

Analysis of Traffic Accidents in Ulaanbaatar, Mongolia (1997- 2011)

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Abstract: The purpose of this paper is to study the causes and other external factors of traffic accidents in Ulaanbaatar from 1997 to 2011. Also, to study the trend of traffic accidents in Ulaanbaatar and to identify preventative actions that could possibly decrease the rate of traffic accidents.

Keywords: Traffic accident, Traffic safety, Vehicle, Factor

1. INTRODUCTION

Over the past 60 years, the urbanization process has intensified around the world. It is estimated that each year 1.2 million people die due to traffic accidents in the world and it is expected that this specific cause of death is the third largest contributor to health problems in the world in 2020 (World Health Organization (WHO), 2011). Furthermore the large number of deaths and the traffic accidents are also responsible for 50 million wounded or incapacitated people (Maria *et al.*, 2012; Cavalcante *et al.*, 2009).

A decade from 2011-2020 has been declared as "The Decade of Secure Traffic Safety Actions" by the United Nations, due to the fact that traffic safety is becoming one of the biggest issues that we are facing, currently.

Mongolian Government supported the cause and decided to resolve some of the urgent problems of traffic safety in the country. During 2011-2020, Mongolia is planning to decrease the death on road rate by 20% and have already taken some actions.

The International Road Organization conducted a survey from 180 countries of the world. According to the survey, Mongolia ranked 16th place on a death on road per 100,000 people rank. Also, a death on road per 10,000 a vehicle rate is twice as much compare to other countries. According to the survey, our country was ranked in the 157th place on thousand people per vehicle (Ganbat, 2010).

During the past 40 years, 33,222 traffic related incidents were recorded by the Traffic Police Department. Out of which, 20,940 accidents were registered in past 15 years. According to the record, there were 5,041 deaths and 18,788 serious injuries caused by the accidents (Proceedings for Statistics of Traffic Accidents and Faults in Mongolia, 2012).

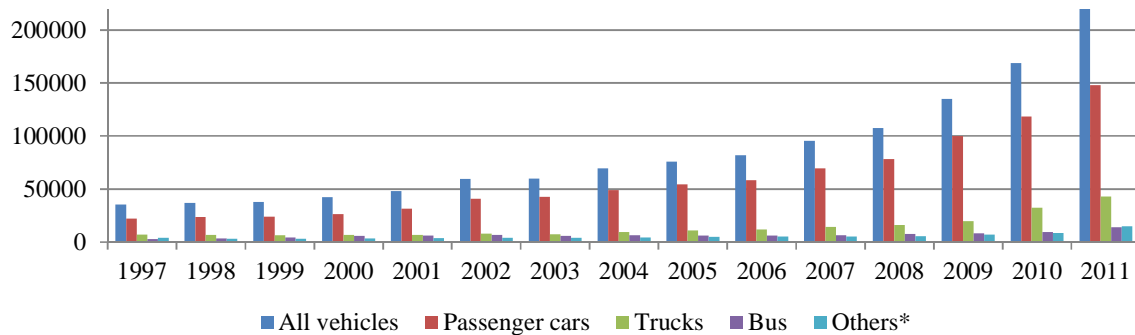
Population and number of vehicles in Ulaanbaatar are continuing to increase and the rate of traffic accidents have been increased accordingly. Therefore, we have tried to study and forecast traffic accidents using mathematical/statistical modules and have tried to come up with effective preventative actions that could be taken.

2. TRAFFIC ACCIDENT CONDITIONS IN ULAANBAATAR

2.1 Number of Vehicles

In Mongolia, there were 114,800 vehicles in 1997 and 349,500 vehicles in 2011 (Bayarsaikhan and Battulga, 2007). A number of the vehicles have been increasing twice in past 15 years. There were some growth of vehicles: 23,1% in 2009, 7,1% in 2010 and 22,4 % in 2011 so that car import has been rising during the past years.

In 2011, there were 209791 cars in Ulaanbaatar and 57,1% of cars registered in Mongolia. Moreover, a number of cars have been rising by approximately 14,2% for past 15 years a year.



**Others include motorcycle, tractors, trailers, and other miscellaneous vehicles that are not separately classified.*

Figure1. Registered vehicles in Ulaanbaatar

Figure 1 shows types of vehicles and its growth numbers for past 15 years in Ulaanbaatar: 59,7% passenger cars, 21,5% trucks, 6,5% buses, 6,4% motorcycles, 3,3% trailers, 1,8% special purposed cars and 0,9% other mechanism.

Car ages in Ulaanbaatar: 3,8 % of cars are used less than 3 years, 17% of them are used 4-9 years and 79,2 % of them are used more than 10 years. 52 % of the cars have steering wheels on the left and 48% of them have steering wheels on the right in Mongolia.

2.2 Traffic Accidents

There were 3259 accidents in 1997 in Mongolia. However, accidents reached to 19940 in 2011 increased by 5,3 times.

Population in Ulaanbaatar was 727,900 in 1997, but it has been raising a year by year. There were 1,203,600 people in 2011.

There were 12226 traffic accidents in Ulaanbaatar for past 15 years because of these accidents 12834 people were occurred, 1814 people were killed and 11020 were seriously injured.

