

# **Factors Influencing Motorcycle Accident Severity in Commonwealth Avenue, Quezon City, Philippines**

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**Abstract:** This study evaluated the different factors affecting motorcycle accidents based on severity: property damage only (PDO), non-fatal injury, and fatal; determined the relationship of the time and year of accidents to the number of accidents occurred; and propose ways or methods in each factor to decrease motorcycle accidents severity in Commonwealth Avenue. Data were gathered from the year 2015-2017 records of the Metro Manila Development Authority (MMDA). By using one-way & two-way Analysis of Variance (ANOVA), relationship between different factors were determined. Results showed that there is a significant difference between the number of accidents to the year of accidents, and that the time of day and the years being considered is a factor in the number of accidents. Descriptive analysis showed that PDO has the highest percentage compared with fatal and nonfatal injury in terms of motorcycle accident severity.

*Keywords: Motorcycle, Accident, Accident Severity, Traffic Congestion*

## **1. INTRODUCTION**

Commonwealth Avenue is located at the central part of Quezon City and it is known to be the “Killer Highway” of the Philippines. It is included in the one of the deadliest and



dangerous highway in the world. Commonwealth Avenue is a major highway road when going to Tandang Sora, Katipunan, Batasan Hills, Litex, Mindanao Avenue, Quirino Highway and Fairview. It is also one of the route when heading to Novaliches, Bulacan and Valenzuela. Passing this highway, different landmarks are located like Iglesia ni Cristo Temple, Sandiganbayan, Commission on Audit (COA), New Era University, University of the Philippines-Diliman (U.P. Diliman), St. Peter Parish: Shrine of Leaders and other shopping centers like Puregold, Wet and Dry Market, U.P AyalaLand TechnoHub, Ever Gotesco and Fairview Center Mall (FCM). Because of different landmarks, connecting routes and other popular areas, Commonwealth Avenue caters a lot of commuters that causes extremely heavy traffic which leads to different vehicle accidents especially involving motorcycle. Along Commonwealth Avenue, Mass Rapid Transit Line 7 (MRT 7) is currently being constructed and because of this, some lanes in both direction of the highway is closed and the roads are shortened. It is one of the causes why commuters in Commonwealth Avenue experience heavy traffic every day.

Fig. 1.1. Traffic Congestion at Commonwealth Avenue.

Commonwealth Avenue is one of the top listed highways in the Philippines that has a highest number of accidents recorded and the large percentage of fatalities and non-fatalities are cause by two-wheeled vehicles [1]. Motorcycle users is rapidly rising every year and it became in demand nowadays. It is because motorcycle is more affordable than to loan on a car or van and the price of the gasoline in the Philippines is increasing every now and then. Using motorcycle as a mode of transportation is the best choice for others, not just because of the low consume in gas but also because of the traffic status in the Philippines. When using motorcycle for transportation, it is easier to travel from one point to another than riding in a

car especially when in the middle of congested traffic. The number of motorcycle accidents is rising as well as the number of motorcycle users is increasing. Motorcycle is more prone to accidents than other vehicles. According to the World Health Organization (WHO), most of the accidents that was recorded are motorcycle accidents and more than half of the total number of people who died on accidents are motorcycle riders [2].

Commonwealth Avenue passers experience heavy traffic and they also encounter minor or major accidents every day. According to police Chief Superintendent of QC Head, Arnold Santiago, the highway experienced 3-5 road accidents every day that is why they called it “killer highway” [3]. Based on the Metro Manila Accident Recording and Analysis System (MMARAS), out of the total of 519 deaths and 17,103 injuries due to road accidents, 262 deaths and 11, 620 injuries came from motorcycles as recorded last year [4].

This study analyzed the different factors that lead to motorcycle accident severity in Commonwealth Avenue. By determining such, practical engineering solutions can be applied to reduce the occurrence of motorcycle-related accidents.

