Research article

Analysis of Traffic Violations and Accidents with Enforcement: A Study in Jimma Town

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Abstract: The level of enforcement of road traffic laws plays a significant role in reducing traffic accidents, especially pedestrians, who are more than a fifth of the 1.24 million people killed each year due to traffic accidents. For assessing traffic law enforcement, the registered traffic violation data for the years 2015-2017 were taken from the Traffic Police Department to describe the activities of traffic police personnel in enforcing traffic laws. The violations were categorized into four groups: -those related to driving, vehicle, parking, and others, and Traffic Law Enforcement into safety and other traffic law enforcement activities. The vehicles involved in the violations were categorized as cars, small load vehicles, motorcycles, Bajaj, etc. Traffic Police had registered 77 traffic law violations in the year 2015, 65 in the year 2016, and 86 in the year 2017. Driving violation was the highest registered violation in the three years, and it was slightly higher in 2017. The cars and small load vehicles categories were the highest registered vehicles in several violations within the three years. For motorized two-wheeled vehicles, the highest number of registered violations in the three years was the one related to driving. All vehicle-related and other violations were registered more commonly for cars in 2015 and 2016. Of the registered violations, the parking-related violation occurred only in 2017. Safety-related traffic law enforcement was 89.96% of the total traffic law enforcement activity.

Keywords: Driving Violations; Enforcement; Traffic Law; Violations.

1. Introduction

More than 1.24 million people are killed each year due to road traffic crashes worldwide. Out of these deaths, more than one-fifth occur among pedestrians. According to WHO, more than 270,000 pedestrians lose their lives on the world's roads each year. More than the estimated amount of people are injured in traffic-related crashes while walking [1]. These incidents cause much suffering, grief, and economic hardship for families and loved ones. The key risks to pedestrians are well documented, and they include infrastructure in terms of a lack of dedicated facilities for pedestrians such as sidewalks, crossings, and raised medians [2].

However, the traffic fatality rates substantially differ across countries; for example, the traffic fatality rate per 100,000 populations is found 8.7 in high-income countries, but in middle-income countries, the rate is recorded as 20.1. In addition, only 52% of the registered vehicles globally are owned by middle-income countries, even though 80% of road traffic fatalities occur in these countries [3]. It can be claimed that the reasons behind these regional differences between countries on traffic fatalities may also be related to enforcement of road behaviors as practices in a country [4].

As a low-income country, Ethiopia has a low number of vehicles with high traffic accidents. According to the Ethiopian transport authority, road traffic injuries caused the loss of 2765, 3331, 3847, and 4352 Ethiopian lives in

2013, 2014, 2015, and 2016 G.C. respectively, with significant body injuries of 5047, 5888, 5839, and 7071 in the respective years. This indicates an increasing trend of road traffic accidents yearly though road traffic safety laws exist and few vehicles in the country [5].

Enforcement of the existing road traffic law is essential to shape road user behavior. Worldwide many organizations analyze road traffic crashes and maintain global crash statistics [3], [6]. For instance, it has a proven record of accomplishment in promoting highly efficient practices in road safety such as helmet and seatbelt wearing, restrictions on drunk driving, implementing traffic regulations [6].

2. Research Methods

2.1. Location of Study

Jimma city, the capital city of Jimma zone, Oromiya National Regional State, is in the southwest part of Ethiopia and 348 km away from the capital city. This city is located at an average altitude of 1700 m above sea level, and its astronomical location is 7° 4' North Latitude and 36° 5' East Longitude. It has a total area of 46.23 km2 (4623 Ha).

2.2. Population

Jimma city was reported to dwell a population of 120,960 during the third Ethiopian census, out of which 50.3% were males, and 49.7% were females. That Jimma shows, it is the largest city in the southwest part of Ethiopia and the ninth most populous city next to Dese, having an estimated total population of 177,943 [7].

2.3. Traffic Law Enforcement Activity

Various vehicles and traffic law violations were subdivided into different groups to make necessary recommendations for action, and this subdivision is used in the analyses. One possible thing is that the vehicle driver may not be available in some traffic violations or when traffic police are unable to stop the person committing the violation but records the vehicle registration number of the vehicle driven by that driver.

