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Identification of Seat Belt Wearing Compliance Associate Factors in Malaysia: Evidence-based Approach

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***Abstract*—**The aim of the study was to identify seat belt wearing factor among road users in Malaysia. Evidence-based approach through in-depth crash investigation was utilised to determine the intended objectives. The objective was scoped into crashes investigated by Malaysian Institute of Road Safety Research (MIROS) involving passenger vehicles within 2007 and 2010. Crash information of a total of 99 crash cases involving 240 vehicles and 864 occupants were obtained during the study period. Statistical test and logistic regression analysis have been performed. Results of the analysis revealed that gender, seat position and age were associated with seat belt wearing compliance in Malaysia. Males are 97.6% more likely to wear seat belt compared to females (95% *CI* 1.317 to 2.964). By seat position, the finding indicates that frontal occupants were 82 times more likely to be wearing seat belt (95% *CI* 30.199 to 225.342) as compared to rear occupants. It is also important to note that the odds of seat belt wearing increased by about 2.64% (95% *CI* 1.0176 to 1.0353) for every one year increase in age. This study is essential in understanding the Malaysian tendency in belting up while being occupied in a vehicle. The factors highlighted in this study should be emphasized in road safety education in order to increase seat belt wearing rate in this country and ultimately in preventing deaths due to road crashes.

***Keywords*—**crash investigation, risk compensation, road safety, seat belt wearing, statistical analysis.

I. Introduction

MALAYSIA can be considered as one of the highly-motorized countries, where more than one million units (1,157,072) of new vehicles were registered in 2010 and the accumulated number of registered vehicles reached over 21 million (21,250,145) by the year 2010 [1]. Therefore, risks on the road become higher as behaviour among the increasing population of road user varies. From the earliest days of motoring up to the present day, risk compensation has been encouraged to transform road user behaviour in response to perceive changes in risks to their safety. One of the risk compensation introduced to road users is seat belt intervention. Around the world millions of motorists are now obliged by law to belt up. Seat belt legislation requires the fitting of seat belts to motor vehicles and/or the wearing of seat belts by motor vehicle occupants. In Malaysia, seat belts have been made compulsory for passenger vehicle in two stages. The first stage was implemented in 1979, making the wearing of seat belts compulsory for the driver and front seat passenger. The second stage was implemented in 2009, which mandated the wearing of rear seat belts. Passenger vehicles registered prior to the 1st January 1995 and those weighing more than 3.5 tons are exempted from this rule. Seatbelts have been shown to be an effective safety device [2] - [5] and its feature has been extensively discussed as an example of a safety measure that yields enormous benefits for minimal cost [6]. However, in a study conducted by a previous researcher [7] focusing in Putrajaya, the administrative centre of the central government of Malaysia, the overall seat belt wearing for drivers, front passengers and rear passengers were low despite legislation for mandatory rear seat belt wearing and advocacy efforts by the government coming into effect six months before the survey. This situation might reflect the reality of seat belt wearing compliance by Malaysian. In order to further evaluate the seat belt wearing compliance among the Malaysian road user, this study was conducted. Utilising evidence-based approach, seat belt wearing compliance data was collected through crash investigation effort. Investigation on road crashes was carried out nationwide for critical crash cases since the establishment of MIROS in 2007. The critical crash is defined as passenger vehicle crashes involving a minimum of three fatalities or commercial vehicle crashes involving a minimum of one fatality. In this study, the passenger vehicle crashes investigated until the year of 2010 that fall within the above mentioned criteria were taken into account. Seat belt wearing compliance among the crash victims were evaluated and the following hypotheses were examined: (a) an increase in number of belted occupant as a function of occupant element i.e. age, gender and seat position; (b) an increase in number of belted occupant as a function of vehicle element i.e. vehicle origin and vehicle manufacturing year; and (c) an increase in number of belted occupant as a function of environment element i.e. road class, vicinity and weather condition.

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II. Methodology

Cross-sectional study was utilised as research method, which involves observation of all individuals in the studied population. This method differs from case-control studies in which it aims to provide data on the entire population under study.Inspection on vehicle and crash scene were mainly performed in a particular crash investigation. During vehicle inspection, physical evidence of seat belt use was accordingly

verified for every person occupied in the collided vehicle. The evidence can be identified based on abrasion marks left on the seat belt D-ring or webbing [8] as depicted in Fig. (1).