In particular, the study focuses and conducted only in the highlighted area:

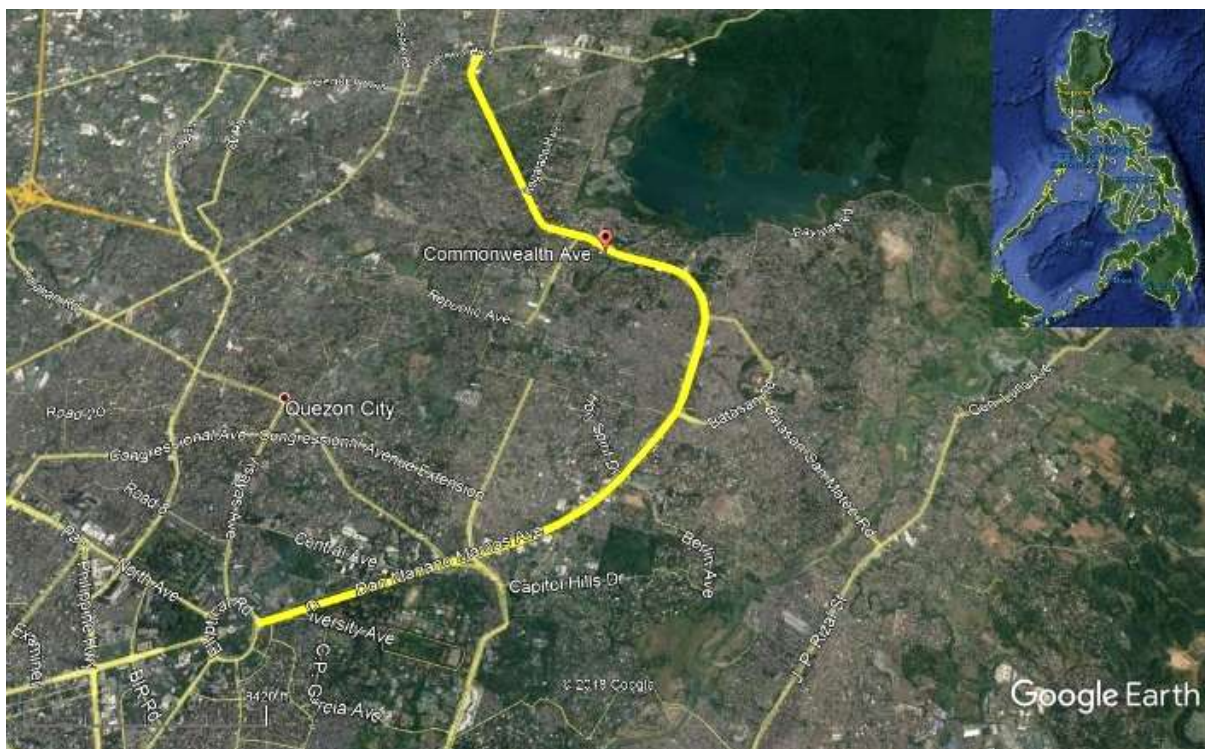


Fig. 1.2. Vicinity Map

## 2. DATA ANALYSIS AND PROCESSING

The raw data gathered from the Metro Manila Development Authority (MMDA) needed subsequent processing to come up with sound conclusions and recommend way to solve problems concerning the motorcycles. With adequate or more information gathered, a definite and concise results were still obtained given the limitation of the MMDA data.

### 2.1 DESCRIPTIVE ANALYSIS

The severity of the accidents was analyzed by determining what is the percentage of the classification of accidents to the different factors like what is the percentage of property damage only, non-fatal injury, and fatal to the accident factors like collision type (ex. Side swipe, hit object, etc.)

**2.2 ANALYSIS OF VARIANCE**

For the analysis of data, under Analysis of Variance (ANOVA), considering the number of accidents and the year, in this part, the researchers considered the number of accidents as the dependent variable while the year of the number of accidents occurred is the independent variable as shown on the table below:

Time	Number of Accidents		
	2015	2016	2017
12:00-1:00am	20	34	9
1:01-2:00am	11	18	10
2:01-3:00am	9	17	6
3:01-4:00am	10	10	12
4:01-5:00am	17	21	5
5:01-6:00am	27	31	26
6:01-7:00am	23	74	14
7:01-8:00am	35	94	13
8:01-9:00am	19	78	27
9:01am-10:00am	37	47	24
10:01-11:00am	28	48	20
11:01am-12:00pm	23	27	19
12:00-1:00pm	23	39	13
1:01-2:00pm	33	36	31
2:01-3:00pm	36	47	35
3:01-4:00pm	34	42	43
4:01-5:00pm	34	55	24
5:01-6:00pm	32	32	18
6:01-7:00pm	23	25	20
7:01-8:00pm	28	43	32
8:01-9:00pm	25	42	33
9:01am-10:00pm	25	47	31
10:01-11:00pm	24	39	23
11:01-11:59pm	31	36	20

