The Validation of the Manchester Drivers's Behaviour Questionnaire (DBQ) on the Zambian Sample

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ABSTRACT

In Zambia road traffic crashes have become one of the leading causes of deaths and disabilities. In 2019 a total of 30,648 road traffic accidents were recorded, with 5012 individuals seriously injured, while 1746 died (RTSA, 2019). Behavioural factors are some of the most important antecedents of road traffic accidents in Zambia (RTSA, 2018). They account for about 81% of road accidents (RTSA, 2018). The Revised Manchester Driver Behaviour Questionnaire (DBQ) is widely utilised for measuring self-reported driving style as well as investigating the relationship between driving behaviour and accident involvement. However, the psychometric properties of this instrument have not been established on a Zambian sample. This study is aimed at investigating the reliability and construct validity of the revised DBQ (Parker, Reason, Manstead & Stradling, 1995) on a Zambian sample.Behavioural factors are important antecedents of road traffic accidents (Burger,2014; Teye-Kwadjo,2011). A psychometrically sound instrument that measures aberrant driver behaviour is therefore required to detect drivers proneness to accidents so as to allow remedial behavioural interventions. The revised 24 item DBQ with four subscales was administered toa non-probability sample of 185 licensed Zambian drivers. The factor structure underlying the DBQ was investigated using confirmatory bi-factor analysis via structural equation modelling. The bifactor solution generated a general aberrant driver competence factor and four weak group factors. Statistical analyses provided good fit of the DBQ measurement with the empirical data.The study demonstrated evidence of construct validity for the usage of the DBQ in the Zambian context. The finding clears the way to investigate the predictive validity of the instrument when used by practitioners for personnel selection purposes. The DBQ can be used by practitioners to identify drivers in need of safety training and development. Government agencies can also benefit with practical usage of the DBQ in public awareness activism programmes.

Keywords: Aberrant driver behaviour, confirmatory bi-factor analysis

INTRODUCTION

There hasbeen an increase in motorisation in Zambia. By 2006 the registered motor vehicle fleet (passenger & commercial vehicles) stood at 183,701 and by mid-2017 the number rose to 714,102 (RTSA, 2018). This increase has enhanced the lives of Zambians in that mobility is made easier and more affordable. Secondly road transport accounts for 90 percent of all local transportation activities, since Zambia is a landlocked country (RTSA, 2018). Road transport consequently without a doubt plays a critical role in the economic growth of Zambia through its impact on the mobility of goods and services (RTSA, 2018). Although Zambia has greatly benefited from the usage of motorised vehicles, the benefits have come with a high price of high motor vehicle accidents, deaths and disabilities. In 1964 a total of 330 fatalities due to road accidents were recorded, which increased to 890 fatalities in 1974, when a total of 10,829 accidents were recorded (Emenalo, Puustelli, Ciampi & Joshi, 1977). Between 1974 and 1976 a total of 630 traffic fatalities were

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recorded (Patel & Bhagwatt, 1977). In 1998, 800 traffic deaths were recorded in Zambia (Mudenda, 2014). Between 2006 and 2016 there have been a total of 282,801 road traffic crashes and 18,560 fatalities (RTSA, 2015; 2016). From 2011 to 2016 a total of 34,228 serious injuries were recorded (RTSA, 2016). These fatality records confirm government's stance that road traffic accidents are the third most important cause of death in Zambia after HIV AIDS and malaria (Auditor General Report, 2015; Kavuyi, 2017).

Although there several antecedents to road safety, such as vehicle-related factors, environmental factors, traffic laws, controls and regulations (Burger, 2014; Jorgensen & Abane, 1999; Teye-Kwadjo, 2011), road traffic statistical evidence in Zambia has shown that driver behavioural factors are the main cause of road traffic accidents in Zambia. In 2015 driver error accounted for 25,307 road crashes representing 75.2% of 33,672 recorded accidents (RTSA, 2015). In the same year about 4668 accidents were due to excessive speed, 4799 due to misjudging distance, 3041 due to cutting in, 1788 due to reversing negligently, 196 due to driving under the influence of alcohol or drugs, while 707 were caused by failure to obey traffic signs (RTSA, 2015). Out of 32,350 road traffic accidents recorded in 2016, a total of 25,613 were as a result of driver error (RTSA, 2016). 4779 accidents were attributed to misjudging distance, 4756 due to excessive speed, 3539 due to cutting in, 2320 due to reversing negligently, 1377 due to overtaking improperly and 124due to driving under the influence of alcohol/drugs. In the first quarter of 2018, 91 percent of road traffic accidents were attributed to driver error (RTSA, 2018).

