

Risky Driving Behaviours and Their Impact on Road Traffic Accidents: Insights from Commercial Bus Drivers in Nigeria

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Abstract

Public transport safety mainly depends on bus drivers due to their crucial roles. Therefore, understanding commercial bus drivers' driving behaviours can aid in determining areas that need urgent attention. The study examines the influence of their risky driving behaviour on road traffic accidents (RTAs) and the moderating effect of the bus drivers' driving experience and education level. The validity results showed that Driver Behaviour Questionnaire (DBQ) is reliable and valid for commercial bus drivers. Also, through the structural model assessment of risky driving behaviour, the findings reveal that violations ($\beta = 0.121$, $p < 0.05$) and errors ($\beta = 0.094$, $p < 0.05$) are significant predictors of road traffic accidents among commercial bus drivers, explaining 4% of the variance in accident involvement. In other words, the study revealed a significant influence of driving violations and errors on RTA, while inattention errors were insignificant. The Importance-performance map indicates that serious measures and attention are needed to reduce driving violations. Additionally, driving experience and educational level did not moderate the relationship between risky driving behaviour and RTA. The study offers unique insights by identifying critical driving behaviour that demands strategic intervention from policymakers, driver trainers, and transport employers.

1. Introduction

Public transportation remains a pillar of a sustainable economy since it enables the efficient and effective movement of people, products, and services. In addition, its contribution to economic growth is invaluable compared to other modes of transportation, such as taxis. This is due to affordability, especially in developing countries where the source of livelihood is below average. Bus transport remains in high demand in Nigeria [1],

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which may be due to the inability to afford air and rail transport [2]. Consequently, this increased usage is not without safety concerns due to the behavioural limitations of transport operators, resulting in road traffic carnage. Globally, the human population has decreased through road traffic deaths [3], and this is due to the significant influence of human factors on RTA [4].

Most RTAs are caused by commercial or public transport drivers [5]. This might be due to their long hours of driving and exposure to different driving scenarios. Bus drivers have been characterized by risky behaviours like overspeeding, distraction, tailgating, phone usage while driving, and drunk driving, often resulting in RTA [6]. In Nigeria, commercial drivers contribute to causing RTAs more than other types of drivers [7]. Specifically, commercial bus drivers in Nigeria, who are an essential category of commercial drivers, are not left out in the display of risky driving behaviours which stem from distraction and addiction to drug and psychoactive substances, which could be a precursor to RTAs [1].

Even though bus drivers, compared to other types of vehicles, contribute a low percentage to RTAs [8], it is still important to examine their dangerous behavioural tendencies primarily due to the growing usage of bus transport globally. Previous studies have reported a significant relationship between RTAs and the risky driving behaviours of drivers [9]–[11]. Based on existing studies, inattention or distraction often impairs drivers' performance, which could result in RTAs [12]. According to Boontob *et al.* [13], road traffic accidents (RTAs) among bus drivers in Thailand can be attributed to speeding, which falls within the category of driving violation. This finding aligns with the research by Wang *et al.* [14], who further emphasize that bus drivers in China commonly engage in aberrant driving behaviours, such as traffic light violations and speed violations, posing significant safety risks. Therefore, while Boontob *et al.* [13] identified speeding as a contributing factor, Wang *et al.* [14] provide additional insights into the broader spectrum of aberrant behaviours exhibited by bus drivers in China. Also, Han & Zhao [15] found driving violations and errors to increase RTA involvement tendencies.

1.1 Literature Review

Several other studies have demonstrated a significant correlation between driving violations and RTA among bus drivers [16], [17]. It was also indicated that there is a significant correlation between driving error and RTA in bus drivers [16].

Based on the study of Zhang *et al.* [18], driving violations were observed to cause more RTAs, unlike driving errors, which did not reflect any influence. Xi *et al.* [19] examined the influence of mental state on accidents and found that bus drivers with depression, emotional instability, and anxiety were prone to RTAs. In the study of Suraji *et al.* [20], brake failure and poor wheel system were reported to be a significant cause of traffic accidents for intercity bus drivers, while Azman & Wea [21] found road factors to be the dominant cause of bus drivers accidents in Malaysia. Furthermore, other driving behaviours reported to influence RTA among drivers are inattention errors which are associated with distraction when driving. Previous studies have found inattention to be linked to inattention errors as they impair drivers attention [15], [22]–[24]. Drivers' inattention may arise from fiddling with phones, operating in-vehicle accessories, mental distractions, conversation with passengers, and route familiarity, which can potentially increase accident severity.

The severity of accidents was attributed to bad road conditions, night driving, collisions with pedestrians, weekend driving, and drunk driving by Sam *et al.* [25]. Similarly, the severity of bus driver accidents was found to be due to weather conditions (rain), head-on collisions, less traffic, large buses, driving in the evening or night, driving on rural roads, driving on curved roads, and having a minimum of three lanes [26]. Drowsiness and violation of traffic rules also increased the propensity for accident severity [27], while Lidbe *et al.* [28] found driving under the influence, over speeding, and driving on a curved road to boost injury. Most of the existing studies on commercial bus drivers have not used the DBQ in their studies, which aids in collecting more driver information that can be used for road traffic accident involvement assessment. Moreso, sparse studies have used structural equation modeling (SEM) in bus driver studies, which is a more reliable analytical method and allows testing for moderating effects, especially as moderating effects of driving experience and education level among bus drivers are rare to the best of the author's knowledge.

Previous studies have shown the varying influence of driving experience and education level of drivers on RTA. The study of Wang *et al.* [29] found driving experience to be insignificant to RTA for bus drivers. The finding is in contrast to the studies of Singh & Kathuria [30] and Zheng *et al.* [17], in which driving experience was found to be significant to safety and thus reduces accidents among bus drivers. The variation in findings could be a result of study location. The more experience a taxi driver has, the more ordinary violations are found in Iran, while truck drivers show fewer errors with long driving experience [30]. The studies of Maslač *et al.* [31] and Davey *et al.* [32] all converge on the findings that longer driving experience builds self-confidence increasing ordinary violations but fewer errors among drivers. Examining taxi drivers, Mekonnen *et al.* [33] found drivers with low driving experience being involved in RTAs. This result is consistent with the study of Maslač *et al.* [34] and Vahedi *et al.* [35]. However, Seo *et al.* [36] found experienced taxi drivers guilty of distraction while driving, which can increase workload and lessen control over the vehicle, thus leading to RTA among taxi drivers. The findings of

Vahedi *et al.* [35]. deviate from the previous study in that no association between taxi drivers' experience and RTA was found. Even though complacency has the likelihood to set in among drivers with experience, risky driving behaviours are expected to decline with increased experience. However, studies on moderating effects of driving experience among commercial bus drivers are still rare.

