“WEATHER IMPACT ON ROAD ACCIDENT IN BANGLADESH”

A Thesis submitted to the Department of Civil Engineering, Daffodil International University in partial fulfillment of the requirements for the Degree of

Bachelor of Science in Civil Engineering

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The thesis titled " Weather Impact on Road Accident in Bangladesh " submitted by Md . Abul Hasnat , Fawsal Ahammed , Mizanur Rahman and , Md . Habibur Rahman has been accepted as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering on 16 - Oct - 2022 .

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DECLARATION

This is to certify that the following students, who worked under my direct supervision, completed the project and thesis titled " WEATHER IMPACT ON ROAD ACCIDENT IN BANGLADESH " in part to satisfy the requirements for the degree of Bachelor of Science in Civil Engineering. This work was completed in the laboratories of the Department of Civil Engineering within the Faculty of Engineering at Daffodil International University.

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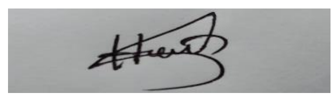

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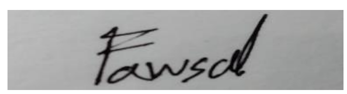

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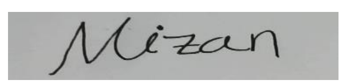

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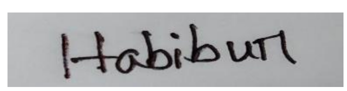

Approval

This is to certify that this project and thesis entitled "WEATHER IMPACT ON ROAD ACCIDENT IN BANGLADESH**"** is done by the following students under my direct supervision and this work has been carried out by them in the Department of Civil Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering.

……………………………
Ms. Shahrin Islam

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"Assalamu Alaikum" At first we say Alhamdulillah. Allah helped us and gave us mental strength, because of which we were able to finish the thesis. Otherwise we would not have finished this work.This work would not have been possible without the support and guidance of Ms. Shahrin Islam , who happen to be our research supervisor for his endless patience, scholar guidance continual encouragement, Constant and energetic supervision, constructive criticism, valuable advice, reading inferior drafts and correcting them at all stages have made it possible to complete this research. And we choose this topic and developed the search. Deep Knowledge and keep interest of our supervisor in the field of Engineering and influenced us to carry out of this research.

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Abstract

Based on Bangladesh's accident data from 2016 to 2020, this research aims to investigate the effect of weather conditions on the frequency of traffic accidents. The methodology is based on the negative binomial (NB) model. They were precipitation, Relative Humidity, Specific Humidity, Wind Speed, Maximum Wind Speed, Minimum Wind Speed, Average Temperature, Maximum Temperature, and Minimum Temperature. Using NB, a data subset with accident records of eight divisions of Bangladesh were examined. The findings revealed that, in the majority of cases, accidents occurred more frequently when there was less precipitation, less relative humidity, and a higher maximum temperature, as opposed to when there was more specific humidity. No correlation between Wind and the crash data has been found.

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Chapter 1

Introduction

1.1 Introduction :

The leading cause of death worldwide is road traffic accidents (RTA). Even though just 54% of the world's registered vehicles come from low- and middle-income nations, 90% of road traffic deaths (RTD) occur in these nations. Road traffic accidents are currently thought to be the ninth most common cause of death worldwide across all age groups, but that number is expected to rise to seventh by 2030. The economies of low- and middle-income nations are developing. The effects of this rising economy include rapid urbanization and motorization. However, infrastructural development policy upgrades are not happening quickly enough to keep up with these more rapid changes in the economy and population. According to research, RTAs cause economic losses in low- and middle-income nations that might amount to 5% of GDP (World Health Organization, 2015).

The official statistics show that more than 60 people die in traffic accidents in Bangladesh for every 10,000 motor vehicles (Alford, 2009). The true mortality rate is probably substantially greater. The according to quium, there are still issues with the accident reporting system and the data it produces and official numbers are prone to underreporting (Alford, 2009). While the number of fatalities grew by around 400% during the same time period the number of accidents increased by 43% between 1982 and 2000 (Girard, 2011) Road accidents are a global tragedy, and Bangladesh like many other nations, experiences significant annual losses as a result of these accidents (Donaldson & Lucey, 2018). The number of road users, urbanization, and motorization are all growing, and with the passing time, there are more road accidents and fatalities. To comprehend or asses the situation appropriately accurate and logical accident rates and corresponding trends are needed (Unesco. Research Centre on the Social Implications of Industrialization in Southern Asia et al., 1956).

In Bangladesh, there were 62 motor vehicle fatalities per 10,000 registered vehicles in 1985 but there were only 45 in 2007 (Bulletin of the Atomic Scientists, 1973). This drop in mortality was even more dramatic when considering road motor vehicles rather than registered motor vehicles, from 98 in 1985 to 56 in 2007, which should be more representative of the real situation (Figure 1: The Road Traffic Accident Death Toll with Motor Vehicles and Non-Motor Vehicles in China from 2007 to 2016, n.d.). The country's population doubled from 1971 to 2007, with accidents and fatalities increasing from 1.14 to 3.87 and 0.41 to 2.98 per 100,000 people, respectively, in some temporary fluctuations (Table 1.3. Road Fatalities per 100 000 Inhabitants, per Billion Vehicle-Km and per 10 000 Registered Motor Vehicles, n.d.)In terms of vehicle kilometers, accident and fatalities rates have decreased by 49.08% and 42.77% respectively per 100 million vehicle kilometers from 1999 to 2004 (Thorpe, n.d.)

