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GREEN DRIVER: DRIVING BEHAVIORS REVISITED ON SAFETY

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Abstract:

Interactions between road users, motor vehicles, and environment affect to driver's travel behavior; however, frailer of proper interaction may lead to ever-increasing road crashes, injuries and fatalities. The current study has generated the green driver concept to evaluate the incorporation of green driver to negative outcomes reduction of road transportation. The study aimed to identify the green driver's behaviors affecting safe traveling by engaging two research phases. Phase one was to identify the safe driving behaviors using Systematic literature review and Content Analysis methods. Phase one identified twenty-four (24) sub-factors under reckless driving behaviors cluster, and nineteen (19) sub-factors under safe driving practice cluster. Second phase was to establish the actual weight value of the sub-factors using Grounded Group Decision Making (GGDM) and Value Assignment (VA) methods, in order to determine the value impact of each sub-factor to green driving. Phase two resulted that sub-factors Exceeding speed limits (DB f2.2.) and Driver's cognitive and motor skills (SD f1.2.2.) have received highest actual values, 0.64 and 0.49, respectively; ranked as the High contributor grade. Contrary, the sub-factors Age cognitive decline (DB f1.2.) and Competitive attitude (DB f1.2.), and Avoid gear snatching (SD f1.1.4.) have the lowest actual values; and ranked in low-contribution grade. The rest of the sub-factors have ranked in medium-contribution grade. The research also found out drivers' personalities (included, physical and psychological characteristics) remains unaccountable and non-measureable yet in driver travel behavior assessment models. The study outputs would be used in development of Green Driver Index Assessment Model.

Key words:
travel behavior, safe driving, reckless driving, driving skills and practice, green driver, index assessment model

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1. Introduction

Combination of interactions between road users, motor vehicles, and environment might affect to driver's travel behavior. The miss-combination of these factors may lead to various road crashes, injuries and death depends on the degree of interaction (European Commission, 2004; Moeinaddini et al., 2015; Hermans et al., 2008; Urbańczyk, 2017). World Health Organization (WHO, 2013) reports that road traffic injuries will be recognized as the leading cause of death by 2030, and is predicted as the fifth leading cause of death in the world. In 2013, over 1.2 million people were killed due to road fatalities while 20-50 million were suffered from various kinds of traffic injuries (WHO, 2013). According to ETSC (2005), in 2014, extra 25,845 people were killed as consequences of road collisions compared to the previous years. According to Malaysian Institute of Road Safety Research (MIROS), nearly 6,500 people were killed while 32,274 were injured on road in 2008, which equals to the ratio of 23.5 into 100,000 people in the population. The recorded rates were found to be higher compared to other countries; for instance, New Zealand (8.6 per 100,000), Australia (6.8 per 100,000), Netherlands (4.1 per 100,000), United Kingdom (4.3 per 100,000), and Sweden (4.3 per 100,000) (MIROS, 2013). Moreover, motor vehicle crashes are significant to young drivers; for example, in the U.S., most of the road deaths are contributed by 15-20 years old age group and about 12% teenagers have involved in fatal crashes in the year 2008 (NHTSA, 2009). It is evidenced that the reasons for most of traffic crashes are consistent with risk-taking behaviors; such as speeding, tailgating, speaking on mobile phone, drunk driving, and so forth (Ainy et al., 2011; Preusser et al., 1998; Reason et al., 1990; Rhodes et al., 2005; Zhou et al., 2012; Vardaki and Yannis, 2013). Thus, safe travel behavior practice is significant nowadays to prevent road accidents and fatalities in the global transportation scenarios, in addition to environmental and economic impacts. On the other hand, the terminology 'green' is no longer limited to the construction and material applications, and it has been recently appraised in the transportation sector. Various green movements have been implemented in transportation studies; included, fuels improvement (CRFA, 2010), green vehicles (USEPA, 2016), green highway design and construction (MSA, 2010), vehicle safety features (NHTSA, 2013; AAA Foundation for Traffic Safety, 2013), green public transportation (Miller, 2011), and Green travel (Jia et al., 2017; Penz et al., 2017). Meanwhile, the concept of eco-driving has gained interest among transportation researchers which opposed the traditional driving style (NRCAN, 2016; ECOWILL, 2010).

2. Problem statement

The safe driving has opposed risky and reckless driving behaviour. Risky behaviour is defined as thrill seeking activities that acquire mainstream approval. Also, reckless behaviour is defined as substantial nuance that is socially unapproved which governs by three (3) main attributes; law violation, putting others in high risk of mortality or negativity, and intentionally deviates from safe driving norms (Malta, 2004). Apparently, the measurement for reckless behaviours is limited to three (3) factors; incomplete instrumentations which are not representing diversity of behaviours while some are too inclusive, mixed constructs and non behavioural phenomena, and finally, composed of non independent and overlap factors. As a result, less studies have focused on the characteristics of the behaviours compared to the intention and motivation of the driver in measuring reckless behaviour in association with safe driving (Gulian et al., 1989). In previous studies, numerous attributes were found as a strong predictor for reckless driving behaviours; such as, gender (Turner and McClure, 2003), driver's perceptions in vehicle control corresponds to any hazards (Groeger, 2006), risk perceptions (Hatfield and Fernandes, 2009), risk willingness (Gibbons and Gerrard, 1998; Lund and Rundmo, 2009), sensation seeking (Jonah, 1997), driving under influence of alcohol, drug, racing, and speeding (Arnett et al. 1997; Arnett, 1996; Burns and Wilde, 1995; Clément and Jonah, 1984; Dahlen and Martin, 2005). Previous researchers have identified significant drawbacks that hindered human behavior study in safe driving behavior studies, as following;

i) The repeatability and reliability of the experiment depends on driver's behavior. Most of the time, it is impossible to obtain a reliable measurement of behavior, because the experiment measures physical factors rather than the psychological factor (Forbes, 1972). For example, road segments, types of engine, speed, and acceleration mainly can be controlled in the experiment; while driver's related factors (i.e.

psychological factors) have been underestimated. Thus, it is crucial to incorporate the physical factors with driver's psychological factors (i.e. personality traits (Jovanović et al., 2011), attitudes and intentions (Lucidi t al., 2014), and risks taking (Cai et al., 2013)). Moreover, cognitive factors; like, management of attention (Mathias and Lucas, 2009), visual functions (Chakrabarty Kamini, 2013), and psychomotor behaviors (Chakrabarty Kamini, 2013) are also important to be explored. As a result, combination of technical and psychological experiment is needed to measure precisely the driver's behaviors towards safe driving.

ii) The comprehensive list of measurement criteria are very essential to be identified in order to assess a good driving (Forbes, 1972). There are no specific measurement criteria for goodness assessment of a driver (Forbes, 1972). It can be described in substantial ways. For instance, reduction of accidents and fatalities greatly reflect the safety practice of a driver, and it could be taken as a measure of goodness of a driver (Forbes, 1972).

According to discussed issues and shortcomings, the current study aims to identify the comprehensive list of Driver's Behaviors Affecting Safe Traveling by exploring the dynamics, behaviors, and actions/reactions of drivers with regard to their driving personality. These behaviors are forming the concept of green driving which can assess the drivers in safe driving practice in association with accident likelihood, road injuries, and death. The outcome of this study will be used in Green Driver Index Model Development, which be presented in future (see Figure 1). To achieve the aim, the research has conducted two phases. Phase one is to identify the safe travel behaviors of driver using Systematic literature review method and conducting Content Analysis method. Second phase is to establish the safe travel behaviors of green driver applying Grounded Group Decision Making (GGDM) and Value Assignment (VA) methods. Ultimately, the research determines the finalized green driver's travel behaviours, and also, the value impact of each behaviour to safe driving; which be all involved in green driver behaviour index model development, in future.

3. Identification of driver behaviors in association with safety

Phase one identifies the comprehensive list of factors (i.e. driver behaviors) that make safe driving. The following sections present the Systematic literature review procedure, and then, content analysis of those synthesized literatures to identify those factors (i.e. driver behaviors).

3.1. The systematic literature review procedure on driver behaviors identification in association with safety

The systematic review analysis was conducted to identify factors (i.e. driver behaviors) that make safe driving; as this method is replicable, scientific, and transparent (Wolf et al., 2001). This method can minimize bias on literature review as it provides comprehensive decisions, procedures, and conclusion from reviewers (Ariens et al., 2001). The methodology for a systematic literature review procedure was divided into four (4) stages; identification, screening, eligibility, and synthesizing.

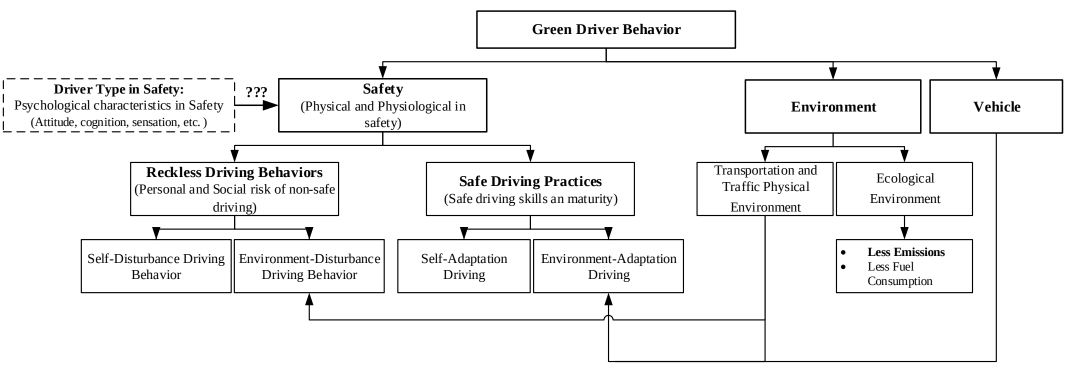

Fig. 1. The Green Driver conceptual framework

The identification stage involved with the process of collecting articles using relevant keywords combination including, "Road safety", "Driver behavior", "Driver Personality", "Driver Psychology, and 159 numbers of articles were found. However, only 128 numbers of articles were included and reviewed for this study which have been published between 1995 and 2015. Among all screened articles, there are only few articles that incorporated human factor (i.e. aggressiveness) in relation with safety while the most of articles have focused more on vehicle and environmental factors. In some cases, few articles were backdated and non-retrieved, hence they deducted from the list. This stage is called as screening (Bouter and Wal, 2001; Lievense, 2002). Subsequently, 99 articles were classified into three (3) categories (i.e. highly relevance, moderately relevance, and less relevance) to verify the eligibility of the documents correspond to the topic. That eligibility stage was completed by 26th Dec 2017. The researchers found two (2) classes to cluster the eligible articles. Hence, the eligible articles were clustered into two (2) classes as; 'reckless driving behaviors' and 'safe driving practices' in association with safety, accident likelihood, road injuries, and death. Lastly, in the synthesizing stage, the articles output from third stage (i.e. eligibility stage) have been deeply synthesized and tabulated which are presented in next section.

