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Introducing a multi-variate classification method: Risky driving acceptance among different heterogeneous driver sub-cultures

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ABSTRACT

Introduction: Heterogeneous driving populations with many different origins are likely to have various sub-cultures that comprise of drivers with shared driver characteristics, most likely with dissimilar traffic safety cultures. An innovative methodology in traffic safety research is introduced which is beneficial for large datasets with multiple variables, making it useful for the multi-variate classification of drivers, driving attitudes and/or (risky) driving behaviours. *Method:* With the application of multidimensional scaling analysis (MDS), this study explores traffic safety culture in the State of Qatar using a questionnaire and investigates the similarity patterns between the questionnaire items, aiming to classify attitudes towards risky driving behaviours into themes. MDS is subsequently applied to classify drivers within a heterogeneous driving sample into sub-cultures with shared driver characteristics and different risky driving attitudes. *Results:* Results show that acceptance of speeding is highest among the young Arabic students and acceptance of distraction and drivers' negligence such as phone use and not wearing a seatbelt is highest among male Arab drivers. Acceptance of extreme risk-taking like intoxicated driving and red-light running is highest among South-Asian business drivers. *Conclusion:* It is important and practical to understand risky behavioural habits among sub-cultures and thereby focussing on groups of drivers instead of individuals, because groups are easier to approach and drivers within sub-cultures are found to influence each other. By indicating which groups of drivers are most likely to perform specific risky driving themes, it is possible to target these groups and effectively emphasise certain subsets of risky driving behaviours during training or traffic safety education. *Practical Applications:* This study provides guidance for the improvement of driver education and targeted traffic safety awareness campaigns, intending to make changes to attitudes and habits within specific driver sub-cultures with the aim to improve traffic safety on the longer term.

1. Introduction

The 8th leading cause of death for people of all ages are Road Traffic Crashes (RTCs), with around 135 million fatalities and 50 million injuries per year (Ameratunga, Hijar, & Norton, 2006; World Health Organization [WHO], 2018). Reduction of traffic fatalities is unconditionally linked to the improvement of traffic safety, making traffic safety an essential aspect of life. Improving traffic safety is a challenging goal that receives increasing attention worldwide. Previous research found that approximately 90–95% of the traffic crashes are related to human error and driving behaviour (Evans, 1996; Lajunen, Parker, & Summala, 2004; Young & Salmon, 2012). Among these human factors that are found to increase the chance for a road traffic crash (RTC) are behavioural factors that promote risk taking while driving, like habitual speeding, indecent driving behaviours, intoxicated driving and not using a seatbelt (Petridou & Moustaki, 2000). In the State of Qatar in specific, crashes caused by reckless driving cover almost half of the total RTCs per year (Timmermans et al., 2019b). Several road safety initiatives have intended to examine the safety attitudes and risky driving behaviours of drivers. For example, the Social Attitudes to Road Traffic Risk in Europe (SARTRE) are projects funded by the European Union Commission to measure road users'

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attitudes and beliefs on risky driving and safety measures (Antov, Banet, Barbier, Bellet, Bimpeh, & Boulanger, 2012; Cauzard, 2004a; 2004b). In addition, the E-Survey of Road users' Attitudes (ESRA) is an international project, initiated by a joint collaboration to assess the traffic safety culture, attitudes and behaviour of road users on several safety indicators (Meesmann & Torfs, 2019), such as speeding (Holocher & Holte, 2019) or distraction by mobile phone use (Pires, Areal, & Trigoso, 2019). The aim of the periodic ESRA project is to provide scientific evidence for policy makers (Meesmann, Torfs, Nguyen, & Van den Berghe, 2017). Finally, the Young Europeans Acting for Road Safety (YEARS) is a project initiated by the European Road Transport Safety Council (ETSC) focused on young novice drivers, because young, inexperienced drivers pose a higher risk for (fatal) RTC's (Atchison, 2017). This higher risk is found to be related to various aspects, like a lack of driving experience (Fisher, Caird, Horrey, & Trick, 2016; Yamani, Samuel, Knodler, & Fisher, 2016), distraction and lack of attention often caused by mobile phone use (Kingery et al., 2015), infrequent use of seatbelts (Litt, Lewis, Linkenbach, Lande, & Neighbors, 2014), speeding (Amponsah-Tawiah & Mensah, 2016), poor risk perception (Ivers et al., 2009), peer pressure (Ross, Jongen, Brijs, Brijs, & Wets, 2016) and regular display of general risk-taking behaviours (Abay & Mannering, 2016). On a global level, speeding violations, aggressive behaviour in traffic, drivers' distraction and being under influence of alcohol and/or drugs while driving, are rising problems that significantly affect traffic safety on the roads. Despite these common international risky driving behaviours, there is international diversity in traffic safety related to cultural differences in environmental road design and traffic enforcements, as well as cultural variations in the driving population (Edwards, Freeman, Soole, & Watson, 2014; Ward & Özkan, 2014).

Cultural variety is not only visible between countries but also within nations, between sub-populations. Therefore, when studying traffic safety, it is important to take a holistic approach by investigating cultural influences on a national as well as sub-cultural level through the study of smaller cultural groups within countries (Edwards et al., 2014). The impact of traditional approaches to improve traffic safety, such as environmental road design and traffic law enforcements are significant but are also found to be scarce and weaken over time, because they do not tackle the underlying cultural believes and attitudes towards risky driving within the populations' sub-groups (Ward & Özkan, 2014). On the other hand, the recently developed concept 'traffic safety culture' is globally used to improve traffic safety on the longer term, by focusing on changing the traffic safety resistance among different sub-cultures. Traffic safety culture aims to adjust the cultural shared cognitions, beliefs and normative perceptions of sub-groups within society into acceptance, instead of denial, of risk in order to increase general compliance with traffic safety regulations (Ward & Özkan, 2014). Similar cognitions about traffic safety are often shared by a group of people from the same sub-culture, because joint cognitions are based on shared values and believes about common ways to behave and collective experiences (Ward, Linkenbach, Keller, & Otto, 2010). The likelihood of risky driving behaviours increases if the driver's sub-culture accepts, encourages and reassures the engagement in risky driving, and the driver itself cognitively justifies risky driving behaviours and rationalises and denies the consequences (Gerard, Gibbons, Reis-Bergan, & Russel, 2000). In line with this, Ward et al. (2010: p. 9) quote "the cognitive strategy of not thinking about the consequences of risky behaviour will increase the propensity to engage in that risky behaviour".

This study investigates traffic safety culture in the State of Qatar by means of a questionnaire. Timmermans, Alhajyaseen, Reinolsmann, Nakamura, and Suzuki (2019a) previously studied traffic safety culture among the professional taxi and public bus drivers in the State of Qatar and found that driving experience and origin had significant impact on the personal acceptance of a variety of risky driving behaviours. The State of Qatar is a unique country in comparison to other countries with regards to its heterogeneous driving population with multiple sub-cultures. Qatar has many expatriates from approximately 55 different nationalities who live and work in Qatar, resulting in a driving population with a large variety of origin. The Traffic Department within the Ministry of Interior of the State of Qatar reveals that per 31st of December 2016 only 7% of the general driving population is Qatari. The other 93% of the driving population is non-Qatari, with 23% having an Arabic origin, and 70% are drivers from other non-Arabic origins. Unsafe road situations can be expected with a culturally heterogeneous driving population that is accustomed to different driving cultures, dissimilar highway codes and various driving test requirements.

This large heterogeneous population of drivers with diverse cultural backgrounds in the State of Qatar emphasises the importance to study the traffic safety awareness, risk acceptance, and social- and personal attitudes towards risky driving behaviours among the driving population.

Accordingly, the first objective of the study is to examine the structure of a traffic safety culture questionnaire by analysing the similarity between questionnaire items, aiming to classify attitudes towards risky driving behaviours into risky driving themes. The second objective is to classify drivers within a heterogeneous driving sample into sub-cultures with shared driver characteristics. The third objective is to investigate how the acceptance for the risky driving behaviours relates to different drivers' sub-cultures.

2. Literature review

There is a lack of knowledge and a great amount of confusion about a clear definition of traffic safety culture, as the concept is not based on an operational model. Also, limited research has been conducted, which prevents the development of a unanimous definition (Ward & Özkan, 2014). Within the literature, traffic safety culture is described as a concept that helps explain why drivers engage in risky or safe driving behaviours (Connor, Steingard, Anderson, & Melloni, 2003) and helps to explain why certain drivers within specific sub-cultures accept or oppose to existing traffic safety policies and laws (Rakauskas, Ward, & Gerberich, 2009). This engagement in risky driving behaviour is incorporated within the traffic safety culture paradigm based on several theories, such as the social cognitive theory, the social normative theory and the theory of planned behaviour (Elliot, Armitage, & Baughan, 2003). Both the theory of planned behaviour (Ajzen, 1991) and the social cognitive theory describe how the internal psychological factors of the driver such as their beliefs, attitudes and expectations interact with the driver's external observation of behaviour committed by others. This interaction could act as motivation that antecedes risky driving behaviour, especially if the consequences of the behaviour are positive and the observed behaviour is committed by a person they perceive as similar to themselves (Cooper, 2000). The social normative theory defines informal rules based on the behaviours learned by observations of others in their community, which influences the behavioural choices of the individual group members in return. If the social norm indicates that certain risky driving behaviours are normal and common among the members of the sub-culture, the individual driver will rationalise their own performance of these specific risky driving behaviours (Ward et al., 2010). For that reason, traffic safety culture is seen as a contextual concept that aids to define high and low risk groups of drivers within sub-cultures among the driving population (Ward, Otto, Swinford, & Borkowski, 2015).

