Effect of Vehicle Related Factors on Auto-crashes along Bode-Saadu-Jebba Highway in Kwara State, Nigeria

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Abstract- ***The growing concern for road safety has led to the introduction of ameliorative measures aimed at reducing the frequency and severity of auto-crashes. Auto-crashes are a major cause of morbidity and mortality, influencing various aspects of societal well-being and economic stability. The study examines the causes of auto-crashes, focusing on vehicle-related factors. This study employed a descriptive survey research design, targeting a population of approximately 1,995 individuals, including road users, commercial drivers, private vehicle owners, passengers, officials from the Federal Road Safety Corps (FRSC) and Vehicle Inspection Officers (VIO). A multi-stage sampling techniques, combining incidental and purposive sampling with a sample size of 333 respondents. Data were collected through structured questionnaires and semi-structured interviews. The data were analyzed using inferential statistics including Multiple Regression Analysis. Findings from the result of multiple regression analysis on effect of vehicle-related factors on auto-crashes along Bode-saadu-Jebba Highway showed that five (5) out of the six (6) explanatory variables were positively significant in explaining the variation of vehicle-related factors. These variables were Vehicle Age (p=0.014), Vehicle Type (p=0.000), Vehicle Speed (p=0.000), Vehicle Load (p=0.000) and Drivers Vehicle Knowledge (p=0.000). This study concluded that vehicle-related factors had significant impact on auto-crashes along Bode-saadu-Jebba Highway. However, it was recommended that government/FRSC should upgrade road infrastructure, enforcing regular vehicle inspections, promoting safe driving education, and incorporating technology like speed limiters.***

Indexed Terms- ***Vehicle Related Factor, Auto-crashes, Bode-Saadu-Jebba Highway***

I. INTRODUCTION

Auto-crashes are a major cause of morbidity and mortality, influencing various aspects of societal well-being and economic stability (Global Status Report on Road Safety, WHO, 2018). The increasing incidence of auto-crashes highlights the urgent need for comprehensive analysis and effective interventions. The frequency and severity of road traffic accidents can be attributed to multiple factors, including driver behaviour, road conditions, vehicle maintenance, and enforcement of traffic regulations (Peden et al., 2018). The economic consequences of auto-crashes have been documented in many high-income countries. In 2000, the Federal budget allocated US$152 billion towards provision of direct healthcare services, training and disease prevention; in the USA, the total cost to society of auto-crashes was estimated to be US$230.6 billion in the year 2000, while injuries from auto-crashes cost an estimated US$146 billion (Pent, 2017). Although the burden of auto-crashes in terms of incidence and mortality has been reported in several countries in sub-Saharan Africa, data regarding both the disability and socioeconomic effects of auto-crashes in this region remain scarce (Bowen, 2019).

Auto-crashes, a major global public health issue, have consistently posed a significant threat to human lives, property, and economic stability. The World Health Organization (WHO, 2018) estimates that auto-crashes claim approximately 1.35 million lives each year, with millions more suffering injuries or disabilities. In Nigeria, auto-crashes contribute to a high fatality rate, with the country accounting for one of the highest occurrences of auto-crashes in Africa (Federal Road Safety Corps [FRSC], 2020). The socioeconomic impact of these auto-crashes cannot be overstated, as they result in significant losses in productivity, healthcare costs, and infrastructural damage. The growing concern for road safety has led

to the introduction of ameliorative measures aimed at reducing the frequency and severity of auto-crashes (Zhao et al., 2020). These measures include policy reforms, road safety campaigns, stricter enforcement of traffic laws, and technological innovations in vehicle safety standards (Olukoga, 2019). Despite the implementation of such measures, the rate of auto-crashes remains alarmingly high in Nigeria, necessitating an in-depth analysis of their effectiveness and potential improvements.

II. LITERATURE REVIEW

Auto-crashes

Auto-crashes are a significant global public health issue, causing extensive loss of life, injuries, and economic losses. According to the World Health Organization (WHO, 2021), approximately 1.3 million people die each year from auto-crashes, with millions more suffering from non-fatal injuries. The increase in vehicle numbers and population growth, combined with the urbanization of many regions, has led to a surge in traffic-related incidents worldwide (Peden et al., 2018). On the contrary, however, Asalor (2010) has shown that Nigerians know quite a lot about what could cause auto-crashes‟ and likened the situation to that in which in the midst of plenty, there could be hunger. Crashes is defined as anything which happens by chance, anything occurring unexpectedly and un-designed, Odugbemi (2010).

