INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 13, Issue 4, (2023) E-ISSN: 2222-6990

Internal Consistency Reliability and Construct Validity of the Safety Questionnaire for Ride-Hailing Car

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v13-i4/16636 DOI:10.6007/IJARBSS/v13-i4/16636

Published Date: *14* April 2023

Abstract

Road traffic accidents involving ride-hailing car (RHC) have become more prevalent in Malaysia in recent years. Therefore, the present study aims to develop a reliable and valid questionnaire for assessing the safety performance of RHC in Malaysia. Three risk domains were identified in the literature, comprising driving behaviour factors, vehicle safety factors, and road environment factors. In these risk domains, a total of 32 risk indicators were selected, and these items were subsequently added to the questionnaire. Afterwards, these questionnaires were randomly distributed to 350 RHC passengers. To have a reliable and valid questionnaire, the internal consistency reliability by Cronbach's alpha as well as construct validity by exploratory factor analysis were used. The finalized findings showed that all of the measurements have excellent reliability standards between 0.823 and 0.925. From the results of construct validity tests, there were three factors extracted from 21 risk indicators. Consequently, a number of questions were amended to better quantify the constructs. The finalized RHC safety questionnaire is a valid and an internally reliable tool for assessing the safety performance of RHC in Malaysia.

Keywords: Ride-Hailing Car, Internal Consistency Reliability, Cronbach's Alpha, Construct Validity, Exploratory Factor Analysis

Introduction

In Malaysia, public transportation (PT) has developed into one of the most important factors that influence the long-term viability of a city centre's expansion. Due to the extraordinary socioeconomic growth in Klang Valley, PT services have become an essential transportation system in this area (Dahalan et al., 2015). There are many options available through the PT system, including taxi, bus, and rail services. The taxi industry, which includes both conventional taxis (CT) and ride-hailing cars (RHC), is a significant contributor to PT in Malaysia. This is because a majority of Malaysians use it as a mode of transportation that allows them to travel via any point on a journey (SPAD, 2015). The service is recognised as being the most convenient and comfortable form of transportation, providing greater flexibility, saving time, and being the most affordable (Aarhaug, 2014). Due to this, the reputation and demand for this service have both significantly increased. Recent technological advancements, which have had a significant impact on the CT industry in recent years, led to the development of the RHC system concept. Due to structural modifications made to the system, users can now use their smartphones to request a RHC from any place with shorter wait and journey times for taxi. Passengers benefit from this because it eliminates the need to wave or hail a taxi on the road. The 33 companies that have received operating permits from the Land Public Transport Agency (APAD) thus far employ about 150,000 drivers for ride-hailing services (Bernama, 2021; APAD 2021). This produced a direct competition for CT, provided passengers with options, and ultimately enhanced service standards while promoting good competition among taxi drivers. Despite a significant increase in demand for RHC services, there are a number of issues that compromise the passengers' safety. Driver distraction, exhaustion, sleepiness are all considerably enhance the risk of road accidents for RHC.

A ride-hailing service needs drivers to interact with a smartphone application in order to function, which is a significant indication that raises the risk of an accident (Dingus et al., 2016; Truong and Nguyen, 2019). Distracted driving is more inclined to occur when using a smartphone application of any kind, whether it is hands-free or not. Undoubtedly, driving while distracted occurs when using a smartphone application to communicate with possible passengers. A crash is more likely when there is such distraction, which also endangers nearby pedestrians, vehicles, and passengers (Dills and Mulholland, 2018). RHC drivers are more likely to use their smartphones while driving since they do so more regularly than other drivers. In addition, because too much increased exposure levels on the roadways, RHC have a higher risk of being in a car accident (Mao et al., 2020). RHC drivers usually drive at fast speeds to save time and increase their earnings (Sui et al., 2019). Moreover, the higher traffic density and the fact that a driver's income was depending on the number of passengers added to the prevalence of risky driving practices on urban roads (Zhao et al., 2014). When there is a strong demand during rush hour, several RHC drivers may decide to work longer hours through heavy traffic. The chance of an accident is greater during rush hour because driving in heavy traffic is linked to a higher crash risk. Furthermore, the long hours that many RHC drivers work as well as unpleasant or physically demanding activities can result in severe exhaustion and drowsiness (Stern et al., 2019; Peng et al., 2022). As a result, RHC could be involved in more road traffic incidents. In light of these, it is crucial to determine the risk domains and risk indicators as well as the RHC's current level of safety performance. Consequently, this study was carried out to create a reliable and valid tool for assessing the safety performance of RHC in Malaysia.