2.1. Analysing traffic safety culture

A variety of modelling techniques have been applied throughout traffic safety culture research to examine the underlying dimensional structures, correlations and causal relationships between observed and latent variables, such as Principle Component Analysis (PCA), Factor- and Cluster Analysis techniques and Structural Equation Modelling (SEM) which incorporates Confirmatory Factor Analysis (Coogan, Campbell, Adler, & Forward, 2014; Islam, Thue, & Grekul, 2017; Lund & Rundmo, 2009). Multidimensional scaling (MDS) is another exploratory type of multi-variate data analysis (Das, Minjares-Kyle, Wu, & Henk, 2019; Roidl, Siebert, Oehl, & Höger, 2013), but is new within the traffic safety research. However, MDS is also developed to discover patterns and structure in a large set of complex data with many variables (Jaworska & Chupetlovska-Anastasova, 2009; Kruskal & Wish, 1978). Multidimensional scaling is regularly applied in the field of psychology, where the underlying social, cognitive and behavioural concepts in measurement scales are often unidentified. According to Schiffman, Reynolds, and Young (1981, p: 3) "MDS helps to systemize data in areas where organising concepts and underlying dimensions are not well-developed". For instance, MDS has significant value when researching qualitative data derived from questionnaire scales (Woosley, Hyman, & Graunke, 2004).

The usefulness of MDS in the field of traffic safety research can be supported by Ward et al. (2010) and Özkan and Lajunen (2011) who proposed the exploration of traffic safety culture to be optimal when using multi-levelled modelling. Driving behaviour is known to be diverse and not isolated, because drivers inevitably perform a set of (risky) driving behaviours instead of one behaviour a time. Therefore, instead of looking at the order of singular driving behaviours, traffic safety culture should be looked at as a multi-dimensional concept with inter-related driving behaviours. With that in mind, MDS is advantageous because the method visually displays the interrelationship of all driving behaviours, each variable with each other variable in terms of proximity (Giguère, 2006; Tsogo, Masson, & Bardot, 2000). Hence, MDS can support to identify the similarity pattern in individuals' responses or behaviours by plotting them as points in space, positioning them together in close proximity on a graphic configuration. This visual representation of each behaviour in relation to each other behaviour will increase the ease of understanding the relationships between driving behaviours. This makes it possible to create and quick glimpse inferences about drivers' behaviour (Davison, 1983; Saeed, Nam, Haq, & Bhatti, 2018). The advantage of MDS over PCA and Factor analysis is its flexibility and large range of applicability, because MDS does not require the general assumptions of linearity and normality; besides MDS does not require a large sample size (Maslovaty, Marshall, & Alkin, 2001; Saeed et al., 2018). Considering the above, MDS is a valuable analysis technique to create understanding about the structure and underlying concepts within the traffic safety culture questionnaire in this study. It is important to classify risky driving (Missikpode, Peek-Asa, McGehee, & Wallace, 2019), as well as classify drivers within a heterogeneous driving population into sub-cultures. Using a multi-variate classification of acceptance towards risky driving behaviours and assessing shared sets of driver characteristics, MDS can visualise the similarity in risky driving attitudes among different drivers' sub-cultures.

3. Methodology

3.1. The questionnaire on traffic safety culture

The questionnaire used in this study is part of a global research project being conducted by the International Association of Traffic and Safety Sciences (IATSS) in which the traffic safety culture within different countries are studied at international level. The questionnaire was created to measure the road traffic safety culture among drivers within the same geographical and cultural environment. It was developed for this specific research project based on common risky driving behaviours and related safety attitudes derived from the literature. The Questionnaire was not based on existing surveys previously used in road safety projects that also assess the safety attitudes of road users, like the SARTRE (Antov et al., 2012) or ESRA projects (Meesmann & Torfs, 2019). To keep the highly heterogeneous driving population of Qatar into account, the questionnaire was delivered in both Arabic and English language. The questionnaire used in this study has five sections measuring different aspects of traffic safety culture and the characteristics of drivers. Section 1 contains demographic questions, Section 2 measures the perceived changes in traffic problems compared to three years ago, Section 3 measures social normative acceptance for risky driving behaviours, Section 4 drivers' personal acceptance for risky driving behaviours, and Section 5 measures the support or opposition towards traffic laws. For more details, the questionnaire can be found in Appendix A.

3.2. Sample

For this study, the sample of drivers selected to represent the driving population of Qatar was derived from students and staff members in Qatar University and via personal contacts in the community among ministries and private sector. The Traffic Safety questionnaire was distributed among 296 drivers, but not all the drivers who completed the questionnaire were used for the analyses in this study, as certain cases were excluded from the sample in order to minimise bias and uncertainty. A data cleaning process was conducted to include only drivers with a Qatari residence and questionnaires with duplicate or missing answers or abnormal values (e.g. age below 18) were eliminated. This resulted in a sample of 264 respondents of whom 167 male (63%) and 97 female (37%) drivers. The drivers had a heterogeneous origin and age, with age ranging from 18 to 64 years and an average age of 30 years. Around 90% of the drivers drove on a daily basis and 50% of the drivers reported to commute to/from work, around 30% reported to drive to/from University and 12% reported to drive as business. Table 1 portrays the driver attributes that are characteristic for a sample of Qatar's heterogeneous driving population. The driver's nationality was divided into regional origin categories: Qatari, Arabic, African, South Asian and Western origin.

3.3. Statistical analysis – multidimensional scaling analysis (MDS)

Two types of MDS analyses have been applied to establish the relationship between traffic safety culture and risky driving behaviours in the State of Qatar; Smallest Space Analysis (SSA-I) and Multidimensional Scalogram Analysis (MSA).

3.3.1. Classification of attitudes towards risky driving behaviours

A Smallest Space Analysis (SSA-I) is performed to analyse the structure of the traffic safety culture questionnaire that measures attitudes on risky driving behaviours. An SSA-I is a non-metric multidimensional scaling procedure pioneered by Lingoes (1973). The strength of SSA-I is the non-metric character, meaning that SSA-I envisions the rank-order of the co-occurrence of variables as relative differences, portrayed as distances in space and does not visualise the absolute values. This is advantageous because samples with predominantly high or low absolute frequencies are less sensitive to biases due to the visualisation of differences instead of absolute values (Guttman, 1968).

Table 1
Driver sample demographic characteristics ($N = 264$).

Driver characteristics		$N = 264$
Gender	Male	167 (63%)
	Female	97 (37%)
Driving purpose	Commuting	133 (50%)
	Driving to/from education	76 (29%)
	Driving as business	31 (12%)
	Unknown driving purpose	24 (9%)
Age cohorts	Young driver (18–30 y)	160 (61%)
	Middle-aged (31–45 y)	71 (27%)
	Old driver (46–65 y)	33 (12%)
Driving experience	Less experienced (<5 years)	165 (62%)
	Very experienced (>5 years)	99 (38%)
Income level	Low income (below QAR10,000)	146 (55%)
	Medium income (QAR10,000–QAR20,000)	56 (21%)
	High income (above QAR20,000)	62 (24%)
Type of car	Car	165 (62%)
	SUV	92 (35%)
	Minivan	3 (1%)
	Unknown type of vehicle	4 (2%)
Driving frequency	Less than once a week	8 (3%)
	Several times a week	21 (8%)
	Every day	235 (89%)
Origin	Arabic	106 (40%)
	South Asian	45 (17%)
	Qatari	34 (13%)
	Western	23 (9%)
	African	12 (4%)
	Unknown origin	44 (17%)

The model fit of an SSA-I analysis plot is calculated with the coefficient of alienation, which identifies if the associations between all questionnaire items are correctly represented by the distances between the points in the SSA plot. The smaller the coefficient of alienation, the better the fit between the spatial representation and the similarity matrix of the variables (Borg & Lingoes, 1987). A perfect fit would have a coefficient of alienation equal to zero, a coefficient smaller than 0.15 is considered as a good fit and a coefficient between 0.15 and 0.2 is a reasonable fit (Guttman, 1968).