Auto-crashes are therefore an unexpected phenomenon that occurs as a result of the use or operation of vehicles including bicycles and handcarts on the public highways and roads. Crashes may be fatal, resulting in deaths of the road users (passengers, drivers or pedestrians), or minor when it is not severe enough as to cause substantial hardship. The dividing line between minor and serious crashes is however blurred. As it has been defined, crashes would rarely give warning although reckless drivers should anticipate the consequences of their recklessness. In general, crashes do not just occur; they are basically brought about by human recklessness, carelessness or negligence.

Even where the immediate cause of a road crashes is attributable to mechanical factor, carelessness in the form of omission to check and maintain the vehicle at the appropriate time would have remotely contributed. Trivial checking and maintenance of the vehicles could avert an imminent crashes. In the ancient Roman Empire, road transport owners / operators in the 11th century must provide a slave who will carry a red flag to warn other road users that a motor car is coming and leave the road space to avoid possible road crashes. Today the car has a faster speed and the need to incorporate gadgets like, the horn, braking system, traficators, headlights and break-lights to avoid road crashes (Jacobs, 2010).

Vehicle-Related Factors

Vehicle-related factors are critical contributors to auto-crashes, influencing both the likelihood of an accident occurring and the severity of its outcomes. These factors encompass various aspects of vehicle design, maintenance, and technology that can either enhance or compromise road safety. Vehicle conditions, such as mechanical failures, tire integrity, and braking systems, are well-established risk elements that can lead to crashes, while the introduction of advanced safety technologies has helped mitigate some of these risks. This conceptual review focuses on vehicle-related factors in auto-crashes, discussing how vehicle defects, poor maintenance, safety features, and technological innovations impact crash occurrences and outcomes.

Mechanical Failures and Defects: One of the most significant vehicle-related factors contributing to auto-crashes is mechanical failure. Mechanical defects, including brake failure, tire blowouts, steering malfunctions, and suspension issues, are often the result of poor maintenance or manufacturing defects. These failures can cause the driver to lose control of the vehicle, increasing the risk of accidents (Evans, 2019). Studies indicate that approximately 5% to 10% of road crashes are directly caused by mechanical failures, with brake failure being the most common issue (National Highway Traffic Safety Administration [NHTSA], 2020).

Brakes are critical to safe driving, and brake failure can result in catastrophic consequences, especially at high speeds. Improperly maintained brakes or manufacturing defects can significantly reduce a vehicle’s ability to stop quickly, increasing the likelihood of a crash (NHTSA, 2020). A study by Evans (2019) found that vehicles with defective

braking systems were involved in more severe crashes, often leading to fatal outcomes, due to the vehicle's inability to decelerate in time to avoid a collision. Regular maintenance of braking systems, including checking brake pads, fluid levels, and hydraulic systems, is essential to preventing such failures.

In addition to brake issues, tire-related problems are another major contributor to auto-crashes. Tire blowouts, worn tread, and under-inflated tires all compromise vehicle handling and increase the risk of crashes, auto-crashes in adverse weather conditions (Shinar, 2017). Research shows that tire blowouts, in auto-crashes, are associated with high-speed accidents, as the sudden loss of tire pressure can cause the driver to lose control of the vehicle. Proper tire maintenance, including routine inspections, rotation, and ensuring adequate tire pressure, can significantly reduce the risk of tire-related crashes (NHTSA, 2020). Vehicle Maintenance and Roadworthiness: Vehicle maintenance is crucial in ensuring that cars, trucks, and buses remain roadworthy and safe to operate. Poor maintenance practices can exacerbate existing defects and lead to mechanical failures that increase crash risk. Regular inspections of critical components such as the engine, transmission, tires, and lights are essential for maintaining vehicle safety (Blows et al., 2015). Research shows that poorly maintained vehicles are more likely to be involved in crashes, auto-crashes in low- and middle-income countries, where resources for vehicle maintenance and inspection may be limited (Blows et al., 2015).