1.2 Problem statement:

Numerous studies have examined the connection between weather conditions and collisions. According to estimates, weather factors can account for 5% of the variation in injury crashes (Brijs et al., 2006). Climate factors like wind, precipitation, and temperature have an impact on how drivers behave on the road and how likely traffic accidents are to occur ("Real-Time Prediction of Crash Risk on Freeways under Fog Conditions," 2020). Strong winds can cause the car to drag and limit the drivers' sight, which can increase the likelihood of crashes ("A Simplified Analysis of Various Types of Wind-Induced Road Vehicle Accidents," 1986). Therefore, in order to help with the adoption of potential preventative measures, it is necessary to analyze the role that such meteorological characteristics play in accident occurrences in Bangladesh.

1.3 Objectives:

The overall objective of this study is to identify the weather factors that trigger accident frequency. However, the specific objectives are

I. To analyze the weather effects on road crash frequency separately for each division .
II. To find their significance by applying negative binomial model .

1.4 Scope:

This investigation aims to attain a comprehensive understanding of the effects of weather parameters on road safety in Bangladesh.

Chapter 02

Literature Review

2.1 What is road accident:

A road accident occurs when a vehicle collides with another vehicle or object while driving on the road (Johnson, 2022). Traffic accidents often result in personal injury, property damage, and even death (Dionne & Laberge-Nadeau, 2012). An incident that involves at least one vehicle on a public road and results in at least one injury or fatality is referred to as a traffic accident (M. et al., 2004). When a vehicle collides with another vehicle, a pedestrian, an animal, road debris, or other stationary objects like a tree, pole, or building, the result is a traffic collision, also known as a motor vehicle collision, car accident or car crash (Fix et al., 2022).

2.2 Causes of road accidents:

A) High speed

B) Distracted driving

C) Driving under the influence

D) Weather conditions

E) Reckless driving

F) Vehicle reason

G) Sleep-deprived driving

H) Aggressive driving

I) Over speeding

J) Wrong way driving

K) Avoiding safety gears like seat belts and helmets

2.3 Important ways to avoid accidents:

A) Acquired the proper attitude toward driving (Fix et al., 2022; Greco & Rose, 2009)

B) Get as much safe driving practice driving as possible (Michigan. Department of Public Instruction, 1951)

C) Always buckle up in a vehicle (United States. National Highway Traffic Safety Administration, 1994)

D) Use of alcohol and drugs by minors is prohibited (Berg, 2012)

E) Limits the passengers

F) Limits the night driving

G) For now, go slowly and safety

H) Prepare for bad weather by exercising

I) Only use cell phones in an emergency when driving (Driving Standards Agency & Driving Standards Agency Staff, 2006)

J) Driving responsibility

K) Keep your speed within the limit

L) Be aware of blind areas

M) Observe the traffic laws

N) Pay attention to lane discipline (Lane, 2007)

2.4 Effects of car accidents:

A) Injury: In some cases of back and spine injuries, tissue damage can cause long term issues. After a car collision, the severity of back and spinal injuries vary greatly (Filler, 2004).

B) Traumatic brain injury: Traumatic brain injuries may sound frightening, but they are only another name for a brain injury that was brought on by something external (Padgett & Seaberg, 2014).

C) Fractures: Car accidents frequently result in fractures. Depending on how severe the fracture is, this kind of damage can need to be surgically treated. Numerous victims in auto accidents get numerous fractures. Some fractures may recover within a few weeks (Lombardo, 2001).

D) Burns: Burns typically take place in collisions where the impact rips a gasoline line or gas tank, which sets off an explosion. Thermal burns are another possible injury. Due to hot metal vehicle components,fires and explosions at the scene of the accident, burn injuries are also frequently caused by car accidents (Bulletin of the Atomic Scientists, 1970).

E) Spinal cord injury: Although they are more likely in major incidents, spinal cords are injuries can also happen in less serious ones. Similar to spinal cord injury and traumatic brain injury.

Another potential consequence of a vehicle collision is spinal cord damage. A serious accident frequently leads to sci. The effects of spinal cord injury are frequently very bad (Advanced Life Support Group (ALSG), 2019).

F) Soft tissue injury: One of the most frequent sorts of injuries following an accident is soft tissue damage. Our tendons, ligaments, and muscles support our bones (Whaley & Wong, 1991).

G) Pain: The forceful impact you feel in a car collision will nearly always cause pain in various bodily Areas. This kinetic energy is released and affects the body in a sudden car crash which may result in pain and injury (Twain, 2015).

H) Back injury: Some of the most frequent vehicle accident injuries are back injuries, including spinal cord damage. After a car collision, back injuries may have long-lasting even permanent implications. Your feet, ankles, and knees could suffer soft tissue damage in a car collision, much as whiplash and back problems are affected by this type of injury (Atlanta, 2004).

I) Shock: At the moment of impact, shock and adrenaline start to take over, exposing your body to the physical pain of an injury. After a car collision, strong levels of shock and adrenaline can sometimes prevent us from detecting damage symptoms and can even temporarily numb the pain (The Advocate, 2001).

J) Knee injuries: When the knees collide with any portion of the vehicle during a crash, injuries can range from bruising to numerous fractures. If there is enough energy in the collision the driver could be thrown forward and their knees could hit the car's footwell (Mort, 2013).

K) Cuts: Car accident victims may sustain cuts by coming into contact with sharp metal, shattered glass, and flying debris. If a person does not correctly treat the wound, they risk developing a skin infection like impetigo or ‘cellulitis’ which is an infection underlying the skin tissue (Morales et al., 2022) .

L) Internal organ damage: An object could pierce an organ or induce compression of the organs due to the impact of an accident if internal bleeding happens, it can be a sign of a serious issue that called be ‘’ fatal’’. The victim can experience shock (Davis et al., 2008).

2.5 Types of car accidents:

Any driver engaged in traffic accidents will most likely have lost control as the primary factor. The types of a car collision that occurs determine what caused this response to arise. The kinds listed below each include a brief description and one or more strategies for avoiding them (Report on the ... International Technical Conference on Experimental Safety Vehicles, 1971).