Additionally, the influence of drivers' education level has divergent results based on existing studies. Highly educated drivers are expected to commit fewer violations due to their road safety knowledge than less educated drivers [30]. Nevertheless, some arguments from studies with divergent findings regarding education and risky driver behaviours remain. The studies of Han & Zhao [15] and Guého *et al.* [37] demonstrated that professional drivers with higher education rarely fall victim to violation which aligns with the findings of Li *et al.* [38]. This is not supported by the findings of Batool & Carsten [39] and Hussain *et al.* [40], who found that the level of education is not a determining factor for risky driving behaviour. However, poor knowledge of traffic regulations has been recorded as unsafe behaviour that causes RTA [41]. Furthermore, the study of Han & Zhao [15] found education level to have a negative relationship with driving violations, while Singh & Kathuria [16] reported bus drivers' education to be significant to road traffic crashes. The inconsistency could be due to differences in the educational style of the study locations. Although these studies have revealed relationships between the influence of educational level on risky driving behaviour and RTAs, the moderating effects of education level on risky driving behaviour and RTAs among bus drivers have not been extensively explored. Additionally, whether education level moderates the relationship between risky driving behaviour and RTAs among commercial bus drivers is still unknown.

Furthermore, most existing studies have focused on the general driving population in countries with effective road safety practices, good road infrastructure, and driving environments, with fewer studies on specific commercial drivers. Consequently, this makes the results from the general driving population lack validity in generalizing findings for all drivers, as different categories of drivers from different driving environments could have peculiar driving behaviours [42]. Also, differences in the sizes of vehicles can influence different driving behaviour [15], thus the need to examine the risky driving behaviours of specific commercial drivers. Compared to other categories of commercial drivers, bus drivers transport more passengers than taxis due to their sizes and affordability, implying that any chances of RTAs can result in more casualties and mortality than other road passenger vehicles like taxis.

Given the unique dimensions of buses and their passenger capacity, it is imperative to analyze the driving behaviour of commercial bus operators. This analysis is vital for identifying and enforcing tailored road safety strategies. Moreover, it is a pivotal responsibility to ensure the security of the many passengers and other road users who might be engaged in commercial bus operations. Furthermore, assessing hazardous driving behaviours facilitates an enhanced understanding of which actions profoundly impact road RTAs. This understanding, in turn, aids in implementing strategic corrective measures to prevent further escalation [16]. To the best of the authors' knowledge, the existing literature lacks a study on the influence of commercial bus drivers driving violations, driving errors, and inattention errors on accident involvement in Nigeria utilizing the DBQ and structural equation modelling (SEM) technique. Thus, this study addresses this gap by not only validating the DBQ for bus drivers but also investigating the influence of their risky driving behaviours (driving violation, driving errors, and inattention errors) on RTA involvement and examine the moderating effects of bus drivers driving experience and education level through the structural equation modelling approach.

1.2 Study Procedure

The study's methodology comprises DBQ development, data collection, and data analysis using SEM (Fig. 1).

1.3 Questionnaire Development

The questionnaire consists of three (3) parts: sociodemographic characteristics, driving behaviours, and road traffic crash experience. The first part covers the background variables of Nigerian professional bus drivers. This part contains the basic information about drivers (gender, educational background, driving experience, and accident involvement). The second part focuses on the DBQ, which is revised based on the driver behaviour scale developed by Han & Zhao [15], Mehdizadeh *et al.* [30], and Useche *et al.* [43]. The modified DBQ was used to examine the bus drivers' risky driving behaviours and involvement in traffic crashes.

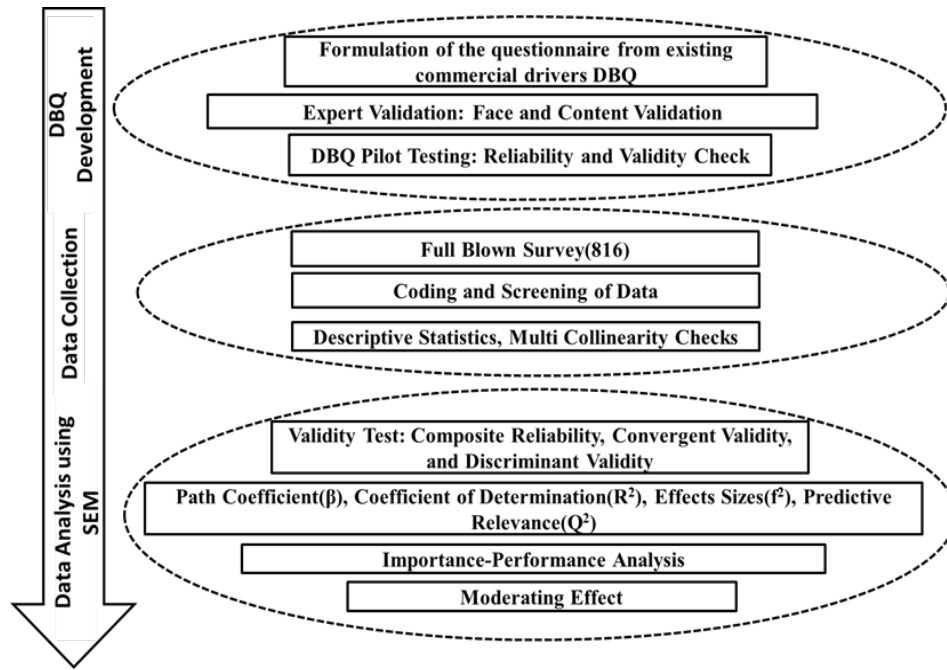


Fig. 1 Study procedure

1.3.1 Risky Driving Behaviour

The risky behaviours in the DBQ were categorized into driving violations, driving errors, and inattention errors, while the third part illustrates the traffic accidents bus drivers have been involved in over the past three years. The risky driver behaviour scale was used to examine driving violations, driving errors, and inattention errors. Basically, intention is the main justification for grouping items or behaviour as errors or violations. When the behaviour is with intention, it is termed violation; when it is without intention, it is called error. Generally, deliberate and aggressive violations are behaviours that involve defiance of stipulated road codes/rules that aid safety and result in conflict with other road users e.g., I use high beam light which throws drivers in front to confusion and not see clearly [44] while errors are usually not a disregard to driving and traffic rules, but involves action or decision that exposes a driver to danger, e.g., I sleep on steering when driving.

Violations are deliberate disregard for traffic or driving rules and can be associated with rule-based mistakes [45]. They include non-compliance to a traffic light or speed limit, car racing due to anger, indiscriminate use of horns to express disapproval to another driver, and ignoring red light warnings [46]. These were used to identify the frequency of the violations exhibited by the drivers.