One assessment tool that was designed to measure perceived aberrant driving behaviours is the Manchester Driver Behaviour Questionnaire (DBQ). The DBA is typically used to predict self-reported road traffic accidents (rather than formally recorded accidents). The DBQ is the most used self-report scale worldwide to measure aberrant driving behaviours and predict risk of crash involvement (Mattsson, 2012; Af Walberg, Dorn & Kline, 2011). Several studies have shown correlations between self-reported aberrant driving practices and unsafe driving behaviour/traffic offences (Charlton & Forward as cited in Freeman, Wishart, Davey, Rowland, & Williams, 2009), aggressive driving (Bjorklund, 2008) and risk of crash involvement (Af Walberg et al., 2011). The DBQ thus holds potential to be used in Zambia as a traffic offence and accident predictor. To justify the use of the DBQ for this purpose in Zambia, however, requires that predictive validity of the criterion-referenced inferences be empirically demonstrated. This requires more than merely demonstrating a correlational relationship between the DBQ and traffic offence or accident measures. To convincingly demonstrate that the derivation of inferences on a specific criterion construct are justifiable the construct validity and the predictor measures as well as the construct validity of the criterion measures have to be demonstrated (Binning & Barrett, 1989). To the researchers knowledge, there has no study been done to validate the construct-referenced inferences derived from the dimension scores obtained on the DBQ on a Zambian sample. It was considered important that the validation of the construct-referenced inferences derived from the dimension scores obtained on the DBQ precedes its use in applied and research settings and precedes the validation of the criterion-referenced inferences derived from the dimension scores obtained on the DBQ. The main research question of the study was thus, is the Manchester Driver Behaviour Questionnaire (DBQ) a reliable and construct valid measure of the perceived aberrant driving behaviour construct as constitutively defined in Zambia.

Research-initiating question

The research-initiating question setting the current research study in motion consequently was the two-pronged question:

- What is the connotative meaning of the perceived aberrant driving behaviour construct?
- Does the DBQ provide reliable and construct valid measures of the perceived aberrant driving behaviour construct as constitutively defined?

Objectives

The broad objective of this study was therefore twofold: Firstly, to explicate the constitutive definition of the perceived aberrant driving behaviour construct, and, secondly to empirically psychometrically evaluate the reliability of the measures and the validity of the construct-referenced inferences derived from the DBQ. From this broad research objective, more specific operational research objectives were derived for this study:

- To explicate the constitutive definition of the perceived aberrant driving behaviour construct that clarifies the connotative meaning of the construct;
- To evaluate the reliability of the dimension scores of the DBQ; and
- To evaluate the construct validity of the DBQ by evaluating the fit of the measurement model implied by the design architecture of the instrument and the constitutive definition of the construct.

CONTRIBUTION TO THE FIELD

An increase in motorisation and dependence on motor vehicles for transport has created a pool of Zambian drivers lacking basic skills, knowledge and attitudes for safe driving (Biemba, Chanda, Munalula, Ngosa, Metitiri, Kanchele & Chizema, 2016; Kavuyi, 2017; Mansuri, AlZalabani, Zalat & Qabshawi, 2015). Biemba et al. (2016) found that aberrant driver behaviour was prevalent in Zambia. Out of 879 drivers 29.4% disregarded speed limits and 37% used mobile phones while driving. A further 29.1% did not dim lights to oncoming traffic, 29.1% overtook other vehicles on solid lines, while 37.7% of the drivers underestimated the speed of an oncoming vehicle when overtaking. Out of 21,292, Zambian drivers 50.8% did not use a seat belt (Habbuno, 2013). The high prevalence of poor road safety attitudes and the lack of safe driving skills among drivers as seen above means that behavioural assessments in terms of errors, violations and lapses is one important way of minimising road traffic accidents in the country. Evidence of good psychometric properties of the DBQ on a Zambian sample will provide some of the required psychometric evidence to justify the use of the instrument for selection, training and development. The promotion and creation of a safe driving environment will be enhanced through education and activism programs on road safety

LITERATURE REVIEW

DBQ factors

The Driver Behaviour Questionnaire (DBQ) was developed by Reason, Manstead, Stradling, Baxter and Campbell (1990) to measure a specific construct carrying a specific connotative meaning. The DBQ is rooted in the human error theory and measures perceived aberrant driving behaviour. The connotative meaning of a construct firstly lies in its internal structure (Kerlinger & Lee, 2000). Based on the model of

human error, Reason et al. (1990) divided human risk behaviour into errors and violations (Lajunen, Parker & Summala, 2004). The two latent dimensions comprising the initial conceptualisation of the perceived aberrant driving behaviour construct are theorised to be governed by two different psychological mechanisms and hypothesised to demand different modes of remediation (De Winter & Dodou, 2010; Reason et al., 1990).

Errors

Reason et al. (1990) defined errors as driving behaviour attributed to limitations on the perceptual, attentional, and information processing abilities of the driver. An error is the failure of a planned action to achieve the desired consequences/goals (Reason et al., 1990). Errors reflect performance limits of the driver such as those related to perceptual, attentional and information processing ability (DeWinter & Dodou, 2010). Errors are further divided into slips, lapses as well as mistakes (Norman, 1981). Slips refer to drivers inadvertently not doing what they meant to do while lapses refer to motor vehicle drivers forgetting to do something. Mistakes in turn refer to decision-making failures which are further divided into skill-based and knowledge-based mistakes (Rasmussen as cited in Warner, 2006).

