Development of an Accident Prediction Model for Intersections of Dhaka City, Bangladesh

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ABSTRACT
Road accidents are increasing at an alarming rate. Every year more than 1.17 million people die in road crashes around the world. The majority of these deaths, about 70 percent occur in developing countries .As a developing country, Bangladesh is not out of this situation. The road safety situation in Bangladesh has been deteriorating with rapid growth in population, motorisation, urbanisation and lack of investment in road safety. The combination of rapid urbanization and motorization has made the problem even severe .

For our paper at first we collect data to analysis the severity of accident in Bangladesh. We collect the data of accidents & rearrange these with respect to weather ,collision type, day of week etc .For this arrangement we collect the data of accident for the last five years . Our main concern were the intersections of Dhaka city. We then select twenty five intersections and collect data of road width and number of approaches. Then we develop a model of accident prediction with the collected data.
The major findings of our project is we found that accidents increase in good weather ,it may be because in good weather drivers may be more relax and less conscious as they think that everything is seen clearly .Another finding is as Dhaka is a populated city, number of accident with pedestrian is much higher than other type (with vehicle ,other objects etc.) of accidents . Again number of accident increase with increase in number of approaches in a intersection and decrease with increase in road width.

From this prediction model we can get the approximate number of accident that can happen per year and we can take proper steps and precautions such as speed breakers , road dividers ,proper signs , marking ,speed limit ,proper signal design to avoid such accidents .

General Terms
Road safety issue.

Keywords
Accident ,Data collection , Analysis, Prediction Model , Utilization.

1. INTRODUCTION
Road traffic accidents with casualties are causing great concern regarding communications within Bangladesh. Though Bangladesh is listed as a developing country it is suffering of various problems . Population is one of the most important problems. It is a small country with a area of 147,570 km^2 and with a huge population of 161,083,804 and Density of 964.42/km.Transportation system for this large population is not developed that much .Specially in Dhaka metropolitan city (DMP) ,capital of Bangladesh , whose area is 360 km^2 but population is 7,000,940.It is a over crowed city with insufficient roads with respect to the number of vehicle. The consequence of this is traffic jam .In most of the time in day traffic jam is a normal view of Dhaka city .This jam causes unnecessary delay to people , causes accident as drivers drive fast to cross the intersection with one signal. Thus overpopulation & limited roads make the accident problems more severe

In urban areas, the traffic roadway system context is more complex where a mixed road user environment prevails and greater perceptual and cognitive demands are placed on the road users. Of particular concern are the urban intersections, particularly the signalized ones that are problematic locations and have been identified as among the most hazardous locations on the roads which account for a substantial portion of traffic accidents (Tay et al., 2006; Helai et al., 2008). The heterogeneity of traffic, plying of modes with varying speed and maneuvering time makes the intersections of cities like Dhaka even more complex. Data show that intersection accidents represent around 40 percent of total accidents occurring in the Metropolitan city of Dhaka.. It demonstrates the burden and seriousness of the problem and emphasizes the need for strict and comprehensive measures to prevent the unwanted and unnecessary loss of lives. Several studies (Hoque, 1986; Hoque et al., 2006) dealt with the traffic safety problem of the city, but very rarely research has been conducted to examine the severity of intersection accident problem in this metropolitan city . The main aim of our project is to analysis the condition of accident in our country & to define a model to predict accident to some extend. So that we can understand the severity of the existing transportation condition and that can make the decision maker more conscious to take some steps to improve the condition of our transportation system.

2. LITERATURE REVIEW
Till now several models have been introduced. Some of these are as follows:

2.1 Empirical Bayesian Method:
Application of Empirical Bayes (EB) through multivariate analysis technique was tried in earlier researches for measurement to find risk sections in roads. Standards used for estimation of some object's risk degrees depends on the object's characteristic and past incident records. When it used only one standard, it has various problems. If it wishes to deduce the number of accident using only one characteristic

of object, it has a serious problem to choose reference group has an object. First, if it tries to find characteristics as like the object has, because the number of sample is decrescent, estimation becomes difficult. Then, some other elements that can contribute in accident are abandoned and analyst can intervene in selection of characteristics.