A key aspect of vehicle roadworthiness is ensuring that safety features such as seat belts, airbags, and anti-lock braking systems (ABS) are functioning correctly. ABS, for example, helps prevent wheel lockup during emergency braking, allowing the driver to maintain control of the vehicle and reduce stopping distance. Vehicles without functioning ABS are at a higher risk of crashes, auto-crashes on wet or slippery roads (Shinar, 2017). Similarly, seat belts and airbags are crucial for reducing injury severity during crashes. According to the NHTSA (2020), vehicles equipped with these features experience lower rates of fatal crashes, as these safety systems help protect occupants in the event of a collision.

In many countries, vehicle inspection programs are in place to ensure that vehicles meet roadworthiness standards. These inspections check for mechanical issues and ensure that vehicles are compliant with safety regulations. However, in regions where such programs are poorly enforced, vehicles in poor condition may continue to operate on the roads, increasing the risk of accidents (WHO, 2021). Proper enforcement of vehicle inspection standards is crucial for ensuring that only roadworthy vehicles are allowed on the roads, auto-crashes in countries with high crash rates.

Vehicle Design and Safety Features: Vehicle design plays a crucial role in both preventing crashes and mitigating the severity of their outcomes. Modern vehicles are equipped with a wide range of safety features, including crumple zones, side-impact beams, and electronic stability control (ESC), all of which help protect occupants in the event of a crash (Evans, 2019). Crumple zones, for instance, are designed to absorb the impact energy during a collision, reducing the force transferred to the occupants and thereby lowering the risk of serious injuries (Anderson et al., 2016).

ESC is another key safety feature that helps prevent crashes by detecting and reducing loss of traction (skidding). It automatically applies brakes to individual wheels, helping drivers maintain control of their vehicles in slippery or dangerous conditions (Caird et al., 2019). Research by Anderson et al. (2016) indicates that ESC reduces the risk of fatal crashes by 33%, auto-crashes in rollover crashes, which are often fatal due to the vehicle's high center of gravity.

Another critical safety feature is the use of airbags, which provide a cushion for occupants during a crash and prevent them from striking the interior of the vehicle or being ejected. Side airbags, in auto-crashes, are effective in reducing fatalities in side-impact crashes, which are among the most dangerous types of collisions (Evans, 2019). Research shows that vehicles equipped with airbags experience lower rates of fatal crashes, as these safety systems significantly reduce the forces experienced by occupants during a collision (Blows et al., 2015).

Advanced Driver Assistance Systems (ADAS) and Crash Prevention: Technological advancements have introduced a new era of vehicle safety, with Advanced Driver Assistance Systems (ADAS) playing a pivotal role in reducing the incidence of Auto-crashes. ADAS includes a range of features such as adaptive cruise control, lane departure warnings, automatic emergency braking, and blind-spot detection (Strayer and Drews, 2017). These systems are designed to assist drivers in maintaining control of their vehicles, alert them to potential hazards, and, in some cases, intervene to prevent crashes. Automatic emergency braking (AEB), for example, is designed to detect imminent collisions and apply the brakes if the driver does not respond in time. Studies have shown that vehicles equipped with AEB are involved in fewer rear-end collisions, as the system can reduce the severity of a crash or prevent it entirely (Caird et al., 2019). Similarly, lane departure warning systems help prevent accidents by auto-crashes drivers when they unintentionally drift out of their lane, which is useful in preventing rollover crashes or head-on collisions (Shinar, 2017).

Blind-spot detection systems use sensors to monitor the areas around the vehicle that are not visible to the driver, when changing lanes. This system helps reduce the incidence of side-swipe crashes on highways (Strayer and Drews, 2017). ADAS features are becoming increasingly standard in new vehicles, and as they become more widespread, it is expected that they will significantly reduce the number of auto-crashes caused by human error.

Vehicle Size and Crash Severity: The size and weight of a vehicle can also influence the likelihood and severity of auto-crashes. Larger vehicles, such as trucks and buses, tend to cause more severe damage in crashes due to their weight and size (Evans, 2019). In collisions between a large truck and a smaller passenger vehicle, the occupants of the smaller vehicle are at a significantly higher risk of injury or death due to the size disparity (Anderson et al., 2016). This is true in frontal crashes, where the size and weight of the larger vehicle can cause the smaller vehicle to crumple, resulting in severe injuries to its occupants. However, larger vehicles also have advantages in terms of crash protection for their occupants. Research shows that occupants of larger vehicles, such as SUVs, are less likely to be seriously injured in crashes compared to occupants of smaller vehicles (Blows et al., 2015). This is due to the higher seating position and greater mass of these vehicles, which provide better protection in collisions. As a result, the size and weight of a vehicle play a dual role in auto-crashes, both increasing the severity of crashes involving smaller vehicles and offering better protection to occupants of larger vehicles.