Violations

Reason et al. (1990) defined violations in turn as the habitual driving style of the driver that developed over after years of driving. Violations represent deliberate deviations from those practices believed necessary for maintaining safe operations of potentially hazardous systems (Reason et al., 1990; Sarbescu, 2013). Violations are intentional failures, in this case drivers deliberately violating road safety rules. Violations can be explained due to social and motivational factors (Reason et al., 1990).

Lapses

Reason et al. (1990) submitted the responses obtained on the 50 DBQ items by a sample of 520 British drivers to a principal component analysis with varimax rotation[1]. The scree plot was interpreted to indicate the extraction of three factors. From the loading pattern in the rotated factor structure the identity of the extracted factors was inferred loaded as deliberate violations, dangerous errors and silly errors (slips and lapses.) Hence the results of the principal component analysis prompted Reason et al. (1990) to reconceptualise the perceived aberrant driving behaviour into a three-dimensional construct by splitting the initial latent error dimension into a latent dangerous errors dimension (comprising dangerous slips and mistakes) and a latent silly errors dimension (comprising "silly" slips and lapses causing embarrassment and inconvenience) (Reason et al., 1990). Although Reason et al. (1990) reported that the three extracted factors only accounted for 37% of the variance in the item data set that did not report the percentage large residual correlations. There was therefore no indication really of the extent to which the extracted principal component solution was able to account for the observed inter-item correlation matrix. The validity (i.e. permissibility) of the extracted principal component structure was therefore unknown.

Aggressive versus ordinary violations

Further research has shown that violation as a DBQ factor can be split into two distinct subfactors that is aggressive and ordinary violations (Lawton, Parker, Manstead & Stradling, 1997). Aggressive violations refers to overtly interpersonal aggressive acts (Rosli,Yunus & Hanan,2017). Ordinary violations on the other hand refer to deliberate deviation from safe driving without a specifically aggressive aim (Lawton et al., 1997). The perceived aberrant driving behaviour construct as measured by the DBQ has thereby evolved into a four-factor conceptualisation comprising the latent dimensions of aggressive violations, ordinary violations, dangerous errors and silly errors.

The connotative meaning of a construct secondly lies in the manner in which it is embedded in a larger nomological network of latent variables (Kerlinger & Lee, 2000). Research studies on the DBQ have found that errors are statistically significant ($p < .05$) predictors of motor vehicle accidents (Delucia, Bleckley, Meyer & Bush, 2003; Freeman et al., 2009), while in Stradling, Parker, Lajunen, Meadows & Xie (1998) violations and not errors statistically significantly ($p < .05$) predicted accidents. Ozkan and Lajunen (2005) reported a statistically significantly ($p < .05$) correlation between ordinary violations and accidents. In one study lapses, when taken together with errors, were statistically significantly ($p < .05$) predictors of accidents (Af Wahlberg et al., 2011). On the other hand Blockey & Hartley (1995) found out that neither error, no violations, were statistically significant ($p > .05$) predictors of accidents.

A broad general aberrant driving behaviour factor

Rowe, Roman, McKenna, Barker and Poulter (2015) proposed that the conceptualisation of the perceived aberrant driving behaviour construct as measured by the DBQ should be further expanded by also making provision for a broad, general aberrant driving behaviour factor unrelated to the four narrow, more specific (group) factors. Using a shortened 27-item version of the DBQ (Lajunen et al., 2004), Rowe et al. (2015) used confirmatory factor analysis to systematically test four different factor structures. The first structure had a single aberrant driving factor; while the second structure had two aberrant driving factors, namely violations (combining aggressive and ordinary violations) and cognitive failures (dangerous errors and silly errors). The third structure had three aberrant driving factors, violations (combining aggressive and ordinary violations), dangerous errors and silly errors. The fourth structure had four aberrant driving factors that is aggressive violations, ordinary violations, dangerous errors and silly errors. Three different measurement models were fitted for each of these structures (except for the one-factor structure), namely a simple first-order structure with correlated latent dimensions, a second-order model and a bifactor model with no residual correlations. The four-factor structure showed superior fit to the other models and the bifactor model showed the best fit of the three four-factor models tested Rowe et al. (2015). Items generally (but not exclusively) loaded more strongly on the broad, general, factor than on the narrow, more specific, factors.