2.4. Data Analysis

After completing data collection, the quantitative and qualitative data have been analyzed. The computer software application is Statistical Package for the Social Science (SPSS), which is helpful for quantitative data analysis, was used to analyze the data obtained from intended sources. The results were presented in quantitative and qualitative terms in tables, bar graphs, and percentages.

2.5. Data Collection Method

The three consecutive years' registered traffic law violation data were taken from Jimma city's traffic department office. The registered traffic law violation for the three years of 2015, 2016, and 2017 have been taken from the department of traffic police of Jimma city and then be used for analysis.

Figure 1. Violations Created Due to Inappropriate Turning. (source: from Jimma city's traffic department office)

2.6. Categories of Vehicles

Five categories of vehicles were used and shown below.
- Cars – this category included automobile, pick-ups, and tax
- Motorized two-wheelers or motorcycles
- Small-load vehicles – the vehicles that carry a small amount of load within the city limits were included in this category.
- Bajaj- these are three-wheeler commercial passenger vehicles that are meant to carry three adult passengers
- Others – this category included buses, trucks, truck trailers, tractors, jeeps, and other vehicles.

Carts and non-motorized cycles also cause violations, and there is a violation for which the vehicle type causing it is unknown.

2.7. Categories of Traffic Law Violations

The traffic law violations were subdivided into four categories of violations for further analysis.
- Driving violations – these included disobeying/jumping a traffic signal, driving on the wrong side of the road (driving opposite to the direction of the traffic), khat (impaired cognitive skill), lack of giving priority for another driver(vehicle), lack of giving pedestrian priority, lack of giving adequate gap in traffic, overtaking another vehicle at a steep grade, overtaking

another vehicle at a curve, making unexpected turning after overtaking, overtaking a vehicle from the wrong side, rash driving, speeding, drink–driving, making wrong turning, disregard traffic police commands, making unexpected driving of a stopped vehicle, fatigue driving, inattention driving, three people riding on a two-wheeler meant for two people and use of mobile phone while driving.
- Parking violations included improper stopping (parking in a no-parking zone and parking in a manner that obstructs traffic flow).
- Vehicle violations – these violations were related to the poor condition of the vehicle and included worn brakes, worn (bald) tires, tire bursts, and steering problems
- Other violations – all the other violations were combined under this category and included carrying extra passengers, improper lighting, violations related to road condition problems, violations related to pedestrian errors, and the like (unknown).

Figure 2. Accidents Caused by Violations of Different Categories of Vehicles. (source: from Jimma city's traffic department office)

Table 1. Categories of Traffic Law Violations

Traffic law violation	2015	2016	2017
Driving violations	69	58	79
Parking violations	0	0	1
Vehicle violations	4	1	0
Other violations	4	6	6

3. Result and Discussions

3.1. Violations of Road Traffic Laws

Based on Table 2, the relationship between total registered violation and various types of violated traffic laws were tested using Pearson correlation. Results showed that total violation was positively correlated with lack of adequate traffic gap (r=0.997, p<0.05). Some of the drivers did not need to give adequate gap and attempt to take a short route to save time or fuel, thereby committing the violation.

The total registered violation positively correlates with drunk driving, lack of priority for another driver, overpassing another vehicle at a curve, Speeding, improper overtaking, inappropriate turning, improper stopping, Fatigue. Furthermore, it negatively correlates with driving on the wrong side of the road, lack of pedestrian priority, overpassing another vehicle at a steep grade, unexpected turning after overpassing, unexpected driving or stopped vehicle, worn brake, and tire burst, pedestrian problem. The registered violation has no relation with Khat (impaired cognitive skill), Disregard traffic police commands, Disregard traffic lights, Disregard stop sign, Disregard of "give priority sign," Inattention driving, Improper lighting, carrying the extra number of passengers (overloading), Worn (bald) tires, Steering problem, Problem of road condition.

Table 2. Correlation Coefficient for Total Violation with Violated Traffic Laws.

Indicated	Total violations	
	Correlation	Sig. (2-tailed)
Drink driving (Drunk driver)	.971	.154
Driving on the wrong side of the road	-.971	.154
Lack of giving priority for another driver	.500	.667
Lack of giving pedestrian priority	-.971	.154
Overpassing another vehicle at a steep grade	-.240	.846
Making unexpected turning after overpassing	-.232	.851
Lack of giving adequate gap in traffic	.997*	.045
Overpassing another vehicle at a curve	.971	.154
Speeding	.148	.905

Indicated	Total violations	
	Correlation	Sig. (2-tailed)
Improper overtaking	.971	.154
Inappropriate turning	.240	.846
Making unexpected driving of a stopped vehicle	-.545	.633
Improper stopping	.971	.154
Fatigue	.971	.154
Worn brake	-.721	.488
Tire burst	-.277	.821
Pedestrian problem	-.693	.512

*. Correlation is significant at the 0.05 level (2-tailed).

