

Traffic and Injury Incidents Involving Buses in Metro Manila, 2005-2020

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ABSTRACT

Background. Despite being a densely inhabited region responsible for the Philippines's major economic activities, Metro Manila's transport system is ill-equipped to provide for the needs of its populace. Herein, buses are preferentially considered as one of the main modes for commuting due to the multitude of routes available, convenience, and perceived safety. Analysis of the factors surrounding these crashes is necessary to prevent these incidents from occurring and to mitigate further risks.

Objective. The authors aimed to determine the distribution, socio-demographic aspects, and factors affecting patient outcome for victims of Metro Manila bus crashes based on the Metro Manila Accident Recording and Analysis System (MMARAS) databases for the years 2005-2020.

Methods. A decade-long exploratory analysis was done on MMARAS data from 2005-2020. Logistic regression was used to analyze relationships between road user mortality and injury and crash-related factors. Nagelkerke R² was used to assess model fit, and Odds Ratios were derived from the model coefficients. These data yield whether the crash variable has an increased or decreased likelihood of affecting patient outcome.

Results. There are four factors which chiefly determine whether a road user is injured or killed in a bus crash. These are collision type, driver's risky behavior, vehicle type, and junction type. Across road user types, risky behaviors were found to greatly aggravate the severity of a bus crash.

Conclusion. The circumstances surrounding bus crashes were identified within this study. It was found that these differentially affect patient outcomes depending on their road user type and sex. This information may then be used to generate strategies to prevent and ease the severity of future bus crashes.

Keywords: bus crashes, road safety, road crash outcomes, Metro Manila



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INTRODUCTION

Metro Manila is the most densely populated region in the Philippines and acts as its industrial center. The area was constructed with private modes of transport in mind. Few provisions were made for public transport, with only four railways and an overreliance on buses and jeepneys to traverse existing roadways. Buses are one of the main modes of public transport, with each bus capable of accommodating around 60 people.¹ There are 98 available routes in the region, and their use is prevalent amongst all social classes.^{1,2}

While road crash incidents involving bus is relatively less often than motorcycles, it is usually more disastrous due to its size and its passenger carrying-capacity. In 2013, the infamous Manila Skyway Bus Incident fatally wounded 22 people and injured 20 others.

While road crash studies in the Philippines have largely characterized general crash patterns, there is limited evidence specifically examining the factors associated with road user outcomes in bus-involved crashes in Metro Manila over an extended period. This study addresses that gap using the Metro Manila Accident Recording and Analysis System (MMARAS) database from 2005–2020.

Specifically, this study aimed to: (1) describe the distribution and socio-demographic aspects of bus-involved crashes in Metro Manila; (2) identify factors associated with road user fatality and injury by road user type using logistic regression; and (3) quantify the burden of bus-involved crashes on road users in Metro Manila to inform safety policy.

METHODS

Study Design

This study employed a retrospective secondary data analysis design using the Metro Manila Accident Recording and Analysis System (MMARAS) database, a road crash reporting system for Metro Manila maintained by the Metro Manila Development Authority (MMDA). The MMARAS records road crash incidents through two channels: (1) full field reports compiled by the MMDA Road Safety Unit researchers from Philippine National Police (PNP) blotter entries and Traffic Enforcement Unit (TEU) station reports, and (2) incidents logged remotely via calls or CCTV footage at the MMDA Metrobase.

Study Variables

The dependent variables were six binary outcome indicators: (1) if a driver is killed, (2) if a driver is injured, (3) if a passenger is killed, (4) if a passenger is injured, (5) if a pedestrian is killed, and (6) if a pedestrian is injured. Independent variables include collision type (Angle Impact, Head-On Collision, Hit and Run, Hit Object, Hit Parked Vehicle, Hit Pedestrian, Multiple Collision, Rear-End Collision, Self-Accident, and Side Swipe), risky road user behavior or accident causation (Human Error, Vehicle Defect,

and Others, with specific subcategories such as Alcohol Suspected and Speeding isolated for analysis), vehicle type involved, and junction type, all as coded in the MMARAS database.

Data Analysis

Forward stepwise logistic regression was performed separately for each outcome. Forward selection was employed as the variable selection strategy given the large number of candidate predictors, as it sequentially introduces only variables that meet the inclusion criterion, reducing the risk of overfitting. Model fit was assessed using the Nagelkerke R^2 , and odds ratios (OR) with 95% confidence intervals (CI) were derived from the exponentiated regression coefficients. Records with missing values on any predictor variable included in the model were excluded via listwise deletion.

