

Road Accidents: The Most Influential Severity and Risk Factors

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Abstract: Many countries all over the world, greatly concern about the growth of mortality and injury rate on the road. Understanding the factors affecting road traffic accident is an important area for a road safety research. The aim of this paper is to present the overview of factors influencing the road traffic accident severity. From the review of literature, the mostly mentioned factors that are found to be significant to road traffic accident severity are speed of vehicle traveled, followed by human characteristics. Other factors that are found to be significant are vehicle types, weather, alcohol consumption, driver's fatigue, and etc.

Keywords- road safety, road accidents, risk factors, accident severity

1. Introduction

Road traffic accidents (RTAs) have a significant impact on individuals, their families and the society. Road accidents are the major problem in the world. The increased rate of motor vehicle crashes worldwide has been attributed to the increased motorization of urban population. About 1.25 million people died each year as a result of road traffic accidents. Without knowledgeable action, road traffic injuries are said to be the seventh leading cause of death by the year 2030 (Mokoatle et al., 2019). World health organisation in 2015 anticipated using statistical results that RTAs would be the third among fifteen more often causes of death by next decade (WHO, 2015). Studies performed worldwide have shown that developing countries represent 67% of world RTA fatalities although they own only 11% of the vehicle fleet (Touahmia, 2018). There are many factors influence the road traffic accident severity as shown by the research article in many study fields. The study of road accident causes remains vital and presents one of the most important tasks for any developed or developing country. The Figure 1 below highlights the worldwide trend of **road traffic deaths over the past 10 years**.

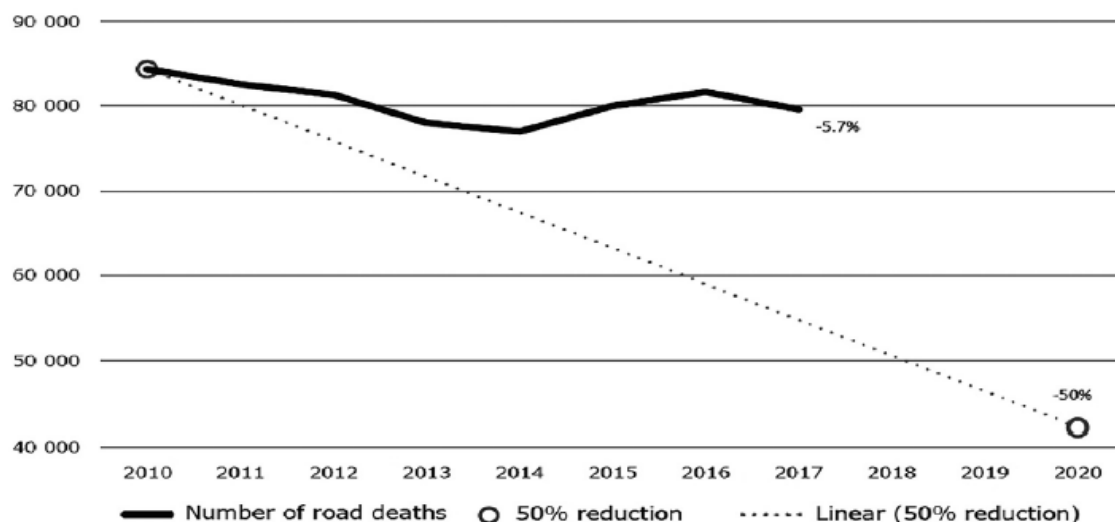


Figure 1. Road traffic deaths over the past 10 years: a worldwide trend. (Source: International transport forum, Road Safety Annual Report 2019)

To reduce the road injury rate, some measures are proposed in regard to infrastructure, information management, technical organization, including wide implementation of automated traffic enforcement systems (Danilov et al., 2020, Evtiukov et al., 2018, Kerimov et al., 2017, Marusin et al., 2018, 2019, 2020, Safiullin et al., 2018, Soo et al., 2020), traffic monitoring systems (Shepelev et al., 2020a, 2020b), protection of the most vulnerable traffic participants - pedestrians (Makarova et al., 2018b) and cyclists (Shubenkova et al., 2018), as well as improvement of vehicle operation safety (Makarova et al., 2018a). However, to accomplish the task of reducing the severity of road accident consequences, including the number of injuries, it is essential to identify the most significant factors affecting the road accident injuries and adopt methods of their elimination in advance.

