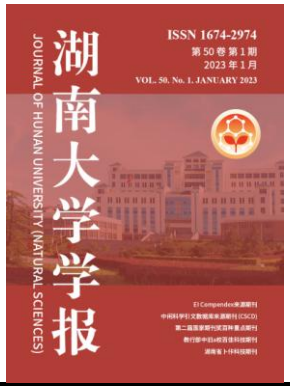

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Validation of Driver Behavior Questionnaire on Nigerian Truck Drivers: A Structural Equation Modeling Approach

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Abstract: Driving behavior questionnaires (DBQs) are widely used in driving research. There has been mixed support for the scale in several countries worldwide. Hence, this study examined the validity and reliability of the driver behavior questionnaire (DBQ) among a large sample of Nigerian commercial truck drivers. The structural equation modeling method was used to analyze the composite reliability and construct validity (Average Variance Extracted (AVE) and Heterotrait-Monotrait ratio). The authors found the constructs' composite reliability, convergent validity, and discriminant validity to be above 0.7, 0.5, and below 0.9, respectively, showing that they are valid and reliable for the sample of Nigerian commercial truck drivers. The novelty of this result is that the driver behavior questionnaire can be used to achieve consistent and valid results for a study of commercial truck drivers' behavior in Nigeria toward achieving RTA reduction.

Keywords: driver behavior questionnaire, truck drivers, reliability, validity.

尼日利亚卡车司机司机行为问卷的验证：一种结构方程建模方法

摘要：驾驶行为问卷(数据库查询)广泛用于驾驶研究。全球多个国家对这一规模的支持褒贬不一。因此，本研究在大量尼日利亚商用卡车司机样本中检验了驾驶员行为问卷(数据库查询)的有效性和可靠性。 采用结构方程建模方法分析复合信度和结构效度（平均方差提取（AVE）和异性-单性比）。作者发现这些结构的综合信度、收敛效度和区分效度分别高于 0.7、0.5 和低于 0.9，表明它们对尼日利亚商用卡车司机样本有效且可靠。该结果的新颖之处在于，驾驶员行为问卷可用于研究尼日利亚商用卡车驾驶员实现实时传输协议减少的行为，从而获得一致且有效的结果。

关键词：司机行为问卷，卡车司机，信度，效度。

1. Introduction

Trucking services are the bedrock for boosting economic growth because many goods are transported from one place to another with truck vehicles. Globally, the necessity of trucks for transport cannot be over-emphasized as they are a notable means of road transport. In other words, their contribution to ensuring door-to-door delivery of goods and services is unquantifiable; for instance, China's economy is strengthened by trucking, which aids in transporting the bulk of the goods produced [1]. Nevertheless, the significant contribution of truck services in boosting cargo transport and economic growth is not without some safety concerns owing to the increasing crash injuries and fatalities they cause [2].

Despite the essential trucking services, increasing road traffic death and injuries stem from truck drivers [3]. According to [4], over a hundred thousand injuries and four thousand road traffic deas have been linked to increased truck crashes in the United States. Similarly, truck crashes in the US resulted in over four thousand fatalities in 2020 [5].

Fatalities from truck crashes outweigh passenger vehicles [6], making the resultant effect more damaging in terms of loss, degree of injury sustained, and damage to lives and properties [6]. This may be attributed to the size of truck maneuverability technicalities and truck drivers' behavior. Human behaviors are a precursor to over 80% of road traffic crashes [7]. It is not uncommon to find truck drivers driving for longer hours than permitted, as their monetary gains depend on the number of goods delivered [8].

The rate of road traffic crashes in developing countries is not decreasing as there is a continuous rise having a 90% share of the global RTA [7]. According to [9], over 2500 lives have been maimed or claimed due to truck crashes in Nigeria. Similarly, a minimum of two lives are lost, while over 15 are injured in every road traffic accident in Nigeria [10]. This may result from overspeeding, mechanical failure, aberrant driving behavior, and other driving violations [11]. It may be safe to assert that the constant truck crashes in Nigeria negatively impair the profits and growth of haulage companies as goods transported could be more expensive than trucks. Thus, an unabated truck accident may force haulage companies out of the transport business. This necessitates identifying critical behaviors that are precursors to RTAs caused by commercial truck drivers in Nigeria.