Ethical Considerations

All bus-involved road crash records from 2005 to 2020 were included in the analysis. In line with the Data Privacy Act, the study utilized de-identified administrative data in this study. Ethical approval was granted by the Department of Health Single Joint Research Ethics Board (DOH-SJREB).

RESULTS

From 2005–2020, there were a total of 99,564 buses involved in road crashes. There is a relative increase in bus crashes over the years, except for the big decline in 2020, probably due to the pandemic. The significant increases were observed from 2015–2019 (Figure 1).

For road user fatalities and injuries, it is classified into drivers, passengers, and pedestrians. For drivers, 129 were killed, and 3,725 were injured; 84 passengers were killed while 10,077 were injured; and 223 pedestrians were killed while 2369 were injured. Pedestrians comprise most fatalities, while passengers comprise most of the injuries. The largest single event count was a crash where 46 passengers were injured.

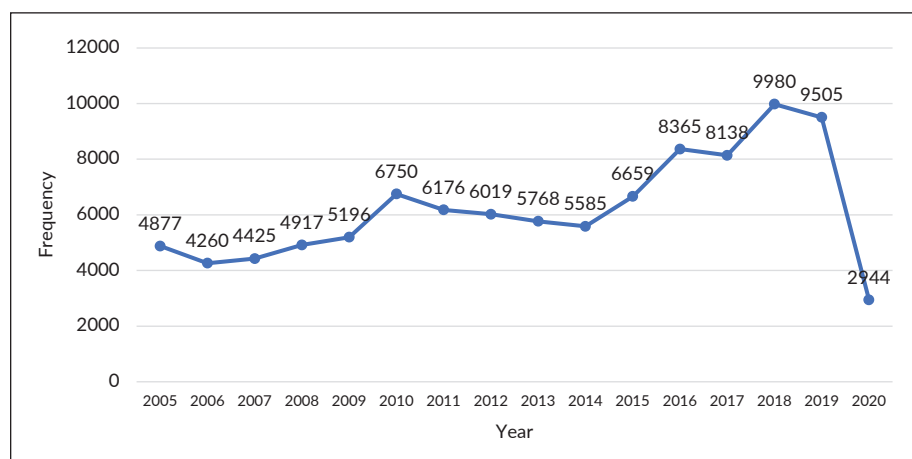


Figure 1. Distribution of bus-involved road crashes in the MMARAS database from 2005–2020 (N = 99,564).

Table 1. Person-level Total Road User Fatality and Injury on Bus-involved Road Crash

Number of road users killed or injured	Total	Largest single event count
<i>Drivers killed</i>	129	1
<i>Drivers injured</i>	3,725	4
<i>Passengers killed</i>	84	8
<i>Passengers injured</i>	10,077	46
<i>Pedestrians killed</i>	223	5
<i>Pedestrians injured</i>	2,369	9

There are also single events where 8 passengers are killed, and in a separate case, 5 pedestrians are killed (Table 1).

For the types of crashes, almost 90% were damage to property, while 9.7% were injurious and 40.4% were fatal. The most commonly reported collision types were side swipe (28%) and rear-end (14.41%). For risky behaviors, the most commonly reported were speeding (3.4%) and bad overtaking (1.94%). Most of the reported collisions occurred on roads outside intersections (not at a junction; 19.81%) and at crossroads (5.08%) (Table 2).

Table 2. Crash Level Distribution of Classification of Crash, Collision Type, Risky Road User Behavior, and Junction Type in the MMARAS Database on Bus-involved Road Crash

	Frequency	Percent
Classification of Crash		
Fatal	401	0.40
Non-fatal (injurious)	9,644	9.69
Damage to property	89,519	89.91
Collision Type		
Angle impact	3,692	3.71
Head-on	188	0.19
Hit and run	2,543	2.55
Hit object	937	0.94
Hit parked vehicle	264	0.27
Hit pedestrian	2,205	2.21
Multiple collision	1,316	1.32
No collision stated	19,898	19.98
Other	792	0.80
Rear-end	14,344	14.41
Self-accident	583	0.59
Side swipe	28,680	28.81
Side swipe-Same direction	45	0.05
Missing	24,077	24.18
Risky Road Behaviors		
Alcohol suspected	12	0.01
Avoid hitting another vehicle	2	0.00
Backing inattentively	19	0.02
Bad overtaking	1,936	1.94
Bad turning	673	0.68
Counterflow	2	0.00
Cut by another vehicle	1	0.00
Disobey enforcer's signal	2	0.00
Disobey sign or traffic lights	508	0.51
Human error	321	0.32
Inattentive	777	0.78
Lost control	15	0.02
No accident factor	62,639	62.91
No signal	7	0.01
Others	142	0.14
Road defect	1	0.00
Tired/Asleep	17	0.02
Too close	288	0.29
Too fast	3,028	3.04
Vehicle defect	90	0.09
Missing	29,084	29.21