Table 2.2.1 Hourly Distribution of the Number of Accidents



The one-way Analysis of Variance (ANOVA) was used in the analysis of the data between the relationship of the involved dependent and independent variables. This is because there is only one independent variable involved, whereas there are three levels of independent variables involved (Years 2015, 2016, and 2017). After having these inputs, one-way analysis of variance can already be performed using the MATLAB software, wherein the values – F value and P value can be obtained.

The F value in one-way ANOVA is a tool to help you answer the question if the variance between the means of two populations significantly different. The F value in the ANOVA test also determines the P value; The P value is the probability of getting a result at least as extreme as the one that was actually observed, given that the null hypothesis is true.

The F value should always be used along with the p value in deciding whether the results are significant enough to reject the null hypothesis. If the F-value is larger than that of the F critical it means it is significantly difference, while a small P value means all the results are significant. The F statistic just compares the joint effect of all the variables together. In other words, reject the null hypothesis only if your alpha level is larger than your p value.

On the other hand, for the two-way ANOVA, the process in terms of analysis is similar to that of the one-way ANOVA, only this time it includes time, year, and the number of vehicles as variables.

	$df_1$ :	1	2	3	4	5	6	7	8	9	10
$df_2$ :	1	647.793	799.482	864.151	899.599	921.835	937.114	948.203	956.643	963.279	968.634
	2	38.506	39.000	39.166	39.248	39.298	39.331	39.356	39.373	39.387	39.398
	3	17.443	16.044	15.439	15.101	14.885	14.735	14.624	14.540	14.473	14.419
	4	12.218	10.649	9.979	9.604	9.364	9.197	9.074	8.980	8.905	8.844
	5	10.007	8.434	7.764	7.388	7.146	6.978	6.853	6.757	6.681	6.619
	6	8.813	7.260	6.599	6.227	5.988	5.820	5.695	5.600	5.523	5.461
	7	8.073	6.542	5.890	5.523	5.285	5.119	4.995	4.899	4.823	4.761
	8	7.571	6.059	5.416	5.053	4.817	4.652	4.529	4.433	4.357	4.295
	9	7.209	5.715	5.078	4.718	4.484	4.320	4.197	4.102	4.026	3.964
	10	6.937	5.456	4.826	4.468	4.236	4.072	3.950	3.855	3.779	3.717
	11	6.724	5.256	4.630	4.275	4.044	3.881	3.759	3.664	3.588	3.526
	12	6.554	5.096	4.474	4.121	3.891	3.728	3.607	3.512	3.436	3.374
	13	6.414	4.965	4.347	3.996	3.767	3.604	3.483	3.388	3.312	3.250
	14	6.298	4.857	4.242	3.892	3.663	3.501	3.380	3.285	3.209	3.147
	15	6.200	4.765	4.153	3.804	3.576	3.415	3.293	3.199	3.123	3.060
	16	6.115	4.687	4.077	3.729	3.502	3.341	3.219	3.125	3.049	2.986
	17	6.042	4.619	4.011	3.665	3.438	3.277	3.156	3.061	2.985	2.922
	18	5.978	4.560	3.954	3.608	3.382	3.221	3.100	3.005	2.929	2.866
	19	5.922	4.508	3.903	3.559	3.333	3.172	3.051	2.956	2.880	2.817
	20	5.871	4.461	3.859	3.515	3.289	3.128	3.007	2.913	2.837	2.774
	21	5.827	4.420	3.819	3.475	3.250	3.090	2.969	2.874	2.798	2.735
	22	5.786	4.383	3.783	3.440	3.215	3.055	2.934	2.839	2.763	2.700
	23	5.750	4.349	3.750	3.408	3.183	3.023	2.902	2.808	2.731	2.668
	24	5.717	4.319	3.721	3.379	3.155	2.995	2.874	2.779	2.703	2.640

Figure 2.2.1: F-Critical Value

### 3. RESULTS AND DISCUSSION

In this study, the researchers were able to do an analysis based on the data gathered as well as obtaining results by using different data analysis process.