Errors can be divided into slips, lapses, and mistakes, with slips resulting from inattention. Lapses emanate from memory failure, which is not intentional but does not usually result in crash involvements [47], e.g., forgetting where your car is parked. In other words, lapses are aberrations in concentration or attention to the driving task. In explaining errors, Chu *et al.* [48] agrees with Sucha *et al.* [49] that errors are planned actions or cognitive decisions that did not achieve the pre-planned goal or wrongly done activity departing from the original objective. This study included driving violations, driving errors, and inattention errors. The present study hypothesizes that:

- H1: Driving violations significantly influences road traffic accidents among bus drivers.
- H2: Driving error significantly influences road traffic accidents among bus drivers
- H3: Inattention error significantly influences road traffic accidents among bus drivers.
- H4: Risky driving behaviours (driving violations, errors, and inattention errors) significantly influence road traffic accidents among bus drivers.
- H5: Driving experience of bus drivers moderates the relationship between risky driving behaviours and road traffic accidents.
- H6: Educational level of bus drivers moderates the relationship between risky driving behaviours and road traffic accidents.

1.3.2 Content and Scale Validation

Experts in transport and academia reviewed the modified DBQ for face and content validity. The modified DBQ used in this study adapts the structure of Han & Zhao [15], Mehdizadeh *et al.* [30], and Useche *et al.* [43], aligning

questions with context-specific driving scenarios observed among Nigerian commercial drivers. Some items were suggested for rephrasing or deletion due to a lack of fit for the proposed bus drivers. For instance, the item "I forgot my bus where I parked it" was suggested for deletion as it doesn't influence accidents. The pilot test of the DBQ was also conducted on a small scale to ascertain the internal consistency and validity of the constructs. They were found to be reliable and valid. However, after the pilot test, one item, 'I do not notice that vehicles ahead intend to swerve left when trying to overtake,' was removed due to a lack of comprehension from respondents. Also, some items (relating to speed violations) loaded as driving errors, as found in the existing commercial drivers DBQ, were moved to driving violations because they connote driving violations in the Nigerian context based on the Nigerian highway code. These items include, "I deliberately disregard the speed limits in the night or very early in the morning, I disregard the speed limit on a residential road, and I disregard the speed limit on a freeway or rural highway."

1.4 Data Collection

The commercial bus drivers selected for this survey were registered commercial bus drivers in Nigeria. A brief explanation of the purpose of the survey and instructions on how to complete the questionnaire was provided to the drivers before the survey began. Moreso, the bus drivers were assured of anonymity and confidentiality of the survey to curtail biased responses. The study was conducted between April and October 2022, and prior approval was obtained from bus station authorities, government organizations, and logistics companies.

1.4.1 Sampling

The G* power software calculated the required sample size based on a linear multiple regression model. The effect size and power level were based on the recommendations from Hair *et al.* [50]. 831 bus drivers recruited through a purposive sampling procedure participated in the survey. Only 816 questionnaires were returned, while four (4) were excluded due to missing data. All the participants were commercial bus drivers in registered bus stations, logistic companies, and government institutions in Nigeria.

1.5 Data Analysis

1.5.1 Descriptive Statistics

To provide a concise summary of the data collected, SPSS 27 was used to process the data. The descriptive statistics were conducted to describe the sociodemographic characteristics of commercial bus drivers, namely gender, education level, driving experience, and accident involvement. Furthermore, the descriptive statistics (mean and standard deviations) for the Driver Behaviour Questionnaire (DBQ) were undertaken.

1.5.2 Multi-Collinearity Check

Common method variance (CMV) denotes potential bias (error) in data due to using a single-source method for data collection. A single-source method is an approach in which only a single data source is used to collect data (dependent and independent variables) for a study to make conclusions based on findings. This method may introduce some risk of methodological bias in the form of response or recall bias, thus limiting the findings' reliability, validity, and generalizability. In handling potential bias acknowledged from the single data source, the variance inflated factor (VIF) of the model variables was examined to detect any multi-collinearity issues associated with the data collected. This was done by regressing the variables against a common variable for the full collinearity test. A VIF of less than 5 indicates the absence of bias from single source data [51].

1.5.3 Model Assessment

Structural Equation Modelling (SEM) was used to validate the DBQ for a sample of commercial bus drivers in Nigeria and to predict the commercial drivers' involvement in road traffic crashes based on the risky driving behaviours reported. The SEM comprises the measurement model (reliability and validity test) and the structural model. In this study, the SEM package used was SmartPLS4.

The measurement model evaluated composite reliability, convergent, and discriminant validity to establish construct reliability and validity. Additionally, within the structural model, the analysis included significance level, path coefficients, Coefficient of determination (R^2), effect sizes (f^2), model's predictive relevance (Q^2), and importance-performance analysis (IPMA) for the risky driving behaviours of the bus drivers. Statistical significance was determined using a benchmark of P values < 0.05 . The moderating effects of driving experience and education level on the relationship between risky driving behaviours and accident involvement were also examined.

1.5.4 Model Theory

Based on the SEM theory [14], [50], x and δ are column q -vectors related to the observed exogenous variables (constructs) and errors, respectively, while y and ε are column p -vectors related to the observed endogenous variables and errors, respectively. The measurement models are defined in the equation (as shown in equations 1, 2 and 3) by the relationships between variables X and ξ , and Y and η while the model describing the link between variables ξ and η is referred to as the structural model.

Measurement Model

$$x = \Lambda_x \xi + \delta \tag{1}$$

$$y = \Lambda_y \eta + \varepsilon \tag{2}$$

Structural Model

$$\eta = B\eta + \Gamma\xi + \zeta \tag{3}$$

where,

B is the structure coefficient matrix (endogenous latent variables or construct),.

Γ is the structure coefficient matrix of the exogenous potential variable ξ , which reflects the effect of the exogenous potential variable ξ on the endogenous latent η . ζ is the error vector of the model.

2. Results

2.1 Sample Characteristics

The cross-sectional survey was conducted in Nigeria. In total, 816 bus drivers (776 males and 40 females) participated in the survey. As shown in Fig. 2, most bus drivers had secondary school education and were 31-43 years old (38.6%). The self-reported accident involvement shows that over 50% had been involved in traffic crashes, while those with four (4) to six (6) years of driving experience were more (30%). The descriptive statistics of the driver's behaviour are shown in Table 1.