Even though the significant economic contribution of truck drivers in Nigeria to transporting goods and services locally and in Sub-African regions cannot be denied [12], considering the losses truck crashes cause to the economy of nations, research on truck drivers' behavior toward ensuring safety is expedient. Therefore, validating a driver behavior measurement scale for truck drivers in Nigeria is critical. Specifically, over 85% of truck accidents result from drivers' behavior [13]. This motivates the need to validate a suitable driving behavior questionnaire (DBQ) for Nigerian commercial truck drivers whose involvement in RTAs is usually more fatal due to truck complexity in terms of size and weight [8].

The Driving Behaviour Questionnaire (DBQ), used worldwide in different cultures, can examine driving habits potentially resulting in RTAs. It has been demonstrated that DBQ can explore the elements that cause drivers to behave in specific ways and how likely they are to be involved in road traffic accidents [14]. However, its adoption for Nigerian commercial truck drivers has not been investigated [15].

This study aims to validate the driver behavior questionnaire (DBQ) for a sample of Nigerian commercial truck drivers. Previous research on driver behavior in Nigeria using the DBQ focused on the general driving population [16] and general commercial drivers [15]. This limits their findings as driving behavior cannot be generalized for all drivers [14], hence the need for a validated scale for a specific class of Nigerian commercial drivers, especially truck drivers. To the best of the authors' knowledge, no validation study for DBQs has been performed specifically for commercial truck drivers in Nigeria using structural equation modeling. This study will assist in using the DBQ to critically evaluate the risky driving behavior of commercial truck drivers that may lead to RTAs in Nigeria and assist in mitigating measures.

2. Materials and Method

2.1. Survey Instrument

The driver behavior questionnaire used for data collection is a 30-item DBQ from previous commercial drivers' studies. Some items were reworded to ease understanding for the respondents (Fig. 1). The survey scale includes commercial truck drivers' sociodemographic factors (gender, marital status, driving experience, educational background, age, dependents who attended driving school, and daily driving hours), accident history (accident involvement, severity, and type), and their driving behaviors (risky and positive driving behaviors). The driving behavior questions focus on the frequency with which a commercial truck driver engages in risky and safe driving behaviors.

Furthermore, four constructs, including driving violations, driving errors, inattention errors, and positive driving behavior, were used to categorize the commercial drivers' driving behavior. The driving behaviors that are related to risky driving include "I

drive with an expired license," "I deliberately violate the speed limits at night or very early in the morning," "I violate the speed limit on a residential road," and the like, while behavioral items such as "I keep the lane clear and do not impede vehicles behind," "I ensure not to obstruct other road users while parking by the road," and "I try to avoid indiscriminate use of horn while driving," are related to positive driving behaviors, with each item in the survey graded on a scale of 1 = never to 5 = always.

2.2. Data Collection Procedure

This study was conducted between April 2022 and October 2022 in some of Nigeria's major economic states, which serve as important transit hubs for the nation. Commercial truck drivers were purposively selected from the government-approved truck stations, the transportation and logistics companies, and some government institutions in Nigeria. Criteria for participation in the study were based on respondents' registration as commercial truck drivers in Nigeria. The consent of the participants was sought after briefing on the research objective before filling out the questionnaires. The less educated had the questions read to ensure everyone was kept informed. Sample sizes for the study were calculated with G power software and Krejci and Morgan's Table. The data for this study consisted of 880 truck drivers who responded to the driver behavior questionnaire (DBQ).

2.3. Data Analysis

The descriptive characteristics of the data collected were computed using SPSS 25 after data coding. Structural Equation Modelling software, SmartPLS4, was employed to examine the construct's reliability and validity, which is the measurement model assessment of the scale (Fig. 1). The internal consistency of the scales for truck drivers was evaluated using composite reliability and Cronbach's alpha. Simultaneously, the construct validity was assessed using convergent and discriminant validity, considering the minimum value of 0.5 and the maximum value of 0.9, respectively. A construct's degree of convergence to explain the variance of its items was assessed using convergent validity [17]. Contrarily, discriminant validity demonstrates how distinct and distinct from other constructs in the structural model a construct is from other constructs empirically.