The structure visualised on the SSA-I plot is used to explore the similarity pattern of the questionnaire items measuring risky driving behaviour attitudes, based on the distances between points on the SSA-I plot. The similarity between risky driving behaviour attitudes is measured using monotonicity coefficients for variables with multiple categories by monotonically transferring correlation coefficients into a visual representation of relativeness. Each item will be visualised in relation to every other item, resulting in a spatial representation of all questionnaire items as points in an SSA plot. If items in the SSA-I plot are positioned close together this indicates a high similarity, but low similarity will result in spreading of the questionnaire items. Interpretation of an SSA-I analysis is based on the 'regionality hypothesis', assuming that risky driving behaviours with the same underlying meaning are located close together within the same region, but dissimilar risky driving behaviours will appear in different regions (Canter & Heritage, 1990; Lingoes, 1973). These regions are specified by boundary lines, which are positioned by the researcher based on the interpretation of a common meaning of several risky driving behaviours positioned close together inside the region. However, these regions are not independent, because items which are plotted close to a boundary line can be inspired by the meaning of the regions on both sides of the line, while items positioned far away from the boundary lines have a clearer meaning based on only one region (Canter & Youngs, 2009). For that reason, the relationship between risky driving behaviour attitudes in the SSA-I is are visualised and interpreted based on themes, describing the underlying feature, and themes blend from one region to another. The researcher has the freedom to label a theme with any name that represents the mutual meaning of the clustered attitudes. The SSA-I analysis in this study is used to establishing risky driving themes within the questionnaire, measuring three different aspects of traffic safety culture: the social normative acceptance of risky driving behaviours, the driver's personal acceptance of risky driving behaviours, and the driver's support or opposition towards the implementation of traffic laws.

3.3.2. Classification of drivers into sub-cultures

To establish the association between drivers in the sample based on a selection of driver characteristics, a Multidimensional Scalogram Analysis (MSA) is conducted (Wilson, 1995). The MSA method is used to classify drivers in the sample based on the level of similarity between the drivers and to visualise their shared characteristics. MSA is beneficial in large datasets which provide diverse information on various variables for each individual respondent.

MSA is related to facet theory, developed by Guttman in which research designs are constructed by prescribing fundamental elements of the research as facets (Guttman & Greenbaum, 1998). Background facets are population parameters that are used to characterise the individuals in a study sample and each facet has several elements (Donald, 1995). The multiple facets and elements used as input of an MSA analysis are connected by the development of a mapping sentence (Shye, Elizur, & Hoffman, 1994). For each driver, all facets in the mapping sentence are combined into a profile, showing a specific combination of facets (letters) and elements (numbers); for example, A1B1C3D2. Each profile is examined using an MSA analysis based on the principle of contiguity, meaning that each driver is compared by the number of elements they have in common, with drivers who share more common elements being empirically more related (Canter, 1983). The MSA analysis in this study thereby indicates the resemblance between drivers and is applied to classify drivers in the sample into subcultures that share similar driver characteristics.

3.3.3. Relationship between sub-cultures and personal acceptance of risky driving behaviours

This study applies Multivariate Analysis of Variance (MANOVA) to analyse the relationship between the risky driving themes and the different drivers' sub-cultures. A first MANOVA measures the acceptance level for risky driving themes as dependent variables and a second MANOVA measures the level of law opposition as dependent variables. Both analyses deploy the drivers' subcultures as independent variables. Furthermore, Bonferroni post-hoc tests were conducted to statistically compare the average levels of acceptance or opposition between all drivers' subcultures. Data was analysed using IBM SPSS Statistics 25. All analyses were initially conducted with significance level $\alpha < 0.05$.

4. Results

4.1. Classification of attitudes towards risky driving behaviours into themes

The similarity pattern between questionnaire items measuring risky driving behaviour attitudes for three different aspects of traffic safety culture are analysed using an SSA-I analysis, in order to establish underlying risky driving themes. Figs. 1–3 show the SSA plots for the questionnaire items measuring the personal acceptance towards risky driving behaviours, the social normative

acceptance towards risky driving behaviours, and the level of opposition for the implementation of traffic laws, respectively. At the right side of each SSA plot a table lists the literal questionnaire items measuring risky driving behaviours, which represent each risky driving theme. The reliability of each risky driving theme is indicated by a Cronbach's alpha.

Fig. 1 provides a three-dimensional SSA plot from the angle of axis 1 versus axis 3, with a coefficient of alienation of 0.10428, revealing a good model fit. The boundary lines in Fig. 1 indicate three underlying themes, divided based on the similarity between the questionnaire items that measure the drivers' personal acceptance of 12 risky driving behaviours. The three risky driving themes indicated in Fig. 1 are labelled 'personal acceptance speeding', 'personal acceptance distraction and driver's negligence' and 'personal acceptance extreme risk-taking' based on the common underlying concept of the questionnaire items. As visible at the side of the SSA plot in Fig. 1, the risky driving theme 'Personal acceptance Speeding' is represented by four traffic safety culture questionnaire items that form a reliable theme, as shown by a Cronbach's alpha of 0.747. The risky driving behaviour theme 'Personal acceptance Distraction and negligence driver' is represented by six questionnaire items, revealing a reliable Cronbach's alpha of 0.798. The risky driving theme 'Personal acceptance Extreme risk-taking' covers two questionnaire items with a Cronbach's alpha of 0.637. The researcher selected a simplex partition for the personal attitudes by dividing the SSA plots into parallel sections which imply an order of, ranging from overall highly accepted risky driving behaviours (speeding) on the left to the less accepted more extreme risky driving behaviours (RLR and intoxicated driving) on the right.

Fig. 2 plots the three-dimensional SSA analysis of the traffic safety culture questionnaire items measuring Social normative acceptance of 12 risky driving behaviours. The distances between the points in the SSA plot correctly represent the association between all questionnaire items, indicated by a coefficient of alienation of 0.08033, which is considered as a good model fit. Fig. 2 reveals four underlying themes for social normative acceptance, labelled as follows: Social norm accepting speeding, Social norm accepting hands-free phone use while driving, Social norm accepting distraction and negligence driver, and Social norm accepting extreme risk-taking. As visible at the side of the SSA plot in Fig. 2, The risky driving theme 'Social norm accepting speeding' is represented by four questionnaire items, revealing a reliable Cronbach's alpha of 0.808. The risky driving theme 'Social norm accepting distraction and negligence driver' covers four questionnaire items with a reliable Cronbach's alpha of 0.867. The risky driving theme 'Social norm accepting extreme risk-taking' is represented by two items, revealing a reliable Cronbach's alpha of 0.742.

Fig. 3 shows the three-dimensional SSA plot from the angle of axis 1 versus axis 2, with a coefficient of alienation of 0.08268, indicating a good model fit. The boundary lines reveal four risky driving themes among the questionnaire items which determine the drivers' opposition towards traffic laws. The four themes are labelled based on a common underlying concept: law against speeding, law against distraction, law against intoxicated driving, and law against red-light running (RLR). As visible at the side of the SSA plot in Fig. 3, the risky driving theme 'law against speeding' contains four laws which form a reliable theme, as shown by a Cronbach's alpha of 0.860. The theme 'law against distraction' is represented by four traffic laws with a Cronbach's alpha of 0.748. The theme 'law against intoxicated driving' is represented by two items, revealing a Cronbach's alpha of 0.715 and the theme 'law against RLR' is also formed by two items with a reliable Cronbach's alpha of 0.852. The researcher selected a radex partition for Figs. 2 and 3, by dividing these SSA plots into several sections which imply a clockwise order ranging from highly accepted risky driving behaviours (speeding) to the least accepted more extreme risky driving behaviours (RLR and intoxicated driving).

4.2. Classification of heterogeneous drivers into drivers' sub-cultures

When studying traffic safety culture for a heterogeneous driving population like in the State of Qatar, it is essential to investigate the association between multiple driver attributes, focusing on sub-cultures instead of single attributes. To determine a set of shared driver attributes and classify drivers into sub-cultures an MSA analysis has been conducted. Sub-cultures in this heterogeneous driving sample are classified using the following descriptive facets: gender, origin, age and driving purpose. A so called "mapping sentence" combining all descriptive facets is visualised below, providing the input for the MSA analysis.