Measurement of aberrant Driver Behaviour

The original version of the DBQ measures aberrant driver behaviours using 50 items describing various forms of aberrant driver behaviour. The items were selected to cover five classes of aberrant behaviour namely slips, lapses, mistakes, unintended violations and deliberate violations (Reason et al., 1990). 520 drivers were asked to indicate on a five point Likert scale how often they committed each type of behaviour while driving. Results indicated that the data were best fitted by a three factor solution namely errors, violations & lapses (Reason et al., 1990). Shorter versions of the DBQ have been developed because the original 50 item questionnaire takes a relatively long time to complete hence limiting the applicability of the measure in many research and applied setting (Rowe et al., 2015). For example a 24 item version was developed using the eight highest loading items on the three factors of errors, lapses and ordinary violations from the original 50 item version (Parker et al., 1995; Rowe et al., 2015). A 27 item DBQ was developed when three additional items on aggressive violations were previously identified as distinguishable from ordinary violations (Lawton et al., 1997; Rowe et al., 2015).

By 2010 there were about 174 studies on the DBQ (De Winter & Dodou, 2010). Notable studies on the DBQ include those done in Australia (Blockey & Hartley, 1995), Brazil (Bianchi & Summala, 2002), China (Xie & Parker, 2002), Czechoslovakia (Sucha, Sramkova & Risser, 2014), Denmark (Martinussen, 2013) France (Obriot-Claudel & Gabaude, 2004), Finland (La-junen, Parker & Summala, 1999; 2004), Greece (Kontogiannis, Kossiavelou & Marmaras, 2002), Iran (Ozkan, lajunen, Chliaoutakis, Parker & Summala, 2006), Malasyia (Rosli, Yunus & Hanan, 2017), Netherlands (Lajunen et al., 1999,2004), New Zealand (Sullman, Meadows & Pajo, 2002), Poland (Niezgoda, Kamiuski, Kruszewski & Tarnowski, 2013), Spain (Gras, Sullman, Cunil, Planes, Aymerich & Font-Mayoles, 2006), Qatar and the United Arab Emirates (Bener, Ozkan & Lajunen, 2008), Turkey (Ozkan et al., 2006) and in the United Kingdom (Reason et al., 1990)

Heterogenous results have been found in terms of the magnitude of the reliability of the DBQ dimension scores. In Parker et al. (1995) a high Cronbach alpha of .84 was obtained. Reliability analysis in Sarbescu (2013) showed that the four DBQ dimensions had Cronbach alpha coefficients ranging from .62 for lapses to .78 for ordinary violations. A study done by Ozkan ,Lajunen & Summala (2006), the alpha reliabilities for mistakes, ordinary violations, aggressive violations and lapses were 0.81, .79, .74 and .67 respectively. In Rosli, Yunus & Hanan (2017) internal consistency reliability of the subscales measuring the DBQ dimensions was high. Reliability coefficients were all above the threshold level of .70 (Hair, Money, Samouel & Page, 2010; Pallat, 2010). They varied from ? = .84 (violations); ? = (errors); to ? = .76

(lapses). In Freeman, Wishart, Rowland, Barraclough, Davey & Darvell (2014), errors had a Cronbach alpha of .81,highway violations, .77 and aggressive violations, .65 respectively. In several studies the DBQ original three factor structure has been replicated although not by all. In Rosli et al. (2017), factor analysis using principal component analysis revealed three factor structure comprising of violations, errors and lapses. In Freeman et al. (2014) factor analytic techniques were implemented and a three factor solution of errors, highway code violations and aggressive driving violations were obtained. In Aberg and Rimmo (1998), an analysis of data based on the original DBQ confirmed the three factorstructure.

Mixed results in terms of the content of the DBQ three factor structure has been obtained. Factor analysis in Blockey and Hartley (1995) revealed three but different factor structure namely general errors, dangerous errors and dangerous violations. In Matar and Al-Mutairi (2020), three factors were extracted but could not be classified into errors, lapses and violations due to social desirability bias.

Other studies found that four factors had to be modelled to adequately account for the interitem covariances (Martinussen, Blomqvist, Moller, Ozkan & Lajunen, 2013; Mesken, Lajunen, Parker & Summala, 2002; Lajunen et al., 2004; Rimmo, 2002; Xie & Parker, 2002), while others come to the conclusion that five factors had to be modelled (Parker, Mcdonnald, Rabbitt & Sutcliffe,2000). One study even found that seven factors underpinned the DBQ (Kontogiannis et al., 2002)

Present Study

The primary objective of this study was to test the reliability, construct validity and discriminant validity of the DBQ as a measure of aberrant driver behaviour interpreted as a construct comprising four correlated narrow-focussed group factors (aggressive violations, ordinary violations, dangerous errors and silly errors) and a broad, general aberrant driving behaviour factor independent of the narrow-focussed group factors, on a Zambian sample

RESEARCH METHODOLOGY

Research design

Research approach

Structural equation modelling (SEM) was used to achieve the objectives set out for this study. A quantitative ex post facto correlational design was used to achieve these research objectives.