In order to improve traffic safety, the authors conducted an analysis to identify the causes significantly affecting the severity of road accidents. The aims of this paper is to review the existing literature regarding the factors that affect the injury severity, and to understand how the factors influence the severity in each case. It is hope that the understanding about these risk factors can lead to prevention of the accident injuries and fatalities.

2. Literature Review

An analysis of publications showed that a large amount of research is devoted to identifying the importance and constructing models that consider factors affecting the possibility of road accidents occurring (Nambuusi et al., 2008, Yannis et al., 2017, Zou et al., 2018). There are fewer papers that investigate the factors affecting the severity of road accidents. However, since 2010, the number of studies analyzing the severity of traffic-related injuries has increased dramatically (Yannis et al., 2017).

Chao(2013) reviewed a number of literature regarding to traffic and road characteristics that affect severity of road accident. They concluded that traffic characteristics such as: traffic speed; density; congestion; and flow have a significant effect on road accident severity. On the other hand, for road characteristic, such as: road infrastructure; and geometry are found to be significant. Furthermore, Susanne Kaiser(2016)revealed that most accidents caused by

human, especially human aggressive driving behavior. A profound relationship between risky driving behavior and traffic accident involvement has been identified. Martha Hajar (1999) studied risk factors in highway traffic accidents by building logistic regression model. In this study, the significant risk factors for injuries due to traffic accidents were found to be being under age 25, traveling work reason, alcohol intake, the Mexico-Cuernavaca road direction, on a week-day, during daylight hours, and under adverse weather.

Niranga Amarasingha (2014) studied gender differences of young drivers involved in injury severity by using logistic regression and ordered logistic regression. It was concluded that: holding a valid license; driving during weekends; crash avoidance; attempting to stop or back; involving in non-collision overturn crashes; collision with a pedestrian; and involving in head-on crashes were significant variables only in the female model. As for the male model, factors affecting the accidents are: travel on unlevelled roadways; travel with passengers; travel on concrete surfaces; travel on wet road surfaces; collision with a vehicle; and rear end collision. Moreover, the variables such as: driver seat belt usage; air bag deployment; alcoholic beverage consumption; travel on rural roads; involvement in run-off-road crashes; travel on debris-filled road surfaces; posted speed limit; vehicle age; driver ejection; vehicle damage; driving on straight roadway; and collision with an animal were significant, at the 0.05 level, in both female and male models.

Ratanavaraha et al. (2014) studied the impacts of accident severity factors on expressways in Thailand by constructing multiple regression model. In this study, the findings verified that speed on the road section is the only factor influencing the severity of crashes on expressway. It poses a greater chance of a fatal accident. Guangnan Zhang (2013) using logistic regression studied the risk factors associated with traffic violations and accident severity in China. From this study, factors such as: male driver; goods vehicles; an unfit safety status of vehicle; overload; no street light at night; bad visibility; and weekends, not only present an increased probability of being associated with traffic violation, but also imply the high risk of accident severity.

Paraskevi Michalaki (2015) explored the factors affecting motorway accident severity in England by using generalized ordered logistic model to compare and contrast the most important factors affecting the severity of Hard Shoulder (HS) and Main Carriageway (MC). In this study, driver's fatigue appears to be more common contributory factor for HS accidents. Speed limit is founded to be the major factor, which increases the severity of MC accidents. In addition, when accident is single vehicle, it is more likely to be fatal. The traffic volume during non-peak time and dry surface conditions of road increase the severity of MC accidents. In contrary, factors such as: left hand-side drive vehicles; the presence of road works at the time of accident; and good visibility have a positive effect, giving more the opportunity of slight injury. Ma et al. (2016) explored the factors affecting injury severity of crashes in freeway tunnels in China using generalized ordered logistic model. They have found that there are 5 independent variables, which are: season; time of day; location; tunnel length; and adverse weather affecting injury severity of crashes in freeway tunnels. Summer season seems to have least effect to the increasing of fatality rate. For the time of day variable, day-time plays a major role than nighttime in influencing the likelihood of crash injuries. The accident severity is founded to be more serious if the accident occurred near the

entrance/exit of the tunnel. In addition, as the tunnel length increases, the injury severity increases. And the crashes occurring under adverse weather is less serious comparing with the normal weather conditions because drivers seem to drive more carefully under the adverse weather condition.

