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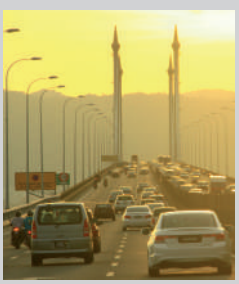
Research Report

Proper Installation and Optimal Usage of Child Restraint System (CRS)



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Abstract

Children are much more likely than adults to get serious injuries in car crashes. Child Restraint System (CRS) has been proven could reduce injury and prevents fatality in the event of a crash. Inappropriate usage of CRS may increase the risk of fatality. This research is aimed to determine the prevalence of CRS improper usage behaviour among CRS users. Driver travelling with children age 11 years old and below were interviewed, and those who restrained their children in CRS were further observed in CRS installation and usage practice. 178 parents were interviewed and 267 children were observed. Overall, out of 267 children, only 12.7% were restrained properly in an appropriate CRS for their sizes, with the correct CRS installation and appropriate seating location in the observed passenger car. Many initiatives could be introduced before the implementation of the CRS law in Malaysia such as awareness, community-based programs and CRS clinics that aim to guide parents on the correct and effective way of installing the CRS device in their car.

1. Introduction

Child Restraint System (CRS) prove the effectiveness on protecting the child while accident (Zaza, 2001). CRS, also known as child safety seats are the most effective way to protect young children involved in Motor Vehicle Accidents (MVA) from serious injury as well as reduce the risk of death. It was estimated that proper usage of CRS may reduce the chance of death in an MVA by 71 percent (Starnes & Eigen, 2002). On the other hand, unrestrained 0-3 years old children have a 1.6 to 5.4 times greater risk of fatal injury than those restrained in a CRS (Starnes, 2005). Moreover, children 2 to 5 years old who is restraint in the adult seat belt are three and half times more likely to suffer a serious injury and more than four times more likely to suffer a serious head injury, than children on the same ages who use CRS (Winston, 2000).

CRS vary according to the size of the child they are designed to restrain, the direction the child should face, the type of internal restraining system, and the method of installation. CRSs are designed to provide two links between the vehicle and the child. The CRS is securely attached to the vehicle seat using the vehicle seat belt or the lower attachments, at the same time that the child is properly secured in the CRS with a separate harness and/or other restraining surface. These two links between the vehicle and the child are critical in reducing injuries or death in the event of a vehicle crash (Weber, 2000).

In day to day situations, utilisation of the CRS may be jeopardised by misuse or inappropriate usage. Misuse of CRS can be attributed to user error or a mismatch between the child restraint and the vehicle. Inappropriate use of CRS can lead to serious injury to the child in the event of a crash. Installation errors may significantly reduce the efficiency of CRS. Since 1999, NHTSA has recognised the difficulties having by parents and caregiver in properly secure a CRS to a vehicle. Since then, NHTSA has establishing a uniform child restraint attachment system known as LATCH, or in Malaysia and outside US and Canada, it's called ISOFIX (Code of Federal Regulations, 2005).

In MIROS previous study, there were up to 42% of 500 parents and caregivers confessed that they usually use child restraint for their children while driving (Noor Faradila et al., 2016). Malaysia is yet to make mandatory the CRS usage in the year 2019. Thus, it is recommended to study the readiness of parents in accepting the new regulation. The current study is designed to ensure and evaluate parents' current practice on:

- Securing the child safely in the seat
- Proper use and installation of the child restraint in the vehicle
- Proper use and installation of booster seats
- Proper use of seat belts
- Proper use of ISOFIX or anchorage
- Appropriate positioning of occupants in vehicles with airbags

This study focused on forms of misuse that could reasonably be expected to raise the risk of injury to a child. These "critical misuses" were identified and listed by NHTSA, in a workshop attended by child passenger safety experts in fields of biomechanics, injury prevention, public health, Child Restraint System (CRS) manufacturing, and program implementation. The critical misuses were:

- age and weight appropriateness of CRS;
- the direction of CRS;
- placement of CRS in relation to airbags;
- installation and secureness of CRS to the vehicle seat (tight safety belt);
- secureness/tightness of harness straps and crotch strap of the CRS;
- use of locking clip for certain vehicle safety belts;
- the fit of vehicle safety belts across a child in a belt-positioning booster seat;
- defective or broken CRS elements.