1) Head on collision: You are travelling north on the highway when all of a sudden, a south bound car jumps the median and comes straight at you. They have lost control are aware that their last

swerve brought them here,and are reluctant to move again. The best advised evasive maneuver is for you to make a right turn (Nastos, 2018).

2) Vehicle rollover: It can result in occupants being turned away when a car or truck (more typically an suv or van) flips onto its side, lands on the roof, or tumbles several times. Unfortunately, there is no time to react, and when a car rolls over, there are likely to be significant injuries and even fatalities. Their survial percentage is significantly boosted when drivers and passengers are wearing seat belts (Backpacker, 2001) .

3) T-bone car accident: When one vehicle collides load on into the side of another, it can result in one of the T- bone automobile accidents most dangerous collisions. This ‘’T’’ effect most usually happens on the car driver's side, which can result in fractured bones, a concussion, and even fatalities. Your best chance of survival in these unexpected, inevitable crashes is when your seat belt is fastened (Popular Mechanics, 2000).

4) Multiple vehicle collision: Multiple vehicle collisions, which involve three or more vehicles in a series of incidents stemming from a single event, are another type of extremely vulnerable traffic mishap. These pileups might be little or large, causing a lot of confusion as well as several injuries and fatalities. Your situational awareness and how you maintain a safe distance from other drivers on the road may very well determine whether you end up in the mix (Men’s Health, 2008).

5) Side swipe collision: Whether you are on a highway or a country road its dangerous to drive right next to another car. Any distraction on the part of the other driver could force them to veer into your lane, bumping you or striking you so hard that it disables you. Avoid these collisions by avoiding your own and other drivers blind spots and paying attention to when other vehicles are travelling too closely to the lane divider (Bruna, 2006).

6) Side- impact collision: A side impact collision occurs when one vehicle is broad sided, or struck in the side by the front end of another vehicle. This kind of collision happens in cars most frequently near intersections. It is not guaranteed, but typically there are witnesses and there may be a traffic camera atop the signal. Regardless of whether you have the green light or not, you have an opportunity to prevent these collisions by slowing down as you approach the intersections (American Academy of Orthopaedic Surgeons, 2011).

7) Single car accident: one vehicle is always involved in a single- vehicle accident, however this does not necessarily mean that the driver is to blame. Usually happens when a single motorist swerves to avoid hitting and object, such as an animal or another car that is weaving, and ends up crashing into a guardrail, tree or electricity pole. The weather is frequently a factor in these situations and might put in evitable obstacles in your path. Your best bet is to slow down as you approach a blind corner or round a curve (Shuve, 2019).

2.6 How different factors of roads contributes in accidents :

A) Drivers: Excessive speeding, reckless driving, not reading road signs, being tired, and drinking (Svenson et al., 1976).

B) Pedestrain: Carelessness, illiteracy, errant crossing, moving on the right of way and jaywalking.

C) Passengers: By extending their body outside the vehicle, talking to the driver, boarding and exiting from the incorrect side while using footboards, catching a moving bus etc. (Ahn & Mizuno, 2022).

D) Vehicles: Brake failure, steering tyre blowout, inadequate lighting, overloading, and projecting load (Comm & Automotive Brake and Steering Hose Standards Comm, n.d.).

E) Road conditions: Potholes, deteriorated or damaged roads, merged rural and interstate routes, detours, and unauthorized speed bumps.

2.7 Effects of weather conditions:

The majority of traffic accidents occur during the rainy season because the tires do not have as much traction on the pavement and cannot stop in time while applying the brakes. To minimize accidents, various businesses have started producing tires with improved traction on slick surfaces (Distribution and Cost of Landslides That Have Damaged Manmade Structures during the Rainy Season of 1972-1973 in the San Francisco Bay Region, California, 1975). Roughly 20% of state DOT maintenance budgets are allocated to winter road maintenance. Over 2.3 billion dollars are spent annually on snow and ice control operations by state and municipal governments entities. 70% of weather related incidents occur on wet pavment and 46% occur during rainfall,these two conditions accounts for the great majority of weather related crashes.Winter weather has a substantially lower percentage of weather related crashes,18% of weather related crashes happen in snow or sleet,13% happen on ice pavement and 16% happen on snowy or siushy pavement.only 3% of events take place while there is fog. Numerous factors including speeding and driving while inebriated or fatigued,contribute to traffic accidents.The weather can affect these accidents in bridgeport and throughout the entire state of connecticut. Unfortunately some drivers endanger other people’s lives and wellbeing by failing to drive properly during bad weather.If someone else’s negligence resulted in a crash that injured you,you should research your alternatives as you work to heal (Nabi et al., 2006).

Chapter 03

Data Collection and Methodology

3.1 Data Collection:

Bangladesh is a South Asian developing nation with a sizable population. The rising frequency and severity of traffic crashes have been a major concern for experts and policymakers in recent years. The Accident Research Institute (ARI), which is governed by the Bangladesh University of Engineering and Technology, provided the information used in this study. The most accurate and trustworthy source of crash information is ARI. The crash reports in the collected dataset covered the study period, which was defined as January 2016 through December 2020. Information about the kinds of vehicles used in the study was included in the dataset. We divided up the crash reports for extraction. The final dataset included daily estimates of total road traffic collisions for eight divisions: Dhaka, Chittagong, Khulna, Barisal, Rajshahi, Sylhet, Mymensingh, and Rangpur.

As independent variables, we have used weather parameters collected from the website of NASA. The independent variables are Precipitation, Relative Humidity, Specific Humidity, Wind Speed, Maximum Wind Speed, Minimum Wind Speed, Average Temperature, Maximum Temperature, and Minimum Temperature.

