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Seatbelt Reminder (SBR) in ASEAN New Car Assessment Programme (ASEAN NCAP) rating: Supportive findings from a case study of seatbelt wearing in Klang Valley, Malaysia

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ABSTRACT

Seatbelt Reminder (SBR) system has been proven in studies overseas to be very effective in increasing compliance usage rate among vehicle occupants. Nevertheless, despite of its effectiveness, limited studies were conducted to understand the influence of SBR on seatbelt usage among vehicle occupants in Malaysia, particularly in Klang Valley. Hence, this study was conducted to determine if there were differences in drivers' and front passengers' seatbelt wearing rates between passenger vehicles with and without SBRs. In addition, seatbelt wearing rates of frontal occupants in vehicles equipped with SBRs of two different type of reminders (visual-only and audiovisual) was also compared and studied. The results revealed that drivers recorded higher percentage of total seatbelt wearing rate with 85.3% as compared to front passengers with 71.5%. The study also showed remarkable findings where drivers in vehicles fitted with SBRs were two times more likely to wear seatbelt than those in vehicles without. Moreover, it was found that seatbelt wearing rates were higher for audiovisual SBRs as compared to SBRs with visual-only reminder. The results of this study is very important especially to government to introduce SBRs as mandatory safety feature in passenger vehicles. It is hoped through standard fitment of this technology in Malaysian passenger vehicles, seatbelt wearing among Malaysian would positively increase. Moreover, the findings from the case study strongly justify for the inclusion of SBRs into ASEAN NCAP rating. One of the recommendations highlighted is to enhance ASEAN NCAP rating scheme by including the SBR as compulsory 4-star and 5-star pre-requisites for front passenger seats and rear passenger seats (second row and beyond), respectively.

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INTRODUCTION

Seatbelt and Seatbelt Reminder (SBR) system:

It is undeniable that seatbelt is one of the most important safety inventions in road safety. Since its introduction as 2-point lap belt in the 1930s, followed by 3-point modern seatbelt as standard equipment for automobile in mid to late 1950s, seatbelt has saved hundreds of thousands of lives. Seatbelt was designed to secure the occupant of a vehicle against harmful movement which may result in during a road accident or a sudden stop. The effectiveness of seatbelt in reducing road deaths and severely injured in road accidents has been documented in many previous studies (Evans, 1986; Evans, 1996; Elvik and Vaa, 2004; Campbell, 1991, Petridou *et al*, 1998). It is most effective especially during frontal vehicle collision with an almost 50% reduction of death and serious injury for driver and front passenger (Evans and Frick, 1986). Similarly, Elvik and Vaa in their study reported (2004) that use of seatbelts reduce the probability of being killed by 40-50% for drivers and front passengers. It was estimated that the risk reduction associated with seatbelts in cars to be 45% and 60% in passenger cars and light trucks, respectively (Kahane, 2000). Furthermore, Shimamura *et al.* (2005)

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has revealed the risk of killed and severely injured of previously unbelted car occupants would reduce when they began to use seatbelts.

Due to the fact that seatbelts are effective safety feature, this has led many countries worldwide to adopt mandatory seatbelt wearing laws on vehicle occupants. Similarly in Malaysia, the compulsory seatbelt use laws for front and rear vehicle occupants took effect on 1 April 1979 (Malaysia Road Transport Ordinance 1958) and 1 January 2009 (Malaysia Road Transport Act 1987), respectively. Nevertheless, many vehicle occupants failed to use seatbelt despite its proven effectiveness and the mandatory seatbelt legislation. For example in Europe, although there is a seatbelt directive, the wearing rate is not 100% in most countries in the region. It was estimated that the seatbelt wearing rate for drivers and front occupants in Europe to be an average of 76% in 2003 (ETSC, 2003). As for in Malaysia particularly in Putrajaya, the overall seatbelt wearing in passenger cars were low despite legislation (Norlen *et al*, 2010). Recent findings (as of 2014) revealed that the nationwide seatbelt wearing rate was 88.6% for drivers and 75.1% for front passengers (observation by MIROS). Surprisingly, the compliance rate for both front occupants was recorded slightly higher in previous year for similar observational study (drivers: 89.3%; front passengers: 83.6%) (Aimi *et al*, 2013; Ilhamah *et al*, 2014; Wahida and Mohamad Suffian, 2014).

