Methods of Forecasting Deaths due to Road Accidents in Pakistan

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Deaths, resultant from road accidents have become a big problem in the developing countries such as Pakistan. The problem grew over time, and has been related to both number of people and roads extended over the past years. This study intends to investigate this issue in Pakistan, hopefully over the past decade. The idea came to the author when he saw an accident on in April, 2008 beside the campus of Comsats Institute of Technology (CIIT) in Islamabad. One of CIIT students was hit by a speedy car that disappeared from Allama Iqbal Road immediately after it injured that student. The student survived the accident, but he had no insurance and was taken to a government hospital for treatment. He may lose the coming semester because of forced absence. Road accidents resulted in year 2002 alone in injury of more than 35 million people worldwide, out of them 5 million became permanently disabled, and 1.2 million died. The developed countries have paid special attention to road accidents in order to improve safety on their roads. France, for example has managed to reduce road deaths from year 2002 to year 2003 by 20%, and plans to reduce road accidents by 30% before year 2020 is reached. The same thing is planned and targeted in the other developed countries.

Unfortunately, about 80% of world road accidents occur in the developing countries including Pakistan. Road accidents are very critical not only because they result in harm and eventual disability or death of people, but also because they result in waste of resources such as those hospital services that could be used for other purposes, and loss of savings and working days of the accident victims which may impact the future life style of their families. There are also the psychological effects of road accidents. We intend to study the trend of road accidents in Pakistan, hopefully over the past decade, and use ARIMA time series analysis to obtain measures of safety and forecasts of roads accidents and eventual deaths. If time allows, we plan also to use the Artificial Neural Network (ANN) method of analysis, and compare both methods to evaluate which of them provides a better forecast and of course control of road accidents in Pakistan till year 2020 and beyond.

Field of Research: Transportation Management.

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1- Introduction

Every year, millions are killed on the roads odd developing countries, and other millions are seriously injured. The most dominant factor in understanding the chain of events leading to an accident is the human factor, and understanding driver's perceptions of the issue are necessary for interventions to be effective. Some countries have provided creative methods of educating people. Internet "talk-backs" to accident news are used as an innovative methods that supplement qualitative techniques such as focus groups or interviews. The BBC provided an alarming report about road accidents in Asia in the last week of April 2008. A bus carrying Hindu and Muslim passengers collided with a large truck in India killing tens of innocent people in the desert state of Rajasthan in western India, and apart from the 85 fatalities some 60 people were injured, many of them seriously. This accident reflected both problems of vehicle conditions, crowded buses; it did not reflect road safety only in India. It is also evident in other Asian Countries including Pakistan. In October 2005 after the infamous earthquake which devastated many countries in Asia including Pakistan was followed immediately by relief caravans to the bereaved areas. In Northern Pakistan many road accidents due to difficult weather condition in winter, snow storms, blizzards, and foggy conditions results in similar accidents that took the lives of hundreds of people in Pakistan. This study is a part of a long term project that investigates the factors leading to road accidents and how to prevent them.

The United Nations Organization (UNO) has many affiliated bodies and programs that help improve road safety worldwide especially in the developing countries such as Pakistan. An important organization IS THE World Bank; in a report sponsored by the World Bank, Geoff Jacobs and Amy Aeron Thomas (2002) cited that between 750,000 and 880,000 people have died as a result of road accidents; the majority of those deaths occurred in developing countries, with approximately half in Asia. They added that road fatalities are expected to increase with a fatality toll estimated between 900,000 and 1.1 million by 2010, and between 1.1 and 1.3 by year 2020. The alarming information is that the total number of people killed in road accidents in the developing countries continues to increase while in the Developed Countries in Europe and North America there has been a steady decrease since the Seventies of last Century. Moreover, international reports show that the highest fatality rates (death per 10,000 Population) worldwide occur in Africa and Asia. They emphasized that pedestrians are a particularly high risk group throughout Africa and Asia.