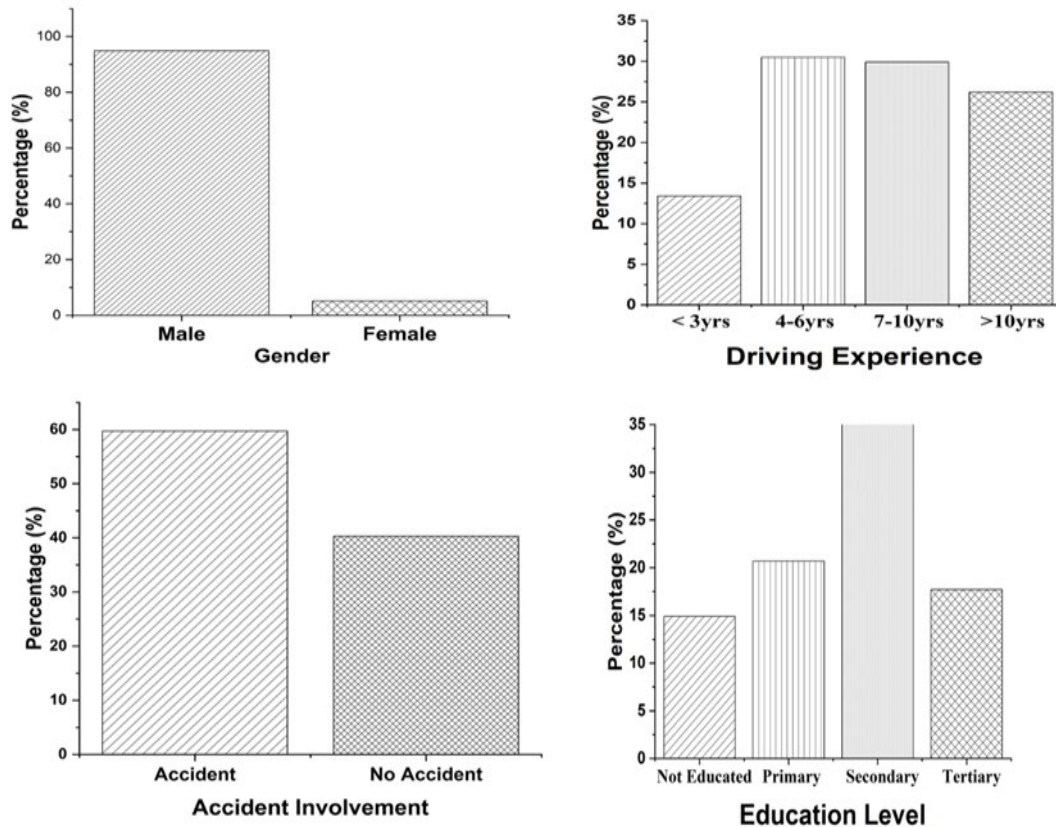


Fig. 2 Bus driver characteristics

Table 1 Descriptive statistics of DBQ for bus drivers (n=816)

| Item | Driving Behaviours | Mean (SD) |
|--------------------------------|--|------------|
| Driving Violations (DV) | | |
| DVBD1 | I get angry at a certain type of driver and express my anger any way I can, like cursing, angry gestures | 3.50(1.32) |
| DVBD2 | I keep driving ahead even when traffic light has turned red | 4.05(1.07) |
| DVBD3 | I answer and make calls with phones when driving | 3.54(1.08) |
| DVBD4 | I use my horn to show my annoyance to another road user | 3.17(1.22) |
| DVBD5 | I become angry at another driver and chase them with the intention of showing them how angry I am | 3.88(1.16) |
| DVBD6 | I do force my way into the traffic | 3.84(1.15) |
| DVBD7 | I take drug and alcohol immediately before or during driving | 4.09(1.15) |
| DVBD8 | I overload my vehicle with passenger and goods. | 3.79(1.19) |
| DVBD9 | I drive with expired driving license. | 3.57(1.38) |
| DVBD10 | I deliberately disregard the speed limits in the night or very early in the morning. | 3.69(1.20) |
| DVBD11 | I disregard the speed limit on a residential road. | 3.98(1.07) |
| DVBD12 | I disregard the speed limit on a freeway or rural highway | 3.68(1.16) |
| Driving Errors (DE) | | |
| DEBD13 | I do not look at the rear-view mirror when changing lanes or merging | 3.99(1.10) |
| DEBD14 | I underestimate the speed of the overtaking vehicles or the oncoming vehicles when overtaking or swerving left. | 4.01(0.96) |
| DEBD15 | I follow so close to the vehicle ahead that it is hard to apply brake in emergency | 4.09(1.03) |
| DEBD16 | I sudden break on a wet road or a road with bad conditions. | 4.06(1.00) |
| DEBD17 | I sleep on steering when driving | 4.31(1.00) |
| DEBD18 | I do not carry out maintenance on my vehicle at the right time | 3.87(1.17) |
| Inattention Errors (IE) | | |
| IEBD19 | I do suddenly apply brake due to failure of the vehicle ahead of me | 3.73(1.14) |
| IBDE20 | I do drive from the main road to the other street roads without paying attention to pedestrian, bicycle or vehicle | 3.98(1.08) |
| IEBD21 | I do forget turn on the indicator or signal light when turning. | 3.95(1.03) |
| IEBD22 | I brake too quickly on a slippery road or when it's raining | 4.00(1.03) |
| IEBD23 | I do switch on one thing, such as the headlights, when I meant to switch on something else, such as the wipers | 3.99(1.08) |
| IEBD24 | I realize that I have no clear memory of the road I have been travelling on | 4.16(0.99) |
| IEBD25 | I do hit something when reversing that I had not previously seen | 4.10(1.02) |

2.2 Multi-Collinearity Assessment

The data for this study was collected using a single source that could raise concerns about common method variance; thus, VIF was checked to assess the CMV. Therefore, based on the recommendation of Marcoulides & Raykov [52], the common method bias was examined by testing the full collinearity of the dependent and independent variables. The variables regressed against a common variable, and the result (Table 2) indicated that

single-source bias did not affect the data collected as the VIF was less than 5 [51], [52]. Therefore, based on the results of the VIF for the variables, common method variance is not a significant issue in this study.

Table 2 Full collinearity testing

| Variables | Driving Violation | Driving Error | Inattention Error | Accident Involvement |
|-----------|-------------------|---------------|-------------------|----------------------|
| VIF | 2.064 | 1.806 | 2.170 | 1.071 |

2.3 Measurement Model

In the measurement model, assessments for reliability (Composite Reliability and Cronbach Alpha), validity (average variance extracted (AVE), and discriminant validity were performed, as shown in Table 3. The internal consistency reliability analysis through Cronbach's alpha, which ranged from 0.751 to 0.915 for the commercial bus driver, shows the reliability of the DBQ. A more reliable measure, composite reliability, was examined and found to be greater than 0.7, indicating good reliability for the scale. The composite reliability values for the bus drivers driving violations, driving errors, inattention error, and accident involvement are 0.865, 0.755, 0.815, and 0.946, respectively, greater than the minimum limits (0.7). The AVE values of the driving violations, driving errors, driving inattention, and accident involvement were 0.533, 0.536, 0.507, and 0.853, respectively, and exceeded the threshold value 0.50 [53].