	Frequency	Percent
Junction Type		
Bridge/Flyover	290	0.29
Crossroads	5,059	5.08
K junction	1	0.00
Not at junction (straight road)	19,723	19.81
Other	554	0.56
Parking area	67	0.07
Rotunda	1,007	1.01
Skew junction	3	0.00
T junction	4,914	4.94
Tunnel/Underpass	136	0.14
U turn slot	857	0.86
Y junction	226	0.23
Missing	66,727	67.02
Total	99,564	100.00

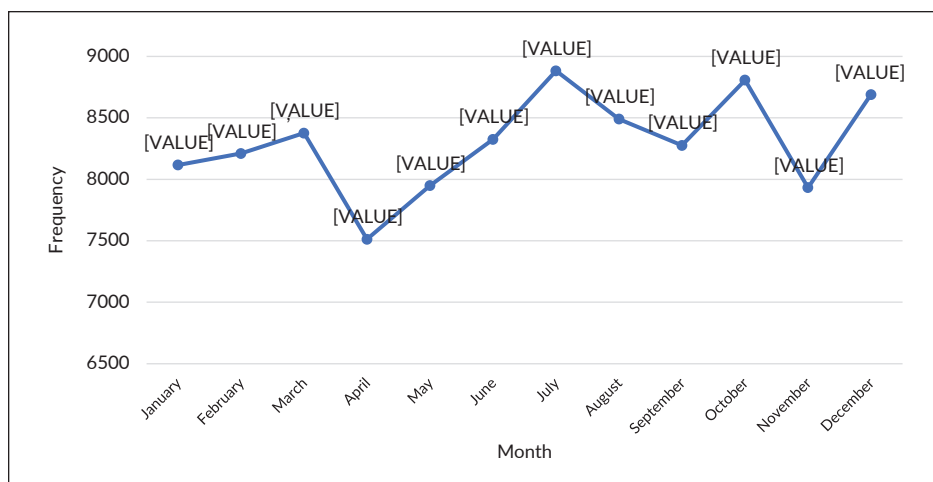


Figure 2. Distribution of month of crash and city of crash in the MMARAS database on bus-involved road crashes.

A considerable 24.1% for the collision type, 29.2% for the Risky Road Behaviors, and 67% for the junction type are missing in the MMARAS database. This limitation is structural, since the MMDA records road crash data into the MMARAS database in two ways: (1) through a full field report by the MMDA's Road Safety Unit, or (2) logged through a call or CCTV footage to the MMDA's Metrobase. Data that came through the first way are more detailed and accurate, while data that came through the second way have more missing data. It is important to note that the frequencies and proportions reported are biased towards crashes that are injurious or fatal since these crashes are more likely to have a full field investigation. Consequently, the distributions reported for collision type, risky behavior, and junction type are more representative of serious crashes, and should be interpreted accordingly.

For the month of crash occurrence, there is no distinct difference across the months. This means that crashes happen throughout the year (Figure 2).

Inferential Statistics

Road User Fatality Outcomes

Logistic regression was used on the dichotomous dependent variable "If a driver was killed," which was transformed from the variable "Drivers Killed," dichotomized such that the value takes on 0 if the number of drivers killed is 0, and 1 otherwise. 16,633 cases are considered in this model. Nagelkerke R-square shows that the model explains up to 28.9% of the variance in the dependent variable. Independent variables are selected through forward selection within vehicle types, collision type, risky road user behavior, and junction type. Records with missing values on any predictor variable included in the forward selection process were excluded from the analysis. For driver fatality, head-on collision (OR = 11.43, 95% CI: 1.21–108.00) and bridge/flyover (OR = 6.31, 95% CI: 1.34–29.78) increase the odds of driver fatality in bus-involved road crashes.

Logistic regression was also done on the dichotomous dependent variable "If a passenger was killed," which was transformed from the variable "Passengers Killed," dichotomized such that the value takes on 0 if the number of passengers killed is 0, and 1 otherwise. 16633 cases are considered in this model. Nagelkerke R-square shows that the model explains up to 17.1% of the variance in the dependent variable. Independent variables are selected through forward selection within vehicle types, collision type, risky road user behavior, and junction type. Similarly, records with missing values on any predictor variable included in the forward selection process were excluded from the analysis. Results show that suspected alcohol intoxication (OR = 615.50, 95% CI: 56.49–6706.88), driving too close (OR = 8.02, 95% CI: 1.00–64.33), driving too fast (OR = 5.48, 95% CI: 1.90–15.81), and vehicle defect (OR = 55.79, 95% CI: 11.38–273.38) significantly increase the odds of a passenger being killed in a bus-involved road crash.