3.2 Methodology:

The over dispersion tests revealed that the null hypothesis of the variance equal to the mean was rejected. Hence, we choose the negative binomial regression model for the study. This model is introduced with:

$$\mathrm{P}(\mathrm{y}=\mathrm{y})=\frac{\Gamma(y+\phi)}{\Gamma(y+1)\Gamma(\phi)}\left(\frac{\phi}{\mu+\phi}\right)^{\phi}\left(\frac{\mu}{\mu+\phi}\right)^{y}, \quad y=0,1,2,3\ldots$$

The mean and variance of the negative binomial distribution are E [y|μ,] = μ and V [y|μ, φ] = μ (1 + μ). Where φ is the dispersion parameter (if > 0 and μ > 0).

To conduct the analysis, jamovi 2.3 software has been utilized. Measures of model performance that take model complexity into consideration are provided by the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). The most popular method of assessing a linear correlation is the Pearson correlation coefficient (ρ), which is used to determine the importance of independent variables.

Chapter 04

Data Analysis And Discussion

4.1 Dhaka Division:

Tables 4.1, 4.2, and 4.3 represent the model information criteria, results from the likelihood ratio test, and parameter estimates for the Dhaka division, respectively. The AIC and BIC values are 7066.65 and 7129.27, respectively. Considering the level of significance at 10% (0.1), we can conclude that, precipitation (-0.00549), relative humidity (-0.01066), and maximum temperature (-0.07752) are negatively correlated with the crash frequency whereas specific humidity (0.06673) is positively correlated. Other parameters are insignificant.

Table 4.1 Model Info - Dhaka

Info	Value
AIC	7066.6540
BIC	7129.2690

Table 4.2 Loglikelihood ratio tests - Dhaka

	X^2	df	p
Precipitation	8.677	1	0.003
Relative Humidity	2.954	1	0.086
Specific Humidity	4.865	1	0.027

Table 4.2 Loglikelihood ratio tests - Dhaka

Wind at 10m	1.826	1	0.177
Maximum Wind	1.841	1	0.175
Minimum Wind	0.284	1	0.594
Temperature	0.855	1	0.355
Maximum Temperature	3.348	1	0.067
Minimum Temperature	2.024	1	0.155

Table 4.3 Parameter Estimates - Dhaka

				95% Exp(B) Confidence Interval			
Names	**Estimate**	**SE**	**exp(B)**	**Lower**	**Upper**	**z**	**p**
(Intercept)	2.41835	0.64073	11.227	3.132	40.180	3.774	**< .001**
Precipitation	-0.00549	0.00189	0.995	0.991	0.998	-2.904	**0.004**

Relative Humidity	-0.01066	0.00610	0.989	0.977	1.001	-1.748	**0.080**
Specific Humidity	0.06673	0.02992	1.069	1.007	1.134	2.230	**0.026**
Wind at 10m	-0.13971	0.10408	0.870	0.710	1.065	-1.342	0.179
Maximum Wind	0.07402	0.05503	1.077	0.968	1.198	1.345	0.179
Minimum Wind	0.03125	0.05846	1.032	0.920	1.158	0.535	0.593
Temperature	0.07515	0.08095	1.078	0.919	1.264	0.928	0.353
Maximum Temperature	-0.07752	0.04220	0.925	0.852	1.006	-1.837	**0.066**
Minimum Temperature	-0.06270	0.04413	0.939	0.861	1.024	-1.421	0.155

4.2 Barisal Division:

Tables 4.4, 4.5, and 4.6 represent the model information criteria, results from the likelihood ratio test, and parameter estimates for the Barisal division, respectively. The AIC and BIC values are 3719.01 and 3781.63, respectively. Considering the level of significance at 10% (0.1), we can conclude that, precipitation (-0.00388), specific humidity (-0.12298), and maximum temperature (-0.13237) are negatively correlated with the crash frequency whereas no positive correlation with any parameters has been observed. Other parameters are insignificant.

Table 4.4 Model Info - Barisal

Info	Value
AIC	3719.0100
BIC	3781.6250

Table 4.5 Loglikelihood ratio tests - Barisal

	X^2	df	p
Precipitation	4.2177	1	0.040
Relative Humidity	2.0594	1	0.151
Specific Humidity	3.0490	1	0.081
Wind at 10m	1.0790	1	0.299
Maximum Wind	0.5880	1	0.443
Minimum Wind	0.0922	1	0.761
Temperature	1.2298	1	0.267

Maximum Temperature	2.8361	1	0.092
Minimum Temperature	0.0553	1	0.814

Table 4.6 Parameter Estimates - Barisal

				95% Exp(B) Confidence Interval			
Names	**Estimate**	**SE**	**exp(B)**	**Lower**	**Upper**	**z**	**p**
(Intercept)	-1.45098	1.54039	0.234	0.0113	4.674	-0.942	0.346
Precipitation	-0.00388	0.00195	0.996	0.9922	1.000	-1.993	**0.046**
Relative Humidity	0.02116	0.01479	1.021	0.9923	1.052	1.430	0.153
Specific Humidity	-0.12298	0.07038	0.884	0.7696	1.015	-1.747	**0.081**
Wind at 10m	-0.14547	0.14176	0.865	0.6561	1.137	-1.026	0.305
Maximum Wind	0.05867	0.07648	1.060	0.9119	1.230	0.767	0.443

Minimum Wind	0.02522	0.08395	1.026	0.8732	1.210	0.300	0.764
Temperature	0.18941	0.17077	1.209	0.8648	1.690	1.109	0.267
Maximum Temperature	-0.13237	0.07819	0.876	0.7507	1.022	-1.693	**0.090**
Minimum Temperature	0.02038	0.08668	1.021	0.8611	1.209	0.235	0.814

4.3 Chittagong Division:

Tables 4.7, 4.8, and 4.9 represent the model information criteria, results from the likelihood ratio test, and parameter estimates for the Chittagong division, respectively. The AIC and BIC values are 5792.20 and 5854.81, respectively. Considering the level of significance at 10% (0.1), we can conclude that, precipitation (-0.00146), relative humidity (-0.02864), and maximum temperature (-0.12659) are negatively correlated with the crash frequency whereas specific humidity (0.14648) is positively correlated. Other parameters are insignificant.