Table 3 Reliability and validity of DBQ for bus drivers

| Variables | Items | Loading | CR | CA | AVE |
|---------------------------------------|---------------------------|---------|-------|-------|-------|
| Bus Driver Driving Violations (DVBD) | DVBD 5 | 0.709 | 0.850 | 0.780 | 0.533 |
| | DVBD 6 | 0.758 | | | |
| | DVBD 7 | 0.766 | | | |
| | DVBD 8 | 0.730 | | | |
| | DVBD 11 | 0.680 | | | |
| Bus Driver Driving Error (DEBD) | DEBD 13 | 0.603 | 0.815 | 0.711 | 0.527 |
| | DEBD 14 | 0.731 | | | |
| | DEBD 15 | 0.813 | | | |
| | DEBD 16 | 0.742 | | | |
| Bus Drivers Inattention Errors (IEBD) | IEBD 20 | 0.625 | 0.815 | 0.858 | 0.504 |
| | IEBD 21 | 0.663 | | | |
| | IEBD 22 | 0.739 | | | |
| | IEBD 23 | 0.718 | | | |
| | IEBD 24 | 0.764 | | | |
| Accident Involvement (BDAI) | IHABD (Accident Period) | 0.923 | 0.946 | 0.915 | 0.853 |
| | WABD (Accident Type) | 0.930 | | | |
| | HSABD (Accident Severity) | 0.917 | | | |

CR=Composite Reliability, CA=Cronbach Alpha, AVE=Average Variance Extracted

Inter-factor correlations were examined using the Heterotrait Monotrait Ratio (HTMT) and compared with the squared correlations of the model's two (2) driving behaviour constructs to establish discriminant validity. The HTMT values were less than 0.90, indicating good discriminant validity (Table 4). Fig. 3 shows the estimated parameters of the influence of driving violation, driving error, and driving inattention constructs on accident involvement among commercial bus drivers.

Table 4 Reliability and validity of DBQ for bus drivers

| Constructs | DEBD | DVBD | IEBD |
|------------|-------|-------|-------|
| DVBD | 0.773 | | |
| IEBD | 0.820 | 0.870 | |
| BDAI | 0.194 | 0.207 | 0.162 |

Inclusion criteria: HTMT < 0.9

2.4 Structural Model Assessment

2.4.1 Risky Driving Behaviour Path Analysis

Fig. 3 shows the estimated parameters of the influence of driving violation, driving error, and driving inattention constructs on accident involvement among commercial bus drivers.

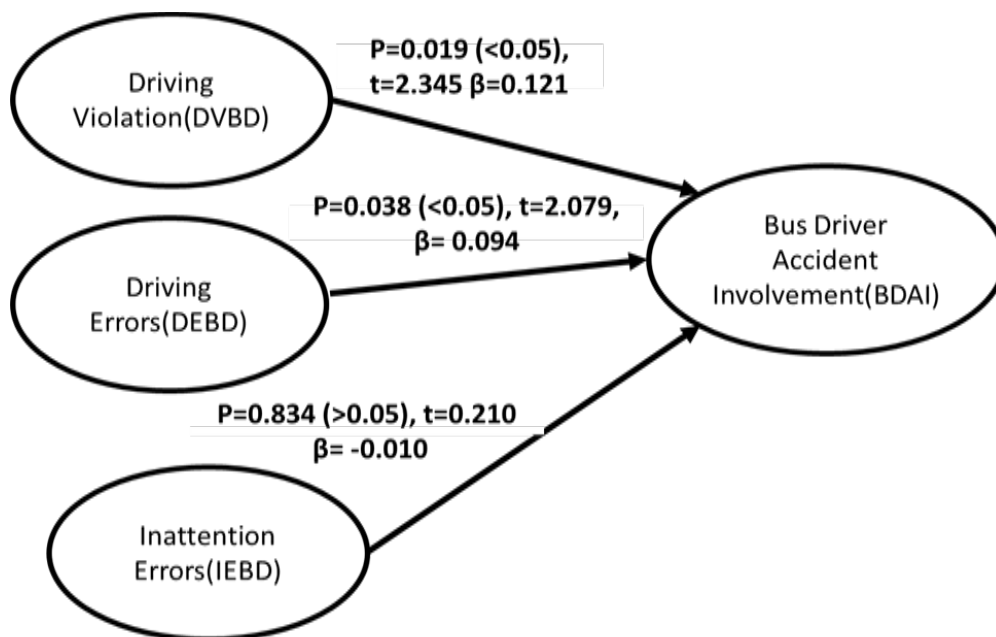


Fig. 3 Risky driving behaviour constructs for commercial bus drivers

From Fig. 3, it is found that both the driving violation ($\beta=0.121$, $t=2.345$, $p=0.019$) and driving errors ($\beta=0.094$, $t=2.079$, $p=0.038$) significantly affect the crash involvement while inattention errors were insignificant to the crash involvement ($\beta=-0.010$, $t=0.210$, $p=0.834$). Also, Fig. 4 shows the estimated parameters of the influence of commercial bus drivers' total risky driving behaviours on their involvement in road traffic accidents. The results showed a significant relationship between the total risky driving behaviours of the bus drivers and their involvement in road traffic crashes ($\beta=0.173$, $t=4.910$, $p=0.000$).