3.2. Synthesis analysis of reckless driving behaviors in association with safety

Driver behaviour is a broad and uncertain subject to be discussed as it is moderately relative and different from one person to another. Driving is highly associates drivers, vehicle and environment. Driving is a complex task that requires attention and multi skill behaviours; but, inattentive driving can possibly cause road fatalities and injuries (Evans, 1985). Indeed, the road fatalities and injuries can be increased due to driver's reckless driving which is folded to; i) Self-Disturbance Driving Behaviours, and ii) Environment-Disturbance Driving Behaviours (see Table 1). Self-disturbance displays sets of individual actions that originated from the driver, while environmental disturbances represent interacted events between drivers and their surrounding (i.e. other road users including driver, pedestrians, road physical, and etc.). The following describes and defines the factors involved in each class, in details.

i) Self-Disturbance Driving Behaviour:

Self is defined as essential human phenomenon that represents the mental states (perceptions, sensations, emotions, and thoughts) and experienced as one's own (Newen and Vogeley, 2003). Self-disturbance phenomenon refers to delusions of unfamiliar control and thought insertion which is caused by distraction. Indeed, in the context of driving behavior, self-disturbance refers to any consequences/predicted actions happened that corresponds to the human's self perceptions, sensations, emotions, and thoughts. The current research come up with twelve (12) sub-factors (see Table 1).

According to the reviewed literatures, risky driving is one of the important features in the safety and accident risks criteria (Macioszek, 2015). Risky behaviours are normally related to aggressiveness of a driver in driving. Aggression is derived from angry feeling. Aggressive driving is a traffic offense or combination of offenses such as; following too closely, speeding, unsafe lane changes, failing to signal intent to change lanes, and other forms of negligent or inconsiderate driving. The trigger for the aggressive driver is usually traffic congestion coupled with a schedule that is almost impossible to meet (Hohn, 1998). In the United States (U.S.) and United Kingdom (U.K.), aggressive drivers have become the major cause of road fatalities, death, and injuries (Dft, 2011; AAA Foundation for Traffic Safety, 1995). Aggressive behavior is divided into two major components. 'Pro-active behavior', which is extent to specific aim and behavioral response towards specific event provoking aggressor to be angry. The first behavior is categorized as instrumental aggressively while the second behavior is categorized as hostile aggressivitiy (Berkowitz, 1993; Buss and Perry, 1992). High anger drivers reported significantly greater state anger and verbal aggressive tendencies as a function of impedance than did low anger drivers. State physical aggressive tendencies followed a slightly different pattern. A significantly higher proportion of high anger (55%) drivers that engaged in more erratic driving than low anger (23%) drivers who are unable to pass a slow driver safely (Deffenbacher et al., 2003). Presently, road rage or aggressiveness has become the most influential predictor of crashes, near misses, loss of focus in driving, tailgating behavior, and vehicle loss control (Stanford et al., 2005; Underwood et al., 1999; Deffenbacher et al., 2003; Gras et al., 2006).

Moreover, based on several driving simulation assessments, angry drivers have been found to be involved in more traffic collision compared to the non aggressive drivers (Deffenbacher et al., 2003; Stephens and Groeger, 2011).
Moreover, as driving behaviour is based on human mental and psycho physical coordination (Deary et al., 2009), it reflects the ability of a driver to perceive driving situations and driving cognitive (for example, at the intersections). Eventually, driving behaviour can alters or reveals drivers' profile and personality subjected to the driving situations and road conditions. According to RSA (2015), "the physical and mental impairment brought about by inadequate rest" which may increase the risk accidents and fatalities. Wilde (1994) has presented a combination of subjective risk and objective risk in determining target risk of driver involved in road accidents via cost and benefit weight analysis based on driver's actions. He further proposed combination between subjective risk estimates and fear. He stated that, experience of fear will adjust driver behaviours on road (Wilde, 1994). Galvanic skin response (GSR) is an alternative device to bridge the driving risk estimation with human fear. Taylor (1964) has found that, human fear (measure of driver arousal) is highly influenced by different types of intersections as a result of any accident probability. In contrast, higher speed was inversely associated with the driver arousal at each road segments. The significant drawback of GSR especially in the interpretation of results has made GSR more challenging and intangible. Thus, GSR results are highly appraised for measurement of human fear or feeling of risks only. In addition, GSR is influenced by variation of temperature. As a result, it reflects covary responses from driver; for example, sweating and level of anxiety (Taylor, 1964).
Previous researches have found that the drivers with cognitive impairment were more likely to restrict their driving than drivers without any cognitive impairment. The reasons behind restricting driving were investigated in two studies by Cotrelland Wild (1999) and Kowalski et al. (2012), which reported that changes in visual abilities, a reduced need to drive, and an awareness of attention deficits as the primary reasons. This finding is consistent with previous research investigating reasons for self-regulation, whereby drivers often report changes in physical abilities such as vision (Charlton et al., 2001; Wackerbarth and Johnson, 1999), and a decrease in confidence levels (Donorfio and D'Ambrosio, 2009) as stronger reasons to restrict driving than declines in cognitive abilities. In addition, cognitive status per person rather than other demographic or performance measures can lead to increased regulation of particular aspects of driving behavior (Festa et al., 2013). Fuller (2000) has studied driver's task capability interface to determine the dynamic correlation between demands in driving and capability of driver. His model visualised the capability of driver in any driving situation; for example, if the driver's capability exceeds the demand, the task is observed as easy and vice versa. In a situation where the task is too difficult, driver tends to loss focus, get distracted, exposed to accident likelihood, and even leads to road collision (Fuller, 2000). However, this model is highly influenced by compentency level of a driver. Indeed, driver's competency can be detracted by attitude, motivation, effort, fatigue, drowsiness, time-of-day, drugs, distraction, emotion, and stress (Arnett et al., 1997; Arnett, 1996; Burns and Wilde, 1995; Clément and Jonah, 1984; Furnham and Saipe, 1993; Greene, Krcmar et al., 2000).
Regarding the age factor, Hatfield and Fernandez (2009) have found that younger drivers perceived higher risks of crashing due to speeding and drink-driving, and being injured or killed in a car crash. The exposures significantly associated with driver injury while racing a motor vehicle for excitement, driving at 20 km/h or more over the speed limit. Driving at 20 km/h or more over the speed limit was associated with an increased risk for younger drivers; however; the increased risk was not significant in older drivers (Blows et al., 2005). On fatigue and sleepiness factors Verwey and Zaidel (2000) have found that 46% of the participants had experience with "almost falling asleep at the wheel" and 12% indicated to have had an accident due to drowsiness.

ii) Environment-Disturbance Driving Behaviour:
Environmental-disturbance factors have significant influence on the driver as the controller and the vehicle as the controlled system. It also includes, pedestrians, other road users, traffic regulations, weather, and route profiles. The Environmental-disturbance clusters have identified tweleve (12) subfactors.
Referring to reviewed literature, on the speed factor,

80% of boys and 70% of girls were reported to drive over than posted speed (Arnett et al., 1997). Substantial proportions of both boys and girls reported engaging in these behaviours more than 10 times in the past year. In addition, over 50% of the boys and nearly 40% of the girls reported racing and overtaking in a non-overtaking zone at least once in the past year. Accordingly, seatbelts were used by the participants (89%) while, alcohol was consumed by the driver in less than 2% of the trips recorded (Arnett et al.,1997). High impulsive females were anywhere from 2.2 to 8.4 times more likely to be involved in risk-taking behaviours than low impulsive females. Higher rates of risk-taking behaviour were also demonstrated in the high impulsive males. These findings suggest that high impulsive adolescents and young adults are at considerable risk of personal injury and present a potential source of injury to others (Arnett et al., 1997). Indeed, failure to wear seat belts did not predict accidents, but did significantly influence the severity of accidents. It was earlier reported that using seat belts 'always' were less likely than others to be injured when accidents did occur (Norris et al., 2000). Unbelted drivers had 10 times the risk of involvement in an injury crash compared to belted drivers after adjustment for multiple confounders (GHSA, 2015). Habitual non-users were likely to be unbelted when involved in a crash (Blows et al., 2005).

In addition, honking behavior is greatly pronounced among women compared to men. Participants were also less likely to honk and tailgate in the morning compared to other periods (Harris & Houston, 2010). High anger drivers engaged in more arguments with other drivers and honked their horn at others in anger more than low anger drivers (Deffenbacher et al., 2003). High anger drivers engaged more of the aggressive behaviors including making hostile gestures, swearing at other drivers or pedestrians, flashing lights in anger, yelling at another driver, losing control of anger while driving, driving up close behind another driver in anger, and cutting someone off in anger compared to low anger drivers (Deffenbacher et al., 2003). Headlight flashing and the use of obscene gestures were also seen as aggressive by most, and had been experienced recently by 59% and 48% of those sampled, respectively (Joint, 1995). On the other hand, Vardaki and Yannis (2013) has investigated driver's behavior corresponds to mobile phone. They reported that almost one third (34%) of drivers "often," "very often," or "always" make or answer calls with a hands-free phone. 61% driver were reported to make/answer phone calls without a handheld, while a clear majority of 70% report that they "never" or "rarely" make or answer a call with a handheld phone. The majority of drivers are younger than 55, drivers who commit traffic violations more often (Vardaki and Yannis, 2013).

The following Table 1 presents enormous types of reckless driving behavior that is highly associates with road accident, crashes, and injuries. The last row of Table 1 indicates the frequency of citation (i.e. Depth of Citation) in the reviewed literatures. The frequency data has been input in Phase 2 of the research to determine the actual value of the sub-factors.

3.3. synthesis analysis of safe driving practices in association with safety

Driver behavior is governs by rules either in an individual situation or in social interactions. As we lived by, we are adhered to certain regulations and to behave in appropriate manners to avoid penalties or fines. Even so, some people do not simply follow rules, and thus, their behaviors have significantly reduced safety margins and increases the likelihood of road fatalities or injuries. Hence, safe driving practices can improve the safety in association with vehicle's quality mechanic, economical driving, safety motives, traffic regulations, and enforcements. The safe driving practices are clustered to self-adaptation driving and environment-adaptation driving, which are presented as follow (see Table 2).

i) Self-Adaptation Driving

Self-adaptation is achieved through the evolution of a secondary set of parameters which parameterize specific statistical properties of the variation operators. Each individual contains its own set of strategy parameters, which is selected together with the set of object parameters. Indeed, in the context of driving behavior, self-adaptation is the ability to adapt in autonomous manner without control to achieved or defined certain desires or properties. The Self-adaptation cluster can be divided to sub-clusters as; i-1) Driving practice (including four (4) sub-factors), and i.2) Skill and safety motive (including two (2) sub-factors) (see Table 3).