In 2015, 77 traffic violations were registered, out of which one was caused by a cart and the other one was caused by a non-motorized bicycle. The more significant number of violations during this year was occurred due to lack of giving pedestrian priority and making unexpected turning after overcoming another vehicle in which each of them accounts for 24.68% (19 in number) of the total recorded violations. Lack of giving adequate gap in traffic (to follow closely) was the second violation in content, accounting for about 11.69% of the total recorded violation.

For 2016, the more significant number of violations was that of speeding, which holds about 32.31% (21 in number) of the total recorded violations. Lack of pedestrian priority was the second higher one, accounting for about 29.23% (19 in number) of the total registered violation. Violation relating to making unexpected driving of the stopped vehicle is the third higher registered violation, holding about 7.69% (5 in number) of the total. Violation relating to lack of giving adequate gap in traffic (follow too closely) was the highest registered violation during the year 2017, accounting for about 41.86% (36 in number) of the total. Speeding was the second major registered violation, and its percentage was 22.1% of the total. Lack of pedestrian priority was the third major registered violation and holds 8.1% of the total.

3.2. Categories of Vehicles Involved in Violations

Depending on the result of Table 3, the total violation was positively correlated with Cars among the categories of vehicles (r=0.999, p<0.05). This indicates that the involvement of cars causing violation increases as a total road traffic violation increases. The total violation was also positively correlated with the Motorcycles category of vehicles (r=0.999, p<0.05).

Table 3. Correlation Coefficient of Violation with Different Categories of Vehicles.

		Total violation	Cars	Motorcycles	Small load vehicles	Bajaj	Other
Total violations	Pearson Correlation	1.000	.999*	.999*	.991	.981	-.454
	Sig. (2-tailed)		.033	.033	.088	.125	.700

*. Correlation is significant at the 0.05 level (2-tailed).

The total violation has a negative correlation with other categories of vehicles. The highest number of violations was that of cars, and the second one was that of small load vehicles from the category of vehicle in 2015. For 2016 the highest registered violation was that of cars, and the second one was that of small load vehicles. In 2017, cars occupied the highest registered violation while small load vehicles were off the next one in the case of registered violation. When combining the three years, cars were involved in 34.21 %, and small load vehicles were involved in 29.39%, another category of vehicles involved in 17.10%, motor vehicles involved in 9.21%, and Bajaj involved in 8.33 % of the total violations. This indicates that most of the registered traffic violations were that of cars and small load vehicles from the three years under the categories of vehicles.

The results and findings of analysis state that commercial vehicles involvement in pedestrian crashes is associated with a greater probability of 41% pedestrian fatality that was so analogous to the result of this study [8]. Damsere-Derry et al. examined pedestrian injury in Ghana and concluded that heavy vehicles are risk factors [9].

Table 4. Distributions of Traffic Law Violations Registered in the Years 2015, 2016 and 2017 for the Various Categories of Vehicles