Literature Review

Globally, the ride-hailing industry has expanded quickly in recent years. Since its establishment in 2010, Uber, the largest ride-hailing operator in the world, has recorded more than 2 billion rides worldwide (Morrison et al., 2018). For 33 ride-hailing companies in Malaysia, there are about 150,000 ride-hailing drivers (Bernama, 2021; APAD 2021). Despite a recent significant increase in demand for ride-hailing services, a study by Meltwater (2017) found that driver behaviour is a serious issue for many users. The data in particular showed that Malaysians reported 82% of the grievances and complaints toward RHC drivers. In the

region, the words “unsafe”, “rude” and “dangerous” are frequently employed to refer to driver behaviour. Since there has been such a heated debate about RHC-related safety in Malaysia recently, this subject has attracted a lot of media attention. Therefore, it is necessary to identify the risk domains and risk indicators that lead to road accidents in order to implement interventions and potentially minimize the risks related to road accidents. A risk domain is a factor that makes accidents more likely to happen (Elvik and Vaa, 2004). Prior research have revealed that the domains of driver, vehicle, and road environment factors have a considerable impact on the chance of an accident and the severity of injuries (Thompson et al., 2013; Zhang et al., 2013; Kadilar, 2014).
Based on the past studies, driving behaviour has the biggest impact on road safety (Dingus, 2016; Weber et al., 2018). A driver could potentially make a mistake as a result of both the vehicle and the road environment factors, which would then be the most substantial cause of the road accident (Babić et al., 2020). Excessive speeding, running red lights, lane departure, improper use of seatbelts, tailgating, street racing, middle-lane hogging, passing on the left, failing to check the rear-view mirror, failing to use turn signals, crossing the centre line, failing to stop at junctions, using a hand-held phone, and secondary task distractions are among the driving behaviour-related risk indicators that have been shown to be significantly linked to road accidents (Pastor et al., 2006; Reimer et al., 2013; Bogstrand et al., 2015; Bulumulle & Bölöni, 2016; Talbot et al., 2016; Olofsson & Nielsen, 2020; Shi et al., 2022). Additionally, it is observed that the vehicle factors play a significant role in road accidents (Jones, 2016; Montero-Salgado et al., 2022). Road accidents is associated with several risk indicators of vehicle factors, including worn-out tyres, unexpected mechanical breakdowns, broken back seatbelts, no side airbags fitted, no fire extinguisher, no rear-view camera, and older automobiles (McGwin et al., 2003; Keall et al., 2011; Bose et al., 2013; Jansen et al., 2015; Cicchino, 2017; Hordofa et al., 2018; Chand et al., 2021). Additionally, the aspects of the road environment had an impact on both the performance of the car and the driver (Batrakova & Gredasova et al., 2016; Wu et al., 2021). Furthermore, this component may help to encourage and support the formation of safe driving style. Significant risk indicators for the aspects of the road environment include driving at night, malfunctioning streetlights, malfunctioning traffic lights, rainy weather, crosswinds, sun glare, foggy weather, poor road markings and traffic signs, road pavement failure, roadside objects, and road congestion (Tay et al., 2008; Bullough et al., 2013; Cai et al., 2013; Mannera & Wünsch-Zieglerb, 2013; Zhang et al., 2013; Mhirech & Alaoui-Ismaili, 2015; Chengula, 2018; Montella et al., 2019; Wu et al., 2021).