Many studies have cited the importance of road safety worldwide, especially in the developing countries of Africa and Asia. The Asian Development Bank provided in March 1996 an important report about Road Safety. A transport Research laboratory (TRL) was established in UK to monitor road accidents and develop a micro-based data system to permit better collection, storage, and analysis of accident data in 20 countries including Pakistan. The Central Road Research Institute (CRRI) in India was established in 1986 in order to give road safety greater emphasis. The works also in areas of non-motorized vehicle accidents, motor cycle helmet usage, design standards and operational practices, road safety in and around schools, and other research into driver evaluation methods.

In Pakistan, the determinants of road accidents have been as follows:

a- Environmental causes (such as weather related causes including blizzards and slippery roads which resulted in deaths of hundreds who left for relief of the bereaved Pakistani regions after the earthquake of 2005)

b- Behavioral causes (such as carelessness of drivers about traffic signals or giving right of the road according to the international conventional rules, overcrowded vehicles such as one motorcycle carrying a family of 5 people, the father in the driver seat, and behind him are both his wife and adult daughter, and in front him are 2 boys les than 6 years of age each, and insufficient training for commercial vehicles such as trucks and buses on the road)

c- Mechanical causes (such as driving vehicles that do not observe vehicle safety conditions; many cars do not have working speedometer or rain wipers…etc.).

2- Literature Review

The following are few of the tens of reference that have been studied:

Abdel Hamid Abbassi (2005) studied road accidents in Kuwait. He used an Auto-regressive Integrated Moving Averages (Box Jenkins) Model and compared it with the Artificial Neural Networks (ANN) Analysis to predict fatalities of the Road Traffic Accidents in Kuwait. He concluded that ANN was better in case of long term series without seasonal fluctuations of accidents or autocorrelation components. Albalata, Daniel (2008) studied the problem of driving while intoxicated. He cited the importance of lowering of blood alcohol content level to avoid road accidents. His study applied the European panel-based data for the period 1991-2003 to evaluate the effectiveness of applying the differences-in-differences method in a fixed effect estimation that allows for any pattern of correlation. The study inferred that drunk driving is one of the leading concerns on several European countries. He concluded that it was important to lower the illegal Blood Alcohol Content levels to 0.5 mg/ml.

Brijs Tom et al. (2007) provided a Bayesian Model for ranking hazardous road sites. They discussed the importance of identifying the sites that are more dangerous than others in order to help in better scheduling road safety policies. They proposed a methodology for ranking sites according to their level of hazard. Their model made use of all relevant information per accident location, including the total number of accidents and the number of fatalities, as well as the number of slight and serious injuries. Moreover, the model included the use of a cost function to rank the sites with respect to their total expected cost to society. Accident data from 519 intersections in Belgium were used to illustrate the methodology proposed.

Factor, Roni; Mahalel and David; Yair, Gad (2007) discussed a sociological model to explain collisions between two drivers or more. They called those collisions social accidents. They discussed empirical findings from prior studies and explained the road accidents through sociological theories. Sociological theory posits that social groups have unique cultural characteristics, which include a distinctive world view and ways of operating that influence its members. These cultural characteristics may cause drivers in different groups to interpret a given situation differently; therefore, they will make

conflicting decisions that may possibly lead to road accidents. The proposed model may contribute to an understanding of the social mechanism related to interactions and communication among drivers by presenting new directions for understanding accidents and collisions. The paper concludes with suggestions for future research that will employ the model to assess its predictive and practical utility.

Kilpeläinen, Markku; Summala, Heikki (2007) studied the winter time slippery roads in Canada, Finland, and Sweden as an elevating risk factor. They noticed that the national road administration in those countries often informed drivers of forthcoming weather and driving conditions in different regions. Their study comprised a sample of drivers who answered a questionnaire on perceptions of weather, self-reported driving behavior, pre-trip acquisition of weather information, and possible travel plan changes. Secondary source data from traffic weather forecasts, automatic traffic counters and weather measurement stations concerning the same areas were also collected. They found that acquisition of weather information for the trip was associated with low recent driving experience, increasing age, female gender, long trip in question and very poor weather conditions perceived by the driver. Drivers who had acquired information had also made more changes to their travel plans, but information acquisition did not have an effect on their on-road driving behavior. They concluded that on-road driving behavior was significantly affected by weather change.