Figure 2 shows that growth of population, a number of traffic accidents and causes of death and injured people from the accidents for past 15 years in Ulaanbaatar.

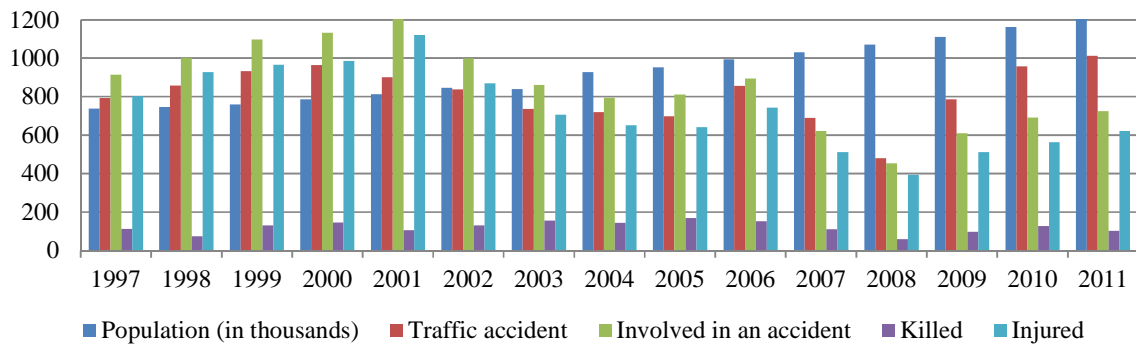


Figure 2. Number of population in Ulaanbaatar, registered traffic accidents, and killed and injured people

Approximately 121 people were dead and 735 people were injured by the traffic accidents in Ulaanbaatar every year. There are a lot of damages for drivers and casualties besides that some health problems due to traffic accidents. According to the survey, damages suffered had been increasing a year by year so that amount of the damages reached to 14 billion 269.5 million tugruqs (Mongolian currency) in 1997-2001.

2.3 Number of Drivers and Victims and Their Ages and Sex

The number of Mongolian drivers was 2,6 times more than the number of cars in 2011 comparing to last 15 years there were 751,000 drivers and it was 6.83 times more. 71% of all drivers are male and 29% are female. Moreover, 9.2% of the drivers - 18-23 aged, 20,95% of the drivers 24-29 aged, 16.8 % of the drivers - 30-34 aged, 18,1% of the drivers – 35-40 aged and 35% of the divers – more 41.

There were 23829 victims in the traffic accidents in 1997-2011. 53,8% of them in Ulaanbaatar and 46,2% of them in rural traffic accidents. 1814 people dead or (35,9 % of death) and 11020 injured people or (58.8% of injured people) were registered in Traffic Police Department in Ulaanbaatar.

Those casualties had a lot of hurts, for instance, 35,1% of them badly hurt their nicks, 18,0% of them injured their whole body, 17,8% of them hurt their legs , 16.9 % of them had their arm and back injuries and 12,2 % hurt their other parts of body.

There were deaths and injured people in Ulaanbaatar because of the traffic accidents, rating their sex: 52, 8% of them were male drivers and 41.8 % of them were female drivers. According to statistics, ages of victims were different, such as 14,4 % of casualties were children aged 0-7, 41,1% of them were people aged 18-34, 35,8% of them were people aged 35-54 and 7.8% of them were people aged more 55 years old.

2.4 Traffic Accident Reasons

There are many reasons caused traffic accidents: driver's faults, pedestrian's wrong steps, road conditions and some technical defects. 82697 traffic accidents were registered in 1997-2011, Ulaanbaatar. The reasons of the accidents: driver's faults were 67309 (81,4%), pedestrian's wrong steps were 15115 (18,3%) , technical defects were 89 (0.1%) and road conditions were 2,2 %.

There were shown some reasons of the traffic accidents in Ulaanbaatar in the Figure 3, that tells (2.3%) small amount of the accidents was caused by technical defects and road conditions.