1.1 Aims and Objectives of the Study

Recently, there is much news reported of an infant, children being thrown out of the vehicle during a traffic accident. By understanding public readiness towards CRS usage,

would influence effective countermeasures and new interventions before implementing new regulation. Thus the aims of this study are:

i. To determine the proper usage of CRS according to children sizes;
ii. To determine the proper installation of CRS in a passenger vehicle;
iii. To identify the use and improper usage of the ISOFIX system.

1.2 Scope and Limitation of the Study

The scope of this study is focusing on licence drivers were licenced drivers travelling with children below 11 years old in Hulu Langat district. The study limitation is it was a regional based data collection which only cater for Hulu Langat province.

2. Literature Review

Child Restraint Systems (CRS) are greatly reducing the risk of a child being injured or killed in a car accident. The seats, suitable for children usually up to 10 years of age, are fitted in the car and used with existing adult seat belts or ISOFIX system. When children are not properly restrained, they are more likely to suffer serious injuries and may increase the risk of fatality in car accidents. Prior to study on the correct usage of CRS, this section will explain further on the importance of CRS, characteristics of CRS and explanation on CRS misuse.

2.1 Prevalence of CRS Usage in Malaysia and ASEAN Region

CRS reduce the risk of injury and death in a car accident by preventing contact between the child and the car's interior, protecting the child from impact and spreading any impact force onto stronger parts of the body. Child restraint system could lower the risk of death to infants (aged <1 year) by 71%; and to toddlers (aged 1‑4 years) by 54% in a car accident (Durbin, 2011; Hertz, 1996).

In the ASEAN region, only three countries have specific laws requiring the use of CRS, namely Brunei, Cambodia and Singapore. However, there is limited information on the rate of CRS usage in these countries. Only Brunei has some insight on the CRS usage in their country. In 2013, The Brunei Times reported that CRS is still uncommon in Brunei despite having the mandatory CRS law in place (The Brunei Times, 2013). The reason for low usage of CRS in Brunei was reported due to low traffic enforcement activity and low availability of CRS in the market.

Malaysia has yet to implement the CRS law in 2019. According to Muammar et al. (2014) observation study conducted in 2012 recorded a very low rate of CRS usage in Kajang district of Malaysia. Out of the 537 children observed, only 9.5% were using CRS. 13% of

children seated in front passenger seats were restrained, compared to only 5% for those seated at the rear. As compared to developed countries, the prevalence of CRS usage in Malaysia could be categorised as very low.

2.2 Characteristics of Child Restraint System

Child restraint system designs vary according to the size of the child they are designed to restrain, the direction the child should face the type of internal restraining system, and the method of installation. CRS is designed for coupling the CRS securely to the vehicle seat using the vehicle safety belt (SB) or ISOFIX system if available, and properly securing the child in the CRS with an attached harness. Securing these two (2) links between the vehicle and the child is critical in reducing injuries or death to a child in the event of a vehicle crash (Weber, 2000). There are four (4) basic types of CRS in current use; infant seats, forward-facing only seats, booster seats, and integrated (built-in) seats. Characteristics of these CRS are described in Table 1. CRS are divided into categories according to the weight of the children for whom there are suitable. These correspond broadly to different age group, but it is the weight of the children that are most important when deciding what type of CRS to use.

Table 1 Characteristics of CRS

Type of CRS & Age/Weight	Characteristics
Infant safety seat **Age:** Birth - up to 1-year-old **Weight:** Up to 9 kg 	• A rear-facing installation seat. • The child is secured in the CRS with a harness. • The top of the child's head should be well contained within the seat's shell. • Harness slots should be at or below shoulder level. • The angle of these seats should never be more than 45 degrees from the vertical position. • Must be installed in the back seat with a seat belt or an ISOFIX.