Table 1. Content Analysis on reckless driving behaviours (i.e. sub-factors) in association with safe driving, road accident likelihood and road injuries

Citation	DB$_{f1}$ **Self-Disturbance Driving Behaviour**												DB$_{f2}$ **Environment-Disturbance Driving Behaviour**											
	DB$_{f1.1.}$ Anger and frustration	DB$_{f1.2.}$ Age cognitive decline	DB$_{f1.3.}$ Impulsive driving	DB$_{f1.4.}$ Tired and sleepiness	DB$_{f1.5.}$ Lack of attention	DB$_{f1.6.}$ Poor observation	DB$_{f1.7.}$ Being hurry and impatient	DB$_{f1.8.}$ Poor health condition	DB$_{f1.9.}$ Competitive attitude	DB$_{f1.10.}$ Showing angry/insulting gestures	DP $_{f1.11.}$ Distraction (drug, music, smoking, eating, etc.)	DB$_{f1.12.}$ Using mobile phone	DB$_{f2.1.}$ Traffic violation	DB$_{f2.2.}$ Exceeding speed limits	DB$_{f2.3.}$ Tailgating	DB$_{f2.4.}$ Dangerous overtaking	DB$_{f2.5.}$ Inconsiderate/Irresponsible driving	DB$_{f2.6.}$ Not wearing seatbelts	DB$_{f2.7.}$ Racing with other driver	DB$_{f2.8.}$ Pulling out at an intersection dangerously	DP $_{f2.9.}$ Lane keeping violation	DP $_{f2.10}$ Honking	DP $_{f2.11}$ Involve in accident or car fines	DP $_{f2.12.}$ Arguing with other driver
(Stanford et al.,1996)	/		/								/		/	/				/						
(Arnett, 1996)											/			/		/			/					
(Assum, 1997)													/	/			/							
(Arnett et al., 1997)											/			/		/			/					
(Lawton et al., 1997)	/					/				/	/		/	/	/	/			/	/	/		/	
(West and Hall, 1997)														/		/							/	
(Clarke et al., 1998)						/								/		/							/	
(Underwood et al., 1999)	/									/	/		/			/	/				/	/	/	
(Gullone et al., 2000)											/		/	/										
(Greene et al., 2000)											/													
(Norris et al., 2000)						/				/			/	/				/						
(Verwey & Zaidel, 2000)				/		/							/								/			
(Deffenbacher et al., 2001)	/				/		/			/	/												/	/
(Ellison-Potter et al., 2001)													/	/	/								/	
(Knee et al., 2001)										/			/	/	/							/		
(Lajunen and Parker, 2001)			/							/			/	/	/	/						/		/
(Deffenbacher et al., 2003)	/				/					/	/			/							/		/	/
(Deffenbacher, 2003)	/				/					/	/			/							/		/	/
(Owsley et al., 2003)	/		/		/	/				/	/		/	/	/				/	/	/			
(Nykolyshyn et al., 2003)													/											
(Iversen, 2004)				/	/						/		/	/	/	/	/	/	/		/			
(Smith et al., 2005)				/							/													
(Blows et al., 2005)											/		/	/				/	/				/	
(Blows et al., 2005)																		/						
(Clarke et al., 2005)					/	/					/		/	/	/	/			/				/	
(Dahlen and Martin, 2005)	/				/					/			/	/		/		/	/	/			/	/
(Babio and Daponte-Codina, 2006)											/	/		/										
(Gras et al., 2006)	/				/	/				/	/		/	/	/	/			/	/	/	/		/
(Segui-Gomez et al., 2007)											/												/	
(Hatfield and Fernandes, 2009)											/			/									/	
(Fernandes et al., 2010)				/							/		/	/				/					/	
(Harris and Houston, 2010)														/	/	/						/		
(Ainy et al., 2011)												/		/										
(González-Iglesias, 2012)	/									/			/	/		/	/				/	/		/
(Vardaki and Yannis, 2013)												/		/										
(Crizzle et al., 2013)								/																
(Festa et al., 2013)		/						/																
(Vadeby and Forsman, 2013)														/									/	
(Hassan et al., 2014)				/	/	/							/	/		/								
(Hasan et al., 2014)	/				/		/		/	/		/	/	/	/	/			/			/		
(Jiménez Mejías et al., 2014)				/							/	/	/	/		/		/				/		/
Frequency (Depth of Citation)	**11**	**1**	**3**	**6**	**10**	**8**	**2**	**2**	**1**	**13**	**21**	**5**	**22**	**31**	**10**	**16**	**4**	**8**	**10**	**4**	**9**	**8**	**15**	**8**

According to the reviewed literature, the acts of regulate vehicle speed contributes mostly to the safe driving practice. However, the act of high speed, accelerating and sudden braking are definitely harmful not only towards the environment degrading (i.e. air pollution) and vehicle, but also in view of safety. Extensive evidence of vehicle collisions, crashes, and deaths have been recorded from time to time due to aggressive driving which is not only harmful to other drivers, but also to pedestrians and cyclists. Several studies have concluded that accident risks will increase and decrease proportionally with traffic speed. Thus, safety is an important feature to be included in, as it is interrelated with the driving characteristics. Driver factor is considered as a major attribute followed by vehicle and environmental conditions in evaluating safe driving practice.

Moreover, driver factor involves the motives and cognitive skills that enhance or promote safe driving and risky behavior which leads to unsafe driving practice. The cognitive skill factors represent most of the frequent failures of skills such as, lack of attention (18.83), ignorant of speed limit (12.28%), tailgating (9.14%), limited observation/views (7.59%), distractions (4.12%), and not looked in relevant direction (3.76%) (Clarke et al., 2005). Safety motives is influenced by age, gender, driving experience and ability to control driving. It also includes, driver's determination to drive at safe distance and speed (Wang et al., 2017); thus, driving feedback is crucial for drivers to improve their safety driving motives (OECD, 2006). Drivers cognitive and motor skills play an important role in safe driving because drivers must have the ability to control a motor vehicle; therefore, factors affecting consciousness (e.g., seizures, syncope, hypoglycemia and sleepiness), perception (e.g., visual acuity and field of vision), mental functioning (e.g., dementia), neuromuscular and musculoskeletal function (e.g., adequate manipulation of vehicle controls), and behavior (e.g., self and impulse control) may limit safe driving (Galski et al., 1993).

Furthermore, Summala (1988) has argued about the concept of risk determinants to identify driver behaviour for safety analysis. He argued, drivers know what to do and not to do to avoid accident risks by maintaning a safe distance (i.e. safety margin). In determining human behaviour towards safety, the driver knows how to anticipate in safer driving environment (Summala, 1988). Estimation of time to collision is a basic human skill that does not require a complicated cognitive computational process (Summala, 1988). Assum (1997) and Gregersen (1996) express that safe distance driving is learned through experiences which becomes automatically a habit. Corresponding to that, the learning model was introduced; however, it is incapable to specify the degree of instantenous behaviour. Thus, more heuristic approach is required to determine driver's decision making prior his/her safe distance driving.

ii) Environmental-Adaptation Driving

The environmental-adaptation is defined as controlling the vehicle's system controls that can help with speed control, steering and signalling (for example, hand controls, electronic accelerators, left foot accelerators, pedal modifications, steering aids, remote control device, and etc.), and also, surrounding environment's monitoring regarding Traffic regulation and enforcement, street design, and whether conditions. The Environmental-Adaptation cluster is divided into three (3) sub-clusters as; ii-1) Vehicle mechanical factors, ii-2) Physical environmental factors, and ii-3) Advanced safety features of vehicle.

Reviewed literature shows that right turn, head on and lose control are the most common non-safe driving practices which lead to overtaking errors among drivers and road fatalities, which is due to poor observation, misjudgment, and excessive maneuvering speed (Clarke et al., 1998). Higher overtaking speed is associated with the aggressive behavior in overtaking maneuvers, therefore, the overtaking driver perceived a shorter gap with the oncoming traffic; hence a shorter decision time, overtaking time and safety margin (Hassan et al., 2014). The most dangerous reported driving act is "drive thru red light", followed by "racing another driver" (Hassan et al., 2014; Żukowska, 2015; Shafaghat et al., 2016). Only 23% of the drivers thought that it was dangerous to drive over 30 km of the legal speed limits. The most often seen unsafe driving action is speeding (70%), followed by driving too closely (57%), failing to use turn signals (53%), drive inattentively (50%), and running red lights (43%). The main causes of unsafe driving behaviors are being in a hurry/time pressure (66%), aggressive behavior of others (52%), and refusing traffic rules (51%) (Hasan et al, 2014).

Moreover, road design and its environmental oriented factor (slope, intersection types, signalization, etc.) are also vital to enhance safety driving practice (WHO, 2004b; West Windsor Bicycle and Pedestrian Alliance, 2002). Proper design of intersections and crossings can reduce the severity of potential conflicts between motor vehicles, buses, trucks, bicycles, pedestrians, and facilities, while facilitating the convenience, ease, and comfort of people traversing the intersections (AASHTO, 2011). Hence, identification of any actual or potential safety-problematic intersection should be conducted adequately to reduce the accident risks among road users (MMUCC, 2012).

In addition, vehicle design factors (includes; lighting, braking, speed level, interior, maintenance), as equal as environment quality factors (i.e. traffic congestion, travelling distance) are essential to ensure safe driving among road users (TxDOT, 2014; Assum, 1997; Brundell-Freij and Ericsson, 2005). Advanced vehicle safety systems and technologies (such as, lane keeping warning system, adaptive cruise control, frontal collision detection, drive camera, and etc.) are some of the intelligent features that have been adopted by most automakers like Honda, BMW, Mercedes Benz, Hyundai-Kia, Toyota, Mazda, and Ford. These features will not only facilitates driving and aid drivers in any collisions, but also improve vehicle fuel economy and safety of the drivers. This feature is also important to maintain an efficient speed and braking activities of a car. Thus, they can promote a safer and economic driving (Honda, 2016; Mazda, 2016; NHTSA, 2016; Nissan, 2016; Toyota, 2015). For instance, ADAS (Advance driver assistant system) is a vehicle control system that uses environment sensors (e.g. radar, laser, vision) to improve driving comfort and traffic safety by assisting the driver in recognizing and reacting potentially to dangerous traffic situations (Gietelink and Ploeg, 2006). Also, drive camera is designed to capture audio and video inside and outside vehicle when triggered by unusual motion such as, hard braking, swerving or a collision (DriveCam, 2009). Frontal collision detection is a sensor located at front part of a car to monitor the distance and relative speed of a vehicle ahead (Transport Canada, 2011). Apart from these features, improving driving practice could also enhance the safe driving practice through vehicle speed control (WHO, 2004b), constant acceleration while overtaking, car following and lane changing advanced monitoring systems (Dey et al., 2006), applying progressive braking smooth and safely (Farlam, 2012), and gear snatching system (IAM, 2016).

The following Table 3 identifies safe driving practices in association with road accident likelihood and injuries. The last row of Table 3 indicates the frequency of citation (i.e. Depth of Citation) of the reviewed literatures. The frequency data has been input in Phase 2 of the research to determine the actual value of each sub-factors.