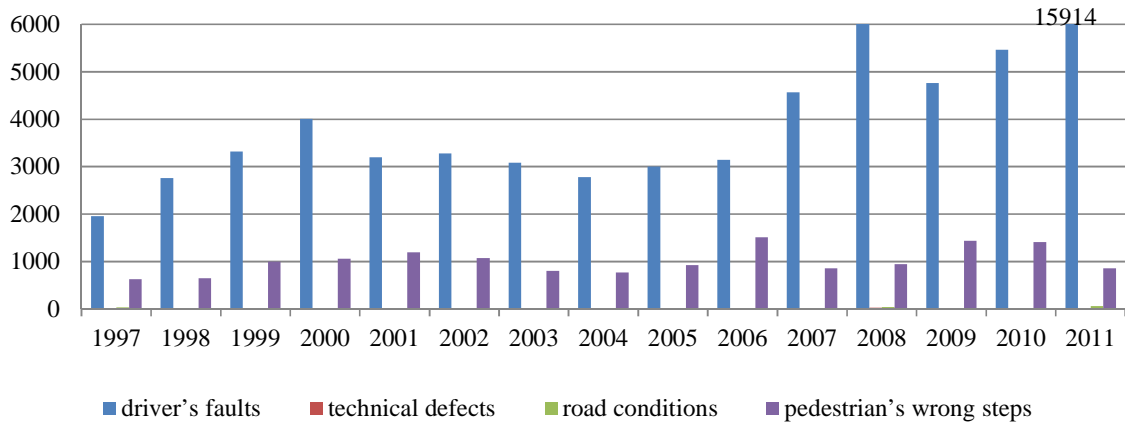
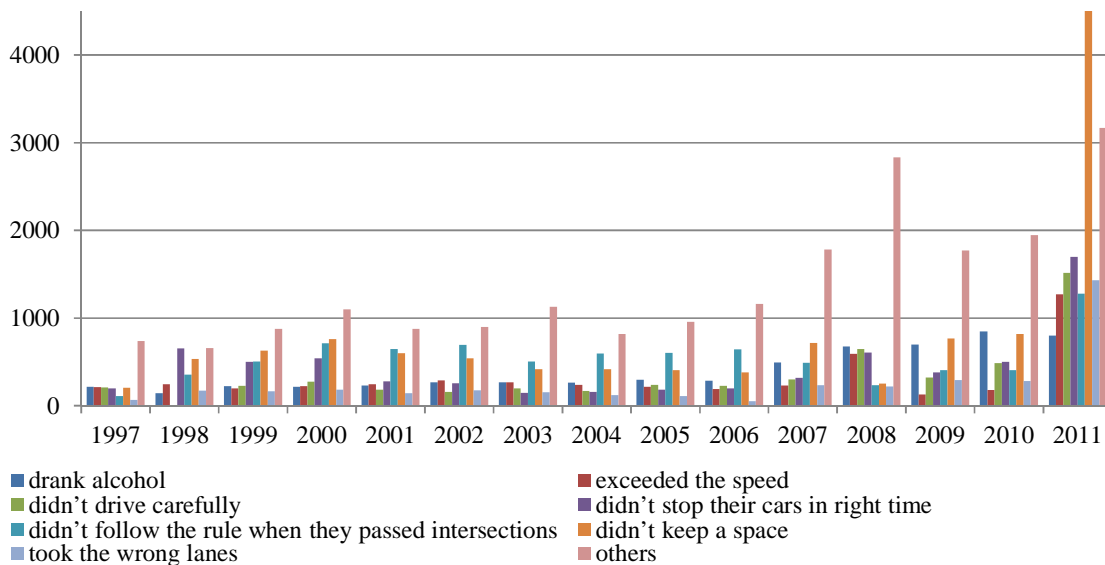


Figure 3. Registered traffic accident reasons in Ulaanbaatar

According to the survey, some traffic accidents could not decrease because drivers drove their cars when they used alcohol, they exceeded the speed and they didn't drive carefully (Bayarsaikhan and Ganjargal, 2010).

Reasons of the traffic accidents could be classifying the followings in the past 15 years (Figure 4): drivers' faults - didn't keep a space (16,1%), didn't follow the rule when they passed intersections (13,9%), didn't stop their cars in right time (9,8%), drank alcohol (9,2%), could not take a turn correctly (9,1%), exceeded the speed (7,1%), didn't drive carefully (7,0%), took the wrong lanes (5,0%), went to the opposite directions (4,2%), drove the car with technical defects (3,4%), didn't reverse correctly (3,3%), didn't follow traffic lights (3,1%), didn't overtake correctly (2,9%) and others (5,6%).



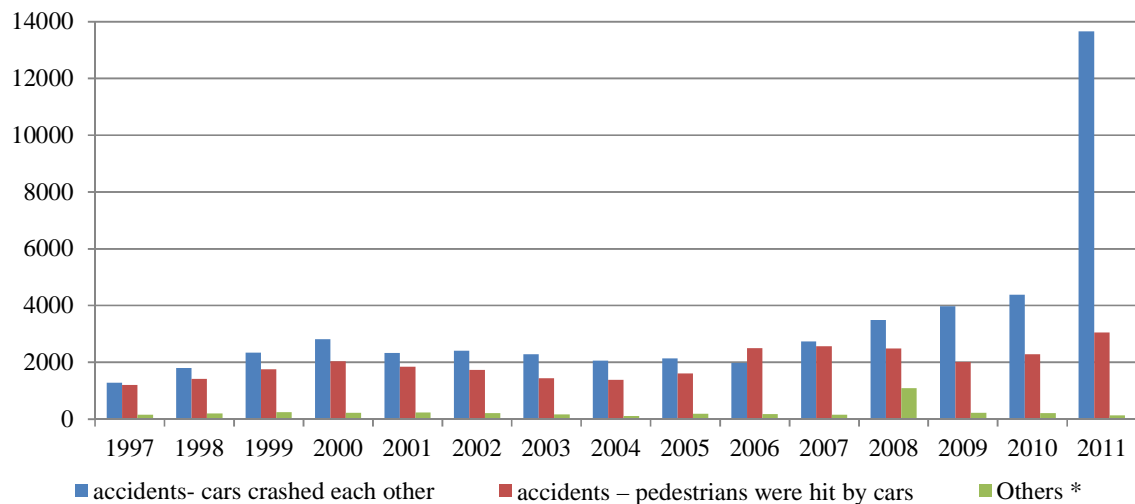
* Others include carrying passengers and load, escaping from the scene of the accidents... etc.,

Figure 4. Traffic accidents caused by drivers' faults registered in Ulaanbaatar

In Ulaanbaatar, traffic accidents caused by exceeding the speed decreased in 2011 comparing to 1997. As a result of the survey, there were 13171 traffic accidents caused by exceeding the speed last 15 years. 15120 (91.4%) of them were registered in Ulaanbaatar. Statistics about the accidents caused by pedestrian’s wrong steps show 18.2% of the total number of traffic accidents in the whole country and 21.7% of them in the capital city. Drink-pedestrians come in the traffic increased so these kinds of accident were 14.4%.