Methodology

A descriptive research design with a questionnaire survey was the primary approach used in this study. Firstly, in-depth literature searches were conducted to discovery pertinent information on risk factors encompassing risk domains and risk indicators that can be utilized to assess RHC’s level of safety. Three risk domains were identified, comprising driving behaviour factors, vehicle safety factors, and road environment factors. Different risk indicators were recognised for each risk domain, and these risk indicators were taken into consideration based on the analytical consistency, measurability, and applicability to the phenomenon being studied. A total of 32 risk indicators were selected, and these items were subsequently added to the questionnaire. The survey questionnaire for this study had six sections. Data on the respondents’ demographics was obtained in Section A of the questionnaire, and travel behaviour and patterns were covered in Section B. The domain of the factors influencing driving behaviour is connected by 14 questions in Section C. The following driving behaviours were considered in this study: speeding, running red lights, lane departure, improper seatbelt use, tailgating, street racing, middle-lane hogging, passing on the left, fail to check the rear-view mirror, fail to use turn signals, centre line crossing, fail to stop at junctions, using a hand-held phone, and secondary task distraction. Each of the above items was rated on a Likert scale of 1 to 5, with 1 representing strongly disagree and 5 representing strongly agree. Section D of the survey asked respondents to react to seven questions about the vehicle safety factors, including bald tyres, unexpected mechanical failure, broken rear seatbelts, no side airbags, no fire extinguisher, no rear-view camera, and old vehicles. A Likert scale of 1 (strongly disagree) to 5 (strongly agree) was used to grade the questions in this section. There are 11 questions in Section E that are concerned with the factors that influence the road environment, such as night-time driving, malfunctioning streetlights, malfunctioning traffic lights, rainy weather, crosswinds, sun glare, foggy weather, poor road markings and traffic signs, road pavement failure, roadside objects, and traffic congestion. The items in this section were similarly scored on a five-point Likert scale, with 1 being the strongly disagree and 5 being the strongly agree. Last but not least, the section on respondents' opinions of RHC's safety in Malaysia contains a number of questions. The equipment was subsequently used to obtain the data during data collections procedure.

Non-probability sampling approaches were used in this study because they are straightforward and affordable (Ary et al., 2018). In specifically, the convenience sampling approach was implemented to collect data for this study since it allows the researcher to choose individuals who are easily available or accessible. The questionnaire was delivered via an online survey technique, and the respondents who were chosen for the survey were English-speaking passengers with past RHC travel experience. Subsequently, the reliability or consistency of an instrument must be evaluated (Sekaran and Bougie, 2010). Lessening study bias and promoting openness are possible effects of reliability and validity (Singh, 2014). The reliability of a measure reveals the extent to which a measurement is error-free, and thus steady across time and across a wide variety of scale items (Sekaran and Bougie, 2010). There are numerous ways to evaluate the reliability of survey tools. However, in this study, the Cronbach's alpha reliability coefficient was employed to evaluate the questionnaire's reliability. The value typically varies from 0 to 1, with 0 representing no relationship between the items on a particular measure and 1 denoting absolute internal consistency (Tavakol & Dennick, 2011). Alpha values above 0.7 are frequently regarded as good and passable, very good above 0.8, and superb beyond 0.9, indicating a high level of internal consistency (Cronbach, 1951). In the field of social research, it is deemed appropriate to use an alpha value range of 0.7 to 0.8. (Nunnally & Bernstein, 1994). Meanwhile, if a measurement tool achieves its goal of measuring something accurately, it is considered to be valid. The exploratory factor analysis (EFA) is frequently used to assess construct validity when the relationships between the variables are unclear. In particular, it is a process used to extract, simplify, and arrange numerous survey questionnaire into a small construct for independent variables. In this study, three risk domains of RHC safety performance namely driving behaviour factors, vehicle safety factors, and road environment factors were used for the purpose of creating a scree plot and establishing the pattern of structure for 32 risk indicators of RHC safety performance. These 32 items with varimax rotation underwent initial EFA using Statistical Package for the Social Sciences (SPPS).

Sample size, The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy or Bartlett's Test of Sphericity, and item communalities are the three factors that must be taken into consideration to evaluate whether EFA is appropriate. First, when considering sample size, some researchers believe that 10 cases for each item were appropriate for factor analysis, while others recommend 5 cases for each item (Pallant, 2001). Besides, the most prevalent example of a guiding rule of thumb is Tabachnic's rule of thumb, which states that at least 300 samples are needed for factor analysis. The number of samples recommends by Field (2009) is 300. Second, a statistical value known as the KMO is employed as an indicator to determine whether or not the sample was sufficient to do the factor analysis. The KMO number must be larger than 0.6 in order to satisfy KMO's criteria that the value must 0.60 or higher for the EFA to continue (Tabachnick and Fidell, 2007). Bartlett's test of Sphericity, which examines the overall significance of correlations between all items on the measuring instrument, was used for the second measure of sampling adequacy. The adequacy of the sample for principal component analysis is evaluated using the Bartlett's test of Sphericity, which is significant at $p < 0.001$. Finally, for each risk indicator, the communalities are then established. By measuring an item's extraction communality, it can determine how much of each variable's variance is explained by the factors (Rietveld and Van Hout, 1993). High extraction communality values showed that there is a strong correlation between the risk indicators within each risk domain. Strong data are those that have different variables loading heavily on each factor and consistently high communalities without cross-loadings. All extraction communalities are limited to more than 0.5 to ensure the accuracy of all risk indicators collected during this study (Field, 2009).