Fig. 1 Abrasive marks indicate physical evidence of seat belt wearing during crash

Additional information on the crash event was obtained by crash scene investigation and supported by information reported by the Malaysian Royal Police Department of Traffic Branch along with newspapers. In general, the investigated parameters consist of details on road safety key elements, which are occupant(s), crashed vehicle and the road itself. Statistical test was carried out in terms of chi-square analysis in order to verify the relationship between attributes and seat belt wearing factor by obtaining *p*-value. The *p*-value is the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true. The null hypothesis is rejected when the p-value is less than the significance level α, which is often 0.05 or 0.01 and the result is interpreted to be statistically significant.Logistic regression analysis was then applied to identify factors associated with seatbelt wearing. Relationship between the identified factors and seat belt wearing compliance in Malaysia was determined by means of odds ratio, (*OR*). The *OR* compares the likelihood of an event between two groups, namely X and Y, as defined in (1).

$$OR = \frac{a/b}{c/d} \quad (1)$$

where *a* is the frequency of an event to occur in group X, *b* is the frequency of an event not to occur in group X, *c* is the frequency of an event to occur in group Y and *d* is the frequency of an event not to occur in group Y. An *OR* of 1, greater than one or less than one implies that the event is equally likely in both groups, more likely in the first group (X) or more likely in the second group (Y) respectively. The possible range of *OR* in the studied population was calculated for a 95% confidence interval (*CI*).Furthermore, seat belt wearing index, SB_i was calculated to observe the wearing rate in a group of classification, namely Group A, as in (2).

$$SB_i = \frac{Number\ of\ belted\ occupants\ in\ group\ A}{Total\ of\ Group\ A\ occupants} \times 100 \quad (2)$$

The overall process flow of data collection and analysis conducted in this study was summarised in Fig. 2.

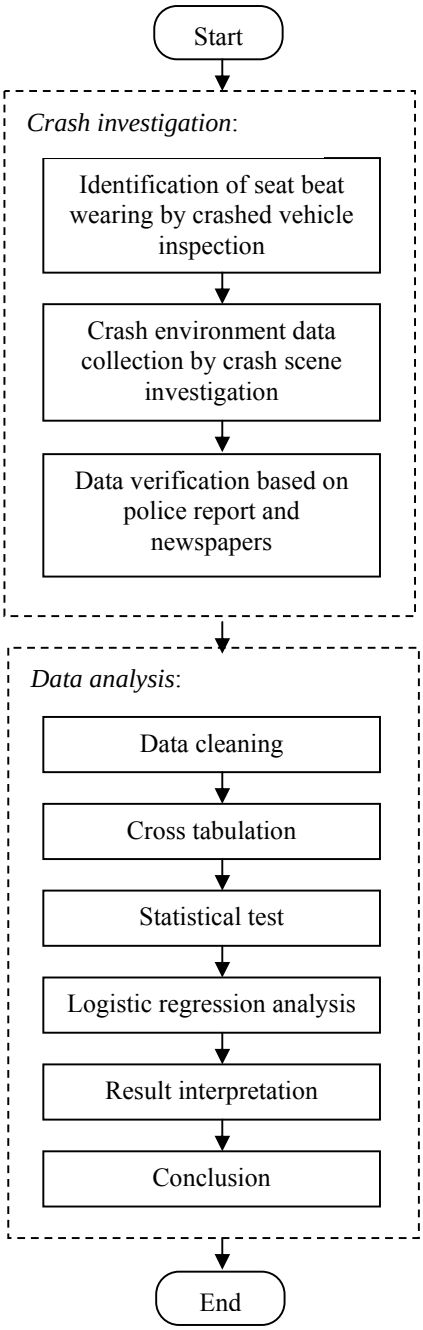

Fig. 2 Process flow of data collection and analysis in this study

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III. Results And Discussions

Data on the entire population under the scope of study was obtained from 99 crash cases involving 240 passenger vehicles and 864 occupants. Seat belt wearing evidence and other information related to those cases including occupant, vehicle and road environment details was accordingly verified.

TABLE I
P-VALUE CALCULATED FOR POSSIBLE FACTORS ASSOCIATED WITH SEAT BELT WEARING COMPLIANCE

Element	Independent variable/Factor	*P*-value	*OR* (95% *CI*)
Occupant	**Gender**: Male Female	0.001	1.9760 (1.317 to 2.964)
	Seat position: Front passenger Rear passenger	0.0001	82.493 (30.199 to 225.342)
	Age For every one year increase	0.0001	1.0264 (1.0176 to 1.0353)
Vehicle	**Origin**: Local Import	0.420	1.128 (0.832-1.528)
	Manufacturing year: After 1995 Before 1995	0.8189	1.0524 (0.6789 to 1.6315)
Road	**Road class**: Non-Expressway (Federal, state, municipal) Expressway	0.2427	1.3023 (0.8295 to 2.0444)
	Vicinity: Community area Others (construction, bridge, agriculture, wood area)	0.2398	1.2601 (0.8533 to 1.8607)
	Weather: Clear day Non-clear day (rain, overcast, fog)	0.595	0.9078 (0.6355 to 1.2967)

Unidentified data on certain variable was treated as missing. Chi-square analysis has been performed to evaluate the significance of crash variables on seat belt wearing compliance. *P*-value of each variable was calculated and the result was presented in Table I.