Table 4.7 Model Info – Chittagong

Info	**Value**
AIC	5792.19800
BIC	5854.81300

Table 4.8 Loglikelihood ratio tests - Chittagong

	X^2	df	p
Precipitation	3.1829	1	0.074
Relative Humidity	4.8036	1	0.028
Specific Humidity	6.0767	1	0.014
Wind at 10m	0.3146	1	0.575
Maximum Wind	0.2263	1	0.634
Minimum Wind	0.0223	1	0.881
Temperature	0.0147	1	0.903
Maximum Temperature	2.6757	1	0.102
Minimum Temperature	0.2621	1	0.609

Table 4.9 Parameter Estimates - Chittagong

				95% Exp(B) Confidence Interval			
Names	**Estimate**	**SE**	**exp(B)**	**Lower**	**Upper**	**z**	**p**
(Intercept)	4.32475	1.4332	75.546	4.585	1239.782	3.018	**0.003**
Precipitation	-0.00146	8.25e-4	0.999	0.997	1.000	-1.764	**0.078**
Relative Humidity	-0.02864	0.0132	0.972	0.947	0.997	-2.178	**0.029**
Specific Humidity	0.14648	0.0596	1.158	1.031	1.301	2.459	**0.014**
Wind at 10m	-0.06591	0.1153	0.936	0.744	1.179	-0.572	0.567
Maximum Wind	0.03061	0.0631	1.031	0.909	1.169	0.485	0.628
Minimum Wind	-0.00971	0.0639	0.990	0.872	1.126	-0.152	0.879
Temperature	0.02028	0.1641	1.020	0.735	1.416	0.124	0.902
Maximum Temperature	-0.12659	0.0762	0.881	0.757	1.025	-1.661	**0.097**

Minimum Temperature	-0.04355	0.0837	0.957	0.810	1.131	-0.520	0.603

4.4 Khulna Division:

Tables 4.10, 4.11, and 4.12 represent the model information criteria, results from the likelihood ratio test, and parameter estimates for the Khulna division, respectively. The AIC and BIC values are 3139.90 and 3202.51, respectively. Considering the level of significance at 10% (0.1), we can conclude that, precipitation (-0.00664), maximum temperature (-0.19784), and minimum temperature (-0.17256) are negatively correlated with the crash frequency whereas specific humidity (0.10567) and average temperature (0.26589) are positively correlated. Other parameters are insignificant.

Table 4.10 Model Info – Khulna

Info	Value
AIC	3139.8950
BIC	3202.5100

Table 4.11 Loglikelihood ratio tests - Khulna

	X^2	df	p
Precipitation	4.764	1	0.029

Relative Humidity	2.184	1	0.139
Specific Humidity	3.325	1	0.068
Wind at 10m	1.206	1	0.272
Maximum Wind	1.372	1	0.242
Minimum Wind	0.158	1	0.691
Temperature	3.064	1	0.080
Maximum Temperature	6.360	1	0.012
Minimum Temperature	4.336	1	0.037

Table 4.12 Parameter Estimates - Khulna

				95% Exp(B) Confidence Interval			
Names	**Estimate**	**SE**	**exp(B)**	**Lower**	**Upper**	**z**	**p**
(Intercept)	1.78029	1.22742	5.932	0.518	65.788	1.450	0.147

Precipitation	-0.00664	0.00323	0.993	0.987	0.999	-2.056	**0.040**
Relative Humidity	-0.01728	0.01157	0.983	0.961	1.006	-1.494	0.135
Specific Humidity	0.10567	0.05772	1.111	0.992	1.245	1.831	**0.067**
Wind at 10m	-0.22064	0.20308	0.802	0.540	1.188	-1.086	0.277
Maximum Wind	0.12244	0.10540	1.130	0.920	1.383	1.162	0.245
Minimum Wind	0.04596	0.11564	1.047	0.837	1.317	0.397	0.691
Temperature	0.26589	0.15094	1.305	0.969	1.757	1.761	**0.078**
Maximum Temperature	-0.19784	0.07810	0.820	0.703	0.957	-2.533	**0.011**
Minimum Temperature	-0.17256	0.08257	0.842	0.715	0.990	-2.090	**0.037**

4.5 Mymensingh Division:

Tables 4.13, 4.14, and 4.15 represent the model information criteria, results from the likelihood ratio test, and parameter estimates for the Mymensingh division, respectively. The AIC and BIC values are 3763.86 and 3826.48, respectively. Considering the level of significance at 10% (0.1), we can conclude that, relative humidity (-0.02985) and maximum temperature (-0.13967) are negatively correlated with the crash frequency whereas specific humidity (0.12866) is positively correlated. Other parameters are insignificant.

Table 4.13 Model Info - Mymensingh

Info	**Value**
AIC	3763.8640
BIC	3826.4780

Table 4.14 Loglikelihood ratio tests - Mymensingh

	X^2	**df**	**p**
Precipitation	0.7079	1	0.400
Relative Humidity	8.0747	1	0.004
Specific Humidity	6.5482	1	0.010
Wind at 10m	0.5208	1	0.470

Maximum Wind	1.3519	1	0.245
Minimum Wind	0.0338	1	0.854
Temperature	0.6429	1	0.423
Maximum Temperature	5.3080	1	0.021
Minimum Temperature	1.9838	1	0.159

Table 4.15 Parameter Estimates - Mymensingh

				95% Exp(B) Confidence Interval			
Names	**Estimate**	**SE**	**exp(B)**	**Lower**	**Upper**	**z**	**p**
(Intercept)	3.39166	1.09342	29.715	3.367	259.849	3.102	**0.002**
Precipitation	-0.00224	0.00270	0.998	0.992	1.003	-0.830	0.406
Relative Humidity	-0.02985	0.01033	0.971	0.951	0.991	-2.889	**0.004**
Specific Humidity	0.12866	0.04986	1.137	1.031	1.255	2.581	**0.010**