Conche, Florence (2006) studied the potential use of images collected through the use of CCTV cameras in urban areas as a means of increasing understanding of the causes of road traffic accidents. They suggested that the use of TV Cameras to record accidents could provide an independent perspective on accidents and have the potential to increase both the quality and quantity of information available to the concerned parties. His study focused on the city of Leeds in Britain, and showed that an existing CCTV camera system used for urban traffic management reasons had the potential to record about 25% of the accidents which occurred in the area. The study suggested that other cities in Britain should have similar camera systems set-up. The study concluded that CCTV had a high potential to provide supportive evidence about the most commonly occurring factors resulting in road accidents.

Özkan, Türker et al. (2006) provided an interesting study about road accidents in 6 countries (Britain, Netherlands, Finland, Greece, Iran, and Turkey). The study hypothesized that there were no cultural differences between drivers of those 6 countries. The study investigated the asymmetric relationship between the driver safety skills and accident involvement. The authors had a sample of 242 drivers chosen from each of the six countries, and tried to make the sample close in terms of age and sex. The study found that safety considerations among drivers were higher in Northern and Western European countries than the other countries. The study found out that the safety skills in Greece, Iran, and Turkey were relatively lower than those in the other countries in spite of high factor similarity found in driving skills. The study concluded that a negative relationship existed between driving safety skills and the number of accidents in Greece and Iran.

Davis, Gary A.and Swenson, Tait (2006) used a probabilistic model to study if an event was a cause of a road accident. They used structural causal models to analyze road accidents. They used video recordings of the accidents, information about vehicles involved before and during the collision. They used the collected information to estimate each driver's initial speed, following distance, reaction time, and braking rate. They using

Brill's model of rear-end accidents to simulate what would have happened, other things being equal, had certain driver actions been other than they were. The studied 3 accidents we found evidence that short following headways by the colliding drivers were probable causal factors for the collisions, at least one driver ahead of the colliding vehicles probably had a reaction time that was longer than his or her following headway, and that if the driver's reaction time been equal to his/her following headway, the rear-end collision probably would not have happened.

Keay, Kevin and Simmonds, Ian (2006) investigated the impact of rainfall on daily road accidents in the metropolitan area of Melbourne, Australia, over 1987–2002. Their analysis from several viewpoints of the accident count, indicated that the effect of rainfall was multifaceted. The found out that the effect of rainfall across the year's 4 seasons showed a tendency for larger values in autumn with smaller values in spring. For the daily (day-time and night-time) cases there was an approximate 40% decrease in road accidents. They obtained a conservative estimate of relative risk of an accident in wet conditions based on a matched-pair analysis of dry and wet periods, and found that the risk was greater than unity in almost all cases suggesting that the presence of rainfall consistently represented a driving hazard. Rainfall occurring after a dry spell had an enhanced effect on the road accidents count as the spell duration increased. Actually, in Pakistan this is evident since both summer and winter blizzards usually increase the risk of road accidents.

Clarke, David D et al. (2005) provided a statistical profile for accidents on road of Nottingham, Britain. The study used statistical methods to compare groups of drivers. The youngest and oldest groups of drivers were found to be over-represented in the junction accidents, and were the least likely to stop before turning. The young drivers had particular problems turning onto major roads. Women were more likely than men to stop before turning; they tended to have their collisions with other women; and they were under-represented as drivers of the non-turning vehicle.

Dankmare Bohning et al. (2004) studied that impact of driver's drug use on road accidents in Thailand. , They used the classic capture-recapture statistical model as in the conventional approach. A population-based study was conducted that utilizes all data on treatment episodes of drug users from all 61 health treatment centers in the Bangkok metropolitan region to estimate the size of drug use in the Bangkok metropolitan region and covered a period of 3 months in 2001. They used a Poisson Model to obtain estimates for the number of unobserved drug users. They used data from drug users during the period. By Their proposed model showed excellent goodness-of-fit, unspecified for drug type and also if specified for the major drug types which allowed the prediction of the unobserved number of drug users in a realistic way. This technique is easy and we plan to use it during the course of this project about Road Accidents in Pakistan.