It can be observed that the *p*-value obtained for each variable varies. Based on the *p*-value, the existence of any significant factor of seat belt wearing was identified. As result, three variables, both categorised in occupant element were statistically proven as significant (*p*-value less than 0.05).Significance in this hypothesis test means that interpretation of the cell in the contingency table is warranted, where effect of the seat belt wearing compliance (dependent variable) on the independent variable is present. The *OR* figures in the Table I will be referred in the following discussions, which consists of the three associated factors (gender, seat position and age) of seat belt wearing compliance in Malaysia.

A. Factor of Gender

Cross tabulation between the gender and seat belt wearing variable is presented in the contingency Table II. Males are 28.4% more frequent involved in critical passenger vehicle crashes as compared to females. In spite of high in frequency, males account 75.7% of the total belted occupants and statistically, they were 97.6% more likely to wear seat belt compared to females (refer to the occupant element in the Table I). This result demonstrates that the road safety education on the importance of seat belt wearing in preventing death should be emphasized among female occupants.

The finding is consistence with finding reported by the previous researcher [6], which claims that gender was a significant factor for seatbelt wearing. However, the trend of finding is contradicted, in which the front female occupants were reported more likely to belt up. The reason could be the difference between this study and the previous approach of study, which differ in terms of the target population.

TABLE II
CROSS TABULATION OF SEAT BELT WEARING BY GENDER

Gender	Seat belt wearing: Belted	Seat belt wearing: Unbelted	Total
Male	117	321	438
% within row	26.7	73.3	100.0
% within column	75.5	60.9	64.2
Female	38	206	244
% within row	15.6	84.4	100.0
% within column	24.5	39.1	35.8
Total	155	527	682
% within row	22.7	77.3	100.0
% within column	100.0	100.0	100.0

**The number of missing data: Gender = 123, seat belt wearing = 68.*

B. Factor of Seat Position

The number of front and rear occupant involved in the investigated crash cases is much equal, 49.6% and 50.4% respectively with only 0.8% difference. Based on Table III, the rate of seatbelt wearing was relatively low for rear passengers, where only 1% of the total number of rear occupant was belted. Unlike the rear, the frontal occupant is better in terms of seat belt wearing compliance, in which the frontal occupants have an odds of belted about 82.5 times greater than the rear.Since the presence of any changes requires some grease period of transition, the rear seat belt compliance could be associated to the later implementation of compulsory rear seat belt wearing as compared to the frontal,

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which is in 1979 for frontal occupant and 2009 for the rear. Even though rear seat belt installation has become mandatory for passenger vehicles manufactured after 1995, the seat belt wearing compliance for vehicles manufactured after the mandated law has taken place is not statistically significant, which it yields a *p*-value of 0.8189 (refer to the vehicle element in the Table I).

TABLE III
CROSS TABULATION OF SEAT BELT WEARING BY SEAT POSITION

Seat Position	Seat belt wearing		Total
	Belted	Unbelted	
Front	178	212	390
% within row	45.6	54.4	100.0
% within column	97.8	35.0	49.6
Rear	4	393	397
% within row	1.0	99.0	100.0
% within column	2.2	65.0	50.4
Total	182	605	787
% within row	23.1	76.9	100.0
% within column	100.0	100.0	100.0

**The number of missing data: Position = 9, seat belt wearing = 68.*

C. Factor of Age

For the purposes of analysis, the subjects were grouped according to age, 1 to 6 i.e. infant, children, youth, early adult, adult and elderly respectively. The cross tabulation of seat belt wearing by age classification was depicted in Table IV.

No belted infant was found among the studied population and it is important to note that the seat belt wearing index for the non-adult age was less than 10%. Even the early adult age accounts the highest frequency of the critical crashes victims (44.5%), the seat belt wearing rate was 13.6% lower than the adult group. Based on the logistic regression analysis, the interpretation would be that for every one year increase in age, the odds of seat belt wearing increased by a factor of 1.0264 (or by about 2.64%), by assuming that the relationship between age and seat belt wearing is linear on a logit scale.