Wind at 10m	-0.12120	0.16904	0.886	0.637	1.231	-0.717	0.473
Maximum Wind	0.10072	0.08655	1.106	0.933	1.308	1.164	0.245
Minimum Wind	0.01862	0.10181	1.019	0.836	1.244	0.183	0.855
Temperature	0.09078	0.11281	1.095	0.877	1.368	0.805	0.421
Maximum Temperature	-0.13967	0.06068	0.870	0.772	0.979	-2.302	**0.021**
Minimum Temperature	-0.08853	0.06300	0.915	0.809	1.035	-1.405	0.160

4.6 Rajshahi Division:

Tables 4.16, 4.17, and 4.18 represent the model information criteria, results from the likelihood ratio test, and parameter estimates for the Rajshahi division, respectively. The AIC and BIC values are 5482.33 and 5544.94, respectively. Considering the level of significance at 10% (0.1), we can conclude that, only precipitation (-0.00741) is negatively correlated with the crash frequency whereas no positive correlation has been found. Other parameters are insignificant.

Table 4.16 Model Info – Rajshahi

Info	**Value**
AIC	5482.32700

BIC	5544.9420 0

Table 4.17 Loglikelihood ratio tests - Rajshahi

	X^2	df	p
Precipitation	3.9492 6	1	0.047
Relative Humidity	0.8805 2	1	0.348
Specific Humidity	3.10e-4	1	0.986
Wind at 10m	0.0309 3	1	0.860
Maximum Wind	0.0037 2	1	0.951
Minimum Wind	0.6038 9	1	0.437
Temperature	0.1091 6	1	0.741
Maximum Temperature	2.1869 5	1	0.139
Minimum Temperature	0.1259 5	1	0.723

Table 4.18 Parameter Estimates - Rajshahi

				95% Confidence Interval	Exp(B)		
Names	**Estimate**	**SE**	**exp(B)**	**Lower**	**Upper**	**z**	**p**
(Intercept)	1.62297	0.68468	5.068	1.294	19.823	2.3704	**0.018**
Precipitation	-0.00741	0.00373	0.993	0.985	1.000	-1.9859	**0.047**
Relative Humidity	-0.00633	0.00663	0.994	0.981	1.007	-0.9549	0.340
Specific Humidity	-5.55e−4	0.03138	0.999	0.940	1.063	-0.0177	0.986
Wind at 10m	0.02193	0.12556	1.022	0.800	1.305	0.1747	0.861
Maximum Wind	-0.00403	0.06685	0.996	0.875	1.133	-0.0603	0.952
Minimum Wind	0.05529	0.07027	1.057	0.919	1.216	0.7868	0.431
Temperature	0.03151	0.09557	1.032	0.856	1.244	0.3297	0.742
Maximum Temperature	-0.07303	0.04997	0.930	0.844	1.024	-1.4613	0.144

Minimum Temperature	0.0181 3	0.051 18	1.01 8	0.921	1.126	0.354 2	0.7 23

4.7 Rangpur Division:

Tables 4.19, 4.20, and 4.21 represent the model information criteria, results from the likelihood ratio test, and parameter estimates for the Dhaka division, respectively. The AIC and BIC values are 4550.28 and 4612.90, respectively. Considering the level of significance at 10% (0.1), we can conclude that, relative humidity (-0.01628), maximum temperature (-0.10624), and minimum temperature (-0.16034) are negatively correlated with the crash frequency whereas specific humidity (0.11386) is positively correlated. Other parameters are insignificant.

Table 4.19 Model Info – Rangpur

Info	**Value**
AIC	4550.283 0
BIC	4612.897 0

Table 4.20 Loglikelihood ratio tests - Rangpur

	X^2	**df**	**p**
Precipitation	2.62 0	1	0.10 6

Relative Humidity	4.878	1	0.027
Specific Humidity	11.182	1	< .001
Wind at 10m	0.531	1	0.466
Maximum Wind	0.203	1	0.652
Minimum Wind	0.482	1	0.488
Temperture	2.106	1	0.147
Maximum Temperture	3.129	1	0.077
MinimumTemperture	6.276	1	0.012

Table 4.21 Parameter Estimates - Rangpur

				95% Exp(B) Confidence Interval			
Names	**Estimate**	**SE**	**exp(B)**	**Lower**	**Upper**	**z**	**p**
(Intercept)	1.52606	0.82235	4.600	0.908	23.206	1.856	**0.063**
Precipitation	-0.00466	0.00290	0.995	0.990	1.001	-1.608	0.108
Relative Humidity	-0.01628	0.00735	0.984	0.970	0.998	-2.213	**0.027**
Specific Humidity	0.11386	0.03423	1.121	1.048	1.198	3.327	**< .001**
Wind at 10m	0.09907	0.13652	1.104	0.846	1.441	0.726	0.468
Maximum Wind	0.03181	0.07047	1.032	0.899	1.185	0.451	0.652
Minimum Wind	-0.05326	0.07724	0.948	0.816	1.102	-0.690	0.491
Temperture	0.15891	0.10816	1.172	0.946	1.453	1.469	0.142
Maximum Temperture	-0.10624	0.05943	0.899	0.799	1.012	-1.788	**0.074**

MinimumTemperture	-0.16034	0.06339	0.852	0.751	0.966	-2.530	**0.011**

4.8 Sylhet Division:

Tables 4.22, 4.23, and 4.24 represent the model information criteria, results from the likelihood ratio test, and parameter estimates for the Dhaka division, respectively. The AIC and BIC values are 3152.31 and 3214.92, respectively. Considering the level of significance at 10% (0.1), we can conclude that, only relative humidity (-0.02403) is negatively correlated with the crash frequency whereas specific humidity (0.12868) is positively correlated. Other parameters are insignificant.

