Untrained**
20	Mazandaran	0.01208	0.07329	0.00318	0.53126	0.68491	0.75033
21	N-Khorasan	0.00562	0.02661	0.01865	0.53688	0.71152	0.76897
22	Qazvin	0.00897	0.00165	0.03890	0.54586	0.71317	0.80788
23	Qom	0.00197	0.00000	0.00054	0.54783	0.71317	0.80841
24	R-Khorasan	0.20197	0.06509	0.00027	0.74981	0.77826	0.80868
25	Semnan	0.02321	0.00000	0.00211	0.77302	0.77826	0.81079
26	Sistan	0.01873	0.08378	0.00387	0.79174	0.86204	0.81466
27	S-Khorasan	0.01268	0.05227	0.01103	0.80443	0.91431	0.82569
28	Tehran	0.14496	0.00000	0.05020	0.94939	0.91431	0.87589
29	W-Azerbaijan	0.01968	0.08569	0.07997	0.96907	1.00000	0.95586
30	Yazd	0.01974	0.00000	0.01912	0.98881	1.00000	0.97499
31	Zanjan	0.01119	0.00000	0.02501	1.00000	1.00000	1.00000
Total		1.00000	1.00000	1.00000			

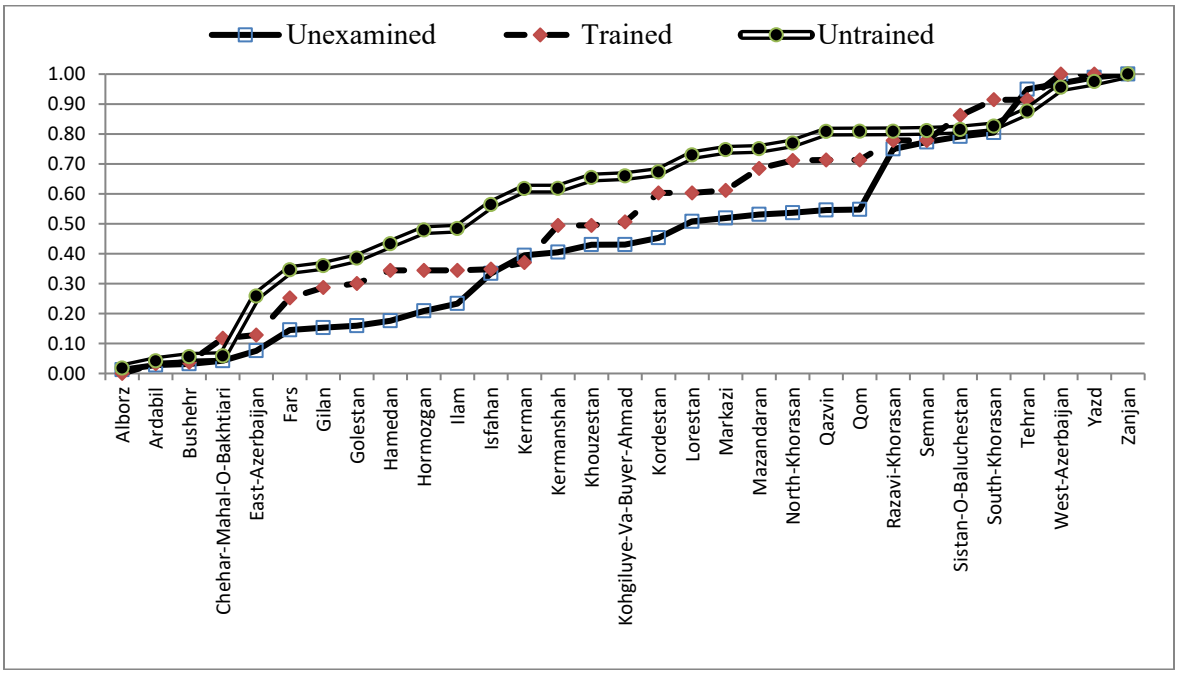

Figure 1: Difference between cumulative proportions of drivers without exams, take exams and take training courses

Conclusion

Since in the process of managing training courses for commercial drivers, it is necessary to investigate more on the distribution function of willingness to take examination and training courses by drivers who are willing to serve as commercial drivers. The overall concept behind the research work is to check the similarity between the drivers who received commercial certificates without taking exams, training courses and exams, and eventually exams without training courses. Data for all types of drivers have been collected in each province and the well-known goodness of fit test of Kolmogorov-Smirnov in its three sample format has been utilized to check if their distribution functions are the same or different. The results revealed that their distribution functions are different. It means that transport authorities should differently design exams and training across the courses where they should be designed different province to province. Further research in this field is recommended to focus more on specific measures such as the rate of acceptance for drivers who were participating in examinations and taking training courses and without training courses. Transport authorities are also recommended to design more applicable training courses to encourage drivers

to take them while the efficiency of training courses in other countries has been approved by previous studies.

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Biographies

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Fatemeh Pourhossein Ghazimahalleh graduated in Information Technology at Mehrastan University, Guilan, Iran. She received MSc degree 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 researches on developing advertising patterns in urban areas as well as conducting statistical analysis in different topics.