2.5 Types of Traffic Accidents

There were 82697 traffic accidents in Ulaanbaatar during 15 years (Figure 5). These accidents could be divided into different types: 49700 (57.8%) accidents - cars crashed each other, 29311 (37,8%) accidents – pedestrians were hit by cars, 1301 (1.6%) accidents- cars turned over, 1338 (1.6%) accidents –cars hit property, 671 (0.8%) accidents - pedestrians were thrown, 209 (0.3%) accidents- cars hit bicyclists, 65 (0.1%) accidents – cars hit animals and 102 (0.2%) others.



*Others turned over, vehicles run over a bicyclist, hit real estate, threw passengers, run over animals

Figure 5. Traffic accident types in Ulaanbaatar

According to the survey, vehicles turned over more in the local areas than Ulaanbaatar. However, vehicles hit pedestrians more in Ulaanbaatar than local areas.

2.6 Periods of Traffic Accidents

According to the survey, traffic accidents could be happened in all four seasons in past 15 years. All registered accidents were happened the following seasons: 23.4% in the winter, 22.2% in the spring, 25.3% in the summer and 29.1% in the fall. 29.1% of all traffic accidents happened in the fall related to increasing traffic in both local areas and urban areas because students moved to Ulaanbaatar to study in universities, colleges and vocational schools.

Days faced traffic accidents in Ulaanbaatar were shown in the Figure 6 and the time of traffic accidents in Ulaanbaatar was shown in the Figure 7.

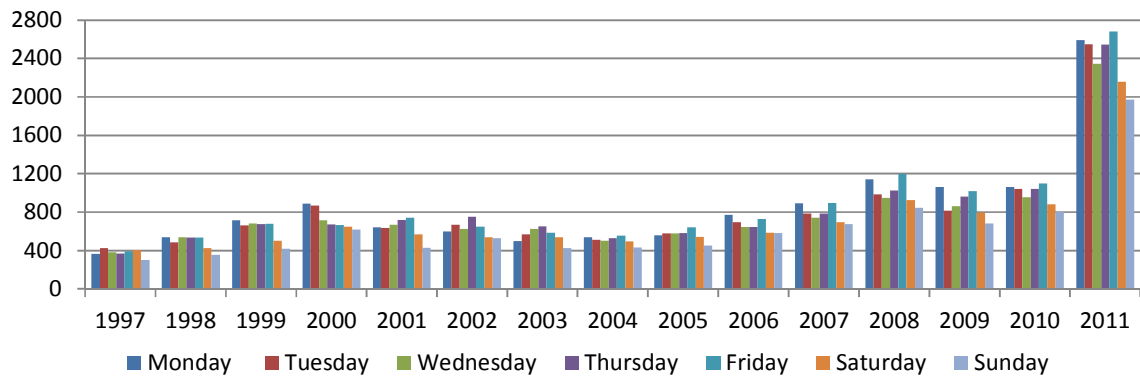


Figure 6. Days faced traffic accidents in Ulaanbaatar

In 1997-2011, there were a plenty of traffic accidents on Mondays and Fridays at 5 pm-7pm in Ulaanbaatar.

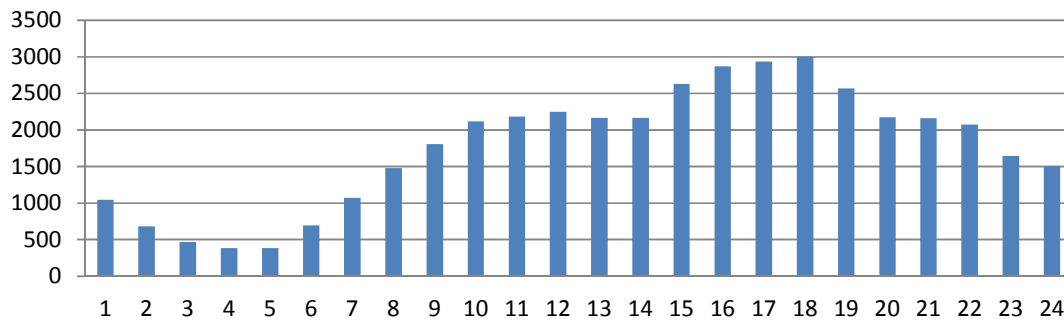
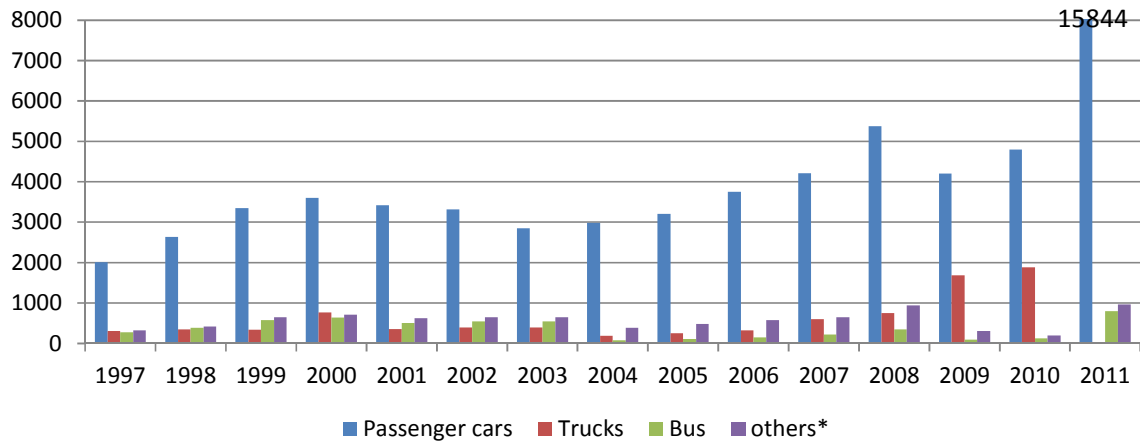