Table 4.22 Model Info – Sylhet

Info	**Value**
AIC	3152.30800
BIC	3214.92300

Table 4.23 Loglikelihood ratio tests - Sylhet

	X^2	**df**	**p**
Precipitation	0.6519	1	0.419
Relative Humidity	2.68	1	0.10

	09		2
Specific Humidity	3.9465	1	0.047
Wind at 10m	0.1347	1	0.714
Maximum Wind	0.4219	1	0.516
Minimum Wind	1.3069	1	0.253
Temperature	0.2081	1	0.648
Maximum Temperature	0.5635	1	0.453
Minimum Temperature	0.0104	1	0.919

Table 4.24 Parameter Estimates - Sylhet

				95% Exp(B) Confidence Interval			
Names	**Estimate**	**SE**	**exp(B)**	**Lower**	**Upper**	**z**	**p**
(Intercept)	2.65787	1.63298	14.266	0.566	342.98	1.628	**0.104**
Precipitation	-0.0022	0.00276	0.998	0.992	1.00	-0.80	0.420

	3					6	
Relative Humidity	-0.02403	0.01463	0.976	0.949	1.00	-1.643	**0.100**
Specific Humidity	0.12868	0.06480	1.137	1.002	1.29	1.986	**0.047**
Wind at 10m	-0.07768	0.21164	0.925	0.610	1.40	-0.367	0.714
Maximum Wind	0.06986	0.10715	1.072	0.867	1.32	0.652	0.514
Minimum Wind	-0.14906	0.12909	0.862	0.669	1.11	-1.155	0.248
Temperature	-0.07417	0.16270	0.929	0.676	1.28	-0.456	0.649
Maximum Temperature	-0.06723	0.08917	0.935	0.784	1.11	-0.754	0.451
Minimum Temperature	0.00849	0.08281	1.009	0.857	1.19	0.102	0.918

4.9 Findings:

1. In case of Dhaka and Chittagong, crash frequency decreases with the increase in precipitation, relative humidity, and maximum temperature and increases with the increase in specific humidity.
2. In Barisal division, crash frequency decreases with the increase in precipitation, relative humidity, and maximum temperature.
3. In Khulna division, crash frequency decreases with the increase in precipitation, maximum temperature, and minimum temperature and increases with the increase in specific humidity and average temperature.
4. In the case of Mymensingh and Rangpur divisions, crash frequency decreases with the increase in relative humidity, and maximum temperature and increases with the increase in specific humidity.
5. In Rajshahi, the crash frequency increases only with the decrease in precipitation.
6. In Sylhet zone, crash frequecy increases with decrease in relative humidity and increase in specific humidity.
7. Wind speed at 10m, minimum and maximum wind speed has no relation with the crash frequency for any division.

Chapter 05

Conclusion

From a broader standpoint, this work is a part of a series of investigations into the effects of weather on traffic safety, assisting in the comprehension of one of the primary factors causing crashes. Such research yields useful information that can be used to create cutting-edge driver assistance systems, which are essential to the acceptance and safety of fully autonomous vehicles. For the purpose of protecting all road users, new driving technology is required to continuously evaluate driving conditions, including weather-related characteristics like visibility and tire-road friction.

5.1) Recommendation:

1. Future research can focus on understanding the hourly effects of weather parameters on crash frequency.

2. Also, driver's characteristics can play a big role in crash occurrences. Hence, how different driving features yield in crash in combination with the weather parameters can be investigated as well.'

3. Furthermore, district wise studies can also be carried out to find out the black spots having high crash frequency.

5.2) Limitation:

1. Based on the availability of accident data, a study period from 2016 to 2020 was chosen for this investigation. Higher time periods, however, are better for capturing the variation of weather parameters. Therefore, a study carried out over a ten-year period would have produced better results.
2. The only factor considered in this study is crash frequency. The aim of further study could be to comprehend tendencies in both injuries and fatalities.
3. We were only able to acquire information about significant parameters from this study. Future research may, however, emphasize on identifying the critical combinations of these weather variables that are most likely to result in a crash.

References

1 Advanced Life Support Group (ALSG). (2019). Major Incident Medical Management and Support:The Practical Approach in the Hospital. John Wiley & Sons.

2 Ahn, S., & Mizuno, S. (2022). Development of 3D projection mapping from a moving vehicle to observe from inside and outside of the vehicle. In ACM SIGGRAPH 2022 Posters. 3https://doi.org/10.1145/3532719.3543247

4 Alford, C. A. (2009). Sleepiness, countermeasures and the risk of motor vehicle accidents. In Drugs, Driving and Traffic Safety (pp. 207–232). https://doi.org/10.1007/978-3-7643-9923-8_13

5 American Academy of Orthopaedic Surgeons. (2011). Emergency Care and Transportation of the Sick and Injured. Jones & Bartlett Learning.

6 A simplified analysis of various types of wind-induced road vehicle accidents. (1986). Journal of Wind Engineering and Industrial Aerodynamics, 22(1), 69–85.

7 Atlanta. (2004).

8 Backpacker. (2001).

9 Berg, R. C. (2012). Effectiveness of Primary Interventions to Prevent the Use of Tobacco, Alcohol and Other Drugs Among Children and Adolescents.

10 Brijs, T., Offermans, C., Hermans, E., & Stiers, T. (2006). Impact of Weather Conditions on Road Safety Investigated on Hourly Basis. https://www.semanticscholar.org/paper/Impact-of-Weather-Conditions-on-Road-Safety-on-Brijs-Offermans/29b329ef80f07de7c7919cc63e2b03bfc708810c

11 Bruna, K. R. (2006). When “Other People’s Children” Are Your Own: A Multicultural Teacher Educator Learns About Difference From the Inside Out. In Multicultural Perspectives (Vol. 8, Issue 4, pp. 49–54). https://doi.org/10.1207/s15327892mcp0804_8

12 Bulletin of the Atomic Scientists. (1970).

13 Bulletin of the Atomic Scientists. (1973).

14 Comm, A. B. A. S. H. S., & Automotive Brake and Steering Hose Standards Comm. (n.d.). Power Steering Pressure Hose - Wire Braid. https://doi.org/10.4271/j190_201207

15 Davis, J. R., Johnson, R., & Stepanek, J. (2008). Fundamentals of Aerospace Medicine. Lippincott Williams & Wilkins.

16 Dionne, G., & Laberge-Nadeau, C. (2012). Automobile Insurance: Road Safety, New Drivers, Risks, Insurance Fraud and Regulation. Springer Science & Business Media.