Table 2. Content analysis table on safe driving practice in association with road accident likelihood and injuries

Citation	SD $_{f1.}$ **Self-Adaptation Driving**						SD $_{f2.}$ **Environmental-Adaptation Driving**												
	SD $_{f1.1.}$ Driving practice				SD $_{f1.2.}$ Skill and safety motive		SD $_{f2.1.}$ Vehicle mechanical factors		SD $_{f2.2.}$ Physical environmental factors					SD $_{f2.3.}$ Advanced safety features of vehicle					
	SD $_{f1.1.1.}$ Regulate vehicle speed	SD $_{f1.1.2.}$ Efficient vehicle acceleration	SD $_{f1.1.3.}$ Gentle and progressive braking	SD $_{f1.1.4.}$ Avoid gear snatching	SD $_{f1.2.1.}$ Driver's safety motives and attitude	SD $_{f1.2.2.}$ Driver's cognitive and motor skills	SD $_{f2.1.1.}$ Environmental quality factors	SD $_{f2.1.2.}$ Vehicle design factors	SD $_{f2.2.1.}$ Traffic regulation/ enforcement	SD $_{f2.2.2.}$ Types of intersections	SD $_{f2.2.3.}$ Weather factors	SD $_{f2.2.4.}$ Crossings Pedestrian	SD $_{f2.2.5.}$ Overtake at legal lane	SD $_{f2.3.1.}$ Advance driver assistant system (ADAS)	SD $_{f2.3.2.}$ Drive camera	SD $_{f2.3.3}$ Frontal collision detection	SD $_{f2.3.4.}$ Adaptive cruise control	SD $_{f2.3.5.}$ Lane keeping system	SD $_{f2.3.6.}$ Sensor based recognition
(Christie and Downing, 1990)						/													
(Arthur et al., 1991)										/									
(Hendrickx and Vlek, 1991)						/													
(Elander et al., 1993)								/											

Citation	SD f1. **Self-Adaptation Driving**						SD f2. **Environmental-Adaptation Driving**												
	SD f1.1. Driving practice				SD f1.2. Skill and safety motive		SD f2.1. Vehicle mechanical factors		SD f2.2. Physical environmental factors					SD f2.3. Advanced safety features of vehicle					
	SD f1.1.1. Regulate vehicle speed	SD f1.1.2. Efficient vehicle acceleration	SD f1.1.3. Gentle and progressive braking	SD f1.1.4. Avoid gear snatching	SD f1.2.1. Driver's safety motives and attitude	SD f1.2.2. Driver's cognitive and motor skills	SD f2.1.1. Environmental quality factors	SD f2.1.2. Vehicle design factors	SD f2.2.1. Traffic regulation/ enforcement	SD f2.2.2. Types of intersections	SD f2.2.3. Weather factors	SD f2.2.4. Crossings Pedestrian	SD f2.2.5. Overtake at legal lane	SD f2.3.1. Advance driver assistant system (ADAS)	SD f2.3.2. Drive camera	SD f2.3.3 Frontal collision detection	SD f2.3.4. Adaptive cruise control	SD f2.3.5. Lane keeping system	SD f2.3.6. Sensor based recognition
(Andrey and Yagar, 1993)											/								
(OECD, 1994)						/													
(Watson, 1994)						/			/										
(Serafin, 1994)						/	/			/	/								
(Williams et al., 1995)	/				/	/			/	/									
(Fridstrøm et al., 1995)										/									
(Wåhlberg, 1997)					/														
(Elvik et al., 1997)						/													
(Khattak et al., 1998)										/	/								
(Edwards, 1999)											/								
(Millar and Millar, 2000)	/		/		/	/													
(Haworth and Symmons, 2001)						/			/	/									
(Meers and Roth, 2001)									/	/									
(Chermak, 2001)					/	/			/										
(Shinar et al., 2001)	/								/										
(Mitchell-Taverner, 2002)						/			/										
(Daigneault et al., 2002)						/													
(Wang et al., 2002)	/				/	/	/	/		/	/	/			/				
(Pohl and Ekmark, 2003)														/				/	
(Brilon, 2016)										/									
(Richardson and Marottoli, 2003)						/		/											
(Ha et al., 2003)							/		/										
(Baldwin et al., 2004)	/	/	/		/	/				/					/				
(Davis et al., 2006)									/										
(Gietelink and Ploeg, 2006)	/	/	/							/		/		/		/	/		
(Baldock et al., 2007)						/													
(Goernig, 2007)	/		/									/							/
(Naveh and Marcus, 2007)									/										
(Mathias and Lucas, 2009)						/													
(Zagreb, 2009)						/													
(Cools et al., 2010)							/			/	/								
(Johnson and Trivedi, 2011)	/	/	/												/				/
(Habibovic and Davidsson, 2011)	/					/				/	/	/		/					
(Walter and Broughton, 2011)	/						/			/									
(Walter et al., 2011)									/	/									
(Obeng, 2011)	/					/	/	/		/	/								
(Classen et al., 2012b)					/	/													
(Gomes and Cardoso, 2012)	/					/				/									
(Classen et al., 2012a)					/	/													
(Iversen and Rundmo, 2012)					/	/			/										
(Mueller and Trick, 2012)	/				/	/					/								
(Chakrabarty, 2013)											/								
(Stanojevi et al., 2013)	/				/	/	/		/										
(Joseph & Michael, 2014)					/	/			/										
(Hasan et al., 2014)						/			/										

Citation	SD $_{f1.}$ **Self-Adaptation Driving**						SD $_{f2.}$ **Environmental-Adaptation Driving**												
	SD $_{f1.1.}$ Driving practice				SD $_{f1.2.}$ Skill and safety motive		SD $_{f2.1.}$ Vehicle mechanical factors		SD $_{f2.2.}$ Physical environmental factors					SD $_{f2.3.}$ Advanced safety features of vehicle					
	SD $_{f1.1.1.}$ Regulate vehicle speed	SD $_{f1.1.2.}$ Efficient vehicle acceleration	SD $_{f1.1.3.}$ Gentle and progressive braking	SD $_{f1.1.4.}$ Avoid gear snatching	SD $_{f1.2.1.}$ Driver's safety motives and attitude	SD $_{f1.2.2.}$ Driver's cognitive and motor skills	SD $_{f2.1.1.}$ Environmental quality factors	SD $_{f2.1.2.}$ Vehicle design factors	SD $_{f2.2.1.}$ Traffic regulation/ enforcement	SD $_{f2.2.2.}$ Types of intersections	SD $_{f2.2.3.}$ Weather factors	SD $_{f2.2.4.}$ Crossings Pedestrian	SD $_{f2.2.5.}$ Overtake at legal lane	SD $_{f2.3.1.}$ Advance driver assistant system (ADAS)	SD $_{f2.3.2.}$ Drive camera	SD $_{f2.3.3}$ Frontal collision detection	SD $_{f2.3.4.}$ Adaptive cruise control	SD $_{f2.3.5.}$ Lane keeping system	SD $_{f2.3.6.}$ Sensor based recognition
(Kidd and Brethwaite, 2014)						/		/				/			/				/
(Hasan et al., 2014)	/				/		/	/	/				/						
(Ellison et al., 2015)	/	/	/		/	/	/			/	/	/							
(Jamson et al., 2015)	/	/	/							/									
(Loon and Martens, 2015)														/				/	
(Kumtepe et al., 2015)	/	/													/				
(Louw et al., 2015)	/	/	/		/	/					/					/	/		
(Vaezipour et al., 2015)	/	/	/	/	/	/		/						/		/	/	/	
(Grove et al., 2015)	/	/	/				/				/				/		/		
(Colonna et al., 2016)	/					/				/									
Frequency (i.e. Depth of Citation)	**25**	**10**	**12**	**1**	**17**	**38**	**13**	**7**	**16**	**23**	**15**	**7**	**2**	**6**	**7**	**3**	**4**	**3**	**3**

4. establishing the green driver behaviors affecting safety

In second phase, the research has conducted an expert input to determine driver behaviors (i.e. sub-factors) can contribute to safe traveling. The research labels those approved and finalized driver behaviors (i.e. sub-factors) as 'green' driver behaviors. Next, the second phase has conducted the Value assignment (VA) to indicate the actual value impact (AVI) of those approved sub-factors to green and safe driving.

The expert input study is being performed in technological innovations which integrates the professionals' inputs to any development process (Lemaire and Moneyron, 2010). The expert input study is such a decision making process which this research has conducted using the grounded group decision making (GGDM) method. GGDM method was carried out in two following contexts such as, a structured or non structured problem and a responsible decision maker. Structured problem case has less need in group decision making as the decision makers may judge by default. Meanwhile, non-structured problem case requires creative problem solving thus, the need for group decision making has become more significant here. In GGDM, the responsible decision maker called "GGDM researcher" will come up with the final decision based on the observed judgments, record the decision process, and analyze the results (Lamit et al., 2013). The GGDM is a dynamic and heterogeneous decision making process that incorporates selection of factors and consensus process upon factors selection. GGDM is a useful method to overcome limitations in both technical and logistical aspect of the existing decision making models. Logistically, GGDM can simplify time arrangement between decision makers and reduce cost of delay for decision making sessions. Technically, GGDM introduces number of experts whom are well versed and skilful in a particular area of study to remediate the difficulties in a discussed matter upon reaching consensus. Therefore, high number of experts are encourage in GGDM process as it will enhance more sound conclusion from different experts point of view as well as voting powers in attaining consensus on the matter. In addition, GGDM process allows experts to propose other experts that are relevant and competent in that particular research area. If one of the proposed expert was duplicated or introduced again by other experts, the decision making process will stop because GGDM method terminates any repetition of proposed experts in the loop (Lamit et al., 2013).

According to GGDM's purposive sampling, a total number of eight experts were involved within three group decision making sessions. The experts have been invited who are practicing transportation planning, transportation engineering, and urban planning. Adapted from Lamit et al. (2013), $FW(a_i)$ (Equation 1) is to calculate final weight (FW) of issue number 'i', (a_i), of the discussion.

$$FW(a_i)=(\sum_{j=1}^{n}(min\{WP_j,\ WPr_j\}\times SV_j))\times a_i,\quad for\ i=1,2,3,\ldots,m \tag{1}$$

where:
i, refers to criteria number (for $i = 1,2,3, \ldots,m$)
a_i, refers to issue of discussion (i.e. Environmental-Conscious Factors)
WP_j, refers to assigned weight by expert number 'j' in close group discussion for issue 'a_i',
WPr_j, refers to assigned weight by resource(s) relevant to the issue, whom introduced by expert number 'j' in close group discussion for issue 'a_i',
SV_j, refers to sessions value of the close group discussion sessions considered by the decision researcher for the set of issues 'a_i',
$FW(a_i)_{max}$, referred to maximum possible weight can be given to the issue 'a_i',

$$FW(a_i)\ /\ FW(a_i)_{max}\ = Consensus\ in\ \% \tag{2}$$

Equation (2) indicates the consensus calculation of GGDM for issue 'a_i'. If the final consensus calculated more than 70%, the alternative is selected, and that criterion is approved.