Figure 7. The time of traffic accidents in Ulaanbaatar

2.7 Types of Car Involved in the Traffic Accidents

Different types of cars involved in traffic accidents: passenger cars - 65537 (79.2%) , trucks - 8624 (10.4%), buses – 5394 (6,5%), mechanism-149 (0.2%), motorcycles - 534 (0.6%), bicycles – 223 (0.3%) and minibuses -2236 (2.7%).

Types of car involved in the traffic accidents from 1997 till 2011, Ulaanbaatar were demonstrated in the Figure 8.



*Others include tractors, trailers, bicycles and other miscellaneous vehicles that are not separately classified.

Figure 8. Types of car involved in the traffic accidents in Ulaanbaatar

3. TRAFFIC ACCIDENT VIEWS IN ULAANBAATAR

3.1 Factors of the Traffic Accidents

Table 1 shows some factors (Kharola *et al.*, 2010; Bodalal *et al.*, 2012) of the traffic accidents in 1997-2011, Ulaanbaatar.

Table 1. Factors of the traffic accidents in Ulaanbaatar

| Factors of the traffic accidents | Guilty person | Specifications |
|----------------------------------|---|---|
| Parties in the traffic | Driver (81,1%) Pedestrian (18,3%) Passengers | Age, Profession, Culture, Gender Drink-drivers Drink-pedestrians Drink- passengers Others |
| Vehicles | Type Technical defects (0,2%) Vehicle aging Place of steering wheel (On the right side -53%, on the left side- 47%) | Cars (79.2%) Trucks (10,4%) Buses (6.5%) Jamming a steering wheel, not working a brake, trouble of traffic lights, engine breakage Others |
| Road | Road (0,3%) Engineering constructions | Surface, conditions Lighting Road signs, notes Others |
| Environment | Period Weather changes | Seasons Traffic jam period Changeable climate Others |

The factors of traffic accidents were shown based on the statistics. Besides that it's obviously influenced on traffic organization in Ulaanbaatar, implementing laws, drivers' behaviors and how they're trained and their driving skills.

3.2 Analysis of the Traffic Accident Statistics

There are a number of factors that affected going up the number of traffic accidents, accidental deaths, casualties and damages (Table 1). Figure 9 and Figure 10 show a correlation between number of vehicles and growth of population in Ulaanbaatar. These calculations were based on Microsoft Excel.