Research Method

Sample

A non-probability sampling method, specifically convenience sampling, was used. The research hypotheses were empirically evaluated using a sample size of 185 licensed drivers from various organisations in the country. Permission for the research was sought from participating institutions in the country. 200 questionnaires with cover letters were distributed to identified participants and 185 completed questionnaires were returned. The sample comprised male (73.3%) and female (26.7%) participants. Level of qualification in the sample was reasonably uniformly distributed with grade 12 (22.8%), bachelor’s degree (28.4), master’s degree (25.9%), PhD (5.6%) and other qualifications (17.3%). The average age of participants was 40.

Measuring Instruments

Aberrant driver behaviours were measured using the modified 24 item Driver Behaviour Questionnaire (Parker et al., 1995). Respondents were asked to indicate on a six-point Likert scale how often they performed each of the 24 behaviours while driving.

Ethical consideration

Ethicalclearance for the research was sought from the research ethics committee of Mulungushi University as a way of mitigating any potential ethical risks relating to the research. Informed consent was sought from participating respondents. The purpose of the study was explained to all participants. Confidentiality and anonymity were guaranteed.

RESULTS AND ANALYSIS

Missing Values

A small percentage of the item data was missing (3.6%). Listwise deletion would have reduced the sample from 185 cases to 125 cases. Multiple imputation (MI) was consequently rather used as the method to solve the problem of missing values since it imputes missing values for all cases (Du Toit & Du Toit, 2001). Treating missing values is the process of dealing with data sets with incomplete responses. The multiple imputation method conducts several imputations for each missing value (Du Toit & Du Toit, 2001; Jöreskog & Sörbom, 1996; Raghunatha & Schafer as cited in Dunbar-Isaacson, 2006; Rubin, 1987). The use of this method resulted in an effective sample size of 185 cases.

Statistical Analysis

The success with which the indicator variables comprising the DBQ represent the aberrant driver behaviour construct comprising four correlated narrow-focussed group factors (aggressive violations, ordinary violations, dangerous errors and silly errors) and a broad, general aberrant driving behaviour factor independent of the narrow-focussed group factors, was evaluated empirically via confirmatory factor analysis (CFA). Item and exploratory factor analyses were not performed on the four subscales because the connotative meaning attributed to the aberrant driver behaviour construct combined with the architecture attributed to the DBQ implied that unidimensionality could not be assumed for any of the subscales of the DBQ. Confirmatory factor analysis was performed via

structural equation modelling (SEM) utilising LISREL 8.80 (Du Toit & Du Toit, 2001; Jöreskog & Sörbom, 1996) by fitting a bifactor measurement model with four group factors (Reise, 2012). The Cronbach alpha and McDonald omega were therefore not calculated for the four subscales, since both these reliability coefficients assume unidimensionality. The reliability of the DBQ total scores and subscale scores was calculated via the multidimensional omega (Kamata, Turhan & Darandari, 2003; Widhiarso & Ravand, 2014).

The Evaluation of the first-order DBQ measurement model

Evaluation of the bifactor measurement model was based on various goodness fit indices (Bollen, 1989). The root mean square error of approximation (RMSEA), Root Mean Squared Residual (RMR), Goodness of Fit Index (GFI), Normed Fit Index (NFI), Non normed Fit Index (NNFI), Comparative Fit Index (CFI), Incremental Fit Index (IFI) and the Relative Fit Index (RFI).

The root mean square error of approximation (RMSEA) focuses on the discrepancy between the observed population covariance matrix and the estimated population covariance matrix implied by the model per degree of freedom (Diamantopoulos & Siguaw, 2000). Values under .05 are indicative of good model fit, values above .05 but less than .08 indicate a reasonable fit. Values greater than .08 but smaller than .1 indicate mediocre model fit, while values greater than .1 indicate a poor fit (Brown & Cudeck, 1993; Diamantopoulos & Siguaw, 2000).

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The root mean squared residual (RMR) is a summary measure of fitted residuals and present the average value of the difference between the observed sample covariance and a fitted (model-implied) covariance (matrices (Diamantopoulous & Siguaw,2000). When assessing the standardised RMR, values below .05 are indicative of acceptable fit (Diamantopoulos & Siguaw, 2000).

The goodness of fit index (GFI) shows how closely the model comes to perfectly reproduce the observed covariance matrix. Acceptable values of the GFI should range between 0 and 1 with values greater than .90 being interpreted as indicating acceptable fit (Diamantopoulos & Siguaw, 2000).The normed fit index (NFI); non-normed fit index (NNFI) and the comparative fit index (CFI) should range between 0 and 1, with values closer to 1 representing good fit (Diamantopoulos & Siguaw, 2000).

Bifactor model of the Driver Behaviour Questionnaire

A bifactor model in which all items loaded on a broad, general, aberrant driver competence factor and each item additionally also loaded on one of four more narrow, specific aberrant driving behaviour group factors (aggressive violations, ordinary violations, dangerous errors and silly errors) was fitted. The group factors were allowed to correlate amongst themselves but were constrained to be orthogonal to the broad, general, factor. A bifactor model specifies that the covariance among a set of items response can be accounted for by a single general factor that reflects the common variance running among all scale items and group factors (DBQ dimensions) that reflect additional common variance among clusters of items, typically with highly similar content (Reise, Moore & Haviland,2010).