Finally, logistic regression was also used on the dichotomous dependent variable "If a pedestrian was killed," which was transformed from the variable "Pedestrians Killed," dichotomized such that the value takes on 0 if the number of passengers killed is 0, and 1 otherwise. 16633 cases are considered in this model. Nagelkerke R-square shows that the model explains up to 18.8% of the variance in the dependent variable. Independent variables are selected through forward selection within vehicle types, collision type, risky road user behavior, and junction type. Similarly, records with missing values on any predictor variable included in the forward selection process were excluded from the analysis. Human error (OR = 14.57, 95% CI: 1.87–113.64), inattentiveness (OR = 10.29, 95% CI: 6.13–17.28), and tunnel/underpasses (OR = 7.74, 95% CI: 1.02–58.58) significantly increase the odds of a pedestrian being killed in bus-involved road crashes (Table 3).

Road User Injury Outcomes

Logistic regression was used on the dichotomous dependent variable “If a driver was injured,” which was transformed from the variable “Drivers Injured,” dichotomized such that the value takes on 0 if the number of drivers injured is 0, and 1 otherwise. 16633 cases are considered in this model. Nagelkerke R-square shows that the model explains up to 47.7% of the variance in the dependent variable. Independent variables are selected through forward selection within vehicle types, collision type, risky road user behavior, and junction type. Records with missing values on any predictor variable included in the forward selection process were excluded from the analysis. Results show that angle impact (OR = 4.49, 95% CI: 3.20–6.29), hit object (OR = 3.46, 95% CI: 1.45–8.28), and rear-end (OR = 1.59, 95% CI: 1.22–2.07) collision types significantly increase the odds of a driver being injured in a bus-involved crash. Suspected alcohol intoxication (OR = 17.44, 95% CI: 1.97–154.71) and inattentiveness (OR = 2.57, 95% CI: 1.63–4.07) are significant risky road user behaviors that increase the odds of a driver being injured in a bus-involved crash.

Logistic regression was done on the dichotomous dependent variable “If a passenger was injured,” which was transformed from the variable “Passengers Injured,” dichotomized such that the value takes on 0 if the number of passengers injured is 0, and 1 otherwise. 16633 cases are considered in this model. Nagelkerke R-square shows that the model explains up to 17.1% of the variance in the dependent variable. Independent variables are selected through forward selection within vehicle types, collision type, risky road user behavior, and junction type. Records with missing values on any predictor variable included in the forward selection

process were excluded from the analysis. Multiple collision (OR = 6.87, 95% CI: 4.73–9.98), self-accident (OR = 8.87, 95% CI: 4.91–16.03), driving too close (OR = 4.79, 95% CI: 3.42–6.71), driving too fast (OR = 3.32, 95% CI: 2.81–3.92), and vehicle defect (OR = 24.19, 95% CI: 13.52–43.31) significantly increase the odds of a passenger being injured in a bus-involved road crash.

Logistic regression was used on the dichotomous dependent variable “If a pedestrian was injured,” which was transformed from the variable “Pedestrians Injured,” dichotomized such that the value takes on 0 if the number of pedestrians injured is 0, and 1 otherwise. 16633 cases are considered in this model. Nagelkerke R-square shows that the model explains up to 54.3% of the variance in the dependent variable. Independent variables are selected through forward selection within vehicle types, collision type, risky road user behavior, and junction type. Records with missing values on any predictor variable included in the forward selection process were excluded from the analysis. Inattentiveness (OR = 69.90, 95% CI: 54.94–88.93), tired/asleep driver (OR = 10.93, 95% CI: 1.00–119.37), and vehicle defect (OR = 4.18, 95% CI: 1.57–11.19) significantly increase the odds of pedestrian injury in bus-involved road crashes (Table 4).