Heterogenous drivers (x) *in a driving sample derived from the State of Qatar are characterised by a combination of the following descriptive facets*

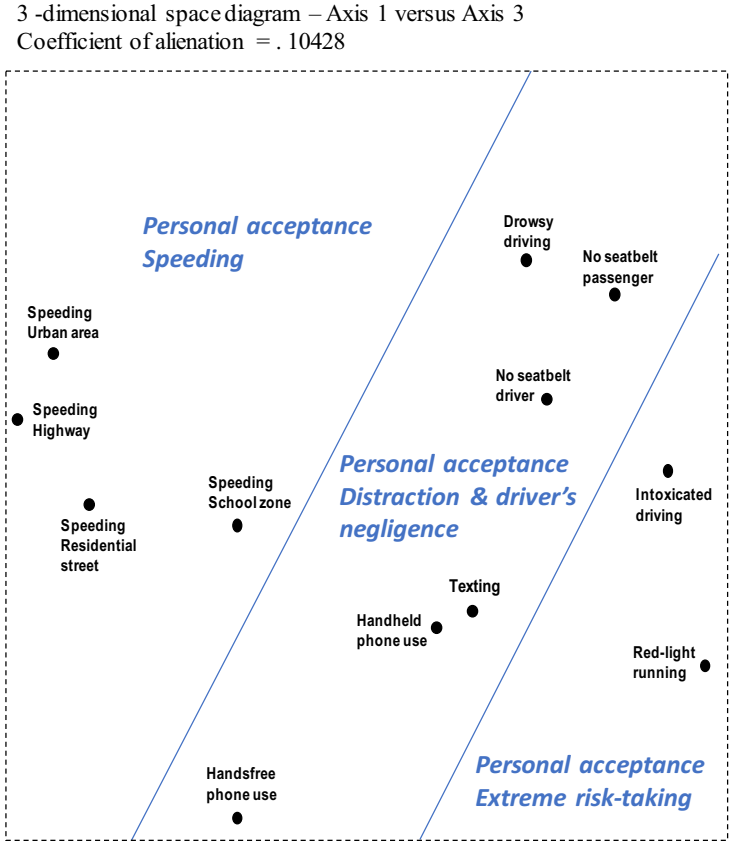
(FACET A) ***GENDER***	*and*	*(FACET B)* ***ORIGIN***	*and*	*(FACET C)* ***AGE***	*and*	*(FACET D)* ***DRIVING PURPOSE***
1. Male		*1. African*		*1. Young (18y-30y)*		*1. Commuting (driving to/from work)*
2. Female		*2. Qatari*		*2. Middle age (31y-45y)*		*2. Driving to/from education*
		3. Western		*3. Old (46y-60y)*		*3. Driving as business*
		4. South-Asian				
		5. Unknown				
		6. Arabic				

→ *Classifying the drivers into* ***Sub-cultures (Y)*** *with shared driver attributes*

Results of the MSA provide a list of profiles and each profile contains the identification numbers of all drivers sharing similar profiles. This output is used to classify the drivers into sub-cultures with shared driver characteristics. Based on this MSA results, the study indicates 11 sub-cultures for this sample, labelled as follows: Male Arab Commuter ($N = 53$), Male Young Arab Student ($N = 43$), Female Arab Commuter ($N = 39$), Female Young Arab Student ($N = 33$), Western Older Commuter ($N = 29$), Male South-Asian Business ($N = 26$), African Male ($N = 13$), South-Asian Commuter ($N = 10$), Young South-Asian Student ($N = 10$), Arab Business ($N = 7$) and Western Business ($N = 2$). Due to the low number of drivers within certain sub-cultures, only six main sub-cultures with more than 15 drivers are taking into consideration for the subsequent comparative analyses.

4.3. Relationship between risky driving themes and drivers' sub-cultures

Two MANOVA analyses are conducted to investigate which drivers' sub-cultures are more risk-accepting for specific driving behaviours, with the established risky driving themes as dependent variables. Table 2 provides the result of the first MANOVA analysis measuring the influence of drivers' sub-culture on the level of acceptance for risky driving behaviours, statistically comparing the average level of acceptance between the six sub-cultures using Bonferroni post-hoc tests. Table 2 also reveals average level of acceptance on a 4-point scale ranging from completely unacceptable (score 1) to completely acceptable (score 4), with an average score above 2 indicating acceptance for the risky driving behaviours. The MANOVA results indicate that there is a significant relationship between drivers' sub-culture and the level of personal acceptance of speeding and extreme risk-taking. All Arabic sub-cultures show acceptance for speeding with an average acceptance above 2. However, the highest level of acceptance is found among the Male Young Arab Student sub-culture (underlined and bold font in Table 2) who show a significantly higher level of acceptance for speeding in comparison to the Western Older Commuter sub-culture ($p = .031$). For the extreme risk-taking theme on the other hand, the Male South-Asian Business sub-culture reveals significantly higher average level of acceptance in comparison to both Male and Female Arab Commuter sub-cultures ($p = .003$ and $p = .001$, respectively) and the Female Young Arab Student sub-culture ($p = .020$). Table 2 also displays a significant relationship between drivers' sub-culture and the social norm accepting



Risky driving theme	Personal acceptance "How acceptable do you personally feel it is for a driver to ……?"	Cronbach alpha
Personal acceptance speeding	- Drive >20km over speed limit on highway - Drive > 10km over speed limit on residential street - Drive >10km over speed limit in urban area - Drive >10km over speed limit in school zone	α = .747
Personal acceptance distraction & negligence driver	- Talk on phone in handsfree mode while driving - Talk on handheld phone while driving - Type text message or email while driving - Drive when so sleepy that cannot keep eyes open (drowsy driving) - Drive without wearing a seatbelt - Drive with passengers not wearing a seatbelt	α = .798
Personal acceptance extreme risk-taking	- Drive through a traffic light that turned red, when they could have stopped (RLR) - Drive when under the influence of alcohol or illegal drugs (intoxicated driving)	α = .637

Fig. 1. Smallest Space Analysis (SSA-I) visualising questionnaire items representing the drivers' personal acceptance of risky driving with inserted partitions to suggest risky driving behaviour themes.

distraction and negligence drivers, as well as social norm accepting hands-free phone use while driving. For social normative acceptance of distraction and drivers' negligence, the Male South-Asian Business sub-culture reveals a significantly lower level of social normative acceptance in comparison to Male Arab Commuter and Male Young Arab Student sub-cultures ($p = .017$ and $p = .018$, respectively). The Male South-Asian Business sub-culture also reports significantly less social normative acceptance of hands-free phone use while driving, in comparison to both Male and Female Young Arab Student sub-cultures ($p < .001$ and $p = .010$, respectively), both Male and Female Arab Commuter sub-cultures ($p = .001$ and $p = .017$, respectively), and the Western Older Commuter sub-culture ($p = .002$).

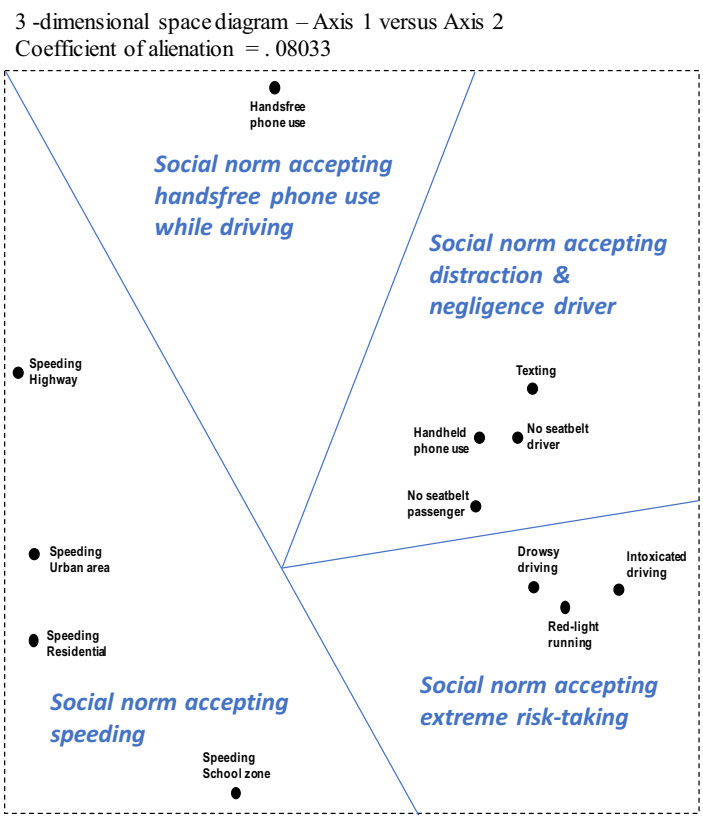
Table 3 provides the result of the second MANOVA analysis measuring the influence of drivers' sub-culture on the level of opposition towards traffic laws, but also shows the average levels of opposition on a 4-point scale, with an average score above 2 indicating acceptance for the risky driving behaviours. Furthermore, Table 3 statistically compares the average levels of opposition between all six different sub-cultures using Bonferroni post-hoc tests. The MANOVA results reveal that there is a significant relationship between drivers' sub-culture and the level of opposition towards the implementation of traffic laws against intoxicated driving and red-light running. The risky driving behaviour theme Law against intoxicated driving is significantly more opposed to by the Male South-Asian business sub-culture (underlined and bold font in Table 3) in comparison to both Male and Female Young Arab Student sub-cultures ($p = .040$ and $p = .036$, respectively). The Male South-Asian Business sub-culture also shows a significantly higher average level of opposition towards RLR in comparison to the Male Arab Commuter sub-culture ($p = .026$).