Forward-facing safety seat **Age:** 9 months–4 years old **Weight:** 9–18 kg 	• A forward-facing seat. • The harness systems are either five-point harnesses or overhead shield restraints. • The height of the shoulder strap is usually above the child's shoulders to effectively limit head excursion. • The height of the seat back should be above the child's ears to protect against rearward bending. • Must be installed in the back seat with a seat belt or an ISOFIX.
Booster seat **Age:** 4–11 years old **Weight:** 15–36 kg 	• Booster seats provide the transition from child seats with an internal harness to vehicle lap/shoulder belts. • These seats are anchored in place with a vehicle's safety belt system. • The booster seat is specially designed as a positioning device for children so that the adult seat belt can fit across their chest and hips safely. • There are three types of booster seats: belt-positioning; high-back belt-positioning; and shield booster.
Adult seat belt **Age:** 8 years–Adult **Weight:** 36 kg+ or at least 145 cm tall	• The seat belt must fit across their chest and hips safely. • Children should sit in the back seat until age 12.

Figure 1 shows the important components of CRS. The user has to understand all these components, especially the routing of the harness to ensure perfect fitment on the child body. It is also crucial to understand on the type of CRS attachment to the vehicle seat, either by seat belt only, by ISOFIX base or ISOFIX without a base, or by the top tether as shown in Figure 2.

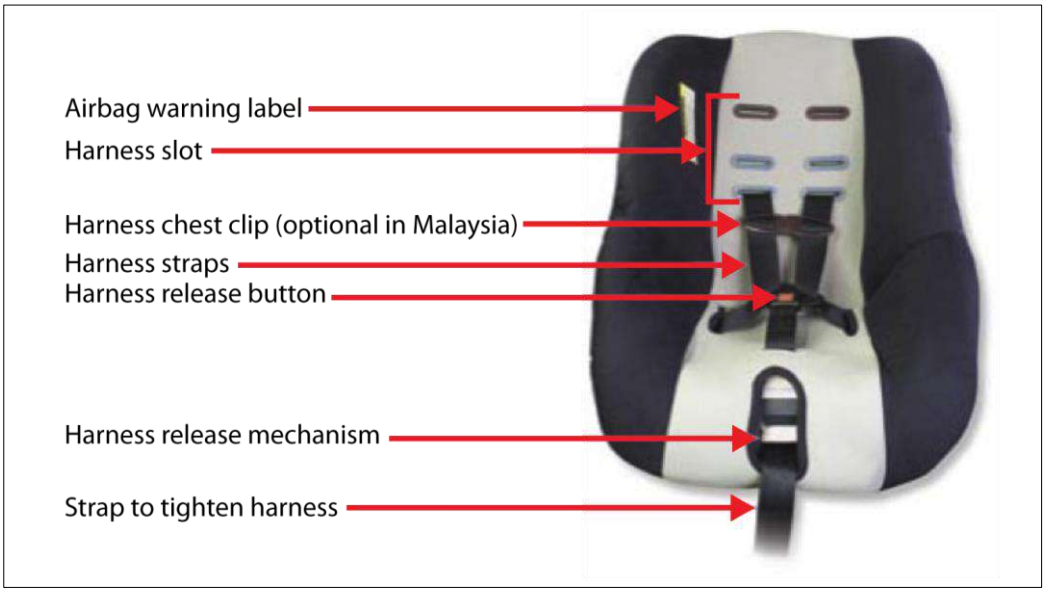

Figure 1 CRS components

Figure 2 Type of CRS installation

2.3 Sub-Optimal Child Restraint System

Age and size-appropriate restraints and rear seating reduce injury in crashes (Arbogast et al., 2009; NHTSA, 2016; Rice & Anderson, 2009). Sub-optimal restraint, including

misuse of the restraint (for instance, harness too loose) or use of the wrong size (inappropriate) restraint, particularly adult seat belts for smaller children, results in significantly higher risk of serious injury to these children (Lennon & Alexia, 2006).

Brown and Bilston (2007) had defined the CRS usage quality as shown in Table 2. There are five (5) categories for quality of use which differentiate CRS sizing suitability, installation and fitment.