III. METHODOLOGY

This study employed a descriptive survey research design, targeting a population of approximately 1,995 individuals, including road users, commercial drivers, private vehicle owners, passengers, officials from the Federal Road Safety Corps (FRSC) and Vehicle Inspection Officers (VIO). A multi-stage sampling techniques, combining incidental and purposive sampling with a sample size of 333 respondents. Data were collected through structured questionnaires and semi-structured interviews. The data were analyzed using inferential statistics including Multiple Regression Analysis.

IV. RESULT AND DISCUSSION

The findings of the result of Multiple Regression Analysis on the effect of vehicle-related factors on auto-crashes revealed a moderate positive significant ($R=0.602$) between vehicle-related factors (drivers' vehicle knowledge, vehicle load, vehicle type, vehicle speed, vehicle age, and vehicle maintenance) and their contribution to auto-crashes along the Bode-Saadu-Jebba highway. The coefficient of determination ($R^2 =0.363$) indicates that 36.3% of the variation in vehicle-related factors is explained by these predictors, while the adjusted $R^2 =0.351$ affirms the model's reliability after accounting for the number of variables included. The model was statistically significant overall ($F=29.728$, $p<0.001$), demonstrating that the independent variables collectively influence vehicle-related factors associated with auto-crashes.

The coefficients highlight the individual contributions of each factor. Vehicle load emerged as the most significant predictor ($\beta=0.447$, $p<0.001$), emphasizing the critical role of overloading in causing auto-crashes.

Similarly, vehicle type (β=0.358, p<0.001) and vehicle speed (β=0.323, p<0.001) significantly impact accident rates, underscoring the importance of appropriate vehicle selection and speed regulation. Drivers' knowledge of their vehicles was also significant (β=0.272, p<0.001), highlighting the need for driver education on vehicle handling and capabilities. Additionally, older vehicles (β=0.157, p=0.014) were found to significantly contribute to crashes, suggesting a need to prioritize the use of newer vehicles. Although vehicle maintenance (β=0.130, p=0.075) was not statistically significant, its practical relevance in reducing auto-crashes cannot be overlooked. These findings underscore the critical impact of vehicle-related factors on auto-crashes along the highway. Policies addressing vehicle load, type, and speed, along with initiatives to enhance driver knowledge, promote regular vehicle maintenance, and encourage the use of newer vehicles, are essential for improving road safety and reducing accident rates.

Table 1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.602[a]	.363	.351	.330

a. Predictors: (Constant), Drivers Vehicle Knowledge, Vehicle Load, Vehicle Type, Vehicle Speed, Vehicle Age, Vehicle Maintenance

Table 2: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.387	6	3.231	29.728	.000[b]
	Residual	34.021	313	.109		
	Total	53.408	319			

a. Dependent Variable: Vehicle Related Factor

b. Predictors: (Constant), Drivers Vehicle Knowledge, Vehicle Load, Vehicle Type, Vehicle Speed, Vehicle Age, Vehicle Maintenance

Table 3: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.309	.151		2.046	.042
	Vehicle Maintenance	.106	.059	.130	1.789	.075
	Vehicle Age	.079	.032	.157	2.472	.014
	Vehicle Type	.140	.020	.358	6.833	.000
	Vehicle Speed	.140	.022	.323	6.391	.000
	Vehicle Load	.147	.016	.447	9.164	.000
	Drivers Vehicle Knowledge	.147	.032	.272	4.594	.000

a. Dependent Variable: Vehicle Related Factor

Source: Author's Computation (2024)

These findings collectively underscore the importance of addressing vehicle load limits, promoting the use of safe vehicle types, enhancing drivers' knowledge through training, and ensuring stringent maintenance routines to improve vehicle-related safety outcomes. Future research should explore these relationships using larger datasets and advanced modeling techniques to develop more targeted road safety interventions.

CONCLUSION AND RECOMMENDATION

Based on the findings, the study therefore concluded that, vehicle-related factors had significant impact on auto-crashes along Bode-saadu-Jebba Highway. However, it was recommended that government/FRSC should upgrade road infrastructure, enforcing regular vehicle inspections, promoting safe driving education, and incorporating technology like speed limiters.

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