The bifactor model converged with an admissible solution after 114 iterations. The path diagram reflecting the completely standardised solution for the fitted bifactor DBQ measurement model is shown in Figure 1. The goodness of fit statistics for the bi factor model for the driver behaviour questionnaire are presented in Table 1. The RMSEA indicates reasonable model fit in the sample (.065) (Diamantopoulos & Siguaw, 2000). The test of close fit indicates that the probability of observing the sample RMSEA estimate under the null hypothesis of close fit in the parameter (H_0: RMSEA £ .05) was sufficiently small ($p < .05$) to reject the assumption of close fit in the parameter. Although the value for the standard root mean squared residual (RMR) (.057) only marginally missed the .05 cut off as an indication of good fit, other goodness of fit indices of the DBQ measurement model namely the GFI, NFI, CFI, NNFI, IFI and the RFI achieved indices greater than .90, which represents good fit (Hair, Anderson, Black, Babin & Black, 2010; Kelloway, 1998). Overall the bifactor measurement model showed reasonable to good fit. The basket of fit statistic was interpreted to mean that the interpretation of the measurement model parameter estimates was warranted.

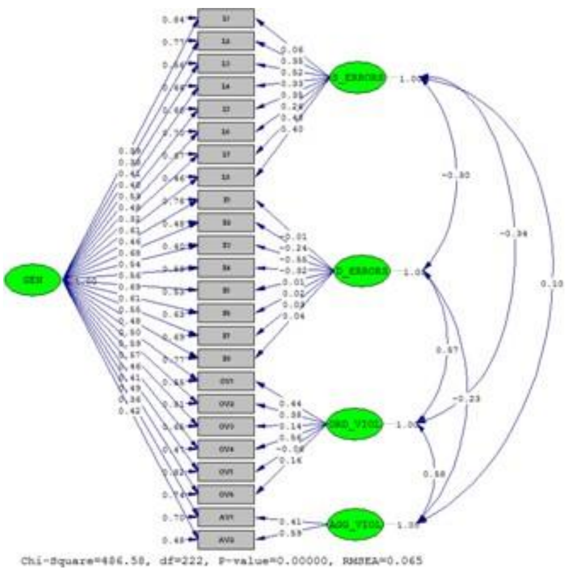

Figure 1. Path diagram of the fitted bifactor DBQ measurement model (completely standardised solution)

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Table 1: Goodness of fit indices for the DBQ (24 item) bifactor measurement model

Model	p_close fit	RMSEA	SRMR	GFI	NFI	NNFI	CFI	IFI
Bifactor	.001*	.065	.057	.97	.92	.95	.96	.96

* p < .05

The completely standardised factor loadings are shown in Table 2. All the items loaded statistically significantly (p < .05) on the broad, general, aberrant driving behaviour factor but for items E3, OV1, OV2 and OV4. The items generally loaded statistically insignificantly (p > .05) on the more specific group factors, Only six of the twenty-four items loaded statistically significantly (p < .05) on their designated group factor. Items L3 and L7 loaded statistically significantly (p < .05) on the silly errors factor, item E3 loaded statistically significantly (p < .05) on the dangerous errors factor and the two items AV1 and AV2 loaded statistically significantly (p < .05) on the aggressive violations factor. Noteworthy is the fact that all the items in the ordinary violations subscale loaded statistically insignificantly (p > .05) on the ordinary violations factor. Given that the broad, general, factor represents the overall aberrant driving behaviour perception, the items of the DBQ written for the ordinary violations found it difficult to tap into an ordinary violations factor that shares no variance with the broad, general factor. The general factor tended to dominate the DBQ.

Table 2 Completely standardised lambda-X factor loading matrix of the DBQ bifactor measurement model

	S_ERRORS	D_ERRORS	ORD_VIOL	AGG_VIOL	GEN
L1	.0609	– –	– –	– –	.3946*
L2	.3509*	– –	– –	– –	.3288*
L3	.5177*	– –	– –	– –	.4146*
L4	.3329	– –	– –	– –	.4796*
L5	.3492	– –	– –	– –	.5307*
L6	.2577	– –	– –	– –	.4831*
L7	.4816*	– –	– –	– –	.3181*
L8	.4038	– –	– –	– –	.6130*
E1	– –	-.0101	– –	– –	.4640*
E2	– –	-.2391	– –	– –	.6815*
E3	– –	-.5525*	– –	– –	.5407
E4	– –	-.3241	– –	– –	.5565*
E5	– –	.0118	– –	– –	.6864*
E6	– –	.0154	– –	– –	.6121*
E7	– –	.0345	– –	– –	.5538*
E8	– –	.0356	– –	– –	.4832*
OV1	– –	– –	.4442	– –	.4999
OV2	– –	– –	.3825	– –	.5862
OV3	– –	– –	.1444	– –	.5748*
OV4	– –	– –	.5618	– –	.4584
OV5	– –	– –	-.0598	– –	.4143*
OV6	– –	– –	.1569	– –	.4892*
AV1	– –	– –	– –	.4129*	.3616*
AV2	– –	– –	– –	.5900*	.4166*