DISCUSSION

MMARAS data encompasses 16 years from 2005–2020, and a trend for the yearly increase in bus-involved road crashes was found. However, both data sets show a drop in cases upon the onset of the COVID-19 pandemic in 2020. This may be attributable to lockdown measures which reduced people’s mobility, as well as the reduced capacity of

Table 3. Logistic Regression on Factors for Driver, Passenger, and Pedestrian Fatality (N = 16,633)

Variables	Parameter Estimate	Standard Error	p-value	Odds Ratio	95% CI for OR	
					Lower	Upper
Driver						
Head-on	2.436	1.146	0.034	11.429	1.210	107.996
Rear-end	-1.816	1.032	0.078	0.163	0.022	1.229
Side swipe	-1.818	0.624	0.004	0.162	0.048	0.552
Bridge/Flyover	1.843	0.791	0.020	6.314	1.339	29.780
Constant	-7.336	0.408	0.000	0.001		
Passenger						
Side swipe	-2.039	0.779	0.009	0.130	0.028	0.599
Alcohol suspected	6.422	1.219	0.000	615.501	56.485	6706.884
Too close	2.082	1.062	0.050	8.020	1.000	64.333
Too fast	1.701	0.541	0.002	5.480	1.899	15.812
Vehicle defect	4.022	0.811	0.000	55.786	11.384	273.383
Constant	-7.346	0.372	0.000	0.001		
Pedestrian						
Human error	2.679	1.048	0.011	14.568	1.868	113.643
Inattentive	2.331	0.265	0.000	10.291	6.127	17.283
Tunnel/Underpass	2.047	1.032	0.047	7.743	1.023	58.580
Constant	-5.297	0.173	0.000	0.005		

Table 4. Logistic Regression on Factors for Driver, Passenger, and Pedestrian Fatality (N = 16,633)

Variables	Parameter Estimate	Standard Error	p-value	Odds Ratio	95% CI for OR	
					Lower	Upper
Driver						
Angle impact	1.502	0.172	0.000	4.489	3.204	6.289
Hit object	1.241	0.445	0.005	3.460	1.447	8.275
Rear-end	0.465	0.134	0.001	1.591	1.224	2.070
Alcohol suspected	2.859	1.114	0.010	17.443	1.967	154.705
Disobey sign or traffic lights	-1.277	0.386	0.001	0.279	0.131	0.594
Inattentive	0.945	0.234	0.000	2.573	1.626	4.073
Constant	-4.768	0.094	0.000	0.008		
Passenger						
Multiple collision	1.927	0.191	0.000	6.872	4.730	9.983
Self-accident	2.183	0.302	0.000	8.873	4.912	16.030
Too close	1.567	0.172	0.000	4.794	3.423	6.713
Too fast	1.198	0.085	0.000	3.315	2.805	3.917
Vehicle defect	3.186	0.297	0.000	24.193	13.515	43.308
Constant	-2.613	0.046	0.000	0.073		
Pedestrian						
Hit object	-2.916	1.041	0.005	0.054	0.007	0.417
Bad overtaking	-2.056	0.583	0.000	0.128	0.041	0.401
Inattentive	4.247	0.123	0.000	69.897	54.936	88.932
Tired/Asleep	2.391	1.220	0.050	10.928	1.000	119.373
Vehicle defect	1.431	0.502	0.004	4.184	1.565	11.187
U turn slot	-1.568	0.628	0.013	0.209	0.061	0.714
A cycle/pedicab is involved in a crash	-2.984	1.067	0.005	0.051	0.006	0.410
Constant	-2.844	0.064	0.000	0.058		

public transportation due to physical distancing protocols.³ Throughout the year, the occurrence of bus crashes was more or less evenly distributed, with a range of 1.4%. The most distinct change that could occur over the course of a year could be weather conditions. For countries experiencing four seasons, the winter months of December to February were associated with more crashes due to roads slick with ice and other phenomena associated with the snow.⁴ An analogous environmental change within the Philippines could be the rainy season associated with flooding from June to November. However, as seen within the data, this does not bear any significant effects on bus accidents. This is supported by literature stating that bus crashes are not particularly influenced by changes in normal weather conditions.⁵⁻⁷

Risk Factors for Bus Crashes

Among all road users killed or injured in bus-involved crashes (n = 16,607), passengers comprised the largest group (n = 10,161; 61.2%), which is expected due to its nature as a mass transport system, followed by drivers (n = 3,854; 23.2%) and pedestrians (n = 2,592; 15.6%). Based on the MMARAS data, the most common collision types involving buses are side swipe (28.81%), non-collision (19.98%), rear-end (14.41%), and angle impact (3.71%) collisions. However, this data may be skewed due to missing information. Due to the location of these impacts, it can be expected that the bus passengers would have a greater likelihood of being affected.