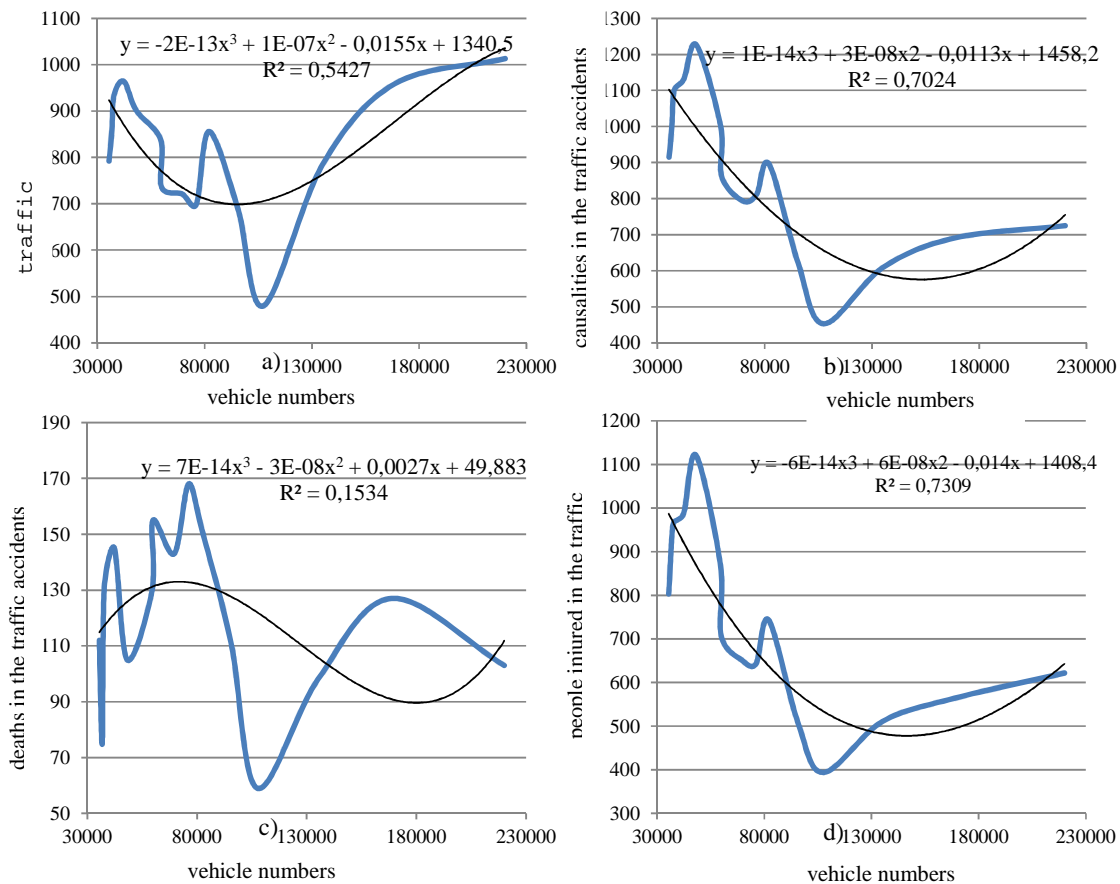


Figure 9. Vehicle growth affects in Ulaanbaatar

When the number of vehicles in Ulaanbaatar increases, the number of deaths and casualties in the traffic accidents will raise. The correlation between an increasing number of vehicles, accidental deaths and casualties separately were shown on the Figure 9 and Figure 10. There is shown how these two factors depend on traffic accidents.

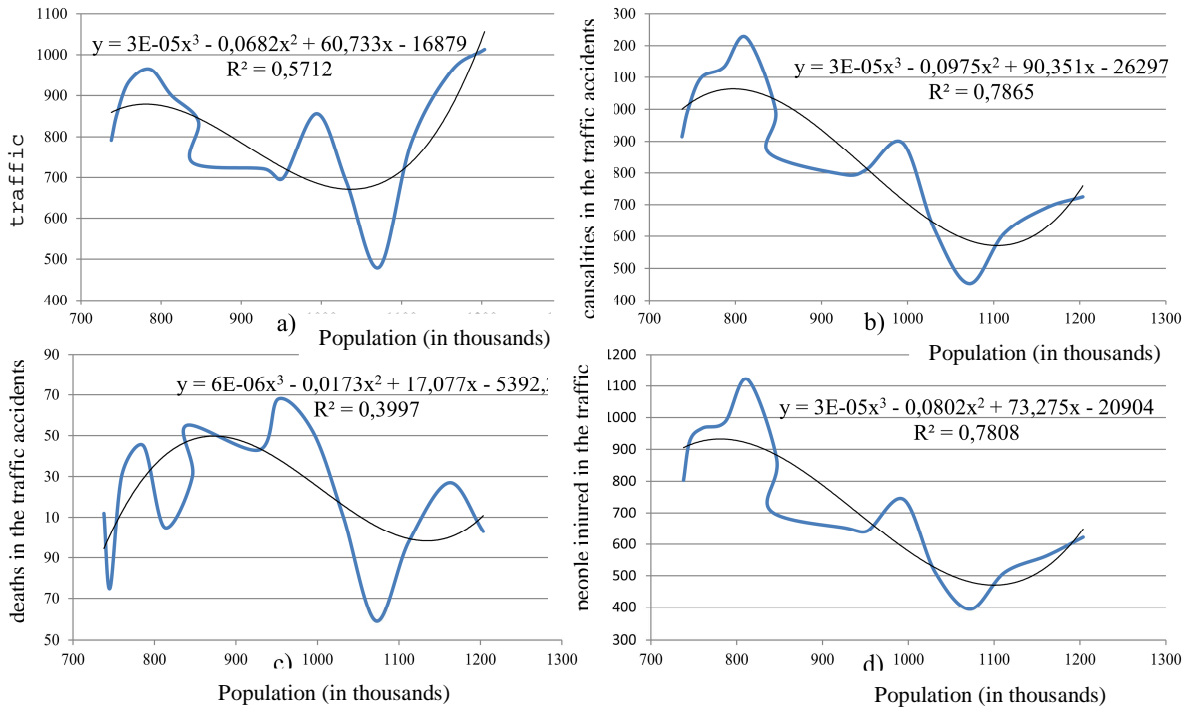


Figure 10. Population growth affects in Ulaanbaatar

Population growth in Ulaanbaatar influenced on the number of deaths and casualties in the traffic accidents which was shown in the Figure 9.

Therefore there is shown related a mathematical formula (1,2) using mathematical and statistical S PLUS 8.0 program on the matrix plot (Figure 11) and an interaction plot of above mentioned factors (Figure 12,13).