5. Discussion

5.1. Risky driving themes

The similarity pattern of questionnaire items measuring different aspects of traffic safety culture (personal acceptance, social norm and traffic law opposition) identified a total of 11 risky driving themes. Each risky driving theme represents a reliable subset of questionnaire items with a similar underlying concept: Personal acceptance Speeding, Personal acceptance Distraction and negligence driver, Personal acceptance Extreme risk-taking, Social norm accepting speeding, Social norm accepting hands-free phone use, Social norm accepting Distraction and negligence driver, Social norm accepting extreme risk-taking, Law against speeding, Law against distraction, Law against intoxicated driving and Law against RLR. The themes labelled acceptance of distraction and negligence driver are named as such, because the listed items refer to phone use and drowsy driving which impact drivers' alertness and refers to the drivers' negligence not to use a seatbelt. The scale extreme risk-taking is labelled based on the rare but extremely dangerous behaviours related to red-light running and driving while being under the influence of alcohol or drugs.

The questionnaire items measuring the personal acceptance versus the items measuring social normative acceptance logically share the same underlying thematic concept, because the questionnaire items refer to the exact same risky driving behaviours. However, the results show slightly different inter-correlations between the questionnaire items, with drowsy driving within the social normative acceptance themes being related to intoxicated driving and RLR. This can be explained because drowsy driving accepted by other drivers is perceived as riskier since crashes often



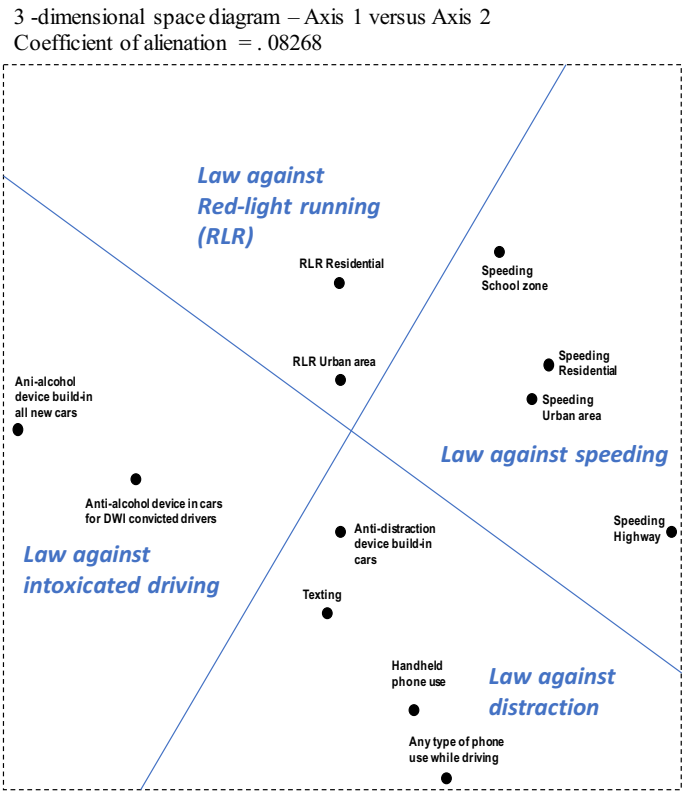
Risky driving behaviour theme	Social normative acceptance: "Where you live, how acceptable would most other people consider for a driver to .....?"	Cronbach Alpha
Social norm accepting speeding	- Drive >20km over speed limit on highway - Drive > 10km over speed limit on residential street - Drive >10km over speed limit in urban area - Drive >10km over speed limit in school zone	α = .808
Social norm accepting handsfree phone use while driving	- Talk on phone in handsfree mode while driving	Not applicable
Social norm accepting distraction & negligence driver	- Talk on handheld phone while driving - Type text message or email while driving - Drive without wearing a seatbelt - Drive with passengers not wearing a seatbelt	α = .867
Social norm accepting extreme risk-taking	- Drive when so sleepy that cannot keep eyes open (drowsy driving) - Drive through a traffic light that turned red, when they could have stopped (RLR) - Drive when under the influence of alcohol or illegal drugs (intoxicated driving)	α = .742

Fig. 2. Smallest Space Analysis (SSA-I) visualising questionnaire items representing the social normative acceptance of risky driving with inserted partitions to suggest risky driving behaviour themes.

involve surrounding cars, as do RLR and intoxicated driving. Furthermore, social norm of hands-free phone use while driving is clearly not scored similarly as social norm related to other phone use, which can be explained by the underestimation of the safety hazard of calling in hands-free phone mode which is not judged as entirely incorrect or risky. This is in line with previous research indicating hands-free phone use to negatively effecting the driving performance (McCarley et al., 2001; Ross et al., 2014). The high level of acceptance of this risky driving behaviour among all drivers' sub-cultures confirms the underestimation of the risk of hands-free phone use while driving among the study population in the State of Qatar. Furthermore, the social normative acceptance for risky driving behaviours is on average higher than the personal acceptance, which can be explained by the human tendency to estimate yourself better than others and, therefore, we report ourselves to be less acceptable of risky driving in comparison to others. For example, this is visible for the risky driving themes personal- and social acceptance of drivers' distraction and negligence. Distraction and negligence are personally not accepted (scores below 2) by the driver but judged as socially accepted (score above 2) by others. Also, among all sub-cultures the social normative acceptance of speeding is higher than the personal acceptance, which can be explained by underestimation of travelling speed among drivers in the State of Qatar (Hussain et al., 2019). In general, the similarity pattern among the questionnaire items and shared underlying themes confirm that traffic safety culture is based on a combination of three aspects; drivers' personal acceptance of risky driving, the risk accepting social norm and traffic law opposition. Therefore, the joint acceptance among these eleven risky driving can guide inferences about the driver's individual likelihood to conduct risky driving behaviours. This finding is in accordance with previous research (Connor et al., 2003; Rakauskas et al., 2009; Ward et al., 2010).

5.2. Risk accepting sub-cultures for specific driving behaviours

The combination of driver characteristics that drivers in a sub-culture have in common will increase the influence of the social norm within a sub-culture, because drivers observe and behave like other drivers that they perceive as similar to their selves. For instance, within risk accepting sub-cultures drivers with shared attributes are likely to imitate risky driving behaviours that are accepted and performed by others in the same sub-culture (Cooper, 2000). Hence, for the implementation of practical traffic safety strategies it is important to establish which sub-cultures report the highest level of acceptance for each specific risky driving theme. Results indicate that the Male Arabic sub-cultures reveal a higher level of acceptance for speeding and distraction and drivers' negligence, in comparison to drivers from other origins, except Western older commuters who also report high level for these risky driving themes. Arabic students in particular report highest levels of opposition towards traffic laws against speeding and distraction, while Western older commuters report lowest levels of opposition. Results in this study for higher acceptance of both risky driving themes among the young Arabic students, specifically males for the theme distraction and drivers' negligence, are also found in previous studies (Bener, Özkan, & Lajunen, 2008; Lajunen et al., 2004; Ross et al., 2015; Soliman, Alhajyaseen, Alfar, & Alkaabi, 2018). Furthermore, these results confirm previous literature that drivers with a younger age report significantly more acceptance for speeding (Amponsah-Tawiah & Mensah, 2016). Descriptive results from this study reveal that 62% of the



Risky driving behaviour theme	Traffic law opposition: "How strongly do you support or oppose to...?"	Cronbach Alpha
Law against speeding	- Implement camera for automatic ticket when driving >20km over speed limit on highway - Implement camera for automatic ticket when driving >10km over speed limit on residential street - Implement camera for automatic ticket when driving >10km over speed limit in urban area - Implement camera for automatic ticket when driving >10km over speed limit in school zone	α = .860
Law against distraction	- Law against reading, typing or sending a text-message or email while driving - Law against using a hand-held phone while driving - Law against using any type of phone, including handsfree - Having government regulate non-driving-devices in cars to prevent distraction driver	α = .748
Law against intoxicated driving	- Build-in anti-alcohol device to let car start for drivers with DWI (Driving While Intoxicated) conviction - Build-in anti-alcohol device to let car start for all new cars	α = .715
Law against Red-light running (RLR)	- Implement camera for automatic ticket when running a red-light in urban area - Implement camera for automatic ticket when running a red-light in urban area	α = .852

Fig. 3. Smallest Space Analysis (SSA-I) visualising questionnaire items representing the drivers' opposition to traffic laws with inserted partitions to suggest risky driving behaviour themes.

Table 2
Summary of MANOVA for the influence of drivers' sub-culture on different risky driving themes, comparing the average level of acceptance for risky driving behaviours.