Table 2 Quality of use definitions (Brown & Bilston, 2007)

Quality of use	Definition
Appropriate & correct (Optimal)	Using most suitable restraint for size and using restraint correctly
Appropriate & incorrect	Using most suitable restraint for size but using restraint incorrectly
Inappropriate & correct	Not using most suitable restraint for size and using restraint correctly
Inappropriate & incorrect	Not using most suitable restraint for size but using restraint incorrectly
Suboptimal	Inappropriate and/or incorrect use

2.3.1 Incorrect Installation

Misuse of child restraint safety may cause various mistakes made by guardians. It may be the case that the car seat did not match with the children sizes, was not installed tightly enough and cause a movement more than an inch when being wiggled or the chest clips on an infant-safety seat or convertible seat is positioned higher or lower than the correct spot, armpit level. Parents are struggling to comply with child passenger safety recommendations (Decina & Lococo, 2007; Greenwell, 2015; NHTSA, 2015). In a survey, 96% of parents show high confidence levels in installing their child seat correctly despite made unintentional potentially hazardous installation mistakes (NHTSA, 2009). Lennon and Alexia (2006) reported Australian studies to show high rates of misuse. On the car park survey in 1998, 39 % of the cases found that CRS installation to be incorrect with lack of top tethers forming one-third of the faults in capsule installations and

incorrect adult belt-threading a similar proportion in forward-facing CRS installations. Other state-based studies have found fitting errors in 21% to 73% of restraints for children up to age four (4) years.

In addition, there was very high CRS misuse overall which is 80% resulted on NHTSA's most comprehensive CRS misuse observation effort in the mid-1990s and certain types of misuse errors such as locking clips, harness retainer clip, harness strap that were more common than others (NHTSA, 2015). Past experience from field studies and accident investigations show that a majority of children are not correctly restrained when travelling in cars (Müller et al., 2012). A common error is restraint misuse that related to the fitting of the restraint to the vehicle and of the child. Its include harnesses that are incorrectly positioned, twisted or too loose, misuse of vehicle head restraints, incorrect use of seat belts, and children being too big or small for the restraint used. A person shouldn't be able to fit more than two (2) fingers between the straps and the child's chest. The straps should fit snug on the child's shoulders, not hang off the top of their arms. All parts of the harness straps should lie flat on the child's body. If the straps are twisted, they can't distribute the crash forces evenly. As stated by Lennon and Alexia (2006) earlier, misuse is the most serious form of sub-optimal restraint apart from being unrestrained and has been associated with greater risk of injury or death, particularly in more severe crashes.

2.3.2 Inappropriate Restraint Use

Children height and weight must be appropriate in accordance with the CRS used. CRS are classified based on children weight to cope and adapt with various phases of infants' and children's body development (Mora & Rive, 2012). An appropriately sized child restraint controls a child's movement away from the vehicle interior and distributes the forces of a crash over the strongest parts of the body, minimising harm to soft tissues. Parents are recommended to keep their children in each class of dedicated child restraint until the child outgrows it since they offer high protection when used properly (Lennon & Alexia, 2006). The premature graduation of CRS may increase injury risk to children involved in crashes than those who are appropriately restrained. Premature graduation includes children moved to booster seats or adult seat belts before the

weight or height limits for forward-facing CRS are reached and while they are still able to use booster seats.

Belt-positioning booster seats are highly recommended for children aged 4–7 years; provide around 50% greater protection to the children wearing them than do adult seat belts (Lennon et al., 2008). Booster seats are a transition CRS from child seats with an internal harness to adult seat belts. These seats are anchored in place with the vehicle seat belt system. They are not restraint systems by themselves, but rather positioning devices that depend entirely on the vehicle safety belts to hold the child and booster seat in place. On the other hand, a three-point seat belt designed for adults is inappropriate for children because of a child's ribs are more fragile than an adult's, whose are more likely to break (Winston, 2000). Therefore, abdominal injuries among children increase and are not optimally effective at preventing ejection. However, it is still better than children travelling unrestrained.

Prolong usage of CRS according to the child sizes and weight could be decreased the rate of children who sustained deadly or debilitating injuries by 17% (Eichelberger et al., 2012). Increase the age of CRS usage by law has been proven could increase by almost three times the rate of children using car seats and booster seats (Eichelberger et al., 2012).