The effect of change in speed on road safety has been extensively investigated by (Goran, 2004). In this paper, the Power Model of before-after studies in Sweden was employed. It was found that changes in the number of accidents can be associated with the changes in speed according to a power function. Positive associations between changes in speed and accidents were found, though the magnitude of severity depends on types of accidents. The factors that affect driver's injury severity in single vehicle crashes, on both rural and urban roadways in the study by Qiong Wu, (2016) are: overturn crashes; crashes with fixed object; snowy condition; alcohol impaired drivers; female drivers; and driver aged of 65-year-old and older. This study conducted by using various statistical techniques such as: nested logit model; mixed logit model; elasticity analysis; and model specification tests to identify the factors that are associated with driver's injury severity.

Zhuanglin Ma (2016) studied the differences in factors affecting various crash types with high numbers of fatalities and injuries in China. The study has found that

- Intersections are more likely to have side impact, especially those with poor visibility at night.
- Freight vehicles are more likely to be involved in arear-end crash when overloaded.
- Distracted drivers are more likely to be involved in ahead-on crash. The main reason for this kind of crashes is inattentive driving or overtaking other vehicle(s) dangerously, and crossing the centerline without noticing the on-coming vehicle.
- Vertical alignment and roadside safety rating are highly associated with single-vehicle crashes in a positive way, and most are run-off-road crashes.

The Figure 2 below provides an overview of contribution of different types of vehicles in RTAs.

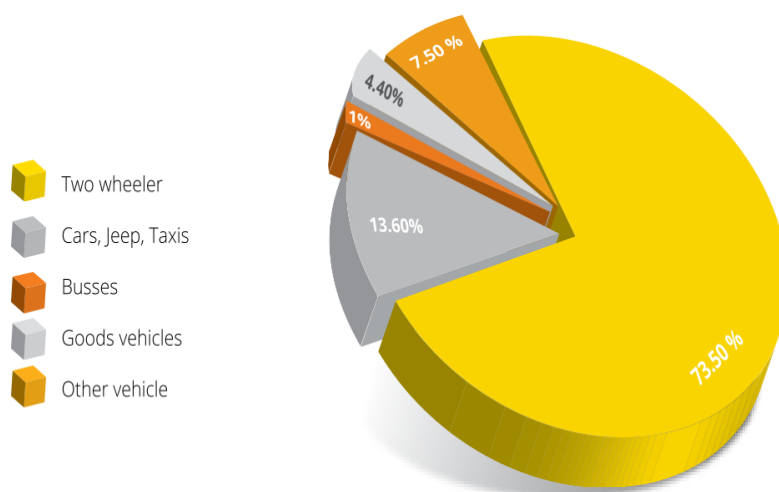


Figure 2. Distribution of RTA by vehicle type (2015)

3. Findings and Discussion

It is evident from the literature analysis that the causes of traffic accident can be categorized into three types: driver-related, vehicle-related, and environment-related critical reasons. Driver-related factors include recognition error, decision error, performance error, and others. Vehicle-related factors include tire/wheel-related, brake-related, steering-related, and other reasons. Environment-related critical reasons for crashes are slick roads, glare, view obstructions, fog/rain/snow, road design, and others. Therefore, traffic accidents usually arise owing to complex reasons. However, it is still difficult to determine the main factor responsible, because traffic accidents can be caused by a complex combination of human, road environment, vehicle, and various other factors. Hence, more specific and detailed analysis is required to reveal complex factors including road, traffic, environmental, and human factors.

Among the most significant factors affecting the injury probability, researchers name annual average daily traffic, traffic lane width, type of surface, vehicle type, use of protective devices (safety belt or helmet), gender of injured, point of impact, and accident location type (Chang and Wang 2006, Zhang et al. 2018). The factors contributing to road accidents are shown below in Figure 3.