A structure of questionnaire form was designed to be filled up by experts during discussion sessions. The questionnaire form was designed using 5-point likert scale from 1 to 5 (1 refers to strongly disagree and 5 refers to strongly agree). Two groups of experts consist of academician and practitioners are adopted in this study. The selection of expert is based on few criteria such as; background, specialization, and number of experiences. The first group consists of lecturers, associate professor, and PhD candidates across different disciplines in urban and transportation fields of research; including highway and transportation, traffic engineering, driver behavior, adaptive behavior, transportation planning, and urban design and landscape architecture. The second group consists of practitioners across different disciplines such as, traffic engineers, police officers, and driving institute instructors. According to purposing sampling size of GGDM, fourteen (14) participants were participated; where, eight (8) of them were academician and the remaining six (6) were practitioners. The result of the discussion is tabulated in separated tables of academic experts and practitioners.

4.1. Expert inputs analysis and results

Table 3 and Table 4 show the expert's judgments and validation results for reckless driving behaviors, while Table 6 and Table 6 show the approach of safe driving practice. There are total four (4) validation sessions required in this study upon reaching consensus; three (3) validation sessions with academic experts, and one (1) validation session with practitioners. Value of validation sessions (i.e. SV) was differentiated according to the years of experience of experts involved in. The first validation session is conducted among academicians with less than 10 years of experience. The second validation session is conducted among academicians between 10 to 15 years of experience. The third validation session was conducted among last-year PhD students. The final validation session was conducted among traffic engineers, police officers and driving instructors as the practitioners, who had more than 10 years of experience.

Referring to GGDM method, the validation aspect of GGDM method is based on $\geq 70\%$ consensus rate. In this regards, the initial results in Table 3 shows four (4) factors which are; age cognitive decline (65%), poor health condition (65%), honking (63%), and involve in car accident or fines (61%) were not approved. Meanwhile, the results in Table 5 shows only sub-factor avoid gear snatching (59%) unapproved. The rest of sub-factors got consensus more than 70%, hence have been approved. However, the sub-factors were not yet finalized because the frequency (i.e. depth of citation) of each sub-factor has to be integrated with its GGDM result. The next session presents the actual value analysis as the normalization stage for integrating the frequency (i.e. depth of citation) and GGDM result. The following presents an example of GGDM calculation steps for determining consensus of the sub-factor Anger and frustration (DB $_{f1.1.}$) in Table 4.

Example:
DB $_{f1.1.}$ Anger and frustration (in Table 4)
Step 1 – Calculate the score $\sum(C_{wp} \text{ x sv})$; C_{wp} is the minimum score

$$FW(a_i) = (\sum_{j=1}^{n}(min\{WP_j,\ \ WPr_j\} \times SV_j)) \times a_i,$$
$$\left(for\ i = 1, 2, 3, \ldots,\ m\right)$$

FW (a_i) = [(C_{wp1} x sv)+(C_{wp2} x sv)+(C_{wp3} x sv)+ ..(C_{wpn} x sv)] = [(4*2)+(4*2)+(3*2)+(4*2)+(3*2)+(4*2)] = 44

Step 2 – Calculate FW $(a_i)_{max}$
FW $(a_i)_{max}$ = [5 x sv x no. of participants] = [5 x 2 x 6] = 60

Step 3 – Calculate the consensus rate (%)
$FW(a_i)\ \ /\ \ FW(a_i)_{max}$ = Consensus in %
(%) = *FW* (a_i)/*FW* $(a_i)_{max}$ = [44/60]*100 = 73% > 70% , approved factor

Table 3. Summary of GGDM data collection and analysis on reckless driving behaviours (Academic Experts)

Cluster	Reckless driving behaviours	Validation session 1													Validation session 2							Validation session 3							Cons. (%)	GGDM Consesus
		Participant 1			Participant 2			Participant 3			Participant 4				Participant 5			Participant 6				Participant 7			Participant 8					
		WP	WPr = c-WP5	c-WP	WP	r-WP	c-WP	WP	WPr = WP1*	c-WP	WP	WPr = WP6	c-WP	SV	WP	WPr	c-WP	WP	WPr	c-WP	SV	WP	WPr = WP8	c-WP	WP	WPr	c-WP	SV		
Self-Disturbance Driver Behaviour DB f1.	DB $_{f1.1.}$ Anger and frustration	3	5	3	5	-	5	-	4	4	-	5	5	2	5	-	5	5	-	5	3	5	3	3	4	-	4	1	**89**	Approv.
	DB $_{f1.2.}$ Age cognitive decline	4	3	3	3	-	3	-	4	4	-	3	3	2	3	-	3	3	-	3	3	4	4	4	4	-	4	1	**65**	Disapprov
	DB $_{f1.3.}$ Impulsive driving	4	3	3	4	-	4	-	5	5	-	5	5	2	3	-	3	5	-	5	3	4	4	4	4	-	4	1	**83**	Approv.
	DB $_{f1.4.}$ Tired and sleepiness	5	4	4	5	-	5	-	4	4	-	5	5	2	4	-	4	5	-	5	3	5	4	4	5	-	5	1	**90**	Approv.
	DB $_{f1.5.}$ Lack of attention	5	3	3	5	-	5	-	4	4	-	4	4	2	3	-	3	4	-	4	3	5	4	4	5	-	5	1	**78**	Approv.
	DB $_{f1.6.}$ Poor observation	4	3	3	4	-	4	-	5	5	-	3	3	2	3	-	3	3	-	3	3	5	5	5	5	-	5	1	**73**	Approv.
	DB $_{f1.7.}$ Being hurry and impatient	4	4	4	5	-	5	-	4	4	-	3	3	2	4	-	4	3	-	3	3	5	5	5	4	-	4	1	**78**	Approv.
	DB $_{f1.8.}$ Poor health condition	4	3	3	3	-	3	-	4	4	-	3	3	2	3	-	3	3	-	3	3	4	4	4	4	-	4	1	**65**	Disapprov
	DB $_{f1.9.}$ Competitive attitude	4	5	4	5	-	5	-	5	5	-	5	5	2	5	-	5	5	-	5	3	5	4	4	5	-	5	1	**96**	Approv.
	DB $_{f1.10.}$ Showing angry/insulting gestures	3	5	3	5	-	5	-	4	4	-	3	3	2	5	-	5	3	-	3	3	5	4	4	5	-	5	1	**79**	Approv.
	DB $_{f1.11.}$ Distraction	5	4	4	5	-	5	-	5	5	-	4	4	2	4	-	4	4	-	4	3	4	4	4	5	-	5	1	**86**	Approv.
	DB $_{f1.12.}$ Using mobile phone	4	5	4	5	-	5	-	5	5	-	5	5	2	5	-	5	5	-	5	3	5	4	4	4	-	4	1	**95**	Approv.
Environment-Disturbance Driver	DB $_{f2.1}$Traffic violation	3	4	3	5	-	5	-	5	5	-	5	5	2	4	-	4	5	-	5	3	5	4	4	4	-	4	1	**89**	Approv.
	DB $_{f2.2.}$ Exceeding speed limits	3	5	3	5	-	5	-	4	4	-	5	5	2	5	-	5	5	-	5	3	5	3	3	4	-	4	1	**89**	Approv.
	DB $_{f2.3.}$ Tailgating	2	5	2	5	-	5	-	4	4	-	4	4	2	5	-	5	4	-	4	3	5	5	5	4	-	4	1	**83**	Approv.
	DB $_{f2.4.}$ Dangerous overtaking	4	5	4	5	-	5	-	5	5	-	5	5	2	5	-	5	5	-	5	3	5	5	5	5	-	5	1	**98**	Approv.
	DB $_{f2.5.}$ Inconsiderable/ Irresponsible driving	2	4	2	4	-	4	-	4	4	-	4	4	2	4	-	4	4	-	4	3	5	4	4	5	-	5	1	**76**	Approv.
	DB $_{f2.6.}$ Not wearing seatbelts	3	4	3	3	-	3	-	5	5	-	5	5	2	4	-	4	5	-	5	3	4	3	3	4	-	4	1	**83**	Approv.

Cluster	Reckless driving behaviours	Validation session 1													Validation session 2							Validation session 3							Cons. (%)	GGDM Consesus
		Participant 1			Participant 2			Participant 3			Participant 4			SV	Participant 5			Participant 6			SV	Participant 7			Participant 8			SV		
		WP	WPr = c-WP5	c-WP	WP	r-WP	c-WP	WP	WPr = WP1*	c-WP	WP	WPr = WP6	c-WP		WP	WPr	c-WP	WP	WPr	c-WP		WP	WPr = WP8	c-WP	WP	WPr	c-WP			
	DB $_{f2.7.}$ Racing with other driver	3	4	3	4	-	4	-	5	5	-	5	5	2	4	-	4	5	-	5	3	5	5	5	5	-	5	1	**89**	Approv.
	DB $_{f2.8.}$ Pulling out at an intersection dangerously	3	4	3	4	-	4	-	4	4	-	4	4	2	4	-	4	4	-	4	3	5	5	5	5	-	5	1	**80**	Approv.
	DB $_{f2.9.}$ Lane keeping violation	4	5	4	3	-	3	-	5	5	-	4	4	2	5	-	5	4	-	4	3	5	4	4	4	-	4	1	**84**	Approv.
	DB $_{f2.10.}$ Honking	3	3	3	2	-	2	-	5	5	-	3	3	2	3	-	3	3	-	3	3	3	3	3	3	-	3	1	**63**	Disapprov
	DB $_{f2.11.}$ Involve in accident or car fines	3	3	3	2	-	2	-	4	4	-	3	3	2	3	-	3	3	-	3	3	4	3	3	4	-	4	1	**61**	Disapprov
	DB $_{f2.12.}$ Arguing with other driver	4	4	4	3	-	3	-	5	5	-	3	3	2	4	-	4	3	-	3	3	5	3	3	4	-	4	1	**73**	Approv.

Note. **WP:** Participant's Rate to the validation aspect, c-**WP:** conclusion of Participant's Rate to the validation aspect considered as $min\{WP_j, WPr_j\}$, **WPr:** Participant introduced resouceRate to the validation aspect, -: Participant did not provide value**, SV:** CGDM Session Value considered by the GGDM researcher, **Aprv**.: the validation aspect is approved based on GGDM Consensus rate of more than 70% agreement, **n-Aprv**.: the validation aspect is not approved based on GGDM Consensus rate of not more than 70% agreement.; **WP1*:** refers to the participant 1 in the non academic expert table below.