Other than legislation, technologies initiative related to seatbelt use have also been introduced to increase seatbelt wearing rate. Previous studies have found that the most common reasons drivers indicate as to why they do not use seatbelt include short trips, carelessness and forgetfulness (Dahlstedt, 1999; Boyle and Vanderwolf, 2003; Rekveldt and Labibes, 2003; Aqbal Hafeez *et al*, 2014). Since the introduction of audiovisual reminder for seatbelt in the early 1970s, followed by series of improvement by car manufacturers, compliance rate of seatbelt use has been found to be significantly increased. Many studies have shown that occupants are much more likely to wear their belts in cars equipped with a seatbelt reminder (SBR) than in those without. Studies in Europe (Lie *et al*, 2008) showed Seatbelt Reminders (SBRs) were highly effective in increasing seatbelt use – 97.5% in cars with SBR and 85.8% in cars without SBR. Similar studies in the U.S. by Williams and Wells (2003) found that seatbelt use among car drivers with the reminders increase by 7%, compared those of unequipped cars. Since 2002, any effort made to ensure that seatbelts are worn via assistance systems will be rewarded by the European New Car Assessment Programme (Euro NCAP). Premium are given to cars having SBRs that meet requirement of having loud and clear visual light with active audio signal for at least 90 seconds if seatbelt is not worn. As a result, such SBR system was quickly introduced in cars in Europe in the same year, followed by more. It is to be noted that the NCAP is a vehicle test programme established with the aim of providing consumers with safety information that will assist their purchasing decisions. Other than in the Euro NCAP, SBRs also boost vehicle's rating in ANCAP (Australia and New Zealand), JNCAP (Japan), CNCAP (China), KNCAP (Korea) and Latin NCAP (South America and Caribbean region) (CARHS, 2014; ANCAP).

To the date of this study, there is no study conducted to understand the effect of SBR on Malaysian situation. With car manufacturers for local markets have made an effort to provide such system in their cars (though not comprehensively), it is best if the effectiveness of SBR on increasing compliance rate could be evaluated for Malaysian people via a case study. With the establishment of Southeast Asian consumer crash test programme (ASEAN NCAP), the findings from this case study could path a direction for the programme and be a strong justification for the SBR inclusion as one of the rating criteria. Hence, this roadside observational case study was conducted with the objectives defined as follows: (a) To evaluate if the presence of technology, in this case, a Seatbelt Reminder (SBR), would increase occupant's seatbelt wearing rate in passenger vehicles, and (b) To compare the seatbelt wearing rate of frontal occupants in passenger vehicles with two different types of SBRs which are (i) SBR with visual-only signal only, and (ii) SBR with both visual and audible (audiovisual) signals. Finally, it is hoped that the findings would indirectly encourage more car manufacturers to equip their cars with SBR system and at the same time increase seatbelt wearing rate among car occupants in the country.

Fig. 1: An example of typical Seatbelt Reminder (SBR) on instrument panel of a passenger car

ASEAN New Car Assessment Programme (ASEAN NCAP):