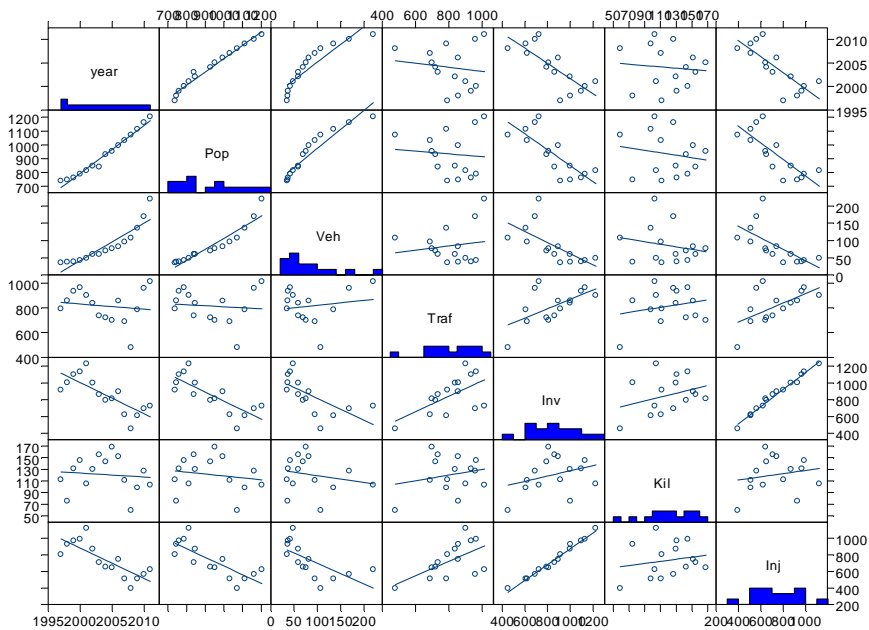


Figure 11. Matrix plot (year-year, pop-population, veh-vehicles, traf-traffic accident, inv-involved in an accident, kil-killed, inj- injured)

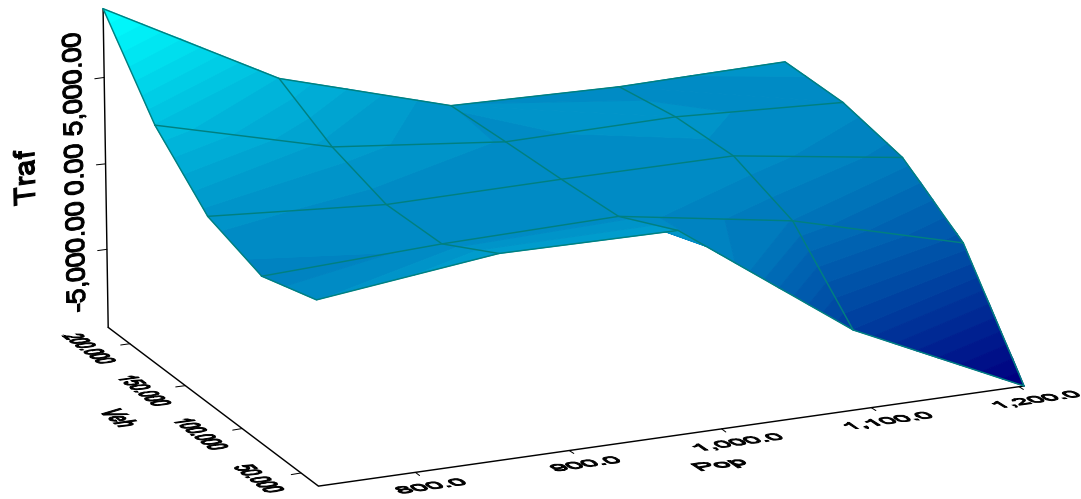


Figure 12. The growth of population and vehicles in Ulaanbaatar Influencing on traffic accidents -3D plot

$$Y_1 = -21600.21 + 64.2x_1 - 203.18x_2 - 0.04x_1^2 - 024x_2^2 + 024x_1x_2 \quad (1)$$

(Multiple R-Squared: 0.75 ; F-statistic: 5.35)

where,

Y_1 : Traffic accidents,

x_1 : The growth of population in Ulaanbaatar (in thousands),

x_2 : The growth of vehicles in Ulaanbaatar.