Risky driving themes	MANOVA analysis Influence of drivers' Sub-culture			Bonferroni post-hoc tests Average level of acceptance for risky driving behaviour per drivers' sub-culture[a]					
	F	df	Sig.	Male Arab Commuter	Male Young Arab Student	Female Arab Commuter	Female Young Arab Student	Western Older Commuter	Male South-Asian Business
Personal acceptance speeding	3.465**	6	$p = .003$	2.22	**2.41**	2.20	2.40	1.82* ($p = .031$)	1.87
Personal acceptance distraction and negligence driver	1.407	6	$p = .213$	1.89	1.99	1.71	1.75	1.88	1.60
Personal acceptance Extreme risk-taking	3.560**	6	$p = .002$	1.14** ($p = .003$)	1.30	1.07*** ($p = .001$)	1.17* ($p = .020$)	1.23	**1.64**
Social norm accepting speeding	2.113	6	$p = .053$	2.69	2.66	2.57	2.41	2.31	2.11
Social norm accepting distraction and negligence driver	2.723*	6	$p = .014$	3.04* ($p = .017$)	3.14* ($p = .018$)	2.87	2.94	3.07	**1.96**
Social norm accepting hands-free phone use while driving	4.148***	6	$p = .001$	2.47*** ($p = .001$)	2.49*** ($p < .001$)	2.12* ($p = .017$)	2.21** ($p = .010$)	2.39** ($p = .002$)	**1.72**
Social norm accepting extreme risk-taking	0.400	6	$p = .878$	1.72	1.72	1.60	1.64	1.84	1.71

Note: *Significant at $\alpha < 0.05$ **Significant at $\alpha \leq 0.01$ ***Significant at $\alpha \leq 0.001$.
Underlined and bolt font: Significantly higher/lower average acceptance compared to other sub-cultures.
[a] Average level >2 indicates acceptance for risky driving behaviours.

sample are young and inexperienced drivers, classified as the Young Students' sub-cultures (male and female). The findings show that these sub-cultures with young drivers have specific attitudes towards different risky driving behaviours. Their high level of personal acceptance for speeding, as well as distraction and drivers' negligence (phone use, no seatbelt and drowsy driving) create a large safety concern. The lack of driving experience and young age makes this sub-culture less accurate in perceiving hazards and slower in their ability to anticipate on traffic hazards, particularly at moments of drowsiness (Smith, Horswill, Chambers, & Wetton, 2009). However research indicates this poor hazard perception in young drivers can be trained to be improved (McDonald, Goodwin, Pradhan, Romoser, & Williams, 2015; Yamani et al., 2016).

Table 3
Summary of MANOVA for the influence of drivers' sub-culture on different risky driving themes, comparing the average level of opposition towards traffic laws.

Risky driving themes	MANOVA analysis Influence of drivers' Sub-culture			Bonferroni post-hoc tests Average level of opposition towards traffic laws per drivers' sub-culture[a]					
	F	df	Sig.	Male Arab Commuter	Male Young Arab Student	Female Arab Commuter	Female Young Arab Student	Western Older Commuter	Male South-Asian Business
Law against speeding	1.048	6	$p = .395$	1.94	2.31	2.07	2.17	1.89	2.16
Law against distraction	1.597	6	$p = .149$	1.94	2.11	1.86	2.21	1.78	1.79
Law against intoxicated driving	2.134*	6	$p = .050$	1.59	1.42* ($p = .040$)	1.55	1.38* ($p = .036$)	1.60	**2.02**
Law against RLR	2.142*	6	$p = .050$	1.28* ($p = .026$)	1.60	1.38	1.49	1.38	**1.87**

Note: *Significant at $\alpha < 0.05$.
Underlined and bolt font: Sub-culture with significantly higher average acceptance compared to other sub-cultures.
[a] Average level >2 indicates opposition towards traffic law implementation.

Younger drivers being more likely to perform risky driving behaviours and a high level of acceptance for speeding is also found for the European countries studied in the SARTRE project (Antov et al., 2012), as well as on a global level within the ESRA project (Holocher & Holte, 2019). The findings of this study in the State of Qatar shows that young, inexperienced drivers have positive attitudes towards speeding, which might be related to the high social normative acceptance that indicates a sense of normality for overspeeding. This might be explained by young novice drivers being more sensitive to other drivers performing risky speeding behaviours and feel a peer-pressure to overspeed, especially when driving together with peers as passengers (Ross et al., 2016). However in contrast to the ESRA project results that show older drivers (age of 65+) in the African region to have the highest acceptance for speeding, our results in the State of Qatar show that the Western older commuter sub-culture has a significantly lower level of personal acceptance towards speeding. This contrast indicates the importance of origin and cultural differences that influence drivers' attitudes towards risky driving behaviours and reveals the importance to investigate traffic safety culture in a heterogeneous driving population like the State of Qatar.

Drivers in the Male South-Asian business sub-culture report significantly less social normative acceptance for distraction and drivers' negligence in comparison to Male Arabic drivers, and significantly less social normative acceptance for hands-free phone use while driving in comparison to both male and female drivers with Arabic or Western origin. Nevertheless, the Male South-Asian Business sub-culture reports significantly higher level of acceptance for extreme risk-taking behaviours like intoxicated driving and red-light running, in contrast to the Male and Female Young Arabic Student sub-cultures and the Female Arabic Commuter sub-culture. In line with this, Male South-Asians who drive as a business also report significantly higher level of opposition towards traffic laws against RLR and intoxicated driving when compared to Arabic drivers. This can be explained by the religious values and strict alcohol regulations for Arabs in comparison to other nationalities inside the State of Qatar. Furthermore, Timmermans et al. (2019a) found similar results among the professional drivers in the State of Qatar, with drivers from South-Asian drivers being significantly more likely to oppose to implementing a law requiring a personal alcohol lock for drivers with a previous DWI conviction (Driving While Intoxicated).

5.3. Study limitations

A limitation of this study on traffic safety culture among drivers in the state of Qatar is that the data is derived from self-reported level of acceptance, but in future research it would be interesting to analyse the correlation between self-reported risk acceptance and police crash/violation records. Moreover, this study uses a 4-point scoring scale without neutral option; however, by using a 5-point scale the study could make a difference between drivers who really report to accept the studied risky driving behaviours in comparison to those drivers who remain neutral. Lastly, this study only examines a sample of the Qatari driving population and future research is required to for a variety of driver samples to strengthen results and generalise the conclusions.

6. Conclusion

This study provides an exploration of traffic safety culture in the State of Qatar using multidimensional scaling (MDS) to visualise the structure of a traffic safety culture questionnaire by analysing the similarity between questionnaire items, aiming to classify attitudes towards risky driving behaviours into risky driving themes. Results reveal similar risky driving themes for personal acceptance, social norm and traffic law opposition with a general tendency of social attitudes towards risky driving, revealing more acceptance in comparison to drivers' personal attitudes. Furthermore, MDS is used to classify drivers within a heterogeneous driving sample into sub-cultures with shared driver characteristics. These identified sub-cultures are subsequently compared for their level of acceptance of risky driving behaviours or opposition towards traffic laws. Acceptance of speeding and opposing to a law against speeding are found to be significantly more accepted within the Male and Female Young Arab students driving to/from education. Acceptance of distraction and drivers' negligence via phone use, drowsy driving and not wearing a seatbelt is also significantly higher among the male Arabic drivers. The male South-Asian business drivers in this sample show significantly higher acceptance for extreme risk-taking behaviours such as red-light running and intoxicated driving.

Within the traffic safety research MDS is a newly applied methodology that has the advantage of providing double classification analyses within one methodology. It can be used to classify drivers into sub-cultures, as well as classify attitudes towards or actual risky driving behaviours into dimensions or so-called risky driving themes. For that reason, this study aids by introducing a valuable analysis method that combines multiple driver characteristics and multiple risky driving behaviours into visual associations, that are easy to understand and thereby directly presentable.

6.1. Practical applications

It is important and practical to understand risky behavioural habits among sub-cultures and thereby focussing on groups of

drivers instead of individuals, because groups are easier to approach and drivers within sub-cultures are found to influence each other (e.g. peer pressure). By indicating which groups of drivers are most likely to perform specific risky driving themes, it is possible to target these groups and effectively emphasise certain subsets of risky driving behaviours during training or traffic safety campaigns. Thereby, this study can provide direction in the improvement of licencing processes and driver training, with emphasis on particular risky driving themes that are highly accepted among drivers in specific sub-cultures. For instance, driving training should inform young drivers about their inability to perceive traffic hazards due to inexperience. Additionally, young novice drivers would benefit from the introduction of a provisional or Graduated driver license (GDL). These licencing processes will prolong the learning stage while gaining additional experience during supervised driving hours, before the young driver has the freedom to drive solitary without restrictions. The gradual stages include extended training periods and the implementation of a provisional licence with restrictions on unsupervised driving, late night driving and taking young passengers, before the official driving licence is obtained. Finally, this study can also help to develop targeted traffic safety awareness campaigns; for example, awareness campaigns displayed at University campus to target students (including their peers) as young novice drivers. These targeted awareness campaigns should inform young student drivers about the hazard of speeding and (hands-free) phone use. Also awareness campaigns should emphasise the importance of a seatbelt as safety measure that can save lives and the effect of peer pressure on driving performance. Moreover, stricter law enforcement for speeding, phone use and seatbelt obligations should be implemented, in parallel with campaigns and driving training courses that should emphasise the risk of detection and consequences of arrest. The stricter licencing process and targeted traffic safety awareness campaigns are proposed practical implications with the intention to make changes to attitudes and habits among different driver sub-cultures, aiming to improve traffic safety on the longer term.