Moreover, if it only uses data of past accident, a problem will be caused by random characteristics of accident, and it will be not easy to find average of reference group including the object. Thus, development of accident prediction models used in before and after test of improvement achievement or comparison test with other targets can be impossible. Therefore, EB method makes estimation model of the number of accident using multivariate analysis technique, and it produces the corrected number of accident using past accident.

EB method assumes that the number of accident depends on not only characteristics of object but also past accident records. When the number of accident is estimated, two factors should be used. If x, the number of accident, follows Poisson distribution and belongs to reference group, which has E(y) and VAR(y), estimation equation of this object is as follows:

$\alpha E(y) \square (1-\alpha)x$ Where, $\alpha = E(y)/ E(y) \square \square Var(y)$

Where, y: the number of accident

Variance of level of risk is as follows: $\alpha(1-\alpha)E(y) + (1-\alpha)^2 x$

2.2 Poisson's Models:

Poisson models deal with discrete data so that they have most of desirable characteristics to describe vehicle collisions of positive number and random attribution. However, these models may produce wrong coefficients and wrong standard errors if data has excessive variance, and it has been problem to apply this model because variables that explain the number of accident were categorized data.

Usually, Log linear models are considered as a basic method to analyze effects of categorized data. Basically, this model can be expressed as follows:

$\ln Yi = \beta(Xi)$ i=1,2,...,n Where, Yi: Number of accident for combination i

Xi : Independent variable i

β Parameters in formula measure relation in Xi and display degrees of explanation power about accidents.

Reason, why this model is widely used, is that elements affecting in accident are categorized data. Moreover, because accidents are discrete essentially, expression of difference about accident reaction is most efficient in expressed data system by categorized style. And log linear method make it possible to test significance of categorized data as fixed quantity. In addition, it can handle positive characteristic of accident by Poisson distribution. However, weighted least squares method (WLSA) that use for exact calculation in this model usually displays high residual and needs large sample generally.

The Poisson distribution has the limitation that the variance and mean should be approximately equal. In the case of accident frequencies, the variance is generally much larger than the mean (described as the over-dispersion phenomenon) at which point the Poisson model becomes inappropriate. To overcome this problem, Maher and Summersgill (1996) suggested using the quasi Poisson model1 and the negative binomial model. The quasi- Poisson model may lead to inefficient coefficients and bias results2, so that the negative binomial model has been suggested as an appropriate model to solve the over-dispersion phenomenon. From a large number of empirical studies carried out by the U.K. Transport Research Laboratory, it was concluded that the negative binomial model is the most appropriate way by which to model over-dispersion, in particular with a large dataset (Maher and Summersgill, 1996). The negative binomial model has been used intensively by recent studies as the most appropriate methodological technique for modeling accident frequencies (for example: Walmsley et al., 1999 and Lee and Mannering, 2002).

2.3 The Negative Binomial Model:

As mentioned above, the limitation of the Poisson model is that the variance and mean must be approximately equal but, in general, accident data have a variance exceeding the mean. To deal with the limitations of the Poisson model, a negative binomial based on a gamma- distributed error term is commonly used. Therefore, equation 2 can be rewritten as follows (Shankar et al., 1995, Walmsley et al., 1999 and Lee and Mannering, 2002):

$E(n_i) = \lambda_i = \exp(\beta X_i) + \varepsilon_i$ Where εi is a gamma distributed error term.