This follows US norms wherein the latter two types were found to be the most common collision types experienced by buses. The same study also found that side swipes account for 14% of fatalities and 36% of injuries, whereas rear-end collisions account for 16% of fatalities and 25% of injuries.⁸ Chimba et al. stated that these crashes are often seen due to the manner in which the buses operate.⁵ Side swipes occurrence is facilitated by lane change attempts of unidirectional traffic, whilst rear-end collisions may be due to sudden stops for embarking and disembarking passengers. On the other hand, “no collision” in the MMARAS database refers to events where there is no direct vehicle-to-vehicle or vehicle-to-object impact. No collision injuries are rated as a likely occurrence in urban buses such as those found within Metro Manila due to overcrowding in the aisles and sudden braking.⁸ There is currently a research gap regarding the effect of no collisions on passenger injury severity.⁴ This is significant as, despite high bus safety ratings, no collisions constitute are among the most common types of accident involving buses according to previous literature.⁶ They are also highly preventable compared to other collisions, which involve a crash and are characterized by passenger falls due to (1) stop-and-go driving and (2) embarking and disembarking.^{4,8} Another limitation presented by the data is the lack of information regarding the vehicle at fault. This is essential in identifying relationships for impact and injury. Whilst all entities are involved within a single crash, labelling

them together would oversimplify the data. As explained by Yasmin et al., the outcome for a rear-ended driver would differ from that of the rear-ender. Additionally, collision types often dictate injury severity for those involved.⁹

Philippine driving conditions have been described as some of the most challenging in the world due to severe traffic, infrastructure limitations, and aggressive driving of other road occupants. These factors make it inconducive for proper driving practices to continually be upheld, especially amongst professional drivers. There is no correlation between the socio-demographic factors surrounding a bus driver and their likelihood of becoming involved in an accident. However, one of the identified factors which do bear influence is a history of risky driving behavior.¹⁰ This is in turn consequential to the accident severity.¹¹ Speeding in particular is a common behavior exhibited by Metro Manila bus drivers.¹² This is concerning due to its overall association with increased fatalities and injuries.¹³ A similar outcome was found with bad overtaking, where a Thailand-based study found that sudden movements without warning were found to be 2.48 times more prone to lead to fatalities.¹¹

Another element of risk is also introduced with the continual use of defective vehicles. In 2016, bus units were recommended to have a maximum turnover rate of 15 years.¹ As of 2018, it remains the operator's prerogative to continue using their vehicles as there is no scrappage standard. On average, the lifespan for buses is 11.529 years.¹⁴ Due to this, vehicles with defects may still be found on the road. These pose risks as the vehicle's roadworthiness is not guaranteed by any enforcement entity. Concerns also arise as statistics show that a significant proportion of injurious and fatal bus crashes consist of protracted units.¹⁰

Safety Measures

The presence of safety measures can determine a patient's condition post-crash. However, data exhibits a severe lack of the use of safety devices. The identified equipment includes seatbelts, helmets, child restraints, and airbags. In total, these do not even constitute 1% of use by vehicles involved in bus crashes.

As stated in R.A. 8750, PUVs such as buses are required to have their front seat passengers wear seatbelts. Otherwise, they would not be allowed to ride on the vehicle.¹⁵ Despite this, enforcement is not strict, and the law is largely flouted amongst the general populace to the extent that it was reported as the most violated traffic law in the Philippines in 2016.¹⁶ This is pertinent as previous analyses of US data suggest that when fatalities ensue from bus crashes, 88% are associated with the absence of seatbelts.⁷ These deaths could thereby be deemed preventable had the mandated safety measures been in place. Furthermore, R.A. 10054 and R.A. 11229 require the use of helmets and child restraints, respectively.^{17,18} No laws mandate the use of airbags for PUVs. The implementation of similar laws mandating these safety measures was associated with decreased road crash

incidents for Colombia during the same period.¹⁹ However, no such associations can be made with the MMARAS and ONEISS data.

Road conditions influence the likelihood that a crash would occur. In a modelling study, it was considered the fourth most important consideration regarding the severity of crashes involving heavy vehicles such as buses.²⁰ This is especially significant given that Metro Manila is characterized by narrow roads which are insufficient to accommodate the transport needs of its residents. Large vehicles such as buses were found to create choke points as they maneuver through such roads.¹² Adjustments made by surrounding vehicles in response to these conditions may then propagate accidents.

MMARAS data (N = 99564) is limited regarding the conditions of the accident site, with most of the data missing (67.02%, N = 66727). Of the available data, the crashes mainly occurred not at junctions (19.81%, N = 19723) compared to other forms of intersections. Notably, this goes against existing literature wherein junctions were found to be amongst the most common crash locations.⁴ Concurrently, junction bus crashes are also associated with higher fatality rates.¹¹ As the primary location of the Metro Manila crash data is not at these junctions, better outcomes can be expected for the road user.