3- Study Methodology and Variables:

This is a working paper or an interim report about what we intend to do in order to analyze road accidents in Pakistan both rural and Urban Areas. We plan to use secondary as well as primary source data. We will start with a regression model

that attributes accidents to weather conditions, driver's skills, condition of the vehicle and may add some other factors such as length of roads, number of population in the different regions of the country, and adherence to car insurance at least to cover for third party in case of road accidents.

3.1 Test Hypothesis

Our test hypotheses are as follows:

H_{11} Road accidents are correlated with the number of population in the region of road accidents

H_{21} Road accidents are correlated with length of roads extended in region of road accidents

H_{31} Road accidents are correlated with weather condition in region of road accidents.

H_{41} Road accidents are correlated with the mechanical condition of the used cars in the region of road accidents.

H_{51} Road accidents are correlated with the driver's safety skills and his consideration of the traffic laws/rules in the region of road accidents.

3.2 Regression Model

We have developed a simple model with the assumption that road accidents follow the normal distribution; so, we need to test that assumption. But, we would like to refer here to the model used by the Flanders in Belgium in year 2001 when 47,444 injury accidents occurred in traffic, with 66780 victims, of which 1486 deaths.

We are using the following multiple regression model:

$RF = RA + + PE + LR + PT + \varepsilon$ where:

RF: Road Fatalities

RA: Road Accidents

PE: Population Estimate

LR: Length of Roads

PT: Population Traffic (passengers/km)

ε : Error of the model including any other factors not included in the study

3.3 Data Sources

Although most of our data has been from secondary source, mainly the Ministries of Interior, and transportation, we felt that a questionnaire to different groups of people including Policemen, normal people (pedestrians), bicycle users, motorbike users, car and cab drivers, public transport such as buses and minivan drivers, commercial vehicles such as truck drivers, insurance brokers…etc are part of those whom we plan to approach with comprehensive questionnaires and interviews. At this time only a convenience sample of 3 student groups at Comsats Institute of Information Technology (CIIT) were interviewed with a short list of questions to understand their perception of road accidents in Pakistan.

3.4 Data Analysis

The common software such as SPSS, and Excel are used to analyze the results of data and provide some graphs of the collected data.

3-5 Expected Contribution of the Study

This study is quite important and it was initiated by an accident close to CIIT that could be fatal to one of its students while the car driver escaped from the accident scene without being apprehended. It is hoped that all parties involved in road accidents in Pakistan will benefit from it. The ministry of interior as well as ministry of transportation may be able to force the existing road safety laws to be respected and that the traffic signs will be followed with violators penalized not only by monetary fines but also by loss of merit points on their driving licenses and eventually imprisonment terms. The ministry of transportation would opt for making it easier for pedestrians to cross the extended roads at safer areas, and that intersections will be easier for vehicle drivers to change ways instead of violating the road direction in order to take a short cut, and that there will be a compulsory insurance on every vehicle to be permitted on the roads of Pakistan; if not comprehensive then at least third party insurance type.

4- Analysis of Results:

Our data will be analyzed using two types: Descriptive and analytic.

4.1 Descriptive Statistics:

The following table was obtained from the Ministry of Interior:

Table 4.1

Year	Total Accidents	Fatal Accidents	Non-Fatal	Persons Killed	Persons Injured	Total Vehicles Involved
1998	9663	4041	5622	4858	11597	10892
1999	10080	4340	5740	5240	11413	12061
2000	9735	4193	5542	5130	11469	11083
2001	10651	4491	6160	5532	13307	11722
2002	10033	4379	5654	5248	11922	10765
2003	9377	4045	5332	4813	10643	10100
2004	10308	4185	6124	5199	12927	10852
2005	9896	4250	5646	5112	12401	10912
2006	9492	4115	5377	4868	11415	10565
2007	10466	4535	5931	5465	12875	11481
20078	10644	4692	5952	5622	11594	11537
Total	110345	47266	63080	57087	131563	121970