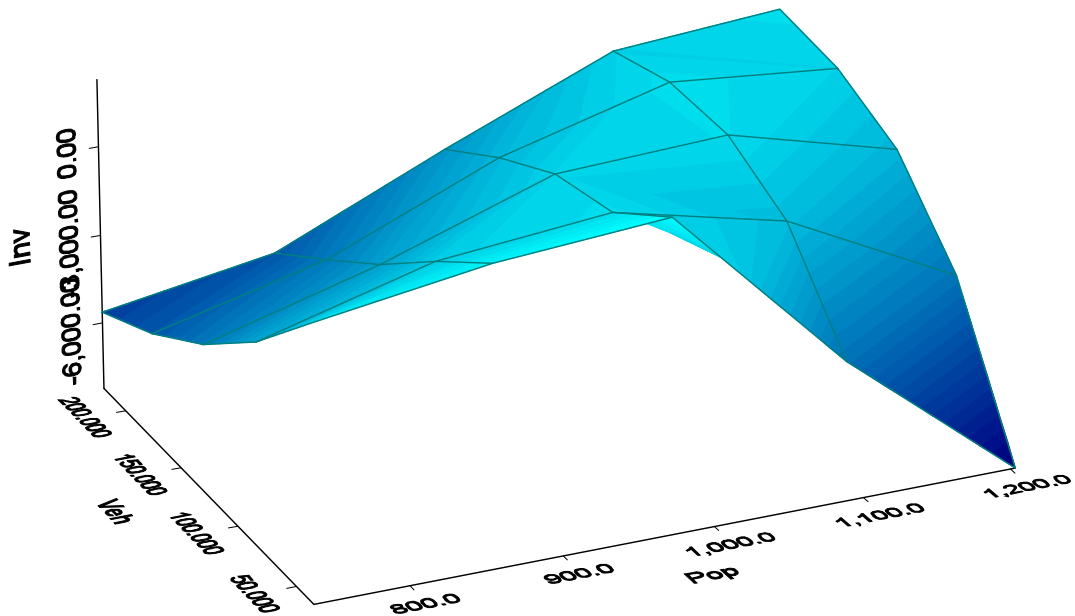


Figure 13. The growth of population and vehicles in Ulaanbaatar influencing on people involved in Traffic Accidents -3D plot

$$Y_2 = -28181.39 + 82.06x_1 - 241.42x_2 - 0.05x_1^2 - 0.27x_2^2 + 0.29x_1x_2 \quad (2)$$

(Multiple R-Squared: 0.87; F-statistic: 12.27)

where,

- Y_2 : The number of victims involved in the traffic accidents,
- x_1 : The growth of population in Ulaanbaatar (in thousands),
- x_2 : The growth of vehicles in Ulaanbaatar.

4. CONCLUSION

It is very important to come up with the following solutions after analyzing traffic accidents from 1997 to 2011 in Ulaanbaatar.

a) Improving legislation Environment

1. Reforming the Road Traffic Safety Law and Road Transportation and Road laws will be passed. Relating to these laws, Road Traffic Rule and standard will be improved.
2. A decision on restricting cars with right- side steering wheels and old cars can be tied up with the policy of road traffic safety.

b) Developing infrastructure, controlling systems

1. Opening up regularity and charging with responsibility to road owners or host organizations when road affected traffic accidents.
2. Changing and renovating organization of road networks and strengthening road repairs.
3. Implementing and organizing vehicle load capacity in traffic to tie up with the International Convention.

c) Developing registration and information systems

1. Creating road traffic safety indicators and connecting with data.
2. Starting up State Registration Data and boosting responsibility to lawbreakers of road traffic law in insurance legislation regulations.

d) Stiffening technical requirements for cars

1. Making new police about vehicle import, restricting vehicle import which are used more than 6 years.
2. Giving work permission to auto service whose service deals with standard requirements

e) Some steps for pedestrians and vehicle owners

1. Providing with complex road devices and improving road qualities, arranging road traffic and controlling in school and kindergarten areas
2. Building some tunnels and crossing for pedestrians in main streets
3. Developing pedestrian skills in traffic
4. Boosting medical service for casualties in traffic accidents
5. Accustoming passengers to belts and children's special seats
6. Supporting civil social organizations and expanding cooperation for giving knowledge about road traffic safety to their road culture to citizens
7. Organizing special training programs for preparing specialized drivers of public transportation

REFERENCES

- Bayarsaikhan, B., Battulga, B. (2007) Research on the motor vehicle distribution, its increase, and traffic accidents in UB. *Scientific Documents*, MUST,7,97-95.
- Bayarsaikhan, B., Ganjargal, O. (2010) Some Indexes used by auto technical experts of traffic accidents and choosing appropriate measurements. Some Issues of Traffic Safety proceedings of theory and practical conference, Ulaanbaatar, 28-31. (in Mongolian)
- Bodalal, Z., Bendardaf, R., Ambarek, M. (2012) A Study of a Decade of Road Traffic Accidents in Benghazi - Libya: 2001 to 2010. *PLoS ONE*. Vol. 7 Issue 7, 1-7.
- Cavalcante, F., Morita P., Haddad, S. (2009) Invisible sequels of traffic accidents: the disorder of post-traumatic stress as a public health problem. *Ciênc.sab&decoletiva*, 14(5),1763-1772.
- Ganbat, Ch. (2010) Some Issues of Traffic Safety proceedings of theory and practical conference. *Information, research center*, Ulaanbaatar, 20-25. (in Mongolian)
- Kharola, P., Geetam,T., Dinesh, M. (2010) Traffic Safety and City Public Transport System: Case Study of Bengaluru, India. Volume 13, No4, ISSN 1077-291X, 63-93.
- Maria, S., Henrique, P., YuriSilva, T., Dyego, T., Divanise S., Jairo, C. (2012) Analysis of deaths from traffic accidents in a Brazilian Capital. *International Journal of Collaborative Research on Internal Medicine & Public Health (IJCRIMPH)*,Vol. 4, No5, 679-684.
- Proceedings for Statistics of Traffic Accidents and Faults in Mongolia. (2012) *Traffic Police Department*, Ulaanbaatar, 5-58.
- World Health Organization (WHO). (2011) Road traffic injury prevention: an assessment of risk exposure and intervention cost-effectiveness in different world regions. Available http://www.who.int/choice/publications/d_2009_road_traffic.pdf.