Based on the MMARAS database, the number of bus-involved crashes with speeding exceeds the average among drivers. There are already designated speed limits and existing traffic laws to regulate speeding. A study on occupational safety conditions among bus drivers in Manila showed that drivers engaged in risky driving behaviors (over-speeding and road racing) to reach their daily quota.²¹ The Filipino Driver's Manual already includes all the necessary information on rules and responsibilities of drivers and conductors, registration, laws, fines, and penalties for violations to equip drivers and conductors with knowledge and skills related to road safety.²² Drivers have a critical role and takes majority of the charges during road crashes; however, risky driving behavior is associated with various factors such as lack of proper training, poor health due to longer work hours, and lack of income security as drivers strive to reach their daily quota according to a survey conducted by the Department of Labor and Employment (DOLE). Generally, these risky behaviors are highly preventable, and there are already existing traffic laws, rules, and regulations targeting these risky behaviors. However, enforcement of existing laws on speed limit, drink-driving, use of seatbelt, and distracted driving remains a challenge.

Road User Crash Outcomes

Out of the three crash classifications, the majority are classified as damage to property, followed by non-fatal and fatal. The results proved a significant relationship between bus-involved crashes and crash classification. The results also proved that damage to property is greater than average, and it is more likely to occur during bus-involved crashes.

The results suggest that bus-involved crashes are more likely to cause damage to property than fatal or non-fatal crashes. Because of their bigger dimensions and larger passenger capacity, buses are more difficult to maneuver and harder to stop compared to other vehicles, thus causing more damage to property during crashes. Damage to property includes damage to the vehicle involved, personal items inside the vehicle, and other damaged properties caused by the accident. The first study on the economic cost of road crashes in Barcelona identified that property damage costs had the biggest part both generally and in direct costs, followed by insurance administration costs and hospital costs.²³ There is a gap in the literature on property damage and economic cost-benefit analysis of bus-involved crashes in the Philippines.

CONCLUSION

This study described the distribution and factors associated with road user outcomes in bus-involved crashes in Metro Manila from 2005 to 2020 using the MMARAS database. Findings quantify the considerable burden of bus-involved crashes on road users, with 99,564 crash records documented over the 16-year study period.

Across all road user types and outcomes, risky driving behaviors, particularly speeding, inattentiveness, and alcohol intoxication, were consistently associated with increased odds of both fatality and injury, underscoring their massive role in determining crash severity. The relevant factors differed by road user type: head-on collision and bridge/flyover location were associated with driver fatality; alcohol intoxication, vehicle defect, and tailgating with passenger fatality; and inattentiveness and human error with pedestrian fatality. These findings highlight the disproportionate burden that bus-involved crashes place on passengers and pedestrians, and underscore the need for better enforcement of existing traffic laws.

The study also highlights the need for better accident reporting. The MMARAS database exhibited substantial missingness in key variables, which affects the generalizability of this study. Improved incident documentation would substantially strengthen the evidentiary basis and reliability for future road safety analyses and policy development.

This study is a comprehensive analysis of bus-involved crashes in Metro Manila. The findings provide an empirical foundation for evidence-based bus safety policy in Metro Manila. The study period predates the PUV Modernization Program, and the EDSA Busway Lane and future research should evaluate whether these initiatives have meaningfully reduced the incidence and severity of bus-involved crashes.

Statement of Authorship

Both authors certified fulfillment of ICMJE authorship criteria.

Author Declaration

Both authors declared no conflicts of interest.