In line with the mission of Decade of Action for Road Safety 2011-2020 towards promoting safer vehicles worldwide (WHO, 2011), the New Car Assessment Programme for Southeast Asia region, also coined as ASEAN NCAP, was established in December 2011 to elevate vehicle safety standards, raise consumer awareness and hence promote market for safer vehicles in the region (ASEAN NCAP; Zulhaidi *et al*, 2013). At the present time, ASEAN NCAP has undergone 3 pilot phases of development (in total) and crash tested 30 vehicle models. The NCAP performs frontal offset crash test at 64km/h with 40% offset for each selected model that produces two separate rating schemes: Adult Occupant Protection (AOP) by star (max. of 5 stars) and point-based (max. of 16.00 points) ratings; and Child Occupant Protection (COP) by star (max. of 5 stars) and percentage-based ratings. Starting Phase 3 onwards, ASEAN NCAP introduces and carries out side impact test according to United Nations Regulation No. 95 at 50km/h as new pre-requisite for 4-star AOP rating and above which only produces a pass-fail result. In term of safety assist (technologies that play important role in accident avoidance and injury mitigation) contribution into the overall rating, SBR (for both frontal occupants) is included as pre-requisite for 5-star AOP rating along with Electronic Stability Control (ESC) via declaration of fitment only (Aqbal Hafeez). Nevertheless, no test is performed and required to assess the functionality of both safety assist technologies.

Methodology:

This section describes the methodology used for the case study as mentioned earlier.

Roadside observation:

The observation targeted all drivers and front passengers (adult only) of non-commercial passenger vehicles, which included cars, vans, multi-purpose vehicles (MPVs) and sport utility vehicles (SUVs) which passed through the observation points. Vehicles with heavily tinted windscreen and windows which may cause uncertainties in determining seatbelt wearing were excluded from the observation.

Systematic random sampling technique was adopted in the observation to select the vehicles. The selection of the vehicles was conducted one in every 3 to 5 vehicles that passed the observation point depending on the traffic volume. In order to avoid any inter-observer bias during the observation, similar enumerators were stationed at strategic locations at the observation points. Prior to actual data collection, adequate training including roadside observation exercise were carried out for the enumerators to familiarize them with the data collection procedure. The enumerators were also trained to distinguish between different vehicle models and were instructed to note what vehicle was observed.

Roadside observational form was used during the data collection to record seatbelt wearing and gender of the frontal occupants, as well as registration number, make and model of the vehicles. The form was developed based on literature reviews and research needs (Lie *et al*, 2008; Freedman *et al*, 2009; Norlen *et al*, 2010; Norlen *et al*, 2011) and was later tested, validated and finalized during roadside observation exercise. The actual roadside observation were conducted for a month, from the third week of September to the second week of October 2013.

Sample size determination:

The sample size calculation was done using PS Power and Sample Size Calculations version 3.0.43. The minimum required sample size was calculated to be 199 subjects by taking a 5% tolerable error at 95% confidence level. However, a minimum of 300 subjects were used for data collection at each observation point after considering the possibility for any missing data.

Survey to vehicle manufacturers:

Short surveys were carried out among vehicle manufacturers to acquire technical information on SBR's fitment availability and signal type for all existing vehicle models and variants of their own make for the Malaysian market. In addition, the vehicle manufacturers were required to indicate if their current year vehicle model or variant had similar SBR setup as previous year model or variant. The information obtained is vital for determining either or not the vehicles observed and recorded were fitted with SBR system, and with which signal category – whether visual-only or audiovisual.

Study setting:

The case study was conducted in Klang Valley which comprises five areas according to their local authorities (Fig. 2). Only five municipalities (from a total of eight) were randomly selected to represent each area due to logistic and cost constraints. The five chosen municipalities are Kuala Lumpur, Petaling Jaya, Klang, Selayang and Kajang which represent urban and suburban settings. Once the municipalities were selected, fixed observation points with high traffic volume were then chosen for each municipality based on traffic count data. Criteria for the observation point include slow moving traffic near to junction, traffic light, roundabout or plaza

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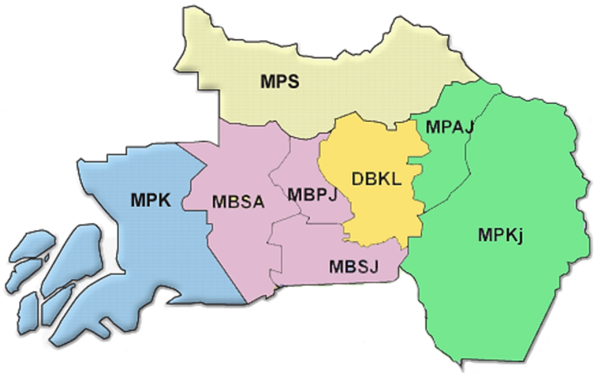
toll which allowed sufficient time for the enumerators to observe the vehicles. In total, there were ten observation points chosen for the data collection with each municipality was represented with two observation points.