2.3.3 Seating Position

Babies and infants need to be carried in rearward-facing baby seats since it can reduce the risk of death or injury in a crash compared with being unrestrained. It is similar to the study described by Lennon and Alexia (2006) that passengers in the rear seat are significantly minimised the levels of risk for injury or death than those who sit in the front seats of vehicles. Rearward-facing seats afford greater protection for the baby's head, neck and spine than forward-facing seats. Lennon and Alexia also stated that the analyses of large USA crash databases such as FARS, National Automotive Sampling System and the General Estimates System provide further evidence for the associated dangers of front seating. Analyses of these databases for 1998–2002 revealed that a much higher percentage of restrained children seated in the front seat was fatally

injured when compared to children seated in the rear seat. When children were unrestrained, while the relative protection from sitting in the rear is reduced, children were still at reduced risk of fatality when sitting there rather than the front seat.

Similarly, using FARS data for 1988–1995, in vehicles without a front passenger airbag, restrained rear-seated child passengers were found to be about 35% less likely to be killed than front seated children. Other analyses have demonstrated increased protection for rear seated children regardless of whether they were restrained, though the addition of a restraint enhanced the protection.

A study by Lennon et al. (2008) found children below four (4) years old who are travelling in the front seat are exposed to the risk of death twice as great as when travelling in the rear and associated with a 60% higher risk of serious injury. The relative risk of death while travelling in the front seat was almost four (4) times greater for children aged below one (1) year. Furthermore, Durbin (2005) also reported children riding in the front seat are 40 to 70% more likely to be injured than children riding in the rear. Figure 3 shows the risk of injury by type of restraint and seating location. Children younger than 13 are at greater risk of injury in front seats than in rear seats.

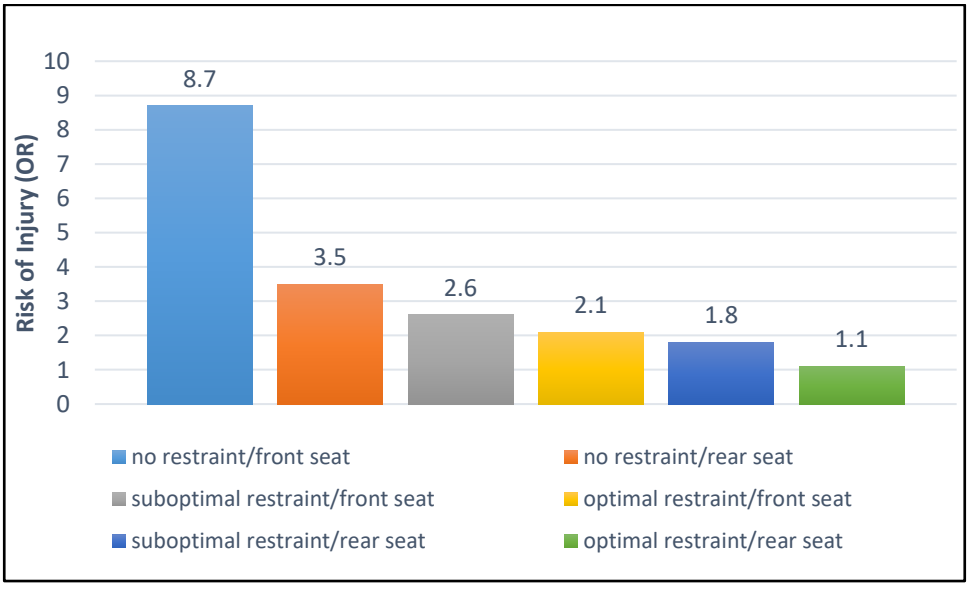

Figure 3 Risk of injury by type of restraint and seating location (Durbin, 2005)

3. Methodology

This study combined both questionnaire interview and visual inspection of CRS use. Questionnaire pen and paper survey method consist of demographic, restraint usage (seatbelt) and experience of using CRS. Meanwhile, the intrusive visual inspection method is conducted to look closely on the practice of using CRS.

3.1 Participants

Study participants were licenced drivers travelling with children below 11 years old (Lawrence et al., 2006). Participants were recruited using stratified random sampling through seven (7) kindergartens, three (3) government offices and four (4) shopping mall located in Hulu Langat district. The sample size was calculated using Krejcie and Morgan (1970) formula.

3.2 Procedures

This study combined both face-to-face driver interview and visual inspection of CRS use. Consent was asked from the eligible participants during drop off or to pick up children for kindergartens sample, during arrival and leaving the shopping mall and after office hour for government offices. Participants who are willing to participate in the study were asked to complete a consent form before being interviewed.