Source: Provincial Police Departments; Data relates to road accidents only, December 2008

From the tables we find that fatal while total accidents have grown by 10+% during the period of 1998-2008 the rate of growth in fatal accident was even worse as they grew by 16+%. This fact is opposite to what we know about the Developed Countries in Europe and North America where the rate of accidents has declined at a rate of 10% during the same period and those countries are planning for even a further decline to 30% by year 2020. If we consider that the population of Pakistan has doubled during the past 25 years, and that most of the increase came in rural areas and segments of the middle and low class people, we expect that road accidents might be attributable to overcrowding public transport with those low income passenger in vehicles that no not pass the safety standard tests to be permitted on the roads.

That is expected since we observe a large increase in the length of roads extended during the 10 years from 1994-2004 by a rate more than 60% which is compatible with the constant increase in the Pakistani GDP by 7% every year since turn of the century. Moreover, the constant growth of car acquisition through Bank Credit facilities since year 2004 has led to a large increase in registered vehicles on the road in urban centers. Of course, one expects that such increase of cars on roads will be accompanied by an increase in road accidents. In 2007 The Federal Ministry of Health, Pakistan established a Road Traffic Injury Research & Prevention Center.

4.1.1 Data from Primary Source Sampled Students of the CIIT

We selected a convenient sample of 39 students that were available during the last week of April 2009. It may provide some supporting evidence and cannot be generalized:

The following interview questions were asked and answered in one session:

Table 4.2

Interview questions about road accidents during the past 12 months (April 2008 – April 2009)

Question	Yes Reply	No Reply	% of Yes Reply
Have you been involved in a car accident during the past 12 months?	16	23	41
Do you own or have access to a car?	18	21	46
For those who have a car, is it insured?	0	16	0
In case of been involved in a road accident has the police been informed and investigated?	2	16	11
In case of been involved in a road accident, have you been treated in a hospital/clinic?	3	15	17
Do you use the public transport or taxi-cabs?	34	5	87
Were the public buses in good condition for operating on the roads?	5	29	15
Were the buses crowded?	26	8	76
Were the public buses drivers skilled/did they respect the traffic signs and conventional rules?	8	26	24
Do you think that Service Road	39	0	100

beside CIIT at its intersection needs traffic signs/ police control?			

The interview of those students showed that all of them felt that a traffic sign as well as police control is needed beside the campus of Comsats in Islamabad. Unfortunately, none of those who had access to cars paid insurance. Moreover, almost 80% felt that the public buses were in bad condition; however, they were crowded because of the need of the poor people to go to work using a cheap method of transport.

4.1.2 Data from Secondary Sources

We obtained data from ministries of interior, transportation, finance, and health:

Table 4.3

Population of Pakistani Regions during the period 1982 – 2008

Region (Population in Million)	**Area** in Sq. Km.	**1972** Population	**1981** Population	**1999** Population	**2008** Population
Punjab *	206,250	25.852	47.633	74.426	89.973
SINDO	140,914	8.367	19.029	30.44	36.800
NWF	74,521	5.731	11.061	17.74	21.445
Balochistan	347,190	1.353	4.332	6.566	7.938
Other	27,220	1.847	2.199	3.18	3.844
All Pakistan	796,095	42.880	84.254	132.352	160.000

Source: Population Census, Social Indicators of Pakistan, 2006 * Punjab includes Islamabad

Table 4.4
Length of Pakistan Roads in Kilometers

1997	170,823
1998	182,709
1999	189,321
2000	196,817
2001	207,645
2002	218,345
2003	229,595
2004	240,885
2005	247,484
2006	248,340
2007	249,959

Source: Finance Division, Government of Pakistan, April, 2009

Table 4.5
Vehicles on the Roads of Pakistan in year 2008

Type of Vehicle	Number in 000
Motorcycles	2140.5
Motor Cars	758.6
Jeeps/land-rovers	67.6
Station wagons	85.6
Tractors	583.2
Buses	93.1
Taxi Cabs	73.5
Rickshaws	94.5
Delivery Vans	186.4
Trucks	160.1
Others	89.5