Area	Municipality
Federal Territory of Kuala Lumpur	DBKL (*Kuala Lumpur*)
District of Petaling	MBSA (*Shah Alam*) MBPJ (*Petaling Jaya*) MBSJ (*Subang Jaya*)
District of Klang	MPK (*Klang*)
District of Gombak	MPS (*Selayang*)
District of Hulu Langat	MPAJ (*Ampang Jaya*) MPKj (*Kajang*)

Fig. 2: Map of Klang Valley and its corresponding municipalities (excluded Putrajaya and Sepang municipalities which are included in Greater Kuala Lumpur)

Data analysis:

Initial data entry was performed by trained research assistants into a database using Statistical Package for Social Science (SPSS) software version 17.0.0. A list of vehicle registration numbers from the data collection were then submitted to Malaysia Road Transport Department to verify the make, model, variant and year, which were needed to match the vehicles with their corresponding SBR characteristics obtained from survey to vehicle manufacturers. The data entered was properly verified by a researcher to ensure any missing important information was dealt with prior to data analysis. Descriptive and crosstab analyses were carried out for the observation data. Odds Ratio were also performed for comparing seatbelt wearing according to SBR fitment and type of signal. It is to be noted that the effect of gender, time and location of observation area (urban or suburban) on seatbelt wearing was not analyzed in this paper in order to meet the objectives as mentioned earlier.

Results:

In total, 3,000 vehicles that met the criteria were recorded during the roadside observation. Based on the observation, 1,255 (41.8%) of the vehicles observed had been identified and confirmed as having the SBR system fitted (at least on driver side). Fig. 3 shows overall seatbelt wearing rate observed for both driver and front passenger. Driver recorded higher percentage of total seatbelt wearing rate with 85.3% as compared to front passenger with 71.5%.

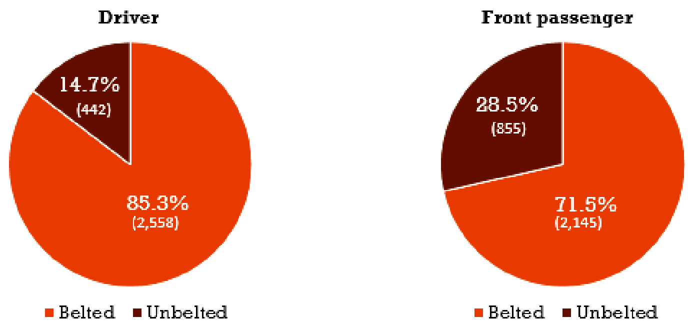


Fig. 3: Seatbelt wearing rate for all observations

In term of SBR fitment, a significant difference in seatbelt wearing rate was found. The total seatbelt wearing rate for driver was 91.2% in passenger vehicles with SBRs, while it was 81.0% in vehicles without, as shown in Table 1. As for front passenger, the total seatbelt wearing rate was found to be 78.3% and 70.0% for in vehicles with SBRs and in vehicles without, respectively. Furthermore from the analysis, drivers in vehicles with SBRs (Odd Ratio: 2.41 [95% CI: 1.91, 3.05]) were two times more likely to wear seatbelt as compared to in vehicles without the reminder system. Whereas the analysis revealed lower Odd Ratio (1.59 [95% CI: 1.23, 1.94]) for front passengers as compared to drivers.