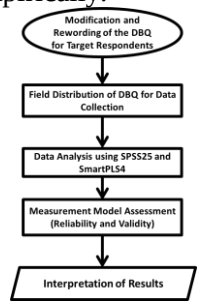

Fig. 1 Schematic representation of the study (Developed by the authors)

2.3.1. Structural Equation Modeling (SEM)

SEM is a combination of factor analysis and route (path) analysis and an extension of regression [18]. It aids a researcher in analyzing the interrelationships among variables (similar to a factor analytic approach) and testing hypothesized correlations among constructs [19]. Furthermore, a simultaneous test of interrelationships can be done using SEM, making it better than the traditional data analytic methods [19]. SEM also differs from other statistical approaches because it allows researchers to combine several measures and reduce measurement errors associated with data [21]. The test of interrelationships in SEM is confirmatory since a priori specification of interrelationships is set [19].

The measurement models are the first focus of model assessment comprising the reliability and validity of the construct measurements, which was assessed by considering PLS-SEM estimations. The composite reliability is used to determine the reliability of the construct because it gives a more accurate and reliable value than Cronbach's alpha [17], which produces lower values and the items are unweighted, making it a less precise measure of reliability [17]. This (composite reliability) was used in this study to examine the reliability of the constructs.

Reflective measurement model assessment also addresses the convergent validity of each construct measure, which is the degree to which a construct converges to explain the variance of its items [17]. The average variance extracted (AVE) for all items in each construct is used to assess convergent validity. A value of 0.50 or high indicates that the construct explains at least 50% of the variance among its elements [18]. Assessment of discriminant validity follows the convergent validity, the degree to which a construct is empirically unique and different from other constructs in the structural model, thus capturing phenomena not represented by other constructs.

3. Results

3.1. Participant Characteristics

Descriptive statistics reveal that commercial truck drivers were 91.1% male and 8.9% female, where 64.0% of them were involved in a road traffic collision. Most drivers had over seven years of driving experience. Table 1 shows the descriptive statistics of the DBQ for commercial truck drivers.

Table 1 Descriptive statistics of DBQ for commercial truck drivers (n = 880) (Developed by the authors)

Item	Driving Violations (DV)	Mean (SD)
DVTKD18	I get angry at a certain type of driver and express my anger any way I can, like cursing, angry gestures	3.12(1.37)
DVTKD19	I keep driving ahead even when the traffic light has turned red	4.32(0.91)

DVTKD20	I answer and make calls with phones when driving	3.21(1.20)
DVTKD21	I use my horn to show my annoyance to another road user	3.28(1.14)
DVTKD22	I become angry at another driver and chase them with the intention of showing them how angry I am	3.79(1.09)
DVTKD23	I do force my way into the traffic	3.81(1.12)
DVTKD24	I take alcohol immediately before or during driving	3.89(1.20)
DVTKD25	I overload my vehicle with passengers and goods.	3.80(1.11)
DVTKD26	I drive with an expired driving license.	4.06(1.07)
DVTKD27	I deliberately disregard the speed limits in the night or very early in the morning.	3.85(1.00)
DVTKD28	I disregard the speed limit on a residential road.	4.11(1.00)
DVTKD29	I disregard the speed limit on a freeway or rural highway	3.60(1.22)
Inattention Errors (IE)		
IETKD30	I do suddenly apply a brake due to failure of the vehicle ahead of me	3.55(1.24)
IBTKD31	I do drive from the main road to the other street roads without paying attention to pedestrians, bicycles, or vehicles	4.14(1.04)
IETKD32	I do forget turn on the indicator or signal light when turning.	4.15(1.25)
IETKD33	I brake too quickly on a slippery road or when it's raining	3.72(1.08)
IETKD34	I do switch on one thing, such as the headlights, when I meant to switch on something else, such as the wipers	3.94(1.03)
IETKD35	I realize that I have no clear memory of the road I have been traveling on	3.99(1.01)
IETKD36	I do hit something when reversing that I had not previously seen	3.92(1.08)
Positive Driving Behaviours (PDB)		
PDTKD37	I like to pay attention and avoid splashing the water to the pedestrians when driving.	2.19(1.30)
PDTKD38	I do keep the lane clear and do not hinder vehicles behind.	1.95(1.12)
PDTKD39	I try to avoid indiscriminate use of a horn while driving	2.18(1.23)
PDTKD40	I ensure not to obstruct other road users while parking by the road	1.88(1.12)
PDTKD41	I do keep a safe following distance while driving	1.95(1.17)
Driving Errors (DE)		
DETKD42	I do not look at the rear-view mirror when changing lanes or merging	4.07(1.16)
DETKD43	I underestimate the speed of the overtaking or oncoming vehicles when overtaking or swerving left.	3.83(1.16)
DETKD44	I follow so close to the vehicle ahead that it is hard to apply the brake in emergency.	3.98(1.04)
DETKD45	I sudden break on a wet road or a road with bad conditions.	3.70(1.10)
DETKD46	I sleep on steering when driving	4.63(0.75)
DETKD47	I do not conduct maintenance on my vehicle at the right time	3.79(1.26)