#### 3.1 DESCRIPTIVE ANALYSIS RESULTS

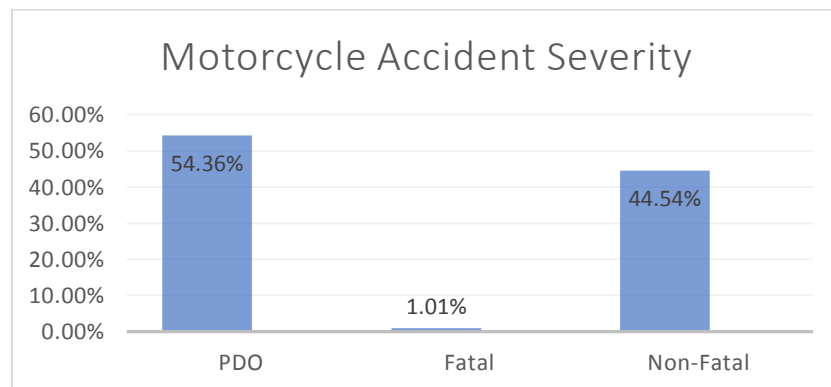


Figure 3.1.1. Motorcycle Accident Severity

The data of 2015-2017 motorcycle accident was merged and categorized by three classifications. The Property Damage Only (PDO), Non-Fatal injury and Fatal. The figure shows that the highest percentage was the Property Damage Only with 54.36%, next is the Non-Fatal Injury with 44.54% and Fatal with the lowest percentage of 1%.

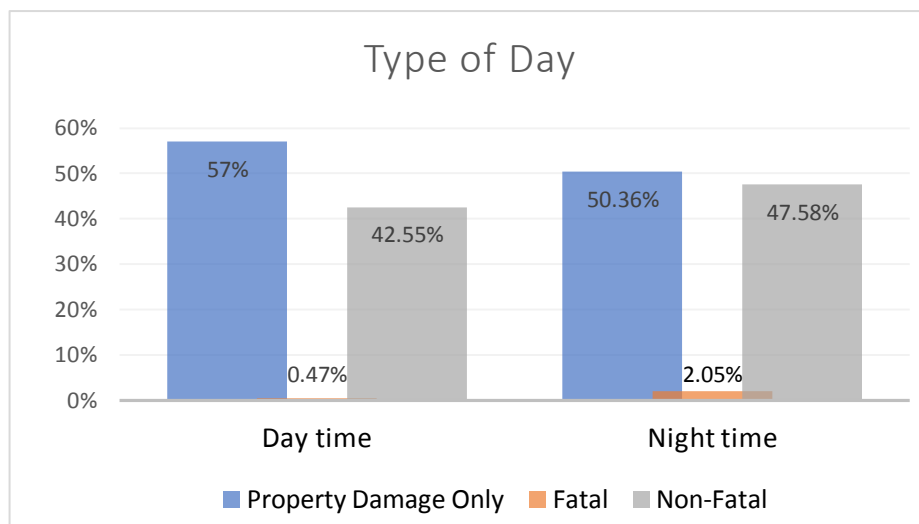


Figure 3.1.2. Type of Day

In terms of the day of the accident occurred, there are two types of day that was considered. The day and the night. The figure shows that Property Damage Only has the highest percentage of classification both type of day with 57% and 50.36% while non-fatal injury has 42.55% on day and 47.58% on night. Fatalities count has a low percentage of 0.47% on day and 2.05% on night.