Table 1: Seatbelt wearing by fitment of SBR in vehicles

SBR fitment	Driver (DR)			Front passenger (FP)		
	Belted	*Unbelted*	*Odd Ratio (CI)*	*Belted*	*Unbelted*	*Odd Ratio (CI)*
Yes	1,144 (91.2%)	111 (8.8%)	2.41 (1.91, 3.05)	418 (78.3%)	116 (21.7%)	1.59 (1.23, 1.94)
No	1,414 (81.0%)	331 (19.0%)		1,727 (70.0%)	739 (30.0%)	

Significant difference in seatbelt wearing rate was also found when comparing between different signal types of SBR (Table 2). For both frontal occupants, total seatbelt wearing rate were higher for SBRs with audiovisual signals or also refer to audiovisual SBRs (DR: 97.3%; FP: 91.0%) as compared to SBR with visual-only signal (DR: 84.4%; FP: 69.2%). Moreover, it was found that the drivers and front passengers were six (Odd Ratio: 6.56 [95% CI: 3.91, 11.01]) and four (Odd Ratio: 4.47 [95% CI: 2.59, 7.77]) times, respectively, more likely to wear seatbelt for audiovisual SBRs than visual-only SBRs.

Table 2: Seatbelt wearing by signal type of SBR

SBR signal type	Driver (DR)			Front passenger (FP)		
	Belted	*Unbelted*	*Odd Ratio (CI)*	*Belted*	*Unbelted*	*Odd Ratio (CI)*
Audiovisual	640 (97.3%)	18 (2.7%)	6.56 (3.91, 11.01)	201 (91.0%)	20 (9.0%)	4.47 (2.59, 7.77)
Visual-only	504 (84.4%)	93 (15.6%)		216 (69.2%)	96 (30.8%)	

Discussion:

Seatbelts effectiveness to save lives in road crashes has been proven and comprehensively elaborated countless times in a number of studies, throughout all these years (Derosa and Larsonneur, 1984; Engberg, 1995; Smith-Seemiller *et al*, 1997; NHTSA, 2003). During crash event, seatbelt helps to restrained occupants of vehicles to stay put in the vehicle compartment thus minimizing heavy and harsh movements and consequently reducing risks of unwanted interactions with surrounding objects and structures (ASEAN NCAP, 2012). Similarly, rear seatbelt benefits were also well proven in reducing the risk of fatalities and severe injuries of passengers (Ichikawa *et al*, 2002; Broughton, 2004).

Aligning with the benefits seatbelt provides, seatbelt wearing laws have been introduced in many parts of the world to make compulsory for vehicle occupants to belt up when travelling. In Malaysia specifically, seat belts laws were introduced way back in year 1979 mainly focussed on front passengers. Correspondingly, rear seatbelt law was implemented later in 2009 (Malaysia Road Transport Act 1987). However, despite legislative efforts, seatbelt wearing rates seems stagnated and below the desired targets (Norlen *et al*, 2011).

To complement, if could be stated as such, and as an enhancement to enforcement initiative and low perception of being caught (Norlen *et al*, 2011), it is envisioned that technological initiative may provide the additional cue for occupants to belt up in vehicles. Visual and audiovisual SBR systems have been increasingly common in vehicles and just timely these technology and manufacturers be rewarded for the efforts (ASEAN NCAP, 2012; Euro NCAP, 2011).

In a preliminary work done by Zulhaidi *et al*. (2013) to study the cost-benefit analysis (CBA) of SBR found that this technology could reach benefit to cost ratio of 1.3 in Malaysia’s environment. This prediction was based on Malaysia’s data on production cost and accident information. However, taking into consideration the real-world function of SBR in the safety harness system inside vehicles, this technology is assumed to not influencing damage-only cases in the calculation. Furthermore, since the analysis is rather sensitive towards the value of cost in the calculation, a minimum and maximum cost has also considered and producing a range of result between 1.1 and 1.6 in benefit to cost ratio.