This addition will make it possible that the variance is different from the mean following the next equation:

$Var(n) = E(n) + \theta E(n)^2$

From equation 6, it can be seen that if parameter θ is equal to zero, then the negative binomial model becomes a Poisson model; therefore the Poisson model can be described as an absolute of the negative binomial model. The negative binomial model is described by the following equation:

$P(ni) = \Gamma((1/\theta)+n)/ \Gamma(1/\theta)n!*((1/\theta)/(1/\theta+\lambda i))^{1/\varphi}*(\lambda i/(1/\theta+\lambda i))^{ni}$

3. MAIN REASON OF ACCIDENT IN BANGLADESH

Numerous factors have been studied for their relationship with accidents which are not possible to give a complete discussion in a paper with limited length. Statistics from the Road Safety Cell (RSC) of the Bangladesh Road Transport Authority (BRTA) show the annual fatality rate in road accident in Bangladesh is 85.6 per 10,000 vehicles which compares to rates of below 3 per 10,000 vehicles in most developed countries. The cause of road traffic accidents are, however, multi-faceted and will take years of concerted and co-ordinate effort to address. In general , it can be said that overloaded or less roadworthy vehicles, lack of awareness of safe road use, poor traffic management and law enforcement and poor driver training are among many reasons for the high levels of road traffic accidents in Bangladesh. Therefore, no attempt is made to provide a complete coverage of all possible reason of accident or risk factors. Instead, the aim is to introduce the representative factors and organize them at stages in the proposed framework.

3.1 Current Condition of some important intersections:

- In most of the intersections light on signals does not works and intersection is operated by police.
- Marking on road are insufficient or not clearly visible.
- Road signs are incorrect or blocked with poster.
- In many intersections the rule :angle between the approaches should be 75^0 are not maintained and so taking turn is difficult & conflict in movement occurs.
- Drainage system is inadequate. As a result in Rainy season roads are flooded with water with small rainfall, which cause miserable situation for vehicle and pedestrian for movement &which is an important cause of accident..
- Road side trading ,kitchen market ,roadside parking etc. have blocked the road ,as a result capacity of road is reduced .In many case these even blocked half width of the road as a result road capacity is reduced to large extent & possibility of accident specially with pedestrian increases.
- Another problem associated with our roads ,that is footpaths are reserved by the flying homeless people. It is mainly a problem of pedestrian. It damage the condition of footpath that is suitable for pedestrian movement. As a result pedestrian move to road & cause hazard for vehicle movement
- Traffic jam is one of the most important reason of accident . As in most of the time a day traffic jam can be seen on road ,people delay is a normal matter in Dhaka city .As driver want to pass the intersection with one signal they drive fast and accident can easily occur with straight going and right turning or with crossing vehicle or with pedestrian.
- Rickshaw is a very severe problem in Dhaka city. The combination of this NMT and Motorized vehicle make the traffic jam more terrible. As because of speed difference this vehicle reduce the overall speed of all vehicle in the intersection. In some intersection rickshaw is not allowed, condition of there is better. In every road rickshaw should have separate lane, so that conflict among vehicle can be reduced
- In our country drivers do not follow any rule of driving. They recklessly overtake another vehicle, change lane without following any rule, drive with over speed etc . These are one of the major reason of accident