In the first part of the study, the interview recorded the driver age, gender, education level, household income status and seat belt usage. In addition, CRS use for all children under 11 years old, who travelled together were also documented, including children's age, gender, estimated weight and the most frequent seating location in the car. Response options allowed collection of this data for up to four (4) children per driver (starting with the youngest). Availability of a front passenger airbag of each vehicle was

also noted. An additional question was asked in cases when child passengers were unrestrained.

The second part of the study applied intrusive visual inspection techniques for a closer look at child occupants in vehicles where trained staff performed a quick assessment of CRS installation and drivers' restrained practice, based on a standardised checklist. This technique allowed the team to identify CRS characteristics such as type/model, looseness of harness and vehicle safety belt systems, and other types of CRS misuse which were hard to detect from outside the vehicle. This study also provided opportunities to collect in-depth data on the types of misuse for various types of CRS. Among them were rear-facing CRS, front-facing CRS, booster seat, vehicle seat belt (either lap and shoulder belt, lap belt only, or shoulder belt only), or unrestrained. Upon completion of the interview and CRS inspection, the drivers were provided with a brochure entitled Child Safety Seat Installation and Guidelines, for their references.

3.3 Materials

Prior to the data collection and field observation activity, the team was trained on the type of CRS, CRS selection, CRS installation, type of CRS improper usage. CRS standard usage checklist was adopted from the NHTSA critical misuses lists and was integrated with Muammar (2014) study. The list consists of:

- age and weight appropriateness of CRS;
- direction of CRS;
- placement of CRS in relation to airbags;
- installation and secureness of CRS to the vehicle seat (tight safety belt/ISOFIX);
- secureness/tightness of harness straps and crotch strap of the CRS;
- defective or broken CRS elements.

4. Result

4.1 Demographic

A total of 178 parents and guardians who have children age 11 years old and below had contributed to the survey. Mean age of the respondents was 33.7, with the youngest was 20 years old and the oldest was 63 years old (mode = 34 YO, median = 33 YO, S.D. = 6.125). As shown in Table 1, more than half of the respondents were female (69.1%) and a mother to the children (61.2%). The majority of the respondents reported household incomes in the lower middle-income category. Lastly, researchers also collected information on front passenger airbag availability. Among 178 observed vehicles, 74.2% were equipped with a frontal passenger airbag.

Table 3 Demographic data of respondents

Variables	Frequency	Percentage, %
Parents/Guardians age		
<=25	8	4.5
26-35	120	67.4
36-45	43	24.2
>45	7	3.9
Parents/Guardians gender		
Male	55	30.9
Female	123	69.1
Relationship with the children		
Mother	109	61.2
Father	48	27.0
Guardian	21	11.8
Education level		
Illiterate	1	0.6

Primary school	-	-
Secondary school	31	17.4
Tertiary school	69	38.8
Degree holder	77	43.3
Household income		
<RM3,000	37	20.8
RM3,001-RM5,000	60	33.7
RM5,001-RM10,000	50	28.1
>RM10,000	31	17.4
Seat belt wearing		
Rarely and never	7	3.9
Some of the time	12	6.7
Most of the time	17	9.6
All of the time	142	79.8
Passenger airbag availability		
Yes	132	74.2
No	46	25.8

Table 3 shows the demographic data of 267 children aged below 11 years old, which inclusive of 56.2% boys and 43.8% girls. Half of them (50.9%) were in the group of 1-3 years old with the mean age was 3.3 years old (S.D: 2.27). Child weight average of 13.4 kg (min 5 kg, max 40 kg, median 12 kg, S.D 5.26). 115 (43.1%) were involved in the CRS observation as they were restrained with either CRS or seat belt. In the CRS observation, 11.6% were restrained by rear-facing CRS, 19.1% used front facing CRS, 4.5% booster seat, 7.9% use an adult seat belt and more than half (56.9%) were travelling unrestrained. By seating location and regardless of CRS, one-third of children (34.8%) were seated in the front passenger seat and the balance was in second-row seats (mostly behind the front passenger seat, possibly for easy driver checking).