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References

Abay, K. A., & Mannering, F. L. (2016). An empirical analysis of risk-taking in car driving and other aspects of life. *Accident Analysis & Prevention, 97*, 57–68. https://doi.org/10.1016/j.aap.2016.08.022.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211.

Ameratunga, S., Hijar, M., & Norton, R. (2006). Road-traffic injuries: Confronting disparities to address a global-health problem. *The Lancet, 367*(9521), 1533–1540. https://doi.org/10.1016/S0140-6736(06)68654-6.

Amponsah-Tawiah, K., & Mensah, J. (2016). The impact of safety climate on safety related driving behaviors. *Transportation Research Part F, 40*, 48–55. https://doi.org/10.1016/j.trf.2016.04.002.

Antov, D., Banet, A., Barbier, C., Bellet, T., Bimpeh, Y., Boulanger, A., et al. (2012). European road users' risk perception and mobility: the SARTRE 4 survey. IFSTTAR. Retrieved November 30, 2019 from http://www.attitudes-roadsafety.eu/index.php?eID=tx_nawsecuredl&u=0&file=uploads/media/Sartre-4-report.pdf&t=1575269525&hash=369d207f3c1ddeff6a34020fa34ff1fa.

Atchison, L. (2017). Reducing casualties involving young drivers and riders in Europe Retrieved on December 1, 2019 from https://etsc.eu/wp-content/uploads/2017_01_26_young_drivers_report.pdf.

Bener, A., Özkan, T., & Lajunen, T. (2008). The driver behaviour questionnaire in Arab Gulf countries: Qatar and United Arab Emirates. *Accident Analysis & Prevention, 40*(4), 1411–1417. https://doi.org/10.1016/j.aap.2008.03.003.

Borg, I., & Lingoes, J. (Eds.). (1987). *Multidimensional similarity structure analysis*. New York, NY: Springer New York.

Canter, D. (1983). The potential of facet theory for applied social psychology. *Quality & Quantity, 17*(1), 35–67.

Canter, D., & Heritage, R. (1990). A multivariate model of sexual offence behavior: Developments in 'Offender Profling'. *Journal of Forensic Psychiatry, 1*, 185–212 http://eprints.hud.ac.uk/id/eprint/9229/.

Canter, D., & Youngs, D. (2009). *Investigative psychology: Offender profiling and the analysis of criminal action*. Chichester: John Wiley & Sons Ltd.

Cauzard, J. P. (2004). European drivers and road risk: SARTRE 3 reports: part 1: report on principal analyses. Retrieved November 30, 2019 from http://www.attitudes-roadsafety.eu/index.php?eID=tx_nawsecuredl&u=0&file=uploads/media/Part_1_Report_on_principal_results.pdf&t=1575270416&hash=5eb6219c22d293668be0c172ba4c057f.

Cauzard, J. P. (2004). European drivers and road risk: SARTRE 3 reports: part 2: report on in-depth analyses. Retrieved November 30, 2019 from http://www.attitudes-roadsafety.eu/index.php?eID=tx_nawsecuredl&u=0&file=uploads/media/Part_2_Report_on_in-depth_analyses_01.pdf&t=1575270416&hash=4d5324a9951d7c19ce902d7559ddeee8.

Connor, D. F., Steingard, R. J., Anderson, J. J., & Melloni, R. H. (2003). Gender differences in reactive and proactive aggression. *Child Psychiatry and Human Development, 33*(4), 279–294.

Coogan, M. A., Campbell, M., Adler, T. J., & Forward, S. (2014). Examining behavioral and attitudinal differences among groups in their traffic safety culture. *Transportation Research Part F, 26*, 303–316. https://doi.org/10.1016/j.trf.2014.03.005.

Cooper, M. D. (2000). Towards a model of safety culture. *Safety Science, 36*, 111–136. https://doi.org/10.1016/S0925-7535(00)00035-7.

Das, S., Minjares-Kyle, L., Wu, L., & Henk, R. H. (2019). Understanding crash potential associated with teen driving: Survey analysis using multivariate graphical method. *Journal of Safety Research, 70*, 213–222. https://doi.org/10.1016/j.jsr.2019.07.009.

Davison, M. L. (1983). *Multidimensional Scaling*. New York, New York: John Wiley & Sons. Retrieved on March 1, 2019 from: https://link.springer.com/content/pdf/10.1007%2FBF02294154.pdf.

Donald, I. (1995). Facet theory: Defining research domains. *Research methods in psychology*, 116–137.

Edwards, J., Freeman, J., Soole, D., & Watson, B. (2014). A framework for conceptualising traffic safety culture. *Transportation Research Part F, 26*, 293–302. https://doi.org/10.1016/j.trf.2014.03.002.

Elliot, M. A., Armitage, C. J., & Baughan, C. J. (2003). Drivers' compliance with speed limits: An application of the theory of planned behaviour. *Journal of Applied Psychology, 88*, 964–972.

Evans, L. (1996). The dominant role of driver behavior in traffic safety. *American Journal of Public Health, 86*(6), 784–786. https://doi.org/10.2105/AJPH.86.6.784.

Fisher, D. L., Caird, J., Horrey, W., & Trick, L. (Eds.). (2016). *Handbook of teen and novice drivers: Research, practice, policy, and directions*. CRC Press.

Gerard, M., Gibbons, F. X., Reis-Bergan, M., & Russel, D. M. (2000). Self-esteem, self-serving cognitions and health risk behavior. *Journal of Personality, 68*, 1177–1200. https://doi.org/10.1111/1467-6494.00131.

Giguère, G. (2006). Collecting and analyzing data in multidimensional scaling experiments: A guide for psychologists using SPSS. *Tutorial in Quantitative Methods for Psychology, 2*(1), 27–28.

Guttman, L. (1968). A General Nonmetric Technique for Finding the Smallest Coordinate Space for a Configuration of Points. *Psychometrika, 33*(4), 469–506. https://doi.org/10.1007/BF02290164.

Guttman, R., & Greenbaum, C. W. (1998). Facet theory: Its development and current status. *European psychologist, 3*(1), 13–36.

Holocher, S., & Holte, H. (2019). *Speeding. ESRA2 Thematic report Nr. 2. ESRA project (E-Survey of Road users' Attitudes)*. Bergisch Gladbach, Germany: Federal Highway Research Institute. Retrieved November 30, 2019 from https://www.esranet.eu/en/deliverables-publications/.

Hussain, Q., Alhajyaseen, W. K., Pirdavani, A., Reinolsmann, N., Brijs, K., & Brijs, T. (2019). Speed perception and actual speed in a driving simulator and real-world: A validation study. *Transportation Research Part F: Traffic Psychology and Behaviour, 62*, 637–650. https://doi.org/10.1016/j.trf.2019.02.019.

Islam, M. T., Thue, L., & Grekul, J. (2017). Understanding traffic safety culture: Implications for increasing traffic safety. *Transportation Research Record: Journal of the Transportation Research Board, 2635*, 79–89. https://doi.org/10.3141/2635-10.

Ivers, R., Senserrick, T., Boufous, S., Stevenson, M., Chen, H. Y., Woodward, M., et al. (2009). Novice drivers' risky driving behavior, risk perception, and crash risk: Findings from the DRIVE study. *American Journal of Public Health, 99*(9), 1638–1644. https://doi.org/10.2105/AJPH.2008.150367.

Jaworska, N., & Chupetlovska-Anastasova, A. (2009). A review of Multidimensional Scaling (MDS) and its utility in various psychological domains. *Tutorials in Quantitative Methods for Psychology, 5*(1), 1–10. https://doi.org/10.20982/tqmp.05.1.p001.

Kingery, K. M., Narad, M., Garner, A. A., Antonini, T. N., Tamm, L., & Epstein, J. N. (2015). Extended visual glances away from the roadway are associated with ADHD-and texting-related driving performance deficits in adolescents. *Journal of Abnormal Child Psychology, 43*(6), 1175–1186. https://doi.org/10.1007/s10802-014-9954-x.