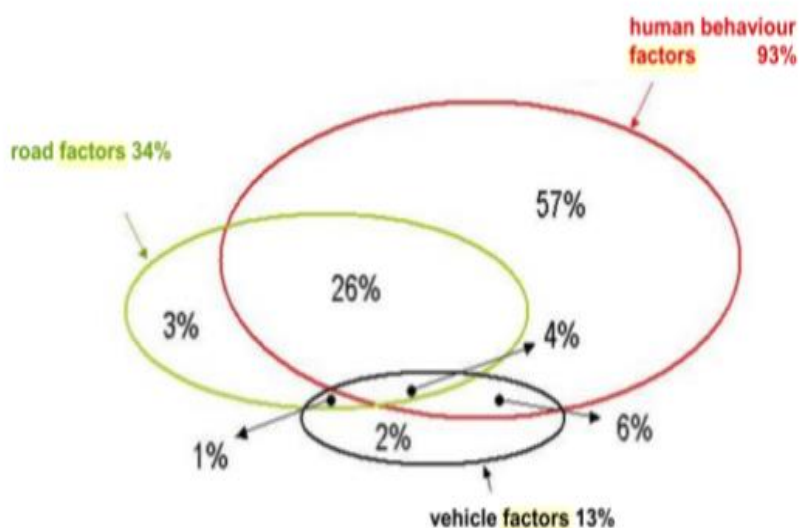


Figure 3. Factors contributing to road accidents

4. Conclusion

One of the most significant purpose for transport policymaker is to reduce the number of accidents and the rate of fatal accident. To improve road safety, it is important to determine all the risk factors that associated with the road traffic accident and accident severity. Acquiring knowledge of the risk factors that contribute to road traffic crashes is important in formulating the priorities of action plans and interventions that can reduce the risks associated with those factors. It is generally recognized that a multi-disciplinary approach is essentially needed in understanding the main causations of RTAs and providing better and appropriate solutions. Stated from the literature reviews, the existing papers have been

reviewed to identify the noteworthy risk factors influencing road traffic accidents and road accident severity.

From the literature reviewed, accident risk factors are categorized into 4 categories namely human, road, vehicle, and environment. Many countries are unable to provide adequate information regarding all factors as stated. Therefore, a limited number of studies could be accomplished to cover all four groups of factors.

There are still debates about some factors that were found to have a mixed effect on road traffic accidents and accident severity. For example, some studies found a positive relationship between speed and the frequency of the accident, but some found the opposite. Furthermore, the significance of factors are varied from one paper to another. These lead to the dissimilar in results and complication in the effort to identify the common factors that have an impacts on accident and severity rate.

References

- [1] Chang, L-Y., Wang, H.-W., 2006. Analysis of traffic injury severity: An application of non-parametric classification tree techniques. *Accident Analysis & Prevention* 38 (5), 1019–1027.
- [2] Chao Wang, M. A. (2013). The effect of traffic and road characteristics on road safety: A review and future research direction. *Safety Science*, 57, 264-275.
- [3] Danilov, I., Marusin, A., Mikhlik, M., Uspensky, I., 2020. Development of the mathematical model of fuel equipment and justification for diagnosing diesel engines by injector needle displacement. *Transport Problems* 15 (1), 93–104.
- [4] Evtiukov, S., Karelina, M., Terentyev, A., 2018. A method for multi-criteria evaluation of the complex safety characteristic of a road vehicle. *Transportation Research Procedia* 36, 149–156.
- [5] Galal, A. A. “Traffic accidents and road safety management: A comparative analysis and evaluation in industrial, developing and rich developing countries”, 29th Southern African Transport Conference, pp. 530-540, 2010.
- [6] Goran, N. (2004). *Traffic safety dimensions and the power model to describe the effect of speed on safety*. Sweden: University of Lund.
- [7] Guangnan Zhang, K. K. (2013). Risk factors associated with traffic violations and accident severity in China. *Accident Analysis & Prevention*, 59, 18-25.
- [8] International transportforum, Road Safety Annual Report 2019, 2019.
- [9] Kerimov, M., Safiullin, R., Marusin, A., Marusin, A., 2017. Evaluation of functional efficiency of automated traffic enforcement systems. *Transportation Research Procedia* 20, 288–294.
- [10] Ma, Z., Steven, I., Chien, J., Dong, C., Hu, D., & Xu, T. (2016). Exploring factors affecting injury severity of crashes in freeway tunnels. *Tunnelling and underground space technology*, 59, 100-104.
- [11] Makarova, I., Mukhametdinov, E. and Tsybunov, E., 2018a. Management of the reliability of intelligent vehicles as a method to improve traffic safety. *Transportation Research Procedia* 36, 465–471.