This study was conducted to evaluate the effectiveness of the SBR systems in elevating seatbelt usage among Malaysian passenger vehicle occupants. Findings from the study is aligned with many other studies that have shown occupants are much more likely to wear their belts in cars equipped with SBRs than in those without. It was found that the odds of wearing seatbelt for drivers in vehicles with SBRs were two times more than for those in vehicles without the reminder system. Likewise, front passenger seatbelt compliance also increased with SBR fitment.

SBR systems with visual-only display showed moderately higher seatbelt use rates than the vehicle without SBR (84.4% versus 81.0%) and lower rates than systems with sounds. This is confirmed by other observational studies conducted among Swedish (Krafft *et al*, 2006) and American drivers (Freedman *et al*., 2009). Krafft *et al*. (2006) reported that seatbelt use was 99% in cars with an acoustic signal with increasing volume SBR system, 93% for a “friendly middle” version (a system that uses a visual signal and a less penetrating acoustic signal) and 83% for cars without SBR. Therefore, an increase in seatbelt wearing rate indicates that the levels of the audio and visual reminder signals are of importance.

While the main concern in occupant safety at the usage stage revolves around the attitude to wear seatbelt, issues relating to SBR in particular are worth to stand as a sub-topic in seatbelt studies. First of all, SBR that comes with acoustic signal could be considered as annoying especially the version that produces the not-stop beep sound (or haptic reminder) until belt is buckle up. Therefore, it is also important to gain the prevalence of users' acceptance on the SBR fitment inside Malaysia's cars since this item is made mandatory for car to be eligible for five-star in ASEAN NCAP's Adult Occupant Protection scheme (Zulhaidi *et al*, 2013). Through the pressure via this consumer program, it is expected that OEMs will highly consider SBR as standard fit equipment in their new cars, thus it is worth to explore on the acceptance of the technology among the users.

The roadside observational study has its own limitations. Since the only dependent measure in this study was seatbelt use, the appropriate comparison from the SBR feature study is with the reported likelihood of seatbelt use. Other measures from the SBR feature study, such as annoyance or preference, could not be measured in the observational study. The observational study quantified actual seatbelt use with various SBR types but, as in any such observational study, interpretation is limited by the fact that the SBR system characteristics are confounded with other vehicle attributes.

Furthermore, this study takes no notice on commercial passenger vehicle. As of June 2014, Public Land Transport Commission (SPAD) registered over 75,550 taxis in the Peninsula Malaysia (The Malay Mail Online, 30 April 2014). Thus, it is suggested that further study should be done to analyze seatbelt compliance among taxi occupants since it is one of the major public transport in Malaysian road. As reported in Lie *et al*. (2008), seatbelt wearing among taxi drivers (79%) in Sweden lower than among private vehicles.

Conclusion And Recommendations:

The results strongly indicate that SBR could assist in seatbelt wearing. Based on the study, it was found that seatbelt wearing rates for both front occupants increase in passenger vehicles equipped with SBRs. Audiovisual SBR showed higher increase of seatbelt wearing rate as compared to SBR with visual-only reminder. The study could provide vital information to government to introduce the SBR as compulsory safety item for passenger vehicles, i.e. SBR to be potential policy for passenger vehicles especially in Malaysia. Additionally, the findings have proven to be a solid justification for SBR inclusion into ASEAN NCAP rating scheme. It is suggested in the future for the ASEAN NCAP to enhance its rating scheme by including the SBR as compulsory 5-star pre-requisite for rear passenger seats (second row and beyond) as well as 4-star pre-requisite for front passenger seats. This would certainly encourage car manufacturers to fit the reminders (most preferably audiovisual SBRs) as standard car safety feature.

The results of the case study may vary with other places in Southeast Asia countries since the study was conducted merely in Klang Valley, Malaysia. Similar studies could be carried out in other countries in the region to further strengthen the justification for having the SBR incorporated into the rating scheme. Finally, the views expressed in this paper are those of the authors and do not necessarily represent the views or policy of MIROS, ASEAN NCAP or any other organization.

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