4. DEVELOPMENT OF AN ACCIDENT PREDICTION MODEL

4.1 Study Area:

For our paper at first we collect data to analysis the severity of accident in Bangladesh . In this case we collect the data from Accident Research Institute ,from several police stations ,we got the information about the road configurations from Dhaka City Corporation. We collect the data of accidents & rearrange these with respect to weather ,collision type, day of week ,age , gender .For this arrangement we collected the data of accident for the last five years . Our main concern were the intersections of Dhaka city .We then selected twenty five intersections , of them Jatrabari ,Farmgate,Saidabad,Shonir Akhra crossing,Staff Rd ,Crossing(Dhk-Myen Road),Topkhana-Purana Paltan,Sonargaon-Panthapath-ETV, Kakoli (Mymen. Rd.+ Kamal At. Av.), GPO (Abdul Gani Rd.), Kuril, Bishwa Rd. at Level Crossing, Tongi Diversion Rd. Bijoy Sarani, New Airport Rd.+ Bijoy Sarani, Shahbag, Hotel Sheraton (Kazi Naz+Mintoo Rd.), Mohakhali, Moghbazar, New Eskaton (NE Rd. + Kazi Naz. Rd.), Shanshad, Manik Mia Av. (at Mirpur Crossing), Kakrail Traffic Signal, Asad Gate, Mowchak, Malibag Crossing, Rokeya Shoroni (Mirpur 10 round circle), Ramna, Bhasani Gate, at Star Gate, Joar Shahara, New Market, Mirpur Rd. Shyamoli, Mirpur Rd. (At Shyamoli Cinema Hall), Katabon Crossing (Near Elephant Rd.) Russel Square are the important ones.

4.2 Data collection and variable selection:

We collect the data of the road condition ,No. of approaches, width of the roads of each intersection . Then we select road width & No. of approaches as the variables of our regression equation .From the other data of accidents that we collected ,we draw graph to analysis the severity of accident condition in Bangladesh. Here are the related data and graphs in the following section.

Table 1: Accident severity with respect to Weather:

Year	**No. of accident at weather**			
	Fair	Rain	Wind	Fog
2009	507	8	1	4
2008	490	7	0	6
2007	501	9	1	5
2006	450	6	0	4
2005	498	10	0	3

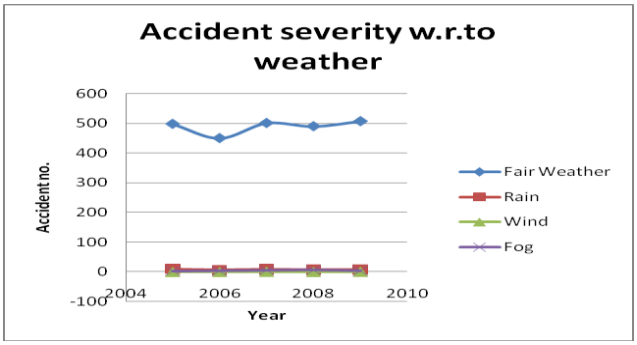

Figure 1:Accident severity with respect to weather

Table 2 :Collision Type According to year:

Year	Rear End	Ped'n	Head O	90de-gree	Side	OverT	Obj.1	Obj.2	Park V	Animal	Other
	Acc. No.	Acc. No.	Acc. No	Acc. No	Acc No.	Acc. No	Acc. No	Acc. No	Acc. No	Acc. No	Acc. No
2009	137	290	30	8	15	9	3	1	6	0	21
2008	125	258	25	10	14	8	2	2	8	1	17
2007	130	270	23	7	17	10	2	1	8	2	20
2006	116	220	33	11	10	18	0	1	9	0	15
2007	120	300	17	9	19	12	3	2	5	0	10

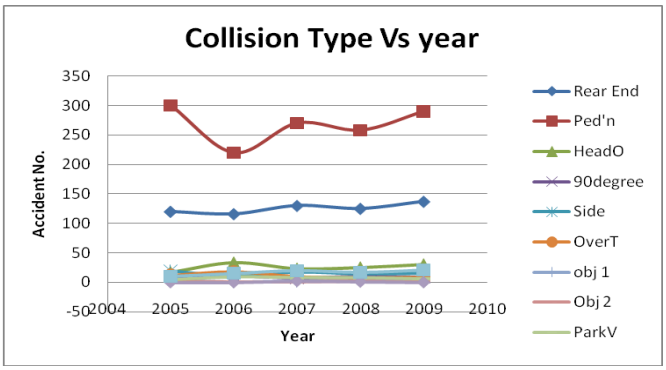

Figure 2: Collision Type Vs Year Curves

Table 3:Accident severity by day of week in DMP

Year	Sun	Mon	Tues	Wed	Thus	Fri	Sat
	Acc. No	Acc. No	Acc. No	Acc. No	Acc. No	Acc. No	Acc. No
2009	60	89	71	76	80	67	77
2008	62	75	67	72	79	63	79
2007	59	70	69	73	82	61	82
2006	50	55	60	70	79	55	80
2005	45	65	72	65	85	60	83