Type of vehicle	Year 2015	Year 2016	Year 2017
Car	**26(33.77%)**	**22(33.8%)**	**30(36.05%)**
Driving	23(29.90%)	19(29.2%)	27(31.4%)
Parking	0(0%)	0(0%)	0(0%)
Vehicle	3(3.89%)	1(1.5%)	0(0%)
Other	0(00	2(3.0%)	3(3.49%)
Two-wheeler motorized cycles	**7(9.09%)**	**5(7.7%)**	**9(10.47%)**
Driving	7(9.09%)	4(6.2%)	8(9.3%)
Parking	0(0%)	0(0%)	0(0%)
Vehicle	0(0%)	0(0%)	0(0%)
Other	0(0%)	1(1.5%)	1(1.16%)
Small load vehicles	**22(28.57%)**	**21(32.3%)**	**24(27.91%)**
Driving	21(27.27%)	20(30.8%)	22(25.58%)
Parking	0(0%)	0(0%)	0(0%)
Vehicle	0(0%)	0(0%)	0(0%)
Other	1(1.3%)	1(1.5%)	2(2.33%)
Bajaj	**7(9.09%)**	**2(3%)**	**10(11.63%)**
Driving	7(9.09%)	1(1.5%)	10(11.63%)
Parking	0(0%)	0(0%)	0(0%)
Vehicle	0(0%)	0(0%)	0(0%)
Other	0(0%)	1(1.5%)	0(0%)
Other	**12(15.58%)**	**14(21.5%)**	**13(15.12%)**
Driving	11(14.29%)	13(20%)	12(13.95%)
Parking	0(0%)	0(0%)	1(1.16%)
Vehicle	1(1.3)	0(0%)	0(0%)
Other	0(0%)	1(1.5%)	0(0%)
Non-motorized cycles and cars	**3(3.9%)**	**1(1.5%)**	**0(0%)**
Driving	0(0%)	1(1.5%)	0(0%)
Parking	0(0%)	0(0%)	0(0%)
Vehicle	0(0%)	0(0%)	0(0%)
Other	3(3.9%)	0(0%)	0(0%)
Total	**77(100%)**	**65(100%)**	**86(100%)**

3.3. Categories of Violations

Among the categories of violations (Table 5), driving violations have a positive relationship with the total registered violations (r=0.998, p<0.05). Other violations have a negative relationship with the total violations. The highest registered violation was a driving-related violation in the three years (89.61% in year, 2015,89.23% in 2016, and 91.86% in 2017). The parking-related violation was registered only in 2017, representing about (1.16%) of the total. 5.19% and 1.54 % of vehicle-related violations were registered in 2015 and 2016, and no vehicle-related violations in 2017. Other related violations occupied 5.19% in 2015, 9.23% in 2016, and 6.98% in 2017. By combining the violation of the three years, the driving violation holds about 90.35% of the total, the other violation holds about 7.02% of the total, and the vehicle violation was 2.19%.

Table 5. Coefficient of Correlation Between Total Violation and Various Categories of Violation

		Total violation	Driving violations	Parking violations	Vehicle violations	Other violations
Total violations	Pearson Correlation	1.000	.998*	.822	-.160	-.082
	Sig. (2-tailed)		.035	.386	.898	.948

Table 6. Coefficient of Correlation Between Violation and Driving Experience of Driver

		Total violations	Haven't license	<1 year	1-2 year	2-5 year	5-10 year	>10 year
Total violations	Pearson Correlation	1.000	.997	.608	1.00**	.998*	.040	.949
	Sig. (2-tailed)		.050	.584	.008	.044	.974	.205

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

3.4. Violations Related to the Driving Experience

Table 6 shows that the total registered violation has a positive and robust relationship with driving experience between 1-2 years (r=1, p<0.01). A positive and relatively strong correlation was observed between total violation and driver experience of 2-5 years (r=0.998, p<0.05). Out of the total violation in 2015, 33.77% of violations were caused by drivers whose driving experience was within 2-5 years and was the highest registered violation relating to the driving experience. The next higher driving experience of drivers that violate traffic law was those having below one-year driving experience in which its involvement was about 20.78% of the registered traffic law violations. This indicates that drivers having 1-5-year driving experience were the significant violators of traffic laws this year.

In the year 2016, drivers having driving experience within the range of 5-10 years were the higher violators holding about 32.3% of the total violations. Driving experience within 2-5 years was the second higher representing about 27.69% of the total violations. 12.3% of the total violations were related to those drivers having above 10-year driving experience. Driving experience for about 18.46 % of the total violation was not known.

For 2017, most of the registered traffic law violations were caused by the drivers having 2-5 years of driving experience, representing about 36.05 % of the total violations. Violations performed by drivers having 5-10

year of driving experience represents 27.91 % of the total. Furthermore, 9.3 % of the registered violations were related to drivers having 1-2 years of driving experience. From this result, most of the drivers vulnerable to traffic law violations had 2-5 years of driving experience. Out of the total violation of the three years, drivers having driving experience of the range 2-5 years contributed 32.89% of the total, 5-10-year driving experience have contributed 25 % of the total, and above ten years have contributed 11.4% of the total. 1-2 years have contributed 10.1% of the total. This finding was analogous to [5], which articulates that young and novice drivers are more likely to road traffic crashes than older and more experienced drivers. Abay [10], determined that novice drivers increase traffic crashes' fatality, which is nearly like this result.