Result and Discussion

This section presents the questionnaire's findings regarding reliability and validity test. A reliability test and validity test were carried out using Statistical Package for the Social Sciences (SPSS). Results of initial internal consistency reliability indicated that all of the Cronbach's alphas for the three risk domains comprising 32 risk domain were found to have very high reliability levels, ranging from 0.845 to 0.925 as shown in Table 1. According to the guideline, a coefficient of 0.60 or more on an instrument denotes moderate reliability, whereas a coefficient of 0.70 or more denotes excellent reliability (Sekaran and Bougie, 2010). In a similar manner, Hair et al (2007) note that although lesser coefficients may still be acceptable, many researchers generally consider an alpha value of 0.70 to be the minimum. Given the specified requirement of 0.70, all of the questions are therefore valid, hence there was no need to eliminate any items.

Table 1
Summary of reliability test

Risk Domain	Risk Indicator	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Driving behaviour factors	Speeding	0.922	0.925
	Red-light running	0.919	
	Lane departure	0.919	
	Improper seatbelt use	0.921	
	Tailgating	0.918	
	Street racing	0.919	
	Middle-lane hogging	0.917	
	Passing on the left	0.923	
	Fail to check rear-view mirror	0.918	
	Fail to use turn signals	0.918	
	Centre line crossing	0.916	
	Fail to stop at junction	0.917	
	Hand-held mobile phone	0.929	
	Secondary task distraction	0.922	
Vehicle safety factors	Bald tyre	0.803	0.823
	Sudden mechanical failure	0.787	
	Malfunctioning rear seatbelts	0.788	
	No side airbags installation	0.781	
	No fire extinguisher	0.817	
	No rear-view camera	0.811	
	Old vehicle	0.810	
Road environment factors	Night-time driving	0.909	0.900
	Malfunctioning streetlights	0.887	
	Malfunctioning traffic lights	0.888	
	Rainy weather	0.890	
	Crosswind	0.892	
	Sun glare	0.893	
	Foggy weather	0.888	
	Poor road markings and traffic signs	0.887	
	Road pavement failure	0.886	
	Roadside objects	0.887	
	Traffic congestion	0.889	

In order to assess the construct validity test's suitability, three factors must be taken into consideration: sample size, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy or Bartlett's Test of Sphericity, and item communalities. Initially, to reflect the entire sample of a sizable RHC passenger population, 350 samples are just about adequate. Besides, the KMO value of 0.911, which was appropriate, and Bartlett's test of sphericity, which was significant with a p-value of 0.0001 indicating that the correlations between variables were significantly different from zero. Prior to completing EFA, these two statistical values provide basic requirements that must be satisfied. In other words, the analysis described above fulfilled with these requirements. The communalities on every risk indicator were then identified in this study. Nonetheless, 9 of the extracted communalities had a value of less than 0.5, which

shows that the risk indicators do not match with the factor solution and therefore must be dropped from the analysis. These risk indicators included speeding, hand-held mobile phone, secondary task distraction, no fire extinguisher, no rear camera, old vehicle, night-time driving, crosswind and sun glare.
A second analysis of EFA was conducted for 23 risk indicators after several risk indicators were removed. The findings showed that all of the EFA requirements are met by the KMO, Bartlett's test, and item communalities. But then, street racing and improper seatbelt use were two risk indicators that should be discarded from the analysis since they were associated with cross loading. As a result, 21 risk indicators were used in the final analysis of the EFA. The results of EFA analysis in Table 2 reveals that the KMO value for every item was 0.896 which was higher above the suggested value of 0.5. Additionally, Table 2 demonstrated that all items passed Bartlett's test of Sphericity with a significant p-value < 0.0001, indicating that the correlations between the variables were significantly different from zero. Both of these KMO and Bartlett's test of Sphericity were two statistical results that satisfied the requirements for conducting EFA. Finally, the communalities for each risk indicator were analyzed, and according to Table 3, the findings demonstrate that the extracted communalities were all more than 0.5. This suggests that the analysis should include all risk indicators because they all suit the factor solution well.