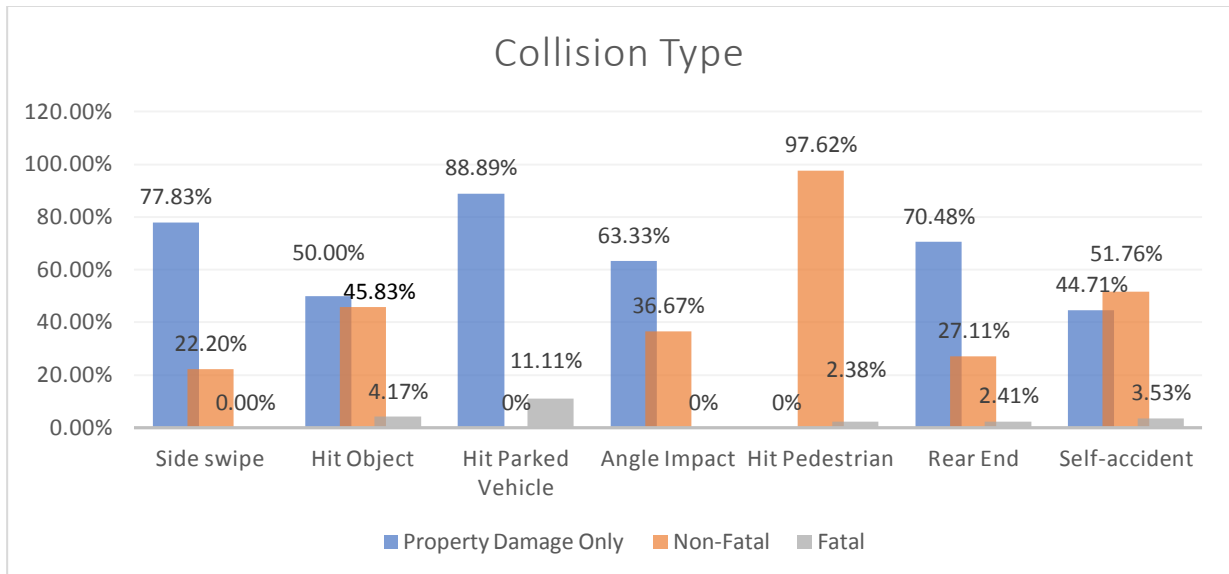


Figure 3.1.3: Collision Type

The figure shows that in every collision type there is different rate of classification. Like in the side swipe, the highest percentage is the property damage only classification. In hit object, property damage only and non-fatal injury shows just a little difference in percentage. Hit parked vehicle has no fatal reported and has a high percentage in the property damage only. Angle Impact has 63.33% on property damage only, 37.67% on non-fatal injury and has no fatality reported. Hit Pedestrian shows 97.62% of non-fatal injury while 2.38% of the accidents are caused fatalities. Rear end has 70.48% property damage only, 27.11% on non-fatal injury and 2.41% on fatal. The last collision type that was considered is the self-accident with 51.76% on non-fatal injury, 44.71% property damage only, and 3.53% on fatal.

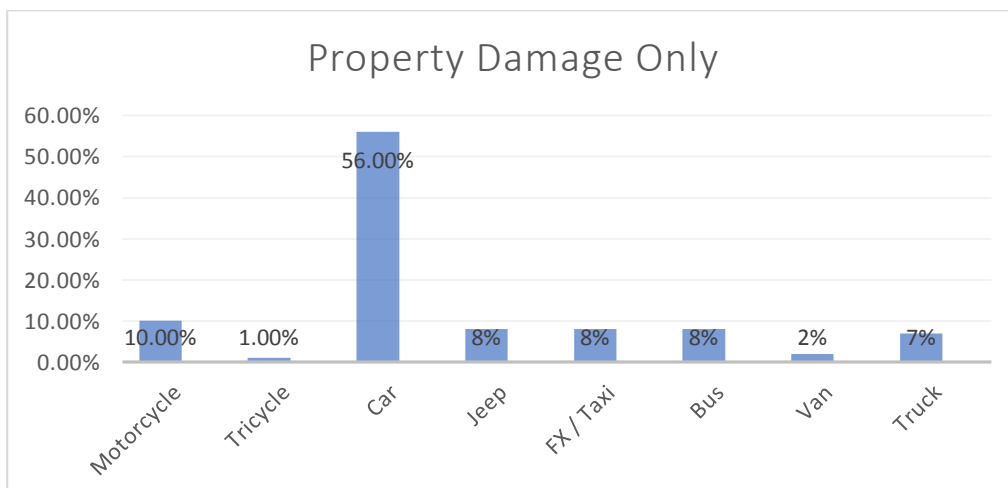


Figure 3.1.4: Property Damage based on Different Vehicle Type

Even though car has the highest percentage in damage on property, motorcycle has the highest percentage based on fatal with 44% and car has 27% only. While tricycle, jeep, FX/Taxi, Bus, Van, and truck has a low percentage compared with motorcycle.