3.5. Violations Related to the Driving Experience

Based on Table 7, There was a positive and robust relationship between total violation and driver age of 18-30 years (r=1, p<0.05). The violation was also positively correlated with the driver's age below 18, 31-50 years. During 2015, 53.25 % of the total registered violation was caused by drivers whose age was 18-30 years. Drivers aged 31-50 years and below 18 years have contributed 23.38 % and 11.69 % to the total registered violations, respectively. This indicates that drivers whose ages were 18-30 years contributed to the total violation.

Table 7. Coefficient of Correlation Between Violation and Driving Experience of Driver

		Total violation	<18 year	18-30 year	31-50 year	>51 year
Total violations	Pearson Correlation	1.000	.957	1.000*	.913	-.012
	Sig. (2-tailed)		.188	.011	.268	.993

*. Correlation is significant at the 0.05 level (2-tailed).

In 2016, 46.15% of the total violations were caused by the drivers whose ages were within the range of 18-30 years, and 26.15 % of the violations were done by the drivers whose ages were within the range of 31-50.

For 2017, 53.49 % of the total violations were caused by drivers whose ages were 18-30 years. Moreover, 23.26 % of the violations were from the drivers whose ages were within the range of 31-50 years. For the total violation of the three years; drivers whose age was within the range of 18-30 years contributed 51.31% to the total, within the

range of 31-50 contributed 24.12% of the total, below 18 years contributed 12.28% to the total and above 51 years old contributed 6.14% to the total. Reached the same conclusion that young drivers under 25 increase crash severity [11].

3.6. Safety Traffic Law Enforcement

By taking the traffic law enforcement activities for the three years together, the safety-related traffic law enforcement was 89.96 % of the total activities performed by the traffic

police. The more significant amount of traffic law enforcement activities related to cars, motorized two-wheeler, small load vehicles, Bajaj, and others was safety TLE (safety traffic law enforcement). Out of driving violations, the significant violations were related to lack of

giving pedestrian priority, lack of giving adequate gap (follow too closely), and speeding. And the left of them could be considered as other violations of the driving violation category
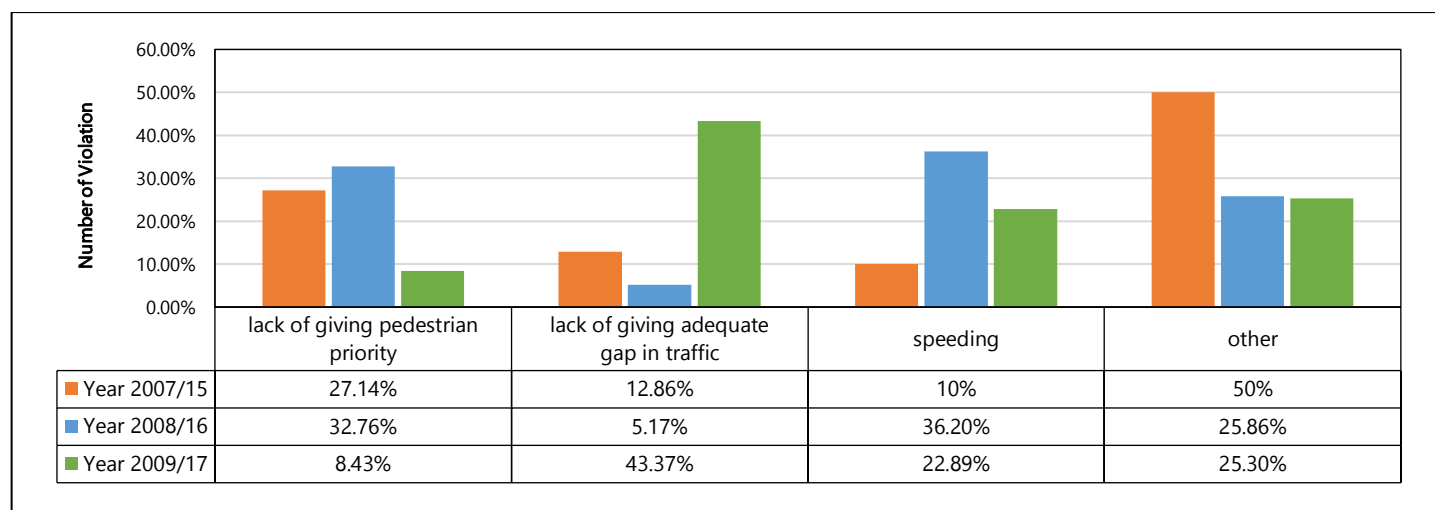