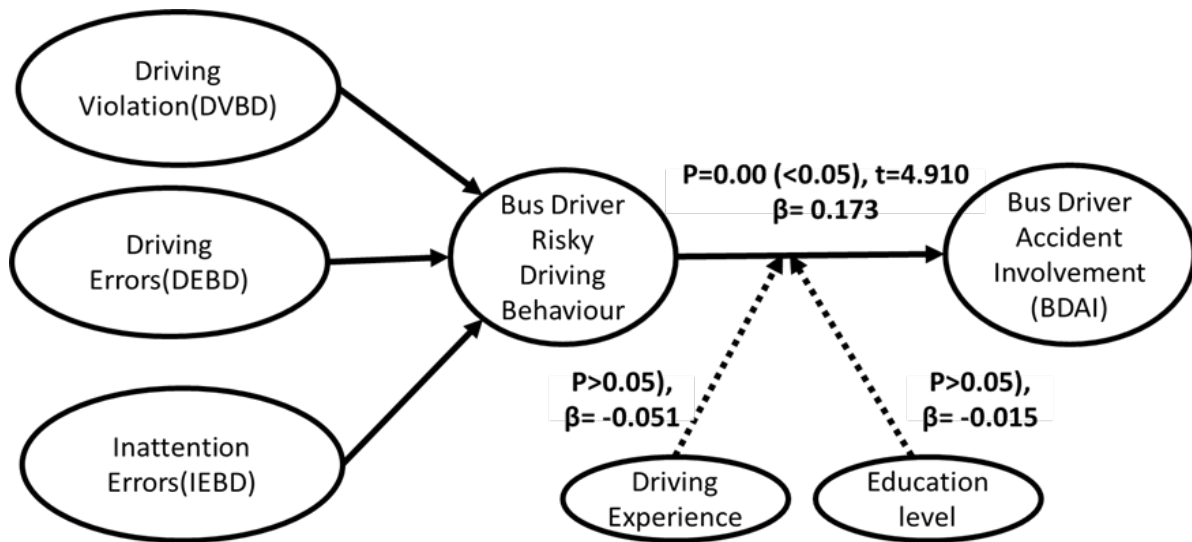


Fig. 4 Total risky driving behaviour model

2.4.2 Prediction Model

Table 5 shows the Coefficient of determination (R-Squared) and effect sizes (f^2), indicating the predictive capability of risky driving behaviours exhibited by the bus drivers in relation to their involvement in road traffic accidents. The effect size is greater than 0.02, while the R^2 is 4%.

Table 5 Reliability and validity of DBQ for bus drivers

| Constructs | R-square | Effects Size of Predictors | Predictive Relevance (Q^2) |
|------------|----------|----------------------------|--------------------------------|
| BDAI | 0.040 | 0.036 | 0.034 |

BDAI=Bus Driver Accident Involvement, TAAI=Taxi Drivers Accident Involvement, TKDAI= Truck Drivers Accident Involvement

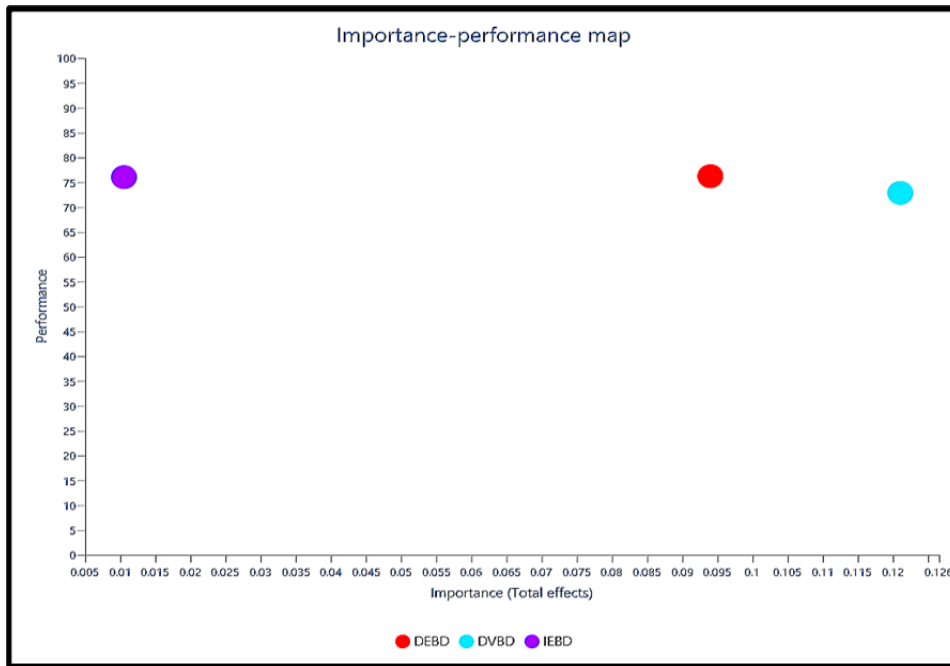
The predictive relevance of this study was assessed using the PLSpredict, and the result (Table 5) showed that the Q^2 value is 0.034 for bus driver models, revealing a good model ($Q^2 > 0$) as the Q^2 is greater than zero, which is the benchmark for predictive relevance. The implication of $Q^2 > 0$ in this assessment of bus driver models holds great significance. It signifies that the employed model performs admirably and is considered a good model [50]. The fact that Q^2 surpasses zero suggests that the model can somewhat explain and predict the observed data. This affirmative value exemplifies that the model possesses a certain level of precision in its predictions, which is promising for future applications.

Also, the Q^2 value exceeding zero implies that the bus driver model outperforms a random predictor or a model with a negative Q^2 . In other words, the model used for this study has the potential for predicting with accuracy and can provide useful insights when applied to new driving behaviour data. These implications highlight the robustness and utility of the model in assessing and comprehending bus driver conduct. This suggests that the accident prediction models developed for Nigerian commercial buses can be adopted to predict the traffic accident involvement for commercial bus drivers in Nigeria to make relevant safety decisions regarding their risky driving behaviours.

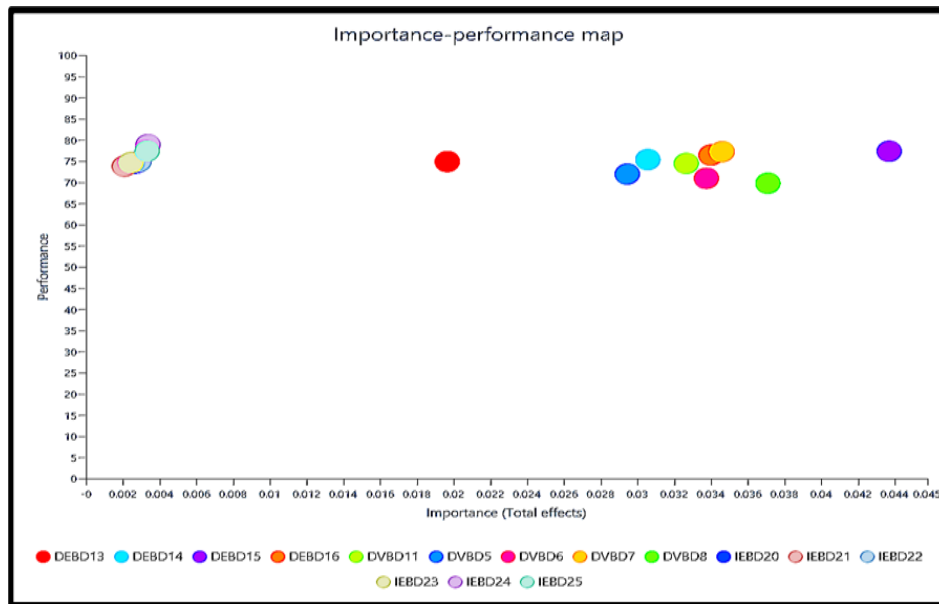
2.4.3 Importance -Performance Analysis (IPMA)