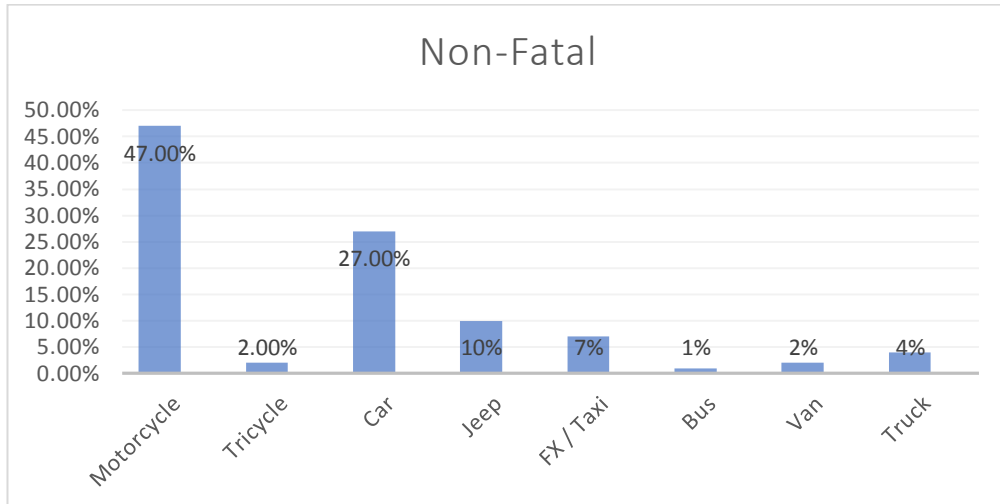


Figure 3.1.5: Non-Fatal based on Different Vehicle Type

On non-fatal damage, still motorcycle has the highest percentage with 47% and car has 27% only. Other vehicle still has a lower percentage on vehicle crashes damage.

## 3.2 ANALYSIS OF VARIANCE (ANOVA) RESULTS

### 3.2.1 ONE-WAY ANOVA

In this part, the researchers considered the number of accidents as the dependent variable while the year of the number of accidents occurred is the independent variable. The analysis procedure that was used in this part is One-way Analysis of Variance (ANOVA) because the independent variable is only one but there three levels of independent variable which are year 2015,2016 and 2017.

By using the MATLAB software, the F value and P value of was determined by performing One-way ANOVA.