17 Distribution and cost of landslides that have damaged manmade structures during the rainy season of 1972-1973 in the San Francisco Bay region, California. (1975).
18https://doi.org/10.3133/mf679

19 Donaldson, H., & Lucey, D. (2018). Enhancing preparation for large Nipah outbreaks beyond Bangladesh: Preventing a tragedy like Ebola in West Africa. In International Journal of Infectious Diseases (Vol. 72, pp. 69–72). https://doi.org/10.1016/j.ijid.2018.05.015

20 Driving Standards Agency, & Driving Standards Agency Staff. (2006). The Official Theory Test for Drivers of Large Vehicles. The Stationery Office.

21 Figure 1: The road traffic accident death toll with motor vehicles and non-motor vehicles in China from 2007 to 2016. (n.d.). https://doi.org/10.7717/peerj.7423/fig-1

22 Filler, A. G. (2004). Do You Really Need Back Surgery?: A Surgeon’s Guide to Neck and Back Pain and How to Choose Your Treatment. Oxford University Press.

23 Fix, J., Redding, E. M., Fliss, M. D., Harmon, K. J., Schiro, S. E., & Waller, A. E. (2022).

Database selection matters: A case study in child restraint use and injury patterns using North Carolina motor vehicle traffic crash report and trauma registry data. Traffic Injury Prevention, 23(6), 339–345.

24 Girard, J. E. (2011). Criminalistics: Forensic Science, Crime and Terrorism. Jones & Bartlett Publishers.

25 Greco, G. L., & Rose, C. M. (2009). The Good Wife's Guide (Le Ménagier de Paris): A Medieval Household Book. Cornell University Press.

26 Johnson, M. B. (2022). The prevalence of alcohol-involved crashes across high and low complexity road environments: Does knowing where drinking drivers crash help explain why they crash? PloS One, 17(4), e0266459.

27 Lane, B. C. (2007). The Solace of Fierce Landscapes: Exploring Desert and Mountain Spirituality. Oxford University Press.

28 Lombardo, L. V. (2001). CIREN, Crash Injury Research and Engineering Network: Program Report.

29 Men's Health. (2008).

30 Michigan. Department of Public Instruction. (1951). They're Going to Drive: A Prologue to Safe Driving.

31 Morales, M. F., MacBeth, A., Swartzman, S., & Girard, L.-C. (2022). Multi-Trajectories of Conduct Problems, Hyperactivity/Inattention, and Peer Problems Across Childhood: Results from the Growing Up in Scotland Birth Cohort. Research on Child and Adolescent Psychopathology. https://doi.org/10.1007/s10802-022-00956-8

32 Mort, N. (2013). Dogs on wheels: Travelling with your canine companion. Veloce Publishing Ltd.

33 M., P., World Health Organization, R., S., World Bank, D., S., Hyder, A. A., Mathers, C.,

Jarawan, E., Hyder, A. A., D., M., & E., J. (2004). World Report on Road Traffic Injury Prevention. World Health Organization.

34 Nabi, H., Guéguen, A., Chiron, M., Lafont, S., Zins, M., & Lagarde, E. (2006). Awareness of driving while sleepy and road traffic accidents: prospective study in GAZEL cohort. BMJ , 333(7558), 75.

35 Nastos, M. (2018). The Cestus Concern. Crossroad Press.

36 Padgett, J., & Seaberg, M. A. (2014). Struck by Genius: How a Brain Injury Made Me a Mathematical Marvel. Houghton Mifflin Harcourt.

37 Popular Mechanics. (2000).

38 Real-time prediction of crash risk on freeways under fog conditions. (2020). International Journal of Transportation Science and Technology, 9(4), 287–298.

39 Report on the ... International Technical Conference on Experimental Safety Vehicles. (1971).

40 Shuve, K. (2019). “Put on the dress of a wife, so that you might preserve your virginity.” In The Symbolism of Marriage in Early Christianity and the Latin Middle Ages. https://doi.org/10.5117/9789462985919_ch05

41 Svenson, O., Dahlstedt, S., & Anders Englund, S. (1976). Reading distances of retroreflective road signs during night driving. In PsycEXTRA Dataset. https://doi.org/10.1037/e405292004-001

42 Table 1.3. Road fatalities per 100 000 inhabitants, per billion vehicle-km and per 10 000 registered motor vehicles. (n.d.). https://doi.org/10.1787/888933385323

43 The Advocate. (2001).

44 Thorpe, E. (n.d.). The Pearson General Knowledge Manual 2012. Pearson Education India.

45 Twain, M. (2015). The Adventures of Tom Sawyer (Bengali Edition).

46 Unesco. Research Centre on the Social Implications of Industrialization in Southern Asia, Unesco. Research Centre on Social and Economic Development in Southern Asia, & Textor, R. B. (1956). The Social Implicatons of Industrialization and Urbanization: Five Studies of Urban Populations of Recent Rural Origin in Cities of Southern Asia.

47 United States. National Highway Traffic Safety Administration. (1994). Federal Motor Vehicle Safety Standards and Regulations: With Amendments and Interpretations Issued Through December 1992.

48 Whaley, L. F., & Wong, D. L. (1991). Nursing Care of Infants and Children. Mosby.

49 World Health Organization. (2015). World health statistics 2015. World Health Organization.