Table 4. Summary of GGDM data collection and analysis on reckless driving behaviours (Practitione)

Reckless driving behaviours	Validation session 1																			Cons. (%)	GGDM Consesus
	Participant 1			Participant 2			Participant 3			Participant 4			Participant 5			Participant 6			SV		
	WP	WPr = c-WP2	c-WP	WP	r-WP	c-WP	WP	WPr	c-WP	WP	WPr	c-WP	WP	WPr = c-WP6	c-WP	WP	WPr= WP8*	c-WP			
DB $_{f1.1.}$ Anger and frustration	4	4	4	4	-	4	3	-	3	4	-	4	3	5	3	5	4	4	2	**73**	Approv.
DB $_{f1.2.}$ Age cognitive decline	4	4	4	4	-	4	5	-	5	4	-	4	4	4	4	4	4	4	2	**83**	Approv.
DB $_{f1.3.}$ Impulsive driving	5	5	5	5	-	5	5	-	5	5	-	5	4	5	4	5	4	4	2	**93**	Approv.
DB $_{f1.4.}$ Tired and sleepiness	4	4	4	4	-	4	5	-	5	5	-	5	4	5	4	5	5	5	2	**90**	Approv.
DB $_{f1.5.}$ Lack of attention	4	4	4	4	-	4	5	-	5	5	-	5	4	5	4	5	5	5	2	**90**	Approv.
DB $_{f1.6.}$ Poor observation	5	5	5	5	-	5	4	-	4	5	-	5	5	4	4	4	5	4	2	**90**	Approv.
DB $_{f1.7.}$ Being hurry and impatient	4	4	4	4	-	4	4	-	4	5	-	5	5	5	5	5	4	4	2	**87**	Approv.
DB $_{f1.8.}$ Poor health condition	4	4	4	4	-	4	4	-	4	5	-	5	4	5	4	5	4	4	2	**83**	Approv.
DB $_{f1.9.}$ Competitive attitude	5	5	5	5	-	5	5	-	5	5	-	5	4	5	4	5	5	5	2	**97**	Approv.
DB $_{f1.10.}$ Showing angry/insulting gestures	4	4	4	4	-	4	5	-	5	5	-	5	4	5	4	5	5	5	2	**90**	Approv.
DB $_{f1.11.}$ Distraction	5	5	5	5	-	5	5	-	5	5	-	5	4	4	4	4	5	4	2	**93**	Approv.
DB $_{f1.12.}$ Using mobile phone	5	5	5	5	-	5	4	-	4	5	-	5	4	4	4	4	4	4	2	**90**	Approv.
DB $_{f2.1}$ Traffic violation	5	5	5	5	-	5	5	-	5	5	-	5	4	5	4	5	4	4	2	**93**	Approv.
DB $_{f2.2.}$ Exceeding speed limits	4	4	4	4	-	4	4	-	4	5	-	5	3	5	3	5	4	4	2	**80**	Approv.
DB $_{f2.3.}$ Tailgating	4	4	4	4	-	4	5	-	5	5	-	5	5	5	5	5	4	4	2	**90**	Approv.
DB $_{f2.4.}$ Dangerous overtaking	5	5	5	5	-	5	5	-	5	5	-	5	5	5	5	5	5	5	2	**100**	Approv.
DB $_{f2.5.}$ Inconsiderable/irresponsible driving	4	4	4	4	-	4	5	-	5	5	-	5	4	5	4	5	5	5	2	**90**	Approv.
DB $_{f2.6.}$ Not wearing seatbelts	5	5	5	5	-	5	5	-	5	5	-	5	3	5	3	5	4	4	2	**90**	Approv.
DB $_{f2.7.}$ Racing with other driver	5	5	5	5	-	5	5	-	5	5	-	5	5	5	5	5	5	5	2	**100**	Approv.
DB $_{f2.8.}$ Pulling out at an intersection dangerously	4	4	4	4	-	4	5	-	5	5	-	5	5	5	5	5	5	5	2	**93**	Approv.
DB $_{f2.9.}$ Lane keeping violation	5	5	5	5	-	5	3	-	3	5	-	5	4	5	4	5	4	4	2	**87**	Approv.
DB $_{f2.10.}$ Honking	5	5	5	5	-	5	3	-	3	3	-	3	3	4	3	4	3	3	2	**73**	Approv.
DB $_{f2.11.}$ Involve in accident or car fines	4	4	4	4	-	4	5	-	5	5	-	5	3	5	3	5	4	4	2	**83**	Approv.
DB $_{f2.12.}$ Arguing with other driver	5	5	5	5	-	5	5	-	5	5	-	5	3	5	3	5	4	4	2	**90**	Approv.

Note. **WP:** Participant's Rate to the validation aspect, c-**WP:** conclusion of Participant's Rate to the validation aspect considered as $min\{WP_j, WPr_j\}$, **WPr:** Participant introduced resouceRate to the validation aspect, -: Participant did not provide value**, SV:** CGDM Session Value considered by the GGDM researcher, **Aprv**.: the validation aspect is approved based on GGDM Consensus rate of more than 70% agreement, **n-Aprv**.: the validation aspect is not approved based on GGDM Consensus rate of not more than 70% agreement; **WP8*:** refers to the participant 8 in the academic expert table above.

Table 5. Summary of GGDM data collection and analysis on Safe Driving Practices (Academic Experts)

	Cluster	Safe driving practices	Validation session 1													Validation session 2							Validation session 3							Cons. (%)	GGDM Consesus
			Participant 1			Participant 2			Participant 3			Participant 4				Participant 5			Participant 6				Participant 7			Participant 8					
			WP	WPr = c-WP5	c-WP	WP	r-WP	c-WP	WP	WPr = WP1*	c-WP	WP	WPr = WP6	c-WP	SV	WP	WPr	c-WP	WP	WPr	c-WP	SV	WP	WPr = WP8	c-WP	WP	WPr	c-WP	SV		
$SD_{f1.}$ Self-Adaptation Driving	$SD_{f1.1.}$ Driving practice	$SD_{f1.1.1.}$ Regulate vehicle speed	4	4	4	5	-	5	-	4	4	-	5	5	2	4	-	4	5	-	5	3	4	4	4	4	-	4	1	**89**	Approv.
		$SD_{f1.1.2.}$ Efficient vehicle acceleration	4	4	4	3	-	3	-	4	4	-	4	4	2	4	-	4	4	-	4	3	4	2	2	4	-	4	1	**75**	Approv.
		$SD_{f1.1.3.}$ Gentle and progressive braking	4	4	4	5	-	5	-	5	5	-	3	3	2	4	-	4	3	-	3	3	4	4	4	4	-	4	1	**79**	Approv.
		$SD_{f1.1.4.}$ Avoid gear snatching	5	3	3	4	-	4	-	4	4	-	2	2	2	3	-	3	2	-	2	3	5	3	3	3	-	3	1	**59**	Approv.
	$SD_{f1.2.}$ Skill and safety motive	$SD_{f1.2.1.}$ Driver's safety motives	4	5	4	5	-	5	-	4	4	-	4	4	2	5	-	5	4	-	4	3	5	5	5	4	-	4	1	**88**	Approv.
		$SD_{f1.2.2..}$ Driver's cognitive and motor skills	4	5	4	5	-	5	-	4	4	-	5	5	2	5	-	5	5	-	5	3	4	4	4	4	-	4	1	**93**	Approv.
$SD_{f2.}$ Environmental-Adaptation Driving	$SD_{f2.1.}$ Vehicle Mechanical factors	$SD_{f2.1.1.}$ Environmental quality factors	3	4	3	4	-	4	-	4	4	-	4	4	2	4	-	4	4	-	4	3	4	3	3	4	-	4	1	**76**	Approv.
		$SD_{f2.1.2.}$ Vehicle Design factors	4	3	3	5	-	5	-	4	4	-	4	4	2	3	-	3	4	-	4	3	4	3	3	4	-	4	1	**75**	Approv.
	$SD_{f2.2.}$ Physical-environmental factors	$SD_{f2.2.1.}$ Traffic regulation/enforcements	4	5	4	5	-	5	-	5	5	-	5	5	2	5	-	5	5	-	5	3	4	3	3	5	-	5	1	**95**	Approv.
		$SD_{f2.2.2.}$ Types of intersections	3	4	3	2	-	2	-	4	4	-	5	5	2	4	-	4	5	-	5	3	4	3	3	4	-	4	1	**78**	Approv.
		$SD_{f2.2.3.}$ Weather factor	4	4	4	5	-	5	-	4	4	-	4	4	2	4	-	4	4	-	4	3	4	4	4	5	-	5	1	**84**	Approv.
		$SD_{f2.2.4.}$ Crossing Pedestrian	4	4	4	4	-	4	-	4	4	-	3	3	2	4	-	4	3	-	3	3	4	3	3	4	-	4	1	**73**	Approv.
		$SD_{f2.2.5.}$ Overtake at legal lane	4	4	4	5	-	5	-	5	5	-	4	4	2	4	-	4	4	-	4	3	4	4	4	4	-	4	1	**85**	Approv.
	$SD_{f2.3.}$ Advanced safety features of vehicle	$SD_{f2.3.1.}$ Advance driver assistant system	5	3	3	5	-	5	-	4	4	-	4	4	2	3	-	3	4	-	4	3	4	4	4	4	-	4	1	**76**	Approv.
		$SD_{f2.3.2.}$ Drive Camera	5	3	3	2	-	2	-	5	5	-	5	5	2	3	-	3	5	-	5	3	5	4	4	5	-	5	1	**79**	Approv.
		$SD_{f2.3.3}$ Frontal collision detection	4	3	3	5	-	5	-	4	4	-	4	4	2	3	-	3	4	-	4	3	5	4	4	4	-	4	1	**76**	Approv.
		$SD_{f2.3.4..}$ Adaptive cruise control	5	3	3	5	-	5	-	4	4	-	5	5	2	3	-	3	5	-	5	3	5	4	4	4	-	4	1	**83**	Approv.
		$SD_{f2.3.5.}$ Lane keeping system	4	3	3	5	-	5	-	4	4	-	3	3	2	3	-	3	3	-	3	3	4	4	4	4	-	4	1	**70**	Approv.
		$SD_{f2.3.6.}$ Sensor based recognition	5	3	3	5	-	5	-	5	5	-	3	3	2	3	-	3	3	-	3	3	5	4	4	4	-	4	1	**73**	Approv.

Note. **WP:** Participant's Rate to the validation aspect, c-**WP:** conclusion of Participant's Rate to the validation aspect considered as $min\{WP_j, WPr_j\}$, **WPr:** Participant introduced resouceRate to the validation aspect, -: Participant did not provide value**, SV:** CGDM Session Value considered by the GGDM researcher, **Aprv**.: the validation aspect is approved based on GGDM Consensus rate of more than 70% agreement, **n-Aprv**.: the validation aspect is not approved based on GGDM Consensus rate of not more than 70% agreement.; **WP1*:** refers to the participant 1 in the non academic expert table below.