The IPMA results for commercial bus drivers reveal that driving violations, driving errors, and inattention exhibit performances of 73%, 77%, and 77%, while the order of importance is 0.123, 0.093, and 0.012, respectively (Fig. 5a). Although the performance rankings for all three driving constructs are relatively high, the result suggests that driving errors and inattention (77%) are the more prevalent risky behaviours, slightly surpassing violations. However, when considering the level of importance, driving violations emerge as the most important factor (importance ranking 0.123). This implies that, despite the higher performance of driving errors and inattention (77%), driving violations are deemed more crucial in terms of overall impact. In other words, when addressing road safety issues, prioritizing the mitigation of driving violations, which has the highest importance ranking (0.123) based on the results, would have the most substantial influence on drivers in preventing road traffic

accidents. Furthermore, the importance-performance based on the individual driving behaviours of the bus drivers (Fig. 5b) shows that in terms of performance and importance, the driving behaviour (DEBD 15) "I follow so close to the vehicle ahead that it is hard to apply brake in an emergency" performs better (77%) and of highest importance (0.0439) concerning accident causes compare to other specific driving behaviours among bus drivers. This implies close following driving among bus drivers ranks highest for driving behavioural consideration in curtailing RTA increase.



(a)



(b)

Fig. 5 (a) Importance-performance map for commercial bus drivers' behaviour constructs; (b) Importance-performance map for commercial bus drivers' specific behaviour

2.4.4 Moderating Effect

The effect of commercial vehicle drivers driving experience shows (Table 6, Fig. 4) that driving experience has an insignificant ($p > 0.05$) moderating role on commercial bus drivers. Similarly, the educational level of the bus drivers had no significant ($p > 0.05$) moderating effect on the commercial bus driver's risky behaviour and RTAs (Table 6, Fig. 4).

Table 6 Reliability and validity of DBQ for bus drivers

| Moderating Relationship | Original Sample | T Statistics | P values |
|-------------------------|-----------------|--------------|----------|
| DEXBD x BRDB -> BDAI | -0.051 | 1.465 | 0.143 |
| ELBD x BRDB -> BDAI | -0.015 | 0.462 | 0.644 |

DEXBD-Bus driver driving experience, ELBD-Bus Drivers Education Level, BRDB-Bus Driver Risky Behaviour, BDAI-Bus Driver Accident Involvement

3. Discussion

The study used the structural equation modelling approach to examine the relationship between risky driving behaviours among commercial bus drivers and road traffic accident involvement. Our findings indicated that driving violations and driving errors showed a significant and strong relationship to road traffic accident involvement, while inattention errors were insignificant. Driving violations among the bus drivers rank highest in order of priority for mitigating the increase in RTA. Also, driving experience and education level did not moderate risky driving behaviour and accident involvement relationships among commercial bus drivers.

3.1 Influence of Driving Violation on Accident Involvement

The significant influence of driving violations on RTA suggests a strong relationship between driving violations and accidents, as the higher the violation by commercial bus drivers, the more accidents they are involved in. This confirms hypothesis 1. A strong driving violation and accident involvement relationship among the bus drivers could be due to long hours of driving, which often culminate into fatigue, impaired judgement, and poor reaction time that can result in driving violations and more probability of RTA involvement. Bus drivers' operational conditions involving unfavourable schedules and strict adherence, gridlocks, and traffic congestion are likely to cause violations. Our results suggest bus driver violations may stem from unfavourable schedules and driving pressures, increasing the risk of road traffic accidents. This is in line with the results of Zhang *et al.* [18], Singh & Kathuria [16], and Zheng *et al.* [17], who found violations significantly increased the chances of RTA among bus drivers. However, in a study in Sweden, driving violations had no effect [55]. The disparity in findings could be due to study locations, as Sweden is a developed country with good road infrastructure and a low accident rate compared to Nigeria, which has poorly maintained roads. It can also be deduced that DVBD7 (I take alcohol and drugs while driving) had the highest indicator loading for bus driver driving violations to construct. It has a strong relationship with RTAs among commercial bus drivers, which is in line with the findings of Oluwadiya *et al.* [56] on general drivers in Nigeria.

3.2 Influence of Driving Error on Accident Involvement

The significant relationship between driving error and RTA among bus drivers in Nigeria supports hypothesis 2. This may arise from varying reasons, such as inadequate knowledge of blind spots or other road hazards that may have increased the error tendencies, especially in Nigeria, where most roads are bad and poorly maintained. Bus drivers' errors could also be traced to inexperience, which could cause misjudging of vehicle distance and tailgating. This could lead to bus drivers exhibiting errors because of limited knowledge to anticipate accident risk. The findings concur with the findings of Af Wählberg *et al.* [55], who found driving errors to increase with RTAs among bus drivers. Also, Han and Zhao [15], reported a significant relationship between driving errors and RTA for bus drivers. In contrast, driving errors did not reflect any influence on RTA in the study of Zhang *et al.* [18]. Similarly, the error factor was insignificant to RTA among bus drivers in China, as found by Wang *et al.* [29]. Variations in findings may be linked to the difference in the type of bus drivers examined, especially variations in the training the bus drivers had received. The bus drivers in China might be exposed to more professional training than the Nigerian bus drivers.

3.3 Influence of Inattention Error on Accident Involvement

Previous studies indicate that inattention errors among drivers can influence accident involvement [15], [22]–[24], [57], [58]. Unlike previous studies, which have found a significant influence of inattention on RTA, this study found an insignificant influence of inattention error on RTA among bus drivers; thus hypothesis 3 is not supported. There are several reasons why there may not yet be sufficient support for this finding. First, the insignificant relationship may be due to the bus drivers' experience, which makes them able to handle errors due to inattention. It is also likely that the bus drivers drive adequately maintained and road-worthy buses with firmly fitted brakes and good tires, which can be easily manoeuvred in case of emergency or crashes, compared to buses that are not road-worthy. Furthermore, variation in results may be due to differences in the driving environment in which the studies were conducted. China, for instance, has a good road infrastructure, which could instigate the drivers not to pay much attention on the road, unlike Nigeria, where there are poor and inadequate road infrastructures that require bus drivers to be more careful in addition to other factors that demand their attention while driving.