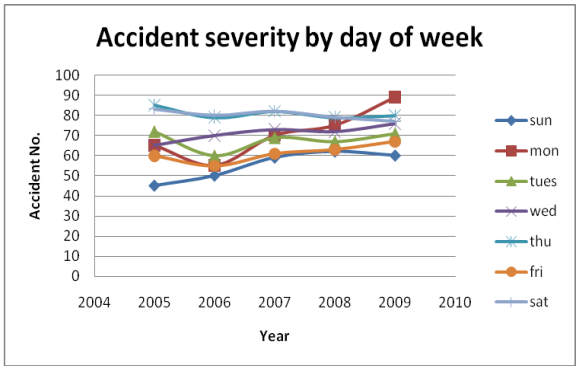

Figure 3:Accident severity by day of week in DMP

From these data we found that accidents increase in good weather ,it may be because in good weather drivers may be more relax and less conscious as they think that everything is seen clearly. Again from the second graph we can find that rear end collisions much higher than other types of accident. From the third graph no clear relationship between accident and day of week can be found.

Here in the following table we can find the data of accidents of our selected intersections from which we have introduced the prediction model:

Table 4. Accident severity at some important intersection

Name of Intersection	No. of Accident/ Year	Width(ft)	No. of Approaches
Jatrabari	105	54	5
Farmgate	71	60	6
Sonargaon-Panthapth-E TV	61	80	5
Bijoy Sarani	61	75	4
Shahbag	48	70	4
Kakoli (Mymen. Rd.+ Kamal At. Av.)	45	70	4
Moghbazar	43	70	4
Saidabad	41	94	3
GPO	39	85	4
New Eskaton (NE Rd. + Kazi Naz. Rd.)	35	80	4
Shapla Chattar	35	74	4
Hotel Sheraton (Kazi Naz+Mintoo Rd.)	34	70	4
Progoti Sarani (Badda)	27	70	3
Tongi Diversion Rd.	26	45	6
Shanshad, Manik Mia Av. (at Mirpur Crossing)	25	105	3
Kakrail Traffic Signal	25	75	3
Kuril, Bishwa Rd. at Level Crossing	24	100	3
Asad Gate	23	70	3
Mowchak	23	70	3
Rokeya Shoroni (Mirpur 10 round circle)	22	80	4
Rokeya Shoroni (At Agargaon Junction)	20	70	4
New Market, Mirpur Rd.	19	85	4
Shyamoli, Mirpur Rd. (At Shyamoli Cinema Hall)	16	80	3
Katabon Crossing (Near Elephant Rd.)	15	65	4
Russel Square	15	75	3

From these data we can draw two graphs to show the relationship of accident with Road width and No. of Approaches .From the graphs we found that No. of accidents reduced with increase in road width but the accident number increases with increase in number of approaches .