Table 6. Summary of GGDM data collection and analysis on Safe Driving Practices (Practitioners)

Cluster		Safe driving practices	Validation session 1																		SV	Cons. (%)	GGDM Consesus
			Participant 1			Participant 2			Participant 3			Participant 4			Participant 5			Participant 6					
			WP	WPr = c-WP2	c-WP	WP	r-WP	c-WP	WP	WPr	c-WP	WP	WPr	c-WP	WP	WPr = c-WP6	c-WP	WP	WPr= WP8*	c-WP			
SD f1. Self-Adaptation Driving	SD f1.1. Driving practice	SD f1.1.1. Regulate vehicle speed	4	4	4	4	-	4	4	-	4	3	-	3	4	5	4	5	4	4	2	**77**	Approv.
		SD f1.1.2. Efficient vehicle acceleration	4	4	4	4	-	4	4	-	4	3	-	3	2	4	2	4	4	4	2	**70**	Approv.
		SD f1.1.3. Gentle and progressive braking	5	5	5	5	-	5	3	-	3	3	-	3	4	4	3	4	4	4	2	**77**	Approv.
		SD f1.1.4. Avoid gear snatching	4	4	4	4	-	4	4	-	4	3	-	3	3	4	3	4	3	3	2	**70**	Approv.
	SDf1.2. Skill and safety motive	SD f1.2.1. Driver's safety motives	4	4	4	4	-	4	4	-	4	3	-	3	5	4	4	4	4	4	2	**77**	Approv.
		SD f1.2.2.. Driver's cognitive and motor skills	4	4	4	4	-	4	4	-	4	3	-	3	4	5	4	5	4	4	2	**77**	Approv.
SD f2. Environmental-Adaptation Driving	SD f2.1. Vehicle Mechanical factors	SD f2.1.1. Environmental quality factors	4	4	4	4	-	4	4	-	4	3	-	3	3	4	3	4	4	4	2	**73**	Approv.
		SD f2.1.2. Vehicle Design factors	4	4	4	4	-	4	4	-	4	3	-	3	3	4	3	4	4	4	2	**73**	Approv.
	SD f2.2. Physical-environmental factors	SD f2.2.1. Traffic regulation/enforcements	5	5	5	5	-	5	3	-	3	4	-	4	3	5	3	5	5	5	2	**83**	Approv.
		SD f2.2.2. Types of intersections	4	4	4	4	-	4	3	-	3	4	-	4	3	5	3	5	4	4	2	**73**	Approv.
		SD f2.2.3. Weather factor	4	4	4	4	-	4	3	-	3	4	-	4	4	5	4	5	5	5	2	**80**	Approv.
		SD f2.2.4. Crossing Pedestrian	4	4	4	4	-	4	4	-	4	4	-	4	3	4	3	4	4	4	2	**77**	Approv.
		SD f2.2.5. Overtake at legal lane	5	5	5	5	-	5	4	-	4	4	-	4	4	5	4	5	4	4	2	**87**	Approv.
	SD f2.3. Advanced safety features of vehicle	SD f2.3.1. Advance driver assistant system	4	4	4	4	-	4	3	-	3	4	-	4	4	5	4	5	4	4	2	**77**	Approv.
		SD f2.3.2. Drive Camera	5	5	5	5	-	5	4	-	4	4	-	4	4	5	4	5	5	5	2	**90**	Approv.
		SD f2.3.3 Frontal collision detection	4	4	4	4	-	4	3	-	3	3	-	3	4	4	4	4	4	4	2	**73**	Approv.
		SD f2.3.4. . Adaptive cruise control	4	4	4	4	-	4	4	-	4	3	-	3	4	4	4	4	4	4	2	**77**	Approv.
		SD f2.3.5. Lane keeping system	4	4	4	4	-	4	3	-	3	3	-	3	4	5	4	5	4	4	2	**73**	Approv.
		SD f2.3.6. Sensor based recognition	5	4	4	4	-	4	4	-	4	3	-	3	4	5	4	5	4	4	2	**77**	Approv.

***Note.* WP:** Participant's Rate to the validation aspect, c-**WP:** conclusion of Participant's Rate to the validation aspect considered as $min\{WP_j, WPr_j\}$, **WPr:** Participant introduced resouceRate to the validation aspect, -: Participant did not provide value**, SV:** CGDM Session Value considered by the GGDM researcher, **Aprv**.: the validation aspect is approved based on GGDM Consensus rate of more than 70% agreement, **n-Aprv**.: the validation aspect is not approved based on GGDM Consensus rate of not more than 70% agreement.; **WP8*:** refers to the participant 8 in the academic expert table above**.**

4.2. Actual weightage value analysis of driving behaviors

This section represents results from the content analysis table (depth of citation) and expert input (GGDM method). The purpose of this section is to analyze the actual weight. Next, this section ranks the sub-factor to indicate which sub-factors are more significant to the green driver behavior study corresponds to the citation depth and expert inputs. Some factors will be eliminated instantly, although the depth of citation is higher than the GGDM consensus rate. The depth of citation is determined using the citation frequency divided by number of cited articles. Meanwhile, GGDM results are summed and divided into 2 to obtain the average values. Therefore, the aim of this section is to finalize the sub-factors which contribute to the green driver assessment protocol.

Actual Weightage Value (AWV) is shown below as the equation 3.

(for k=1,2,3,…n)

$$AWV_{a_i} = DC_{a_i} \times GC_{ai} = \frac{\sum_{k=1}^{n} CR_{a_i}}{\sum_{k=1}^{n} R} \times GC_{ai} \quad (3)$$

where:

i, refers to criteria number (for: *1,2,3, ….,m)*

k; refers to article number *(for k=1,2,3,…n)*

DC_{a_i}, refers to Depth of Citation of factor ‘ a_i ’ (extracted from Table 1: Content Analysis)

GC_{ai}, refers to GGDM Consensus of factor ‘ a_i ’ (extracted from Table 2: GGDM result)

C, number of referenced articles involved in content analysis table (extracted from Table 1: Content Analysis) which equals to 26.

CR, number of articles have cited the factor ‘ a_i ’ (extracted from Table 1: Content Analysis)

The following presents an example of Actual weightage value calculation for the sub-factor Anger and frustration (DB $_{f1.1.}$) (see Table 7).

Table 7 shows the weightage analysis of reckless driving behaviours that influence accident likelihood, injuries, or crashes in association with driving behavior. According to Actual Weightage Value analysis, the sub-factor DB $_{f2.2.}$ Exceeding speed limits (0.64) which was followed by DB $_{f2.1}$Traffic violation (0.49), and DB $_{f1.11.}$ Distraction (0.46), and DB $_{f2.4.}$ Dangerous overtaking (0.39). In contrast, the sub-factors DB $_{f1.2.}$ Age cognitive decline and DB $_{f1.9.}$ Competitive attitude received the lowest Actual Weightage Value (0.02).

The weightage values have been classified into three (3) ranking grades as; i) 0-0.3, ii) 0.31-0.5, and iii) ≥0.51. The weightage value which is less than or equals to 0.3 signifies factor which has weaker contribution to the accident likelihood followed by, 0.31-0.5 which represents moderate contribution and finally, ≥0.5 indicates high factor contribution as visualized in Figure 2. According to Figure 2, there is a big gap between High-contribution sub-factors and low- contribution ones. Only one sub-factor DB $_{f2.2.}$ Exceeding speed limits was ranked in the High contribution grade; while the rest of sub-factors ranked in lower grades. The three sub-factors; DB $_{f2.1}$Traffic violation, and DB $_{f1.11.}$ Distraction, and DB $_{f2.4.}$ Dangerous overtaking, are ranked in medium-contribution, and the rest of twenty (20) sub-factors contibute sligtly to reckless driving behaviours.

Besides, Table 8 shows the weightage analysis of Safe driving practices that influence accident likelihood, injuries, or crashes in association with driving behavior. According to the results of Actual weightage analysis, SD $_{f1.2.2..}$ Driver’s cognitive and motor skills has received the highest value (0.49). Surprisingly, non of the Safe driving practice sub-factors involved in the high-contribution grade. Contrary, the sub-factor SD $_{f1.1.4.}$ Avoid gear snatching got the lowest actual value (0.01). Referring to Figure 3, out of nineteen sub-factors. The sub-factors SD $_{f1.2.2..}$ Driver’s cognitive and motor skills, and SD $_{f1.1.1.}$ Regulate vehicle speed have placed in the Medium-contribution grade, and the rest of seventeen (17) sub-factors ranked in low-contribution grade.

Example:

DB $_{f1.1.}$ Anger and frustration

Content analysis table
Depth of citation = 11
Total cited articles = 41
Average depth of citation = 11/41 = **0.27**

Expert inputs
GGDM consensus rate (academician) = 0.89
GGDM consensus rate (practitioners) = 0.73
Average GGDM consensus rate = (0.89+0.73)/2 = **0.81**

So,
Actual weightage value = Average depth of citation x Average GGDM consensus rate = 0.27 x 0.81 = **0.22**

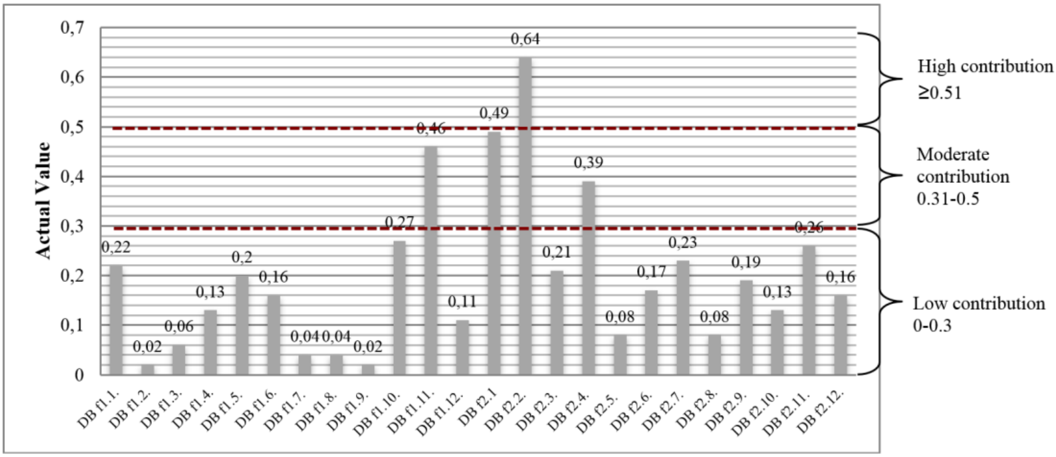

Fig. 2. Ranking grades of reckless driving behaviours

Table 7. Actual weightage analysis of reckless driving behaviours

Sub-factors	Depth of Citation		GGDM results			Actual Value
			Academic	Practitioners	Average	
DB $_{f1.1.}$ Anger and frustration	11	0.27	.89	.73	.81	**0.22**
DB $_{f1.2.}$ Age cognitive decline	1	0.02	.65	.83	.74	**0.02**
DB $_{f1.3.}$ Impulsive driving	3	0.07	.83	.93	.88	**0.06**
DB $_{f1.4.}$ Tired and sleepiness	6	0.15	.90	.90	.90	**0.13**
DB $_{f1.5.}$ Lack of attention	10	0.24	.78	.90	.84	**0.20**
DB $_{f1.6.}$ Poor observation	8	0.20	.73	.90	.82	**0.16**
DB $_{f1.7.}$ Being hurry and impatient	2	0.05	.78	.87	.83	**0.04**
DB $_{f1.8.}$ Poor health condition	2	0.05	.65	.83	.74	**0.04**
DB $_{f1.9.}$ Competitive attitude	1	0.02	.96	.97	.97	**0.02**
DB $_{f1.10.}$ Showing angry/insulting gestures	13	0.32	.79	.90	.85	**0.27**
DB $_{f1.11.}$ Distraction	21	0.51	.86	.93	.90	**0.46**
DB $_{f1.12.}$ Using mobile phone	5	0.12	.95	.90	.93	**0.11**
DB $_{f2.1}$Traffic violation	22	0.54	.89	.93	.91	**0.49**
DB $_{f2.2.}$ Exceeding speed limits	31	0.76	.89	.80	.85	**0.64**
DB $_{f2.3.}$ Tailgating	10	0.24	.83	.90	.87	**0.21**
DB $_{f2.4.}$ Dangerous overtaking	16	0.39	.98	1	.99	**0.39**
DB $_{f2.5.}$ Inconsiderable/irresponsible driving	4	0.10	.76	.90	.83	**0.08**
DB $_{f2.6.}$ Not wearing seatbelts	8	0.20	.83	.90	.87	**0.17**
DB $_{f2.7.}$ Racing with other driver	10	0.24	.89	1	.95	**0.23**
DB $_{f2.8.}$ Pulling out at an intersection dangerously	4	0.10	.80	.93	.87	**0.08**
DB $_{f2.9.}$ Lane keeping violation	9	0.22	.84	.87	.86	**0.19**
DB $_{f2.10.}$ Honking	8	0.20	.63	.73	.68	**0.13**
DB $_{f2.11.}$ Involve in accident or car fines	15	0.37	.61	.83	.72	**0.26**
DB $_{f2.12.}$ Arguing with other driver	8	0.20	.73	.90	.82	**0.16**