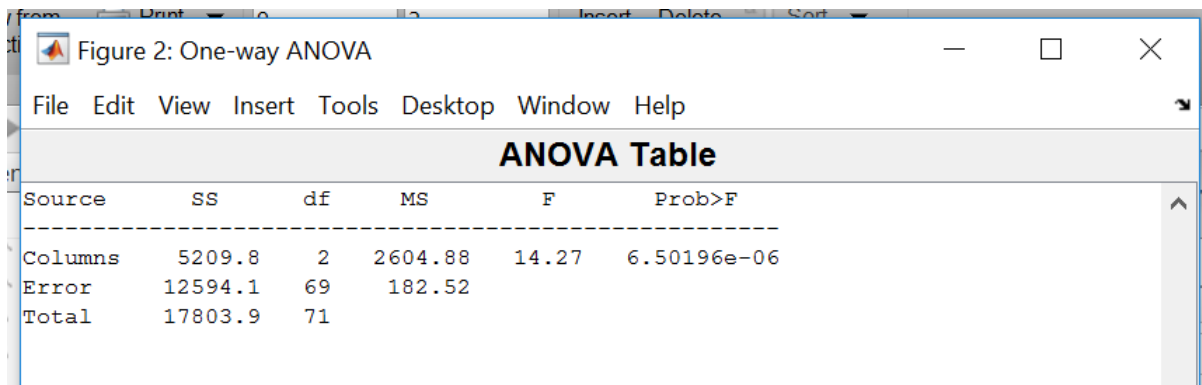


Figure 3.2.1.1: Result of One-way ANOVA



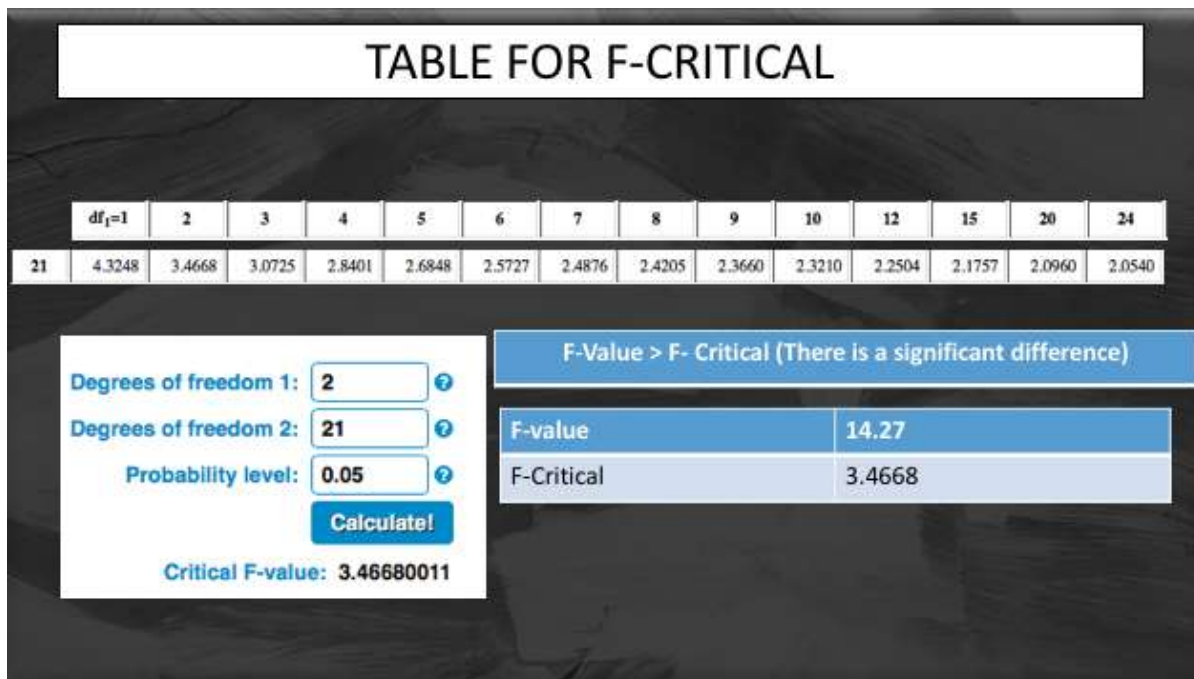


Figure 3.2.1.2: F-critical versus F-value (One-way ANOVA)

The P value is equal to 6.50196e-6 which is less than 0.05 which means the null hypothesis was rejected and the F-value will need to consider next. The F-value is 14.27 and it is greater than the F-critical value of 3.4688 which means that null hypothesis was also rejected.

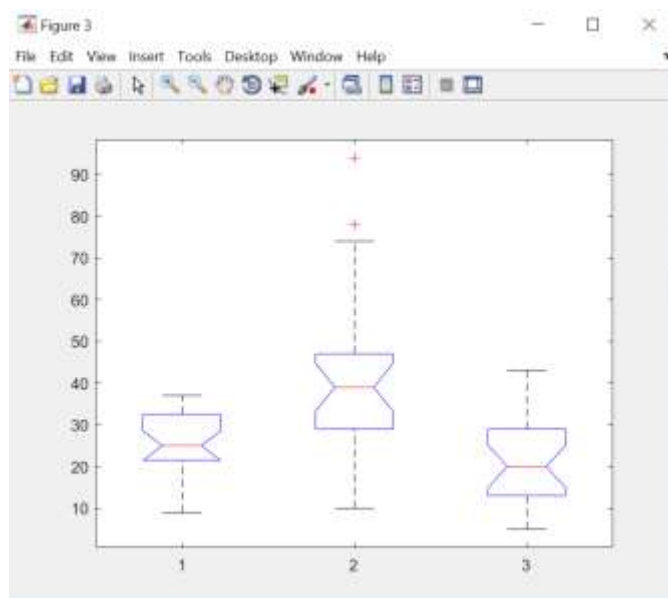


Figure 3.2.1.3: Graph of the result of One-way ANOVA

The results of one-way ANOVA reflected the graph that the three level of independent variable has a different number of accident occurred. Year 2016 has the highest number of accident occurred while year 2015 has the lowest number of accident.