	lack of giving pedestrian priority	lack of giving adequate gap in traffic	speeding	other
Year 2007/15	27.14%	12.86%	10%	50%
Year 2008/16	32.76%	5.17%	36.20%	25.86%
Year 2009/17	8.43%	43.37%	22.89%	25.30%

Figure 3. Distributions of the Types of Driving Violation Categorized as Safety Traffic Law Enforcement (TLE) Activity for the Three Years Combined in Jimma City.

From the total of safety TLE activities, violations related to lack of giving pedestrian priority accounts 19,19 and 7 in the year 2015, 2016, and 2017; violations related to lack of giving adequate gap accounts about 9,3, and 36 in each of the respective three years; violation relating to speeding accounts about 7, 21, and 19 in each year respectively; and violations relating to others accounts about 35,15, and 21 in the three years respectively.

4. Conclusion

The data of registered traffic law violations for the three years was also used in the analysis. Driving violation was registered in a more significant number during the three years, and it was slightly higher in 2017. The categories of cars and small load vehicles were the most registered vehicles for violations for the three years. The safety-related traffic law enforcement was 89.96 % of the total traffic law activities performed by the traffic police. Out of driving violations, the significant violations were the lack of giving pedestrian priority, adequate gap (follow too closely), and speeding. The total violation was positively correlated with Cars and Motorcycles among the categories of vehicles. The highest registered violation was a driving-related violation in the three years (89.61% in 2015, 89.23% in 2016, and 91.86% in 2017. The total registered violation has a positive and robust relationship with driving experience in the range of 1-2 years (r=1, p<0.01), and with the driver having driver experience of 2-5 years. During 2015, 53.25 % of the total registered

violation was caused by drivers whose age was within the range of 18-30 years. In 2016, 46.15% of the total violations were caused by the drivers whose ages were within the range of 18-30 years, and 26.15 % of the violations were done by the drivers whose ages were within the range of 31-50. For 2017, 53.49 % of the total violations were caused by drivers whose ages were 18-30 years.

Acknowledgments

References

[1] World Health Organization, *Global status report on road safety 2015*. World Health Organization, 2015.
[2] World Health Organization, "Pedestrian safety: a road safety manual for decision-makers and practitioners," 2013.
[3] Violence, Injury Prevention, & World Health Organization., *Global status report on road safety: time for action*. World Health Organization, 2009.
[4] T. Özkan and T. Lajunen, "Person and environment: Traffic culture," in *Handbook of traffic psychology*, Elsevier, 2011, pp. 179–192.
[5] Ethiopian Road Transport Authority, "Total number of vehicles registered 2016." Ethiopian Road Transport Authority, 2016.
[6] N. P. Muhlrad and G. E & Yannis, "Road Safety Data, Collection, Transfer and Analysis DaCoTa. Deliverable 1.6:

Final Report of WP1–road safety policy.," 2015.

[7] Central Statistical Agency, *Statistical Report on Urban Employment-Unemployment Survey*. Addis Ababa, Ethiopia: Central Statistical Agency of the Federal Democratic Republic of Ethiopia, 2015.

[8] V. Iragavarapu, D. Lord, and K. Fitzpatrick, "Analysis of injury severity in pedestrian crashes using classification regression trees," 2015.

[9] J. Damsere-Derry, B. E. Ebel, C. N. Mock, F. Afukaar, and P. Donkor, "Pedestrians' injury patterns in Ghana," *Accid. Anal. Prev.*, vol. 42, no. 4, pp. 1080–1088, 2010.

[10] K. A. Abay, "Examining pedestrian-injury severity using alternative disaggregate models," *Res. Transp. Econ.*, vol. 43, no. 1, pp. 123–136, 2013.

[11] R. F. Moghaddam, R. T. Moghaddam, P. M. Khiavi, and A. M. Ghorbani, "Crash severity modeling in urban highways using backward regression method," *World Acad. Sci. Eng. Technol.*, vol. 60, pp. 223–228, 2009.