TABLE IV
CROSS TABULATION OF SEAT BELT WEARING BY AGE

Age classification	Seat belt wearing		Total
	Belted	Unbelted	
Infant	0	10	10
% within row	0.0	100.0	100.0
% within column	0.0	2.1	15.8
Children	3	99	102
% within row	2.9	97.1	100.0
% within column	2.0	20.6	16.1
Youth	5	60	65
% within row	7.7	92.3	100.0
% within column	3.3	12.5	10.3
Early adult	77	204	281
% within row	27.4	75.6	100.0
% within column	51.0	42.4	44.5
Adult	59	85	144
% within row	41.0	59.0	100.0
% within column	39.1	17.7	22.8
Elderly	7	23	30
% within row	23.3	76.7	100.0
% within column	4.6	47.8	4.7
Total	151	481	632
% within row	23.9	76.1	100.0
% within column	100.0	100.0	100.0

. **The number of missing data: Age =164, seat belt wearing = 68.*

Utilising (2), seat belt wearing index for every age class was calculated and the pattern of seat belt wearing by means of seat belt wearing index can be observed as illustrated in Fig. 3.

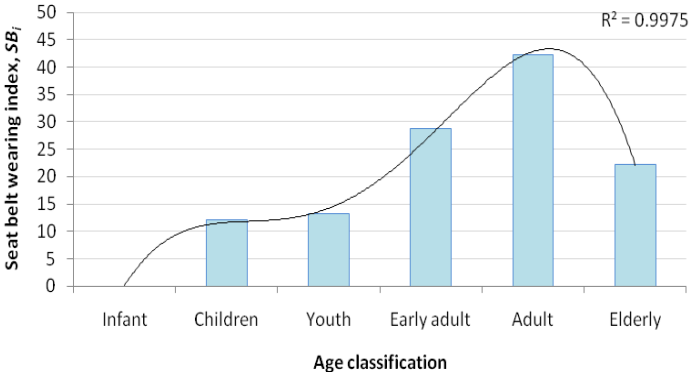

Fig. 3 Seat belt wearing index by age classification

By observing the trend of seat belt wearing index by age, it can be seen a gradual increment in the seat belt wearing index from the children to the youth class of age. The behaviour of children which normally driven by curiosity and a need for excitement, yet curbed by their sense of danger [5] could be the reason. The action of belting up while being occupied should be concerned by the older individuals as most decisions about risks involving infants and young children are taken by adults [5]. However, an incline in the seat belt wearing compliance is remarkable from the youth until the adult class of age. This is because there is a progressive handing over of responsibility between infancy and adulthood as adults are considered responsible for their actions [5].Moreover, there is a reflection point of frequency trend as the class of age exceeds the elderly group. The reason could be that with normal aging, there was a significant decrease in communication efficiency without significant changes in the quantity of content conveyed as indicated by previous studies [9] – [10]. However, the factor of medication, education, and health status could affect the communication effectiveness among these older individuals as well. Regression analysis has been performed in order to observe the pattern of data distribution. Possible type of functions such as polynomial, exponential, power and Fourier have been tested to fit the

distribution. As result, the highest correlation coefficient was obtained by cubic polynomial function curve fitting as presented in Fig. 4. By differentiating the function, the age reflection point of seat belt wearing was obtained at 51. Therefore, the minimum of this age should be focused in seat belt wearing education for the elderly target group.

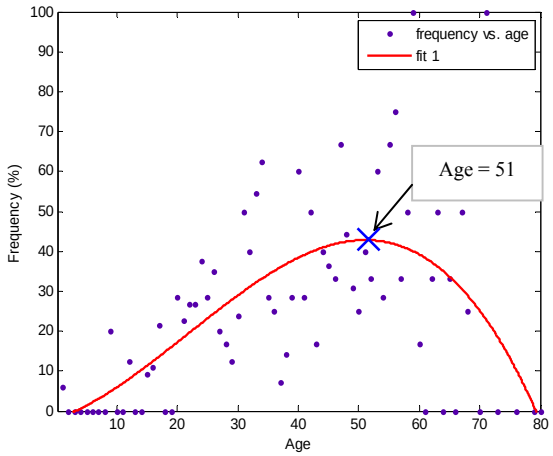

Fig. 4 Frequency distribution of seat belt wearing by age

IV. Conclusion

This paper discussed on the factors associated with seat belt wearing among the passenger vehicle fatal crashes occupants. It could indirectly reflect the seat belt wearing compliance in Malaysia through crash investigation, an evidence-based approach. The factor of gender, seat position and age were proven as statistically significant. Identification of these key factors enables road safety officer to carry out road safety education more efficient. Therefore, advocacy information can be disseminated in an appropriate and focused target group. Hence, the effort of risk compensation can be performed comprehensively in order to improve the Malaysian fatality statistic and ultimately prevent casualties due to road crashes.

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