### 3.2.1 TWO-WAY ANOVA

Source	SS	df	MS	F	Prob>F
Columns	5209.7	2	2604.87	21.08	0
Rows	6909.9	23	300.43	2.43	0.0051
Error	5684.3	46	123.57		
Total	17803.9	71			

Figure 3.2.1.4: Result of Two-way ANOVA

In testing if there is a significant difference between the different years versus the time (Rows) of the days relative to the different years (Columns), the Two-Way Analysis of Variance was used and results show an F values of 21.08 and 2.43 with the p-values 0 and 0.0051, respectively. This shows that the time of the day and the years being considered shows a factor in the number of accident.

Degrees of freedom 1:	2	F-value	21.08
Degrees of freedom 2:	21	F-Critical	3.4668
Probability level:	0.05	F-Value > F-Critical (There is a significant difference)	
Critical F-value: 3.46680011			
Degrees of freedom 1:	23	F-value	2.43
Degrees of freedom 2:	21	F-Critical	2.0632
Probability level:	0.05		
Critical F-value: 2.06328036			

Figure 3.2.1.5: F-critical versus F-value (Two-way ANOVA)

## 4. CONCLUSION & RECOMMENDATION

This part includes the researchers' interpretation and conclusion based on the in-depth analysis of the data as well as the results interpreted with the aid of various statistical analyses.

The different factors which are the time of day/time of occurrence and collision type have a different interpretation with respect to the severity of accidents.

In the type of accident and time occurrence of the accidents, property damage occurred higher on day time than on night time. It is because during daytime, motorcycle drivers can easily see other paths in between the congested vehicles. By that, the risk of bumping into other vehicles and barriers increases resulting to a higher percentage of property damage during daytime. Meanwhile, the fatal and non-fatal injury has a higher percentage in the night time as recorded. From the data, it was also determined that the number one (1) cause of accidents is “drink and drive.” Drunk people usually appear at night resulting to a higher percentage of fatal and nonfatal accidents during nighttime compared with daytime. Other major factor that causes accidents is “over-speeding.” Accidents caused by over-speeding also happen during nighttime because roads have lesser traffic at night compared with daytime.

There are different types of collision happening with different reasons. Side swipe usually happens when a motorcycle crosses the thin paths in between the vehicles resulting for side swiping the vehicles that are being crossed. Another type is of collision is “if a vehicle hits a traffic control device” or any other object on the road: usually a barrier, a fence or even a vehicle, that is why property damage only has the highest percentage in this type. Same thing with the “Hit Parked Vehicle and Rear End.” “Hit pedestrian” type of collision usually results into non-fatal result that usually happens when the pedestrians are jaywalking, some of the result are fatal due to the impact caused by the motorcycle. “Self-inflicted accidents” usually happen when the road is slippery or hitting objects around the road resulting to property damage and non-fatal or minimal injuries.

For PDO, cars have the highest percentage with 56% compared with motorcycle with only 10%, it is because the side-swipe collision type is not only common on motorcycle but in all type of vehicle. Other than side- swipe, hit object, hit parked vehicles, angle-impact, rear-end and self-accident are different collision type that may leads to damage on property.

On fatal and non-fatal, motorcycle has the highest percentage with 44% and 47% respectively. Because motorcycle do not have any protection unlike the four-wheeled vehicles like cars, there are more chances to have both fatal and injury accidents when other vehicle crashes on motorcycles. Also, improper use of safety equipment, like helmets, is the reason why motorcycle has a high percentage in fatal and injury accidents.

Using the analysis of variance (ANOVA), the relationship between factors are determined. In one-way ANOVA, the relationship of the independent variable to the dependent variable was determined by the value of the P and the F. In P-test, the null hypothesis was rejected which means that there is a significant difference between the number of accidents to the year of accidents, which obviously is in an increasing trend. The results also show that the number of traffic accidents show a dependence on the year for the number of traffic accidents that occur. Despite the increasing trend, in figure 4.5, it illustrates that 2016 has a higher number of accidents occurred than in 2017. This might be caused by the new law implemented in that year, Republic Act 10913 or the Anti-Distracted Driving Act, but might have been affected by other factors as well which needs further investigation. Two-way ANOVA was used in testing if there is a significant difference between the different years versus the time of the days relative to the different years. The results show an F values of 21.08 and 2.43 with the p-values 0 and 0.0051, respectively. By comparing the obtained value to the critical value, the researchers conclude that the time of the day and the years being considered shows a significant factor in the resulting number of accidents.

## ACKNOWLEDGEMENT

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