- [12] Makarova, I., Shubenkova, K., Mavrin, V., Buyvol, P., 2018b. Improving safety on the crosswalks with the use of fuzzy logic. *Transport Problems* 13 (1), 97–109.
- [13] Martha Hajar, C. M. (2000). Risk factors in highway traffic accidents: a case control study. *Accident Analysis & Prevention*, 32, 703-709.
- [14] Marusin, A., Marusin, A., Ablyazov, T., 2019. Transport infrastructure safety improvement based on digital technology implementation. *Atlantis Highlights in Computer Sciences*, Vol. 1. International Conference on Digital Transformation in Logistics and Infrastructure (ICDTLI 2019), 353–357. sss
- [15] Marusin, A., Marusin, A., Danilov, I., 2018. A method for assessing the influence of automated traffic enforcement system parameters on traffic safety. *Transportation Research Procedia* 36, 500–506.
- [16] Marusin, A.V., Danilov, I.K., Khlopkov, S.V., Marusin, A.V., Uspenskiy, I.A., 2020. Development of a mathematical model of fuel equipment and the rationale for diagnosing diesel engines by moving the injector needle. *IOP Conference Series: Earth and Environmental Science* 422, 012126.
- [17] Mokoatle, M., Vukosi Marivate, D., & Michael Esiefarienrhe Bukohwo, P. (2019, June). Predicting road traffic accident severity using accident report data in South Africa. In *Proceedings of the 20th annual international conference on digital government research* (pp. 11-17).
- [18] Nambuusi, B., Brijs T., Hermans, E., 2008. A review of accident prediction models for road intersections. Publication RA-MOW-2008-004. Policy Research Centre for Traffic Safety, Flanders.
- [19] Niranga Amarasingha, S. D. (2014). Gender differences of young drivers on injury severity outcome of highway crashes. *Journal of Safety Research*, 49, 113.e1-120.
- [20] Paraskevi Michalaki, M. A. (2015). Exploring the factors affecting motorway accident severity in England using the generalised ordered logistic regression model. *Journal of Safety Research*, 55, 89-97.
- [21] Qiong Wu, G. Z. (2016). Analysis of driver injury severity in singlevehicle crashes on rural and urban roadways. *Accident Analysis & Prevention*, 94, 35-45.
- [22] Ratanavaraha, V. S. S. (2014). Impacts of accident severity factors and loss values of crashes on expressways in Thailand. *IATSSResearch*, 37, 130-136.
- [23] Safiullin, R., Kerimov, M., Afanasyev, A., Marusin, A., 2018. A model for justification of the number of traffic enforcement facilities in the region. *Transportation Research Procedia* 36, 493–499.
- [24] Shepelev, V., Aliukov, S., Nikolskaya, K., Das, A., Slobodin, I., 2020a. The use of multi-sensor video surveillance system to assess the capacity of the road network. *Transport and Telecommunication* 21 (1), 15–31.
- [25] Shepelev, V., Glushkov, A., Almetova, Z., Mavrin, V., 2020b. A study of the travel time of intersections by vehicles using computer vision. In: Berns, K., Helfert, M., Gusikhin, O. (eds). *Proceedings of the 6th International Conference on Vehicle Technology and Intelligent Transport Systems* 1, 653–658.
- [26] Shubenkova, K., Boyko, A., Buyvol, P., 2018. The technique of choosing a safe route as an element of smart mobility. *Transportation Research Procedia* 36, 718–724.

- [27] Soo, S., Abdel Sater, K.I., Khodyakov, A.A., Marusin, A.V., Danilov, I.K., Khlopkov, S.V., Andryushenko, I.S., 2020. The ways of effectiveness increase of liquid fuel with organic addition appliance in aerospace equipment. *Advances in the Astronautical Sciences* 170, 833–838.
- [28] Susanne Kaiser, G. F. (2016). Aggressive Behaviour in Road Traffic - Findings from Austria. *Transportation Research Procedia*, 14, 4384-4392.
- [29] Touahmia, M. (2018). Identification of risk factors influencing road traffic accidents. *Engineering, Technology & Applied Science Research*, 8(1), 2417-2421.
- [30] World Health Organization, Global Status Report on Road Safety 2015, 2015.
- [31] Yannis, G., Dragomanovits, A., Laiou, A., La Torre, F., Domenichini, L., Richter, T., Ruhl, S., Graham, D., Karathodorou, N., 2017. Road traffic accident prediction modelling: a literature review. *Proceedings of the Institution of Civil Engineers – Transport* 170 (5), 245–254.
- [32] Zhang, J., Li, Z., Pu, Z., Xu, C., 2018. Comparing prediction performance for crash injury severity among various machine learning and statistical methods. *IEEE Access* 6, 60079–60087.
- [33] Zhuanglin Ma, S. I.-J. (2016). Exploring factors affecting injury severity of crashes in freeway tunnels. *Tunnelling and Underground Space Technology*, 59, 100-104.
- [34] Zou, X., Yue, W.L., Vu, H.L., 2018. Visualization and analysis of mapping knowledge domain of road safety studies. *Accident Analysis & Prevention* 118, 131–145.