3.4 Effects of Risky Driving Behaviours

The total combination of driving violations, driving errors, and inattention errors as risky driving behaviours exhibited by bus drivers reveal a strong significant influence on their RTAs involvement, confirming hypothesis 4. This aligns with the findings of Wang *et al.* [6] that bus drivers are characterized by risky driving behaviour involving speed violations and distractions which could contribute to RTAs. The potential justification could be due to their driving schedules and frequent long driving hours on the road, exposing them to situations that could result in RTAs. In some instances, the drivers rarely rest, culminating in stress and fatigue, exposing them to driving behaviours that cause RTAs. However, the relationship between the bus drivers' risky driving behaviour and RTA involvement appears weak. The effect size of the bus drivers' risky driving behaviours suggests a small effect of risky driving behaviours in their accident involvement. This may be because accidents involving them result from other factors like environmental factors, as suggested by Agyapong & Ojo [59], who found that environmental factors were highly significant in causing RTAs. This is supported by the findings of La *et al.* [60] that bus drivers' behaviours are not the sole RTA contributors; there are other factors. However, risky driving behaviour accounts for 4% of road traffic accidents among bus drivers, a small percentage consistent with the study of Nasri & Aghabayk [8], who found that the percentage of RTA contributed by bus drivers is small. The Low R^2 values are common in SEM behavioural models, especially when unobserved external factors such as environmental or vehicle conditions are excluded. However, the possibility for an increase cannot be downplayed as road traffic accidents have been reported daily in Nigeria [61], resulting in the maiming of lives and loss of properties. This suggests the need to put proper strategic measures in place to ensure RTA contributions from the bus drivers do not record any increase due to their risky driving behaviours.

3.5 Importance-Performance of Risky Driving Behaviours

The importance-performance analysis suggests that RTAs will increase by 0.12 with increased driving violations. It signifies the construct with the highest importance and high performance, indicating that driving violation is risky behaviour that needs to be prioritized for addressing RTA issues among commercial bus drivers in Nigeria, especially for substantial RTA reduction. This concurs with the findings of Han and Zhao [15] and Mallia *et al.* [62] on bus drivers who observed bus drivers exhibit driving violations more than other risky driving behaviours. Also, on the driving behavioural item level, the IPMA reveals that the item DEBD15, i.e., "I follow so close to the vehicle ahead that it is hard to apply brake in an emergency," is the driving behaviour that will increase RTA by 0.044 with a unit increase in performance. This implies that driving too close to vehicles, otherwise known as tailgating, is driving behaviour that reflects the most influencing driving behaviour and significantly predispose bus drivers to RTA involvement which indicates the most important behavioural item to be addressed for the bus drivers to curtail RTAs. This is consistent by the study of Zemanek & Jiri Prnka [63], that not observing adequate following distance could result in RTAs. This is because driving too close to a vehicle could make braking difficult if the vehicle ahead decides to do an emergency stop.

3.6 Moderating Effect of Driving Experience and Education Level

The insignificant moderating effect of driving experience on bus drivers suggests hypothesis 5 is to be rejected. The driving experience is insignificant, perhaps because Nigerian bus drivers may have become complacent in driving due to habitual driving in the same driving environment, thus limiting the influence of their experience on risky driving behaviour and accident involvement. The insignificant effect of the driving experience confirms the study of Wang *et al.* [29]) that driving experience was insignificant to RTA for bus drivers. The finding is in contrast to the studies of Zuobo Zhang *et al.* [18], Singh and Kathuria [16], and Zheng *et al.* [17], in which driving experience

was found to be significant to safety and thus reduces accidents among bus drivers. The disparity in findings may be traced to differences in the driving culture and environment in which the studies were done.

Furthermore, the insignificant moderating effect of bus drivers' educational level on risky driving behaviour and accident involvement suggests hypothesis 6 is not supported. The result suggests education may not be a determining factor for risky driving behaviour among bus drivers because both educated and uneducated bus drivers do not show any difference in exhibiting risky behaviours in Nigeria. Also, driving among bus drivers may be seen as an individual perception, which may have been developed based on culture and environment rather than their education level. The insignificant moderating effect of educational level aligns with the findings of Batool & Carsten [39] that educational level is not associated with risky driving behaviour, which is in variation with the study of Han and Zhao [15], who reported education level as having a negative relationship with driving violations. Also, Singh and Kathuria [16] found bus drivers' education significant to road traffic crashes. The inconsistency could be due to differences in the educational style of the study locations.

4. Application of Findings

Most of the road safety interventions in Nigeria are generic in application, ranging from enforcement, policy, and training, which limits the mitigation of road traffic accidents. The current findings suggest that specific strategies to curtail RTAs for vehicle types could be adopted. This is in addition to prioritizing risky driving behaviours regarding violations, errors, and inattention errors to address quick intervention among bus drivers. The study suggests that driving violations and errors should be considered to reduce RTAs. Furthermore, most of the curriculum in training drivers is generic in context without tailor-made training that focuses on handling driving violations, overcoming driving errors, and curtailing inattention errors. The findings from this study can aid driver trainers in developing training for bus drivers to address the risky driving behaviours associated with them, as found in the current study. Additionally, findings suggest the formal education system can be enhanced by inculcating road safety in all school-level curricula to ensure that irrespective of drivers' education level, their driving behaviours are significantly influenced in promoting driving and road safety. Retraining drivers after certain years of driving before license renewal can also be introduced and enforced to ensure that the driving experience improves with relevant training that impacts safety.

5. Conclusion and Future Directions

This paper validated the professional DBQ for commercial bus drivers and examined the influence of their risky driving behaviours on road traffic accident involvement. The study found that driving violations have more influence on the risky driving behaviour of bus drivers than their driving errors, unlike their inattention errors, which were insignificant in causing RTAs. Strategic measures that could aid in alleviating the exhibition of risky driving behaviours, especially driving violations, will go a long way to curtail the RTA propensities among bus drivers. Some measures could include adequate enforcement of driving safety codes, strict sanctions on aberrant drivers, and adopting specialized bus drivers' training and retraining. The current findings provide novel insight into identifying specific bus driver behaviour that requires intervention in terms of importance and performance that bus transport employers and relevant government agencies could address. Also, the insignificant moderating role of driving experience and education level on the drivers' behaviours reveals having driving experience or a high educational background may not lead to driving safety. However, other sociodemographic factors may significantly influence their risky driving behaviour and RTA involvement. This study only focuses on commercial bus drivers; therefore, examining the influence of risky driving behaviours on road traffic accident involvement for other categories of drivers (e.g., trucks and taxis) using the structural equation modelling is recommended. Also, since the data collected are specifically from commercial bus drivers, it implies a deficiency in generalizing the findings for all categories of commercial drivers. Future studies may consider examining the importance-performance of driving anger, fatigue, and risky behaviours among bus drivers to aid in prioritizing driver characteristics for more effective road traffic accident mitigation.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Taiwo Austine Olusegun, Sitti Asmah Hassan, Norashikin Mahmud, Rahmat Bin Mohsin; **data collection:** Taiwo Austine Olusegun ; **analysis and interpretation of results:** Taiwo Austine Olusegun, Sitti Asmah Hassan; **draft manuscript preparation:** Taiwo Austine Olusegun, Sitti Asmah Hassan. All authors reviewed the results and approved the final version of the manuscript.

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