Respondents who did not restrain their children were asked on the reasons for their action. The main reason given out by respondents was children have grown up and did not require CRS (23.2%) and was seconded by the refusal of children to be restrained (13.9%). Grown-up was in many cases defined as the children were perceived to no longer require CRS when travelling (though in fact they still require restraint, at least in

this study) and was similar to findings in the previous study (Noor Faradila et al., 2016). It also points to lack of information and knowledge on CRS utilisation and possibly to a shortage of CRS awareness. Other explanations such as a place on passenger lap (4.9%) and short travel (5.2%) further specify the prevalence of take-it-for-granted attitude on safety matter, as the case was with children without a helmet on a motorcycle (Noor Faradila et al., 2014). Next, excuses such as no CRS (6%) and CRS in other cars (4.1%) and space constraints (1.5%) implies the cost of owning CRS may be a burden to certain income groups.

Table 4 Demographic data of observed children involved in the study

Variables	Frequency	Percentage, %
Child age		
<1	26	9.7
1-3	136	50.9
4-7	92	34.5
8-11	13	4.9
Child gender		
Boy	150	56.2
Girl	117	43.8
Child weight (kg)		
0-9.0	58	21.7
9.1-18.0	159	59.6
18.1-36.0	48	18
>36.0	2	0.7
Restraint type		
Rear facing	31	11.6
Front facing	51	19.1
Booster seat	12	4.5
Seat belt only	21	7.9
Unrestrained	152	56.9
Seating location		
Front passenger seat	87	32.6
Behind driver	47	17.6
Middle	40	15.0
Behind front passenger	93	34.8
Reason unrestraint		
Do not own a CRS	16	6.0

Put on passenger lap	13	4.9
Child has grown up	62	23.2
Child refuses to be restraint	37	13.9
Short distance	14	5.2
CRS in the other car	11	4.1
Others	9	3.4

Table 4 depicts the CRS use details by weight and seating locations. By weight, almost all children observed in the study would require CRS to travel in vehicles. However, a big proportion (56.9%) were unrestrained therefore were exposed to unnecessary risks of injuries if a crash were to occur. Correspondingly, the figure indicates the common practice of the respondents, if not the public, of not ensuring safe travel for children. Next, 115 of 267 children (43.1%) were restrained with either CRS or seat belt. By CRS type, 11.6% was restrained by rear-facing CRS, 19.1% used front facing CRS, 4.5% use d booster seats and 7.9% used adult seat belts (based on age and weight, possibly they are not ready to use seat belts).

Table 5 CRS use among children (N=267)

Child weight (kg)	CRS type				
	Rear facing	Front facing	Booster	SB	Unrestraint
0-9.0	24 (41.4)	8 (13.8)	1 (1.7)	1 (1.7)	24 (41.4)
9.1-18.0	7 (4.4)	39 (24.5)	10 (6.3)	10 (6.3)	93 (58.5)
18.1-36.0	-	4 (8.3)	1 (2.1)	10 20.8)	33 (68.8)
>36.0	-	-	-	-	2 (100)
Total	31 (11.6)	51 (19.1)	12 (4.5)	21 (7.9)	152 (56.9)

4.2 Optimal CRS Usage

4.2.1 Appropriate CRS Usage

The focus for the CRS intrusive observation and inspection is to identify the appropriateness and correctness of CRS use among the drivers who are restrained the children while travelling. The result on CRS usage appropriateness is illustrated in Figure

3. From the observation, 91.5% (86) of the CRS used complied with UNECE Regulation No.44 (UN R44). It reflected that parents who use CRS to secure their children are willing to invest in CRS that is certified as compliance with UN R44. Most of the rear facing (77.4%) and front facing (84.3%) CRS were appropriately used, which the weight of child is suitable with the type of CRS. Nonetheless, in the bigger picture, 41.7% of the restrained children, drivers failed to choose appropriate CRS for them. None of the drivers uses a booster seat that is appropriate for their children. The booster seat is only recommended for children with the weight in between 18-36 kg. 18% of the children were fitted with an adult seat belt but none of the children has reached the required weight to use the seat belt.

These findings indicated that drivers failed to understand the appropriate way of using a booster seat and adult seat belt on their children. It could be said that older children are prematurely graduated from the front facing into booster seats and from booster seats into the adult seat belt. Older children, who are not appropriately restrained, according to their age and weight are reported over-represented in serious casualty and fatality in MVA (Koppel et al., 2008; Vesentini & Willems, 2007).