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REFERENCES

- Guillén D, Villaraza C, Mettke C. Transforming Public Transport in the Philippines [Internet]. Metro Manila: Department of Transportation (DOTr) of the Philippines; 2016 [cited 2023 May 17]. Available from: https://changing-transport.org/wp-content/uploads/Full_NAMA_Concept_Jeepney_NAMA.pdf.
- Never B, Ramon J, Albert G. Unmasking the middle class in the Philippines: Aspirations, lifestyles and prospects for sustainable consumption. *Asian Stud Rev*. 2021;45(4):594-614. doi:10.1080/10357823.2021.1912709.
- Vingilis E, Beirness D, Boase P, Byrne P, Johnson J, Jonah B, et al. Coronavirus disease 2019: What could be the effects on Road safety? *Accid Anal Prev*. 2020;144:105687. doi:10.1016/j.aap.2020.105687. PMID: 32683133; PMCID: PMC7364169.
- Zhou H, Yuan C, Dong N, Wong SC, Xu P. Severity of passenger injuries on public buses: A comparative analysis of collision injuries and non-collision injuries. *J Safety Res*. 2020;74:55-69. doi:10.1016/j.jsr.2020.04.003.
- Chimba D, Sando T, Kwigizile V. Effect of bus size and operation to crash occurrences. *Accid Anal Prev*. 2010;42:2063-7. doi:10.1016/j.aap.2010.06.018. PMID: 20728663.
- Jovanis PP, Schofer JL, Prevedouros P, Tsunokawa K. Analysis of bus transit accidents: empirical, methodological, and policy issues. *Transp Res Rec*. 1991;1322:12-28.
- Olivares G, Yadav V. Injury Mechanisms to Mass Transit Bus Passengers During Frontal, Side and Rear Impact Crash Scenarios. In: *Proceedings of the 21st (WSV) International Technical Conference on the Enhanced Safety of Vehicles*. Stuttgart, DE; 2009.
- Elvik R. Risk of non-collision injuries to public transport passengers: Synthesis of evidence from eleven studies. *J Transp Health*. 2019;13:128-36. doi:10.1016/j.jth.2019.03.017.
- Yasmin S, Eluru N, Pinjari AR, Tay R. Examining driver injury severity in two vehicle crashes - A copula-based approach. *Accid Anal Prev*. 2014;66:120-135. doi:10.1016/j.aap.2014.01.018. PMID: 24531114.
- Feng S, Li Z, Ci Y, Zhang G. Risk factors affecting fatal bus accident severity: Their impact on different types of bus drivers. *Accid Anal Prev*. 2016;86:29-39. doi:10.1016/j.aap.2015.09.025. PMID: 26513334.
- Mahikul W, Aiyasuwan O, Thanartthanaboon P, Chancharoen W, Achararit P, Sirisombat T, et al. Factors affecting bus accident severity in Thailand: A multinomial logit model. *PLoS One*. 2022;17(11):e0277318. doi:10.1371/journal.pone.0277318. PMID: 36350836; PMCID: PMC9645622.
- Boquet Y. Bus transportation in the Philippines. *Travel Behav Soc*. 2013:511-8.
- Kaplan S, Prato CG. Risk factors associated with bus accident severity in the United States: A generalized ordered logit model. *J Safety Res*. 2012;43(3):171-80. doi:10.1016/j.jsr.2012.05.003. PMID: 22974682.
- Rith M, Soliman J, Fillone A, Bienvenido J, Biona M, Stephen Lopez N. Analysis of Vehicle Survival Rates for Metro-Manila. In: *Proceedings of the 2018 IEEE 10th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM)*; 2018 Nov 29-Dec 02; Baguio, Philippines. doi: 0.1109/HNICEM.2018.8666408.
- Seat Belts Use Act of 1999. Republic Act No. 8750. August 5, 1999.

16. Dayao DLC. Seat Belt Law: The Most Violated Road Rule in the Philippines [Internet]. Washington, D. C.: Pulitzer Center; 2023 [updated 2018 Mar 26; cited 2022 Jul]. Available from: [https://pulitzercenter.org/stories/seat-belt-law-most-violated-road-rule-philippines#:~:text=In%202016%2C%20Republic%20Act%20\(RA,at%20the%20Land%20Transportation%20Office.](https://pulitzercenter.org/stories/seat-belt-law-most-violated-road-rule-philippines#:~:text=In%202016%2C%20Republic%20Act%20(RA,at%20the%20Land%20Transportation%20Office.)
17. Motorcycle Helmet Act of 2009. Republic Act No. 10054. March 23, 2010.
18. Child Safety in Motor Vehicles Act. Republic Act No. 11229. December 11, 2018.
19. Argote-Aramendiz K, Molloy MS, Hart A, Voskayan A, Sarin R, Ciotton GR. Effect of road safety laws on deaths and injuries from road traffic collisions in Colombia. *Prehosp Disaster Med.* 2020;35: 397–405. doi:10.1017/S1049023X20000758. PMID: 32552918.
20. Azhar A, Ariff NM, Bakar MAA, Roslan A. Classification of driver injury severity for accidents involving heavy vehicles with Decision Tree and Random Forest. *Sustainability (Switzerland).* 2022;14(7):4101. doi:10.3390/su14074101.
21. Santos JA, Lu JL. Occupational safety conditions of bus drivers in Metro Manila, the Philippines. *Int J Occup Saf Ergon.* 2016;22(4): 508–13. doi:10.1080/10803548.2016.1151700. PMID: 27093582.
22. Land Transportation Office. Filipino Driver Manual 2018. Vol 1. Quezon City: Land Transportation Office; 2018.
23. García-Altés A, Pérez K. The economic cost of road traffic crashes in an urban setting. *Inj Prev.* 2007;13(1):65–8. doi:10.1136/ip.2006.012732. PMID: 17296693; PMCID: PMC2610566.