Table 2
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.896
Bartlett's Test of Sphericity	Approx. Chi-Square	4121.607
	Df	210
	Sig.	.000

Table 3. Communalities

	Initial	Extraction
Red-light running	1.000	.553
Lane departure	1.000	.539
Tailgating	1.000	.614
Centre line crossing	1.000	.643
Passing on the left	1.000	.570
Fail to check rear-view mirror	1.000	.602
Fail to use turn signals	1.000	.668
Overtake at a double line	1.000	.711
Fail to stop at junction	1.000	.638
Bald tyre	1.000	.582
Sudden mechanical failure	1.000	.739
Malfunctioning rear seatbelts	1.000	.693
No side airbags installation	1.000	.624
Malfunctioning streetlights	1.000	.613
Malfunctioning traffic lights	1.000	.604
Rainy weather	1.000	.588
Foggy weather	1.000	.512
Poor road markings & traffic signs	1.000	.631
Road pavement failure	1.000	.659
Roadside objects	1.000	.615
Traffic congestion	1.000	.558

The EFA in this study was carried out utilising varimax rotation and principal component analysis extraction. Total variance explained was an extraction technique used to simplify the risk indicators into a meaningful quantity prior to further exploration. Regarding to the procedure, the most useful components were identified using eigenvalues greater than 1.0. The results showed that three components with eigenvalues exceeding 1.0, accounting for 61.7% of the total variance, were identified via principal component analysis. The inflexion point on the Scree plot in Figure 1 occurs at the fourth data point, further supporting the Kaiser's criterion that three factors should be retained.