The Truck Driver Behaviour Model had second-order constructs (Fig. 2). Tables 2 and 3 show the composite reliability, convergent validity, and discriminant validity. Assessment of the composite reliability for the measurement models for the driving errors, violations, inattention errors, and positive driving behavior of truck drivers was performed with six, twelve, and seven indicators, respectively. Each construct's resulting alpha and composite reliability values were above the accepted minimum.

Table 2 Composite reliability and convergent validity of truck drivers (Developed by the authors)

Second-Order Constructs	**First-Order Constructs**	**Items**	**Measurement Model Type**	**Loading**	**CR**	**CA**	**AVE**
Truck Driver Behavior	Truck Driver Driving Error (DETK)	DETK 42	Reflective	0.749	0.741	0.711	0.560
		DETK 43		0.796			
		DETK 45		0.744			
		DETK 47		0.702			
	Truck Driver Driving Violations (DVTK)	DVTK 23	Reflective	0.740	0.818	0.799	0.560
		DVTK 27		0.706			
		DVTK 28		0.775			
		DVTK 29		0.768			
	Truck Drivers' Inattention Errors (IETK)	IETK 32	Reflective	0.739	0.738	0.733	0.522
		IETK 33		0.636			
		IETK 34		0.770			
		IETK36		0.739			
	Truck Positive Driving Behaviour (PDTK)	PDTK37	Reflective	0.767	0.877	0.865	0.648
		PDTK38		0.814			
		PDTK39		0.813			
		PDTK40		0.839			
		PDTK41		0.793			

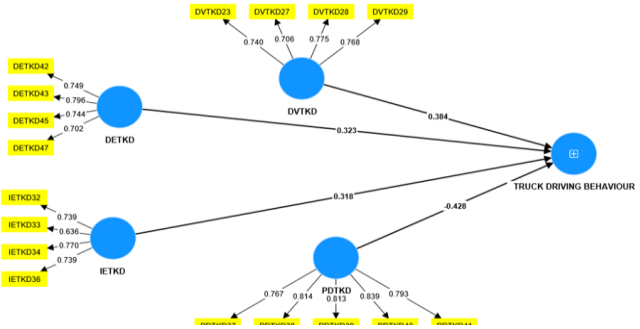

Fig. 2 Truck risky driving behavior measurement model (Developed by the authors)

3.2. Reliability

The scale's consistency level, referred to as reliability, was assessed using the composite reliability, which is preferable to Cronbach's alpha, which underestimates dependability in a reflective model [23]. For this statistic, values between 0 and 1 are acceptable if they are greater than 0.6 [24]. The constructs' composite reliability for the scale ranged from 0.738 to 0.877, which is an acceptable level for reliability assessment (Table 2).

3.3. Convergent Validity

The average variance extracted (AVE) was used to evaluate the convergent validity in which the formulation of a latent variable must satisfy the requirement that it should account for at least 50% of the variance in each of its indicators [17]. The results of the convergent validity analysis showed that except for the positive driving behavior construct (AVE = 0.648), the average variance extracted (AVE) was below the acceptable minimum, which necessitated the removal of the following items with low loadings from the constructs: Driving Violations (DVTKD18, DVTKD19, DVTKD20, DVTKD21, DVTK22, DVTKD24, DVTKD25, DVTKD26), Driving Errors (DETKD46), and Inattention Errors (IETKD30, IETKD31, IETKD35; after that, AVE for each construct increased to 0.560 (Driving Errors), 0.560 (driving violation), and 0.522 (inattention error) conforming with acceptable limits of AVE greater than 0.5 [17] for convergent validity to be established.