Table 8. Actual weightage analysis of factors on Safe driving practices

Sub-factors	Depth of Citation		GGDM results			Actual Value
			Academic	Practitioners	Average	
SD $_{f1.1.1.}$ Regulate vehicle speed	25	0.38	.89	.77	.83	**0.31**
SD $_{f1.1.2.}$ Efficient vehicle acceleration	10	0.15	.75	.70	.725	**0.11**
SD $_{f1.1.3.}$ Gentle and progressive braking	12	0.18	.79	.77	.78	**0.14**
SD $_{f1.1.4.}$ Avoid gear snatching	1	0.02	.59	.70	.645	**0.01**
SD $_{f1.2.1.}$ Driver's safety motives	17	0.26	.88	.77	.825	**0.21**
SD $_{f1.2.2..}$ Driver's cognitive and motor skills	38	0.58	.93	.77	.85	**0.49**
SD $_{f2.1.1.}$ Environmental quality factors	13	0.20	.76	.73	.745	**0.15**
SD $_{f2.1.2.}$ Vehicle Design factors	7	0.11	.75	.73	.74	**0.08**
SD $_{f2.2.1.}$ Traffic regulation/enforcements	16	0.24	.95	.83	.89	**0.22**
SD $_{f2.2.2.}$ Types of intersections	23	0.35	.78	.73	.755	**0.26**
SD $_{f2.2.3.}$ Weather factor	15	0.23	.84	.80	.82	**0.19**
SD $_{f2.2.4.}$ Crossing Pedestrian	7	0.11	.73	.77	.75	**0.08**
SD $_{f2.2.5.}$ Overtake at legal lane	2	0.03	.85	.87	.86	**0.03**
SD $_{f2.3.1.}$ Advance driver assistant system	6	0.09	.76	.77	.765	**0.07**
SD $_{f2.3.2.}$ Drive Camera	7	0.11	.79	.90	.845	**0.09**
SD $_{f2.3.3}$ Frontal collision detection	3	0.05	.76	.73	.745	**0.03**
SD $_{f2.3.4..}$ Adaptive cruise control	4	0.06	.83	.77	.80	**0.05**
SD $_{f2.3.5.}$ Lane keeping system	3	0.05	.70	.73	.715	**0.03**
SD $_{f2.3.6.}$ Sensor based recognition	3	0.05	.73	.77	.75	**0.03**

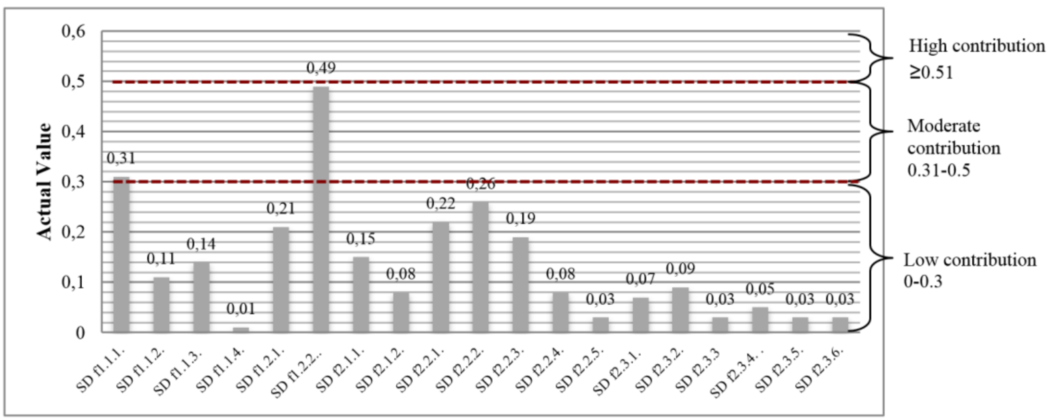

Fig. 3. Ranking grades of safe driving practices

5. Findings and discussion

The research identified total forty three (43) driver behaviors through a systematic literature review and content analysis procedure. Weightage value of all driver behaviors (i.e. sub-factors) have been calculated according to GGDM consensus rate and the depth of citation (i.e. frequency of citation). In the cluster of reckless behaviors, overall, five (5) sub-factors; including; poor health condition (65%), honking (63%), and involve in car accident or fines (61%), and avoid gear snatching (59%) could not reach the consensus approval in GGDM process. In this reason, the depth of citation was integrated with GGDM results to normalize the impact value of the sub-factors so called actual weightage value. The sub-factor exceeding speed is nominated as highly significant reckless behaviors that increase accident likelihood on road. On the other hand, under safe driving practices cluster, regulate control vehicle speed (0.31) are among the highest weightage recorded for enhancement of existing driving practices (ranked in medium-contribution grading). According to these results, the speed sub-factor has shown a strong relationship in terms of reckless driving behavior and at the same time, in a way to improve the existing driving practices. Furthermore, speeding behavior is more translatable and easily distinguished the difference between aggressive or non-aggressive driving practice. A significantly higher proportion of high anger (55%) drivers that engaged in more erratic driving than low anger (23%) drivers crashed in the simulation involved being unable to pass a slow driver safely (Deffenbacher, Deffenbacher et al., 2003). The exposures significantly associated with driver injury were racing a motor vehicle for excitement (PR 2.4, 95% CI 1.6–3.7), driving at 20 km/h or more over the speed limit (PR 2.5, 95% CI 1.4–4.3), and number of traffic convictions (one conviction, PR 2.1, 95% CI 1.5–3.0; two convictions PR 2.7, 95% CI 1.5–4.9; three convictions PR 3.4, 95% CI 1.8–6.6) (Blows et al., 2005).

The research shows that the voluntary risk taking or distraction behaviors is a contributory sub-factor in the accident, which was supported with the previous studies. Clarke et al. (2005) mentions that driver exceeded the posted speed limit (25.92%), drunk-driving (7.13%), recklessness (i.e. racing another vehicle and drive exceed posted speed (5.62%), dangerous overtaking at various road intersection/sections (1.98%), twoc (1.63%), tailgating (1.39%), and traffic violation (0.93%). They also state that the highest number of accidents occurred during hours of darkness were recorded for wet condition (29%), excess alcohol (17.1%), poor observation (27.8%), and excess speed limit (47.8%) whilst, tailgating, over steering, misjudged speed and aggressive recklessness were recorded lower. And, the highest number of accidents occurred during hours of daylight were recorded for wet condition (23.2%), poor observation (44.9%), excess speed limit (38.3%), and tailgating (20%) whilst, excess alcohol, over steering, misjudged speed and aggressive recklessness were recorded lower (Clarke et al., 2005).

Moreover, unbelted drivers had 10 times the risk of involvement in an injury crash compared to belted drivers after adjustment for multiple confounders. Non-use of seatbelts, at the time of the crash/survey, is report by 14.2% of cases and 1.8% of controls. Non-use of seatbelts at the time of the crash was associated with a greater than 10-fold increase in car crash injury (OR 10.3, 95% CI 3.4–31.2) after adjustments of driver's demographic and driving exposures (Blows et al., 2005). In view of tailgating behavior and weather condition, Harris and Houstion (2010) has reported that people were more likely to tailgate on smaller roads, in heavier traffic, and when the weather was clear as opposed to rainy or foggy.

Conclusively, only few factors are significant and meaningful to assist driving behavior-safety which are, distraction, traffic violation, speeding behavior, and dangerous overtaking, regulate/control vehicle speed and driver's cognitive and motor skills. This study indicates the psychological factors in driving behavior was neglected. This is supported by Jovanović et al. (2011), as they express that the psychological factors should be linked and investigated in parallel with drivers' psychological attributes such driver's personality traits, attitudes and intentions, or risks. Besides, cognitive factors like, management of attention (Mathias and Lucas, 2009), visual functions (Chakrabarty Kamini, 2013), and psychomotor behavior (Chakrabarty Kamini, 2013) also important to be explored in green driver behavior assessment studies.

6. Conclusion

Driver behavior assessment is vital to improve the existing human travel behaviors. This paper has investigated numerous factors that influence vehicle fuel consumption and tailpipe emission in association with driving behaviour. From the analysis, human factors are seldom underestimated in consideration towards fuel and emission from vehicle. Researchers are keen to investigate the environmental and vehicle effects towards fuel and emission as these components have become more translatable and measurable compared to human behaviour. Human behaviour is rather complex and governs with psychological, psychosocial, and cognitive attributes which made us human different from one another. It is highly associated with how well our brain works and translates the information through motor skills. Thus, it is highly recommended to pursue specific driving behavioral studies as we could explore and understand human mind and how they made decision. In addition, development of continuous and advanced monitoring devices to assess driving behaviour is highly treasured so that, behaviour can be more measurable in the future. Lastly, the outcome of this study has constructed the firm platform for developing the green driver behaviour index model which can assess the greenery of any individual driver in safe driving. To develop such index model this comprehensive list of sub-factors will be applied, as a decision support checklist, by transportation researchers to carry out experimental works on green driver behaviours measurement.

Further study is needed to investigate driver's decision making on his/her travel behavior. The missing link between fuel consumption and tailpipe emission with human behaviour can be obviously seen from the collected references. There are limited sources of literature which emphasize types of drivers in association with driving and energy. Psychological aspects of drivers are often neglected where more researchers have focused on the physical aspect. Thus, more researches are intended to bridge the gap. Additionally, the less important variables (refers to the first array) should be improved and studied. For instance, personality traits could be incorporated into any of these factors and studied thoroughly.

Further research can be divided to two categories; one that can be referred to as 'Macro' scale and the other as 'Micro' scale of study. Macro-scale studies address upstream research parallel to the current study. Micro-scale studies address downstream research in more detail and in continuation of further development of the current study. Based on this, further studies may focus on;

- Correlation analysis of green driver behaviors.
- Formulating correlation of green driver behaviors and development of green driver behaviour index model.

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