Kruskal, J. B., & Wish, M. (1978). *Multidimensional scaling*. Newbury Park, CA: Sage.
Lajunen, T., Parker, D., & Summala, H. (2004). The Manchester driver behaviour questionnaire: A cross-cultural study. *Accident Analysis & Prevention, 36*(2), 231–238. https://doi.org/10.1016/S0001-4575(02)00152-5.
Lingoes, J. (1973). *The Guttman-Lingoes non-metric program series* Master Thesis. University of Michigan.
Litt, D. M., Lewis, M. A., Linkenbach, J. W., Lande, G., & Neighbors, C. (2014). Normative misperceptions of peer seat belt use among high school students and their relationship to personal seat belt use. *Traffic Injury Prevention, 15*(7), 748–752. https://doi.org/10.1080/15389588.2013.868892.
Lund, I. O., & Rundmo, T. (2009). Cross-cultural comparison of traffic safety, risk perception, attitudes and behaviour. *Safety Science, 47*, 547–553. https://doi.org/10.1016/j.ssci.2008.07.008.
Maslovaty, N., Marshall, A. E., & Alkin, M. C. (2001). Teachers' perceptions structured through facet theory: Smallest space analysis versus factor analysis. *Educational and Psychological Measurement, 61*(1), 71–84. https://doi.org/10.1177/00131640121971077.
McCarley, J. S., Vais, M., Pringle, H., Kramer, A. F., Irwin, D. E., & Strayer, D. L. (2001). Conversation disrupts visual scanning of traffic scenes. *9th Vision in Vehicles Conference, Brisbane, Australia*.
McDonald, C. C., Goodwin, A. H., Pradhan, A. K., Romoser, M. R. E., & Williams, A. F. (2015). A review of hazard anticipation training programs for young drivers. *The Journal of Adolescent Health, 57*(Supplement), S15–S23. https://doi.org/10.1016/j.jadohealth.2015.02.013.
Meesmann, U., & Torfs, K. (2019). *ESRA2 survey methodology. ESRA2 report Nr. 1. ESRA project (E-Survey of Road users' Attitudes)*. Brussels, Belgium: Vias Institute. Retrieved November 30, 2019 from https://www.esranet.eu/en/deliverables-publications/.
Meesmann, U., Torfs, K., Nguyen, H., & Van den Berghe, W. (2017). *Do we care about road safety? Key findings from the ESRA1 project in 38 countries. ESRA project (E-Survey of Road users' Attitudes)*. Brussels, Belgium: Vias Institute. Retrieved from November 30, 2019 https://www.esranet.eu/en/deliverables-publications/.
Missikpode, C., Peek-Asa, C., McGehee, D. V., & Wallace, R. (2019). Classifying and predicting risky driving among novice drivers: A group-based trajectory approach. *Journal of Safety Research, 68*, 215–222. https://doi.org/10.1016/j.jsr.2018.10.014.
Özkan, T., & Lajunen, T. (2011). Person and environment: Traffic culture. In *Handbook of traffic psychology* (pp. 179–192). American Press.
Petridou, E., & Moustaki, M. (2000). Human factors in the causation of road traffic crashes. *European Journal of Epidemiology, 16*(9), 819–826.
Pires, C., Areal, A., & Trigoso, J. (2019). *Distraction (mobile phone use). ESRA2 Thematic report Nr. 3. ESRA project (E-Survey of Road users' Attitudes)*. Lisbon, Portugal: Portuguese Road Safety Association. Retrieved November 30, 2019 from https://www.esranet.eu/en/deliverables-publications/.
Rakauskas, M. E., Ward, N. J., & Gerberich, S. G. (2009). Identification of differences between rural and urban safety cultures. *Accident Analysis & Prevention, 41*(5), 931–937. https://doi.org/10.1016/j.aap.2009.05.008.
Roidl, E., Siebert, F. W., Oehl, M., & Höger, R. (2013). Introducing a multivariate model for predicting driving performance: The role of driving anger and personal characteristics. *Journal of safety research, 47*, 47–56. https://doi.org/10.1016/j.jsr.2013.08.002.
Ross, V., Jongen, E., Brija, T., Ruiter, R., Brijs, K., & Wets, G. (2015). The relation between cognitive control and risky driving in young novice drivers. *Applied Neuropsychology: Adult, 22*(1), 61–72. https://doi.org/10.1080/23279095.2013.838958.
Ross, V., Jongen, E. M., Brijs, K., Brijs, T., & Wets, G. (2016). Investigating risky, distracting, and protective peer passenger effects in a dual process framework. *Accident Analysis & Prevention, 93*, 217–225. https://doi.org/10.1016/j.aap.2016.05.007.
Ross, V., Jongen, E. M., Wang, W., Brijs, T., Brijs, K., Ruiter, R. A., et al. (2014). Investigating the influence of working memory capacity when driving behavior is combined with cognitive load: An LCT study of young novice drivers. *Accident Analysis & Prevention, 62*, 377–387. https://doi.org/10.1016/j.aap.2013.06.032.
Saeed, N., Nam, H., Haq, M. I. U., & Bhatti, D. M. S. (2018). A survey on Multidimensional Scaling. *ACM Computing Surveys, 51*(3), 1–25 http://hdl.handle.net/10754/631358.
Schiffman, S. S., Reynolds, M. L., & Young, F. W. (1981). *Introduction to multidimensional scaling: Theory, methods and applications*. New York: Academic Press.
Shye, S., Elizur, D., & Hoffman, M. (1994). *Introduction to facet theory: Content design and intrinsic data analysis in behavioral research*. SAGE Publications Inc..
Smith, S. S., Horswill, M. S., Chambers, B., & Wetton, M. (2009). Hazard perception in novice and experienced drivers: The effects of sleepiness. *Accident Analysis & Prevention, 41*(4), 729–733. https://doi.org/10.1016/j.aap.2009.03.016.
Soliman, A., Alhajyaseen, W., Alfar, R., & Alkaabi, I. (2018). Changes in driving behavior across age cohorts in an Arab Culture: The case of State of Qatar. *Procedia Computer Science, 130*, 652–659. https://doi.org/10.1016/j.procs.2018.04.116.
Timmermans, C., Alhajyaseen, W., Reinolsmann, N., Nakamura, H., & Suzuki, K. (2019a). Traffic safety culture of professional drivers in the State of Qatar. *IATSS Research*. https://doi.org/10.1016/j.iatssr.2019.03.004.
Timmermans, C., Alhayjaseen, W., Al Mamun, A., Wakjira, T., Qasem, M., Almallah, M., et al. (2019b). Analysis of road traffic crashes in the State of Qatar. *International Journal of Injury Control and Safety Promotion, 1–9*. https://doi.org/10.1080/17457300.2019.1620289.
Tsogo, L., Masson, M. H., & Bardot, A. (2000). Multidimensional scaling methods for many-object sets: A review. *Multivariate Behavioral Research, 35*(3), 307–319. https://doi.org/10.1207/S15327906MBR3503_02.
Ward, N. J., Linkenbach, J., Keller, S. N., & Otto, J. (2010). *White paper on traffic safety culture white papers for: Towards zero deaths: A national strategy on highway safety*. Montana: Western Transport Institute, College of Engineering Montana State University. Retrieved on March 1, 2019 from: http://www.towardzerodeaths.org/wp-content/uploads/Draft_TZD_White_Paper_2_Safety_Culture.pdf.
Ward, N., & Özkan, T. (2014). In consideration of traffic safety culture. *Transportation Research Part F, 26*, 291–292. https://doi.org/10.1016/j.trf.2014.09.004.
Ward, N., Otto, J., Swinford, S., & Borkowski, J. (2015). Measuring Minnesota's Traffic Safety Culture, (April). Retrieved on March 1, 2019 from: https://www.dot.state.mn.us/trafficeng/safety/shsp/safetyculture.pdf.
World Health Organization [WHO] (2018). Global status report on road safety 2018 Retrieved on June 30, 2019 from: https://www.who.int/violence_injury_prevention/road_safety_status/2018/en/.
Wilson, M. (1995). Structuring qualitative data: Multidimensional scalogram analysis. *Research Methods in Psychology*, 259–273.
Woosley, S. A., Hyman, R. E., & Graunke, S. S. (2004). Q-sort and student affairs: A viable partnership? *Journal of College and Student Development, 45*(2), 231–242. https://doi.org/10.1353/csd.2004.0031.
Yamani, Y., Samuel, S., Knodler, M. A., & Fisher, D. L. (2016). Evaluation of the effectiveness of a multi-skill program for training younger drivers on higher cognitive skills. *Applied Ergonomics, 52*, 135–141. https://doi.org/10.1016/j.apergo.2015.07.005.
Young, K. L., & Salmon, P. M. (2012). Examining the relationship between driver distraction and driving errors: A discussion of theory, studies and methods. *Safety Science, 50*(2), 165–174. https://doi.org/10.1016/j.ssci.2011.07.008.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jsr.2020.02.009.

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Veerle Ross is a postdoc at Hasselt University (UH). She obtained Bachelor's degrees in Occupational Therapy (2007) and Cognitive Psychology (2010), a master's degree in Health and Social Psychology (2011), and a PhD in Transportation Sciences (2016). In the past, she studied underlying mechanisms of driving behavior in young adults with and without autism. She also investigated (unconscious) attitudes, and how these affect transportation behavior. Her recent research involves driving (technology), fleet safety management, and active transportation, combined with specific target groups such as elderly drivers, autism, cardiac or depression patients. Veerle also coordinates the UH Master in Transportation Sciences.

Hideki Nakamura is a professor of Nagoya University. His field of expertise is traffic engineering, traffic safety and transportation planning. Prof. Nakamura has been leading many scientific activities in several academic societies, e.g. Japan Society of Traffic Engineers (JSTE) and International Association of Traffic and Safety Sciences (IATSS), and edited and published several guidelines and manuals in the field of traffic engineering. He was a committee member of the Transportation Research Board (TRB) and is currently a vice-chair of the Scientific Committee of the World Conference on Transport Research Society (WCTRS).