3.4. Discriminant Validity

Discriminant validity was assessed with heterotrait-monotrait (HTMT) ratio, which must be less than 0.9 to be discriminately valid [25]. The values for all the constructs are below the threshold of 0.9, which implies the establishment of discriminant validity (Table 3).

Table 3 Discriminant validity of truck driver measurement model (Developed by the authors)

Constructs	DETK	DVTK	IETK
DVTK	0.524		
IETK	0.477	0.868	
PDTK	0.270	0.251	0.156

4. Discussion

This study used the structural equation method to examine the reliability and validity of the driver behavior questionnaire on a large sample of truck drivers in Nigeria. It was found that the driver behavior questionnaire was reliable and valid for commercial truck drivers in Nigeria.

The indicators exhibit reliability statistics higher than the 0.7 acceptable cut-offs [22]. Consequently, it is proved that DBQ is reliable. However, the constructs' convergent validity (AVE) was not met, necessitating the removal of a few items with low loadings to increase the convergent validity. The removal of the low-loading items suggests that they did not account for 50% of the variance in their respective constructs, which caused the AVE of the constructs to rise over the minimum threshold of 0.5.

According to the convergent validity test, the items DV (23, 27, 28, and 29) reflect traffic violations committed by commercial truck drivers. Also, the variables DE (42, 43, 45, 47) and IE (32, 33, 34, 36), respectively, explain the constructs of driving errors and inattention errors. The positive driving behavior was reflected by items PDTK (37, 38, 39, 40, 41).

All the constructs were found to meet the HTMT values for the discriminant validity, which states that constructs with their indicators should have a stronger correlation than other constructs when compared [17]. This suggests a stronger association between all the elements expressed by the particular constructions than with other constructs.

The highest loadings for the driving violation was DVTK28 *"I disregard the speed limit on a residential road"* agrees with the findings of [15] who found speed violation as one of the items with the highest loadings for sample drivers in Nigeria implying drivers in Nigeria mostly violate speed limits and could be due to poor enforcement of road traffic rules. However, the result varies from the findings of [20], who reported *"Whistle or curse other vehicle drivers for expressing dissatisfaction and anger"* is the highest loading for driving violations. It is possible that the findings are due to cultural differences between the study locations, as the study was conducted in China, which has a different culture from Nigeria. Based on inattention errors, the item IETK34, *"I do switch on one thing, such as the headlights, when I meant to switch on something else, such as the wipers"* had the highest loadings on the inattention error constructs, which is inconsistent with the findings of [15] and may be due to the variation in the category of drivers examined. The driving error and positive driving behavior had items DETK43, *"I underestimate the speed of the overtaking or oncoming vehicles when overtaking or swerving left"* and PDTK40, *"I ensure not to obstruct other road users while parking by the road"* as the highest loading. This does not align with the study of [20], who found *"Do not look at the rear-view mirror*

when changing lanes or merging" and "Pay attention and avoid splashing the water to the pedestrians when driving" as the highest loading for driving error and positive driving behavior. This may be due to the cultural difference of the sample drivers and variation in the specific category of drivers examined.

The driving behavior questionnaire is suitable for commercial truck drivers driving behavior assessment in Nigeria because the constructs' reliability and validity of the scale exceed the acceptable minimal threshold.

5. Conclusion

The study validated the DBQ for a large sample of Nigerian commercial truck drivers and found it reliable and valid for truck driver behavior assessment for truck drivers' training improvement and policy development that would reduce road traffic accidents among truck drivers in Nigeria. Using the structural equation modeling approach, where composite reliability, convergent validity, and discriminant validity were assessed, the driver behavior questionnaire has an excellent convergent and discriminant validity. It can be used for further other detailed studies of truck drivers in Nigeria. The structural equation modeling method is more reliable than the first-generation analytical method.

It may not be possible to rule out the problem of self-report bias specific to questionnaire studies. However, this may have been decreased in this study because the subjects' anonymity was guaranteed. In addition, this study only focused on commercial truck drivers who may not be applied to other categories of drivers.

The study recommends that DBQs for other specific groups of commercial drivers such as taxi and bus drivers in Nigeria be validated for discrepancies in their driving behavior that could influence road traffic accidents. This will provide more in-depth information about the commercial drivers in Nigeria for traffic safety.

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