Note: S_ERRORS refers to silly errors (lapses) ,D_ERRORS refers to serious errors, ORD_VIOL refers to ordinary violations, AGG_VIOL refers to aggressive violations and GEN refers to a broad, general, aberrant driving behaviour factor

* ($p < .05$)

The completely standardised measurement error variances are shown in Table 3. All the items were statistically significantly ($p < .05$) plagued by measurement error but for item E3. Achieving perfectly reliable and valid item measures invariably raises a concern of simply too good to be true. The items of the DBQ were generally quite aggressively plagued by systematic and random measurement error.

Table 3 Completely standardised measurement error variances

L1	L2	L3	L4	L5	L6
.8406*	.7688*	.5601*	.6592*	.5964*	0.7002*
L7	L8	E1	E2	E3	E4
.6670*	.4612*	.7846*	.4784*	.4024	.5853*
E5	E6	E7	E8	OV1	OV2
.5288*	.6250*	.6922*	.7652*	.5527*	.5100*
OV3	OV4	OV5	OV6	AV1	AV2
.6488*	.4742*	.8248*	.7360*	0.6988*	.4783*

The squared multiple correlations when regressing each item onto the broad, general factor and its designated narrow group factor are shown in Table 4. Because the correlation between the group factors and the broad, general factor was constrained to zero. The R^2 values in Table 4 are the sum of the squared completely standardised factor loadings for each item as shown in Table 2. Table 4 echoes the fact reflected in Table 3 that the DBQ items generally were quite noisy with only five items (L8, E2, E3, OV4 and AV2) in which more than 50% of the variance was explained by the factors the item were designated to reflect.

Table 4 Squared multiple correlations for the items of the DBQ

L1	L2	L3	L4	L5	L6
.1594	.2312	.4399	.3408	.4036	.2998
L7	L8	E1	E2	E3	E4
.3330	.5388	.2154	.5216	.5976	.4147
E5	E6	E7	E8	OV1	OV2
.4712	.3750	.3078	.2348	.4473	.4900
OV3	OV4	OV5	OV6	AV1	AV2
.3512	.5258	.1752	.2640	03012	.5217

The inter-latent aberrant driver behaviour dimension correlations are shown in Table 5.

Table 5 Inter latent aberrant driver behaviour dimension correlations

	S_ERRORS	D_ERRORS	ORD_VIOL	AGG_VIOL	GEN
S_ERRORS	1.0000				
D_ERRORS	-0.2951	1.0000			
	(1.1304)				
	-0.2610				
ORD_VIOL	-0.3351	0.5665	1.0000		
	(1.2454)	(0.7812)			
	-0.2690	0.7252			
AGG_VIOL	0.0988	-0.2263	0.5842	1.0000	
	(0.2536)	(1.0019)	(0.3580)		
	0.3897	-0.2259	1.6320		
GEN	– –	– –	– –	– –	1.0000

Note: S_ERRORS refers to silly errors (lapses) ,D_ERRORS refers to serious errors, ORD_VIOL refers to ordinary violations, AGG_VIOL refers to aggressive violations and GEN refers to a broad, general, aberrant driving behaviour factor

* ($p < .05$)

An examination of the phi matrix of the bifactor model (see Table 5) revealed low to moderate correlations (between .0988 and .5842) between the dimensions of the DBQ. All of the correlations between the four group factors were statistically insignificant ($p > .05$). Discriminant validity therefore did not present a problem, although the validity of three of the subscales as measures of the DBQ group factors (especiallythe ordinary violations subscale) did present a problem. More sophisticated analyses of the discriminantvalidity with which the DBQ measures the five latent dimensions of the aberrant driving behaviour construct(i.e., calculating the 95% confidence intervals for f_{kj} and calculating the average variance extracted (AVE)for each latent dimension of the aberrant driving behaviour construct and comparing AVEk and AVEj with f^2kj) was not considered necessary. The construct-referenced inferences on Zambian drivers' standing on the five-dimensional aberrant driving behaviour construct, derived from the DBQ, could be considered valid (i.e. permissible) if:

- The measurement model reflecting the design intention on the manner in which the DBQ items should reflect the five latent dimensions of the aberrant driving behaviour construct shows close (or at least reasonable) fit;
- The unstandardised factor loadings l_{ij} are statistically significant ($p < .05$);
- The completely standardised factor loadings are large (l_{ij}³.50);
- The unstandardised measurement error variances q_{dii} are statistically significant ($p < .05$);
- The completely standardised measurement error variances are small (q_{dii}£.75);
- The inter-latent aberrant driving behaviour dimensions correlate f_{kj} statistically significantly ($p < .05$) but low with each other.

In the current study the DBQ to a limited degree met this evidentiary burden but failed to do so in an unqualified manner.

Reliability of the DBQ total score and subscale scores.

The multidimensional omega was calculated for the DBQ (Kamata et al., 2003; Widhiarso & Ravand, 2014). The multidimensional omega is defined by equation 1 where $?_{ij}$ refers to the (completely standardised) factor loading of the i^{th} item on the j^{th} factor and and e_i refers to the (completely standardised) measurement error variance of the i^{th} item (Widhiarso & Ravand, 2014, p. 116). In the case of the DBQ j sums to k = 5 and i sums to p = 24.

The multidimensional omega was calculated via an Excel macro and returned a highly satisfactory value of .911510923.

Utilising the same formula but only summing the factor loadings and error variances across the items of each subscale the following highly satisfactory multidimensional omega coefficients were obtained: .966205148 (silly errors), .967265705 (dangerous errors), .974855687, ordinary violations) and .991870109 (aggressive violations).

DISCUSSION

The objective of this study was to assess the reliability and construct validity of the driver behaviour questionnaire on a Zambian sample. The reliability of the DBQ total scores and subscale scores was highly satisfactory. The current study was unable to establish the validity of the construct-referenced inferences derived from the DBQ dimension scores beyond doubt. Limited support for the construct validity of the DBQ was obtained. The findings of the study suggest that the DBQ is able to measure the broad, general, aberrant driving behaviour factor reasonably well on a Zambian sample. The statistical insignificance (p >05) of numerous loadings of items on their designated group factors, however, prevented a more unqualified positive verdict

The finding of the current study justifies the descriptive use of the total score obtained on the DBQ. The current study, however, failed to render the necessary evidence to justify the descriptive use of the subscale scores. Neither did the current study generate the necessary evidence to confidently use the DBQ for selection. To convincingly establish the validity (i.e. permissibility) of criterion-referenced inferences derived from the scores obtained on the DBQ, the validity of the criterion measure would also have to be established as well as the statistical significance of the relationship between the clinically or mechanically derived) criterion-referenced inferences and the actual criterion scores.

The study was successful in providing limited evidence of the construct validity of the construct-referenced inferences derived from the DBQ scores. However the study had limitations which should be acknowledged. The connotative meaning of a construct not only lies in the internal structure of the construct but also in the manner in which it is embedded in a larger nomological network of constructs. Validating the construct-referenced inferences derived from the measures of an instrument designed to measure a construct to which a specific connotative meaning has been attached in a specific manner therefore requires more than demonstrating that a measurement model reflecting the design intention underpinning the instrument fits the data. It also requires that a structural model that reflects the manner in which the construct is embedded in a larger nomological network fits the data. Future research should attempt to explicate such a structural model and examine its fir to empirical data.

The fitted DBQ bifactor model required the estimation of 78 freed measurement model parameter[2]. In terms of the rule of thumb proposed by Bentler and Chou (1987) a sample size of between 390 and 780 would be required to obtain a really credible test of the DBQ bifactor measurement model. The size of the sample analysed in the current study (285) fell just over a hundred observations short of the lower bound suggested by the Bentler and Chou (1987) rule of thumb.

Ideally the sample should have been a representative of racial demographics of Zambia. This requirement was not met due to the non-probability sampling procedure (convenient sampling). Future studies should determine the measurement equivalence of the DBQ across different Zambian gender and culture groups.

Furthermore there is need to replicate the study using a fleet of drivers employed in both private and public organisations

The description use of the DBQ in Zambia is dependent on the availability of recent construct-referenced norm tables. Data on the DBQ should be collated over time to allow the calculation of a variety of construct-referenced norm scores (e.g. stens, stanine, percentile ranks)

CONCLUSION

The factor structure of the DBQ was evaluated using the bifactor analysis to examine the general aberrant driver factor and four group factors. Results of the study provided limited evidence of the construct validity of the DBQ. The practical contribution of the study is in the advancement of the body of knowledge on the psychometric properties of the DBQ on the Zambian sample

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FOOT NOTES

[1] The Reason et al. (1990) study should be questioned in its choice of statistical analysis technique. Since the hypothesis guiding the development of the DBQ was that the perceived aberrant driving behaviour construct comprises two latent dimensions (errors and violations), a confirmatory factor analysis in which a two-factor measurement model was fitted, would have been more appropriate. The decision to use an orthogonal rather than an oblique rotation should also be questioned.

[2] The bifactor model comprised 24 factor loadings on the broad, general aberrant driving behaviour factor, 24 factor loadings on four narrower group factors, 24 measurement error variances and 6 inter-latent dimension correlations.