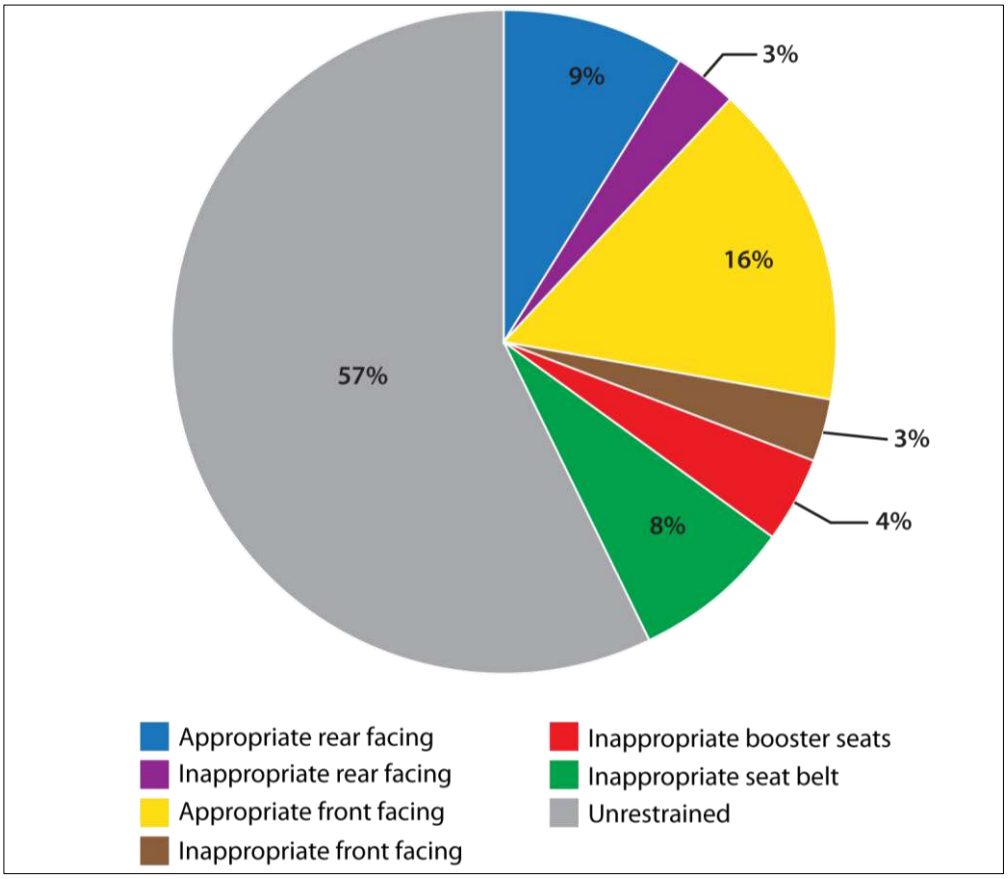

Figure 4 Proportion of children restrained in the inappropriate CRS

4.2.2 Correct CRS Usage

Among the children who were restrained in a CRS, 94 children were further observed to determine the misuse of CRS. Five items related to misuse of CRS were examined which are as shown in Table 6. Most of the drivers (66.0%) allow infant less than two (2) years old facing to the front of the vehicle, which could pose additional risk to the child to injury in case of the occurrence of MVA. One-third of the children were allowed to ride in the front seat, which was installed with the airbag. Nonetheless, only 3.2% of the

children used CRS with damage sign. Almost 80% of the drivers properly installed the CRS in the vehicle, which means the CRS is fitted securely with the vehicle seat.

Table 6 Proportion of children restrained in the incorrectly used CRS

Type of misuse	Yes	No
Child riding in the front seat with airbag	29 (30.9)	65 (69.1)
Infant <2YO facing the front of the car	62 (66.0)	32 (34.0)
CRS has a sign of problem	3 (3.2)	91 (96.8)
Incorrect harness strap usage	23 (24.5)	71 (75.5)
Incorrect CRS installation	19 (20.2)	75 (79.8)