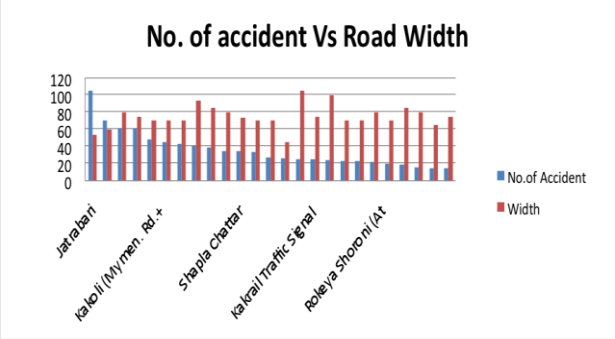

Figure 4 :Number of Accident Vs Road Width

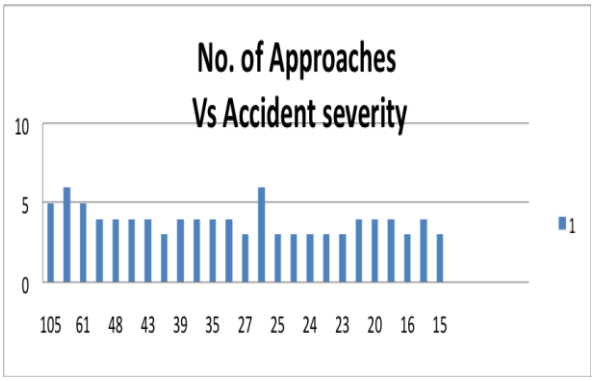

Figure 5 : No. of Approaches Vs Accident Number

4.3 Construction of Model Formula:

In our study ,we use Poisson's Model for our prediction. We choose road width & No. of approaches of the intersection as variables. Then comes our regression equation:

$Y=aX_1+bX_2$,

Where Y=Accident No.(per year)

X_1 =Road Width (ft)

X_2=No. of Approaches

a,b=Co-efficient

From our solution we found a=-0.109989307

b=11.42570672

Summary Output:

	Coefficients	P-value	R Square Value
Intercept	0	N/A	0.830326441
X Variable 1	-0.109989307	0.429436424	
X Variable 2	11.42570672	0.000222389	

Our Prediction Model is:

$Y= -0.109989307* X_1 +11.42570672*X_2$;

Where Y=Accident No.(per year)

X_1 =Road Width (ft) ; X_2=No. of Approaches

5. LIMITATIONS OF THE FORMULA

First, dependent variables are assumed to follow normal distribution in this model, but the number of accident is not so. And it is assumed that there is no relation between error and independent variable, but this assumption is not always true in case of accident in actuality. In addition, this model can deduce the negative number that could not appear as the number of accident. Moreover, when accident did not happen in any spot, this method always predicts zero as the number of accident, and this result strains the truth that zero number means that spot absolutely safe.

6. RECOMMENDATIONS

As our thesis is the first one introducing accident prediction model for intersection of Dhaka city, Bangladesh, more and deep analysis is recommended for future researchers to find out ways for reduction of traffic accidents and casualties. Road Safety Initiatives, argue the need for safer roads, safer vehicles and safer people. The policy-makers may decide for reduction of traffic accidents and casualties following this thesis. Some proposed recommendations are as follows:

- Improve the planning, management and co-ordination of road safety and reduce the traffic accidents and casualties by implementation of adequately resourced national and district multi- sectored road safety plan under the guidance of the National Road Safety Council .
- Get better traffic accident and casualty data system and establish an accurate and comprehensive national accident and casualty database, to ensure that the data are disseminated by used to identify problems and design remedial measures.
- Develop the road safety engineering and prevent the traffic accidents and casualties through safety conscious planning, design, construction and maintenance of roads and improve hazardous locations using low-cost engineering measures.
- Look up the road and traffic legislation; and revise and precise the traffic legislation promoting road user compliance with regulations intended to maintain a safe and efficient traffic flow.
- Apply traffic enforcement and develop a more effective and efficient traffic police capable of instilling safer road user attitudes and behaviour through the use of modern training, increased mobility, equipment and expanded powers.
- Update the driver training and testing; and Improve road safety by ensuring minimum standards for driver competence through improved driver training and testing procedures.
- Alter the vehicle safety and improve the road worthiness of vehicles using Bangladesh's roads by ensuring that minimum safety standards are met.
- Implement the road safety education and publicity programmes in order to improve the knowledge, attitudes and behaviour of all road users, through a combination of formal education, non-formal education, adult programmes and mass communication.

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