Source: Finance Division, Government of Pakistan, April 2009

4.2 Results of the Regression Model

We are using the suggested model on the following prepared data:

We prepared the following table out of the collected data, December 2009;

Table 4.6

Fatal Road Accidents	Total Road Accidents	Population Estimate in millions	Length of Roads In 000 km	Passenger (Million Traffic/km)	Total Vehicles Involved
4041	9663	130.245	182.709	131.352	10892
4340	10080	132.352	189.321	135.000	12061
4193	9735	134.345	196.817	137.037	11083
4491	10651	136.000	207.645	146.132	11722
4379	10033	139.000	218.345	154.566	10765
4045	9377	142.000	229.595	163.751	10100
4184	10308	146.000	240.885	173.587	10852
45250	9896	152.000	247.340	185.236	10912
4115	9492	156.000	248.340	196.692	10565
4535	10466	160.000	249.959	208.370	11481
					11537

4.2.1 Analysis of The Data About Fatal Accidents

The following was the result obtained from Excel supported by E-Views:

Regression Statistics

Variable	*t* – Statistic	*P*-value	Regression Statistics
X_1		0.7669	Multiple R = 0.628062
X_2	0.317319	0.5143	R Square = 0.394417
X_3	0.714704	0.3768	Adjusted R Square =
X_4	0.993232	0.4108	0.362562
X_5	-0.917392	0.7265	Standard Error = 15.13267
	0.372224		Durbin Watson Stat.
			2605.322

[**ANOVA**]

Source of Variation	***d. f.***	**SS**	**MS**	***F***
Regression	5	418.9645	83.7929	0.52104
Residual	4	9.16 E +6	2.29 E +6	
Total	9	422.2044		

Although about 40% of the variability in fatal road accidents can be explained using our model, with a multiple correlation coefficient of 0.6281 all results are not significant and the variable of passenger/road km has given a negative coefficient which mean that either the model needs some transformation of data or that data needs to be larger. It is evident since only 10 years have been included while 5 variables are considered as attributable to fatalities of road accidents.

We need to analyze the other data on monthly basis and probably use an exponential of logistic model to test the relationship since we cannot either reject or accept any of the hypotheses with our model offering about 40% of predictability.

Well, we have to continue and further this research in order to reach more convincing results.

5- Conclusion and Recommendations

5.1 Conclusion

We conclude from the results shown on the table above the following:

1- There is a positive relationship between the number of road accidents and population of the area where the accidents have occurred; but the result is not significant.
2- There is a positive relationship between the number of fatal accidents and number of vehicles on the road, but again the result is not significant.
3- There is a positive relationship between the number of fatal accidents and length of roads installed in the country, and again the relationship is insignificant.
4- There is a positive relationship between the number of fatal accidents on the roads and the total population of the country. Surprisingly the relationship is not significant.
5- The really surprising result was the negative regression coefficient between the number of fatal accidents on the roads and passenger/traffic km which make us unable to reject the null hypothesis.

5.2 Recommendations

We have made some personal obtrusive observations at several intersections and main roads in Islamabad, and would like to provide the following recommendations:

1. Increase width of the streets where pedestrians move frequently to common places such as shopping plazas, schools and universities, hospitals, business and governmental offices.

2. It is recommended that a movable steel barrier be placed on the U-turn spot so that U-turn is not allowed and wrong way driving also stops. Also, consider to make intersections accessible to many streets in the vicinity to help motorists avoid making short cuts and moving in the opposite direction of the normal traffic.

3. A pedestrian bridge has to be built adjacent to the railway line so that people can cross the road safely.

4. Bus stops should be allocated to the public transport near pedestrian bridge for safe loading and unloading of passengers.

5. Warning signs should be installed and correctly placed wherever

needed.

6. Proper Street lights should be ensured.

7. Working in progress should not disturb the regular traffic, and the pavements should be repaired so as to achieve a good riding surface.

8. Signs about speed limits should be constructed near intersection and passage of pedestrians, also when city roads branch into Inter-City Highways.

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