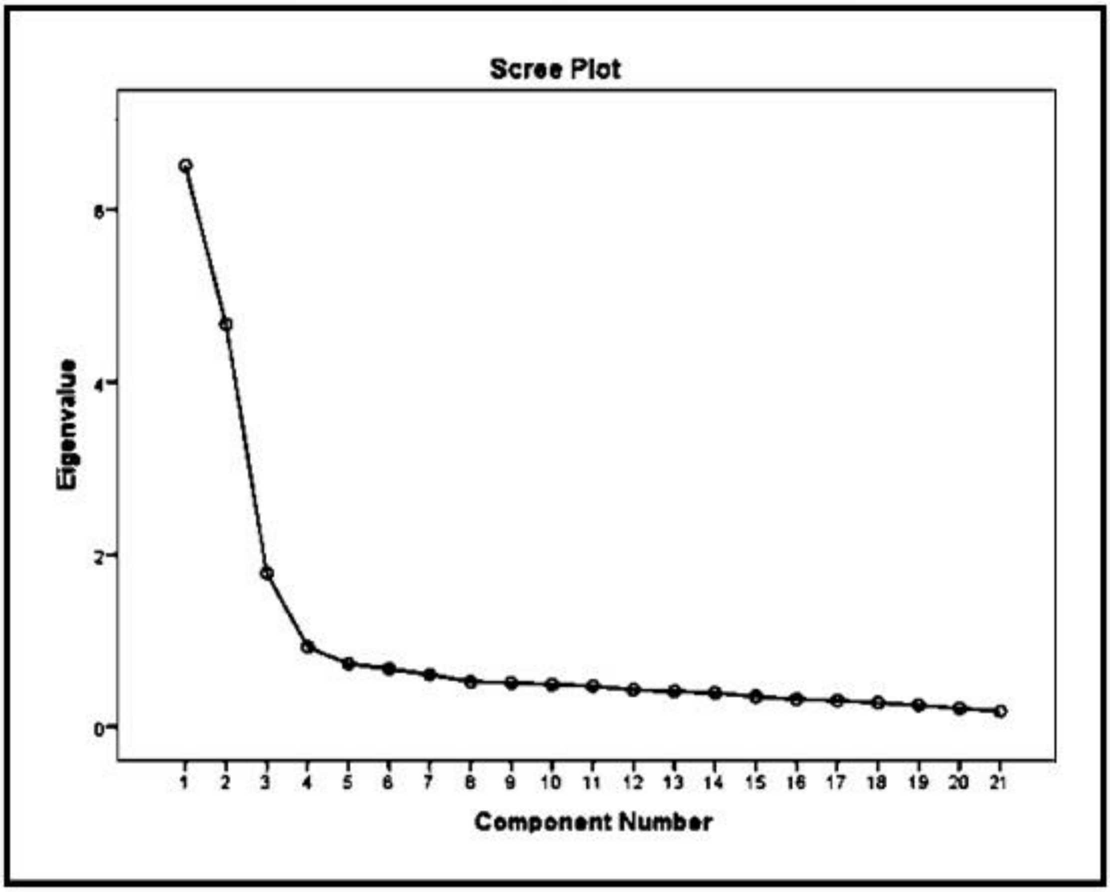

Figure 1. Scree Plot

The factor analysis's most crucial finding is the rotated component matrix, which gathers data on the construct validity of the scale. Specific risk indicators correspond to which element are revealed by this analysis. Additionally, it displays the correlation between factors and variables as well as the importance of each variable for each factor. All loadings above 0.60 are bolded in Table 4, which displays the component loadings. According to Tabachnick and Fidell (2007), if an item exhibits increased component loading as well as weak cross loadings on other domains, it is seen as a good indicator of the underlying domain. If the component loading is positive, the risk indicator was inversely linked with RHC safety. Most of the variance (25.3% of the overall variance) is explained by the first domain, which was referred to as driving behaviour factors. The second domain, which is referred to as road environment factors, is responsible for 22.3% of the total variance, and the third domain, which is referred to as vehicle safety factors, is responsible for 14.1% of the total variance. These results conclusively demonstrate that the group of items that contributed to the factors were identical to those mentioned in the literature. Furthermore, the finalized results of internal consistency reliability tests for 21 risk indicators have excellent reliability standards between 0.823 and 0.925. Driving behaviour factors received a result of 0.925, followed by road environment factors at 0.900 and vehicle safety factors at 0.823. In light of the outcomes of internal consistency reliability and construct validity, the researcher therefore created a valid and reliable version of the instrument.

Table 4
Rotated component matrix

	Component		
	1	**2**	**3**
Centre line crossing	**0.820**	-0.016	0.195
Fail to use turn signals	**0.813**	0.051	0.067
Tailgating	**0.765**	-0.086	0.145
Fail to check rear-view mirror	**0.756**	0.013	0.176
Passing on the left	**0.748**	0.078	-0.063
Fail to stop at junction	**0.740**	-0.061	0.294
Middle-lane hogging	**0.719**	0.026	0.355
Lane departure	**0.691**	-0.035	0.246
Red-light running	**0.662**	-0.04	0.336
Road pavement failure	-0.042	**0.810**	0.042
Poor road markings & traffic signs	-0.034	**0.791**	0.058
Roadside objects	-0.059	**0.780**	0.062
Malfunctioning traffic lights	0.025	**0.769**	-0.109
Malfunctioning streetlights	0.072	**0.758**	-0.181
Traffic congestion	-0.049	**0.738**	0.103
Rainy weather	0.061	**0.733**	-0.216
Foggy weather	-0.008	**0.715**	0.008
Sudden mechanical failure	0.331	-0.082	**0.789**
Malfunctioning rear seatbelts	0.259	-0.08	**0.787**
No side airbags installation	0.213	-0.015	**0.761**
Bald tyre	0.213	0.037	**0.732**

Conclusion

The finalized results of internal consistency reliability tests indicated that all of the measurements have excellent reliability standards between 0.823 and 0.925. Driving behaviour factors received a result of 0.925, followed by road environment factors at 0.900 and vehicle safety factors at 0.823. Regarding to the finalized results of construct validity tests, there were three factors extracted from 21 risk indicators. The results of EFA analysis revealed that the KMO value for every item was 0.896 which was higher above the suggested value of 0.5. In addition, the results of Bartlett's test of Sphericity demonstrated that all items passed with a significant p-value < 0.0001, indicating that the correlations between the variables were significantly different from zero. Both of these KMO and Bartlett's test of Sphericity were two statistical results that satisfied the requirements for conducting EFA. Finally, the communalities for each risk indicator were analysed and the results demonstrated that the extracted communalities were all more than 0.5. These showed that all these 21 risk indicators were suit well with the factor solution. Consequently, the findings of this study indicated that the RHC safety questionnaire is a reliable and valid instrument for assessing

RHC's safety performance in Malaysia. We believe that this instrument will assist future road safety research needs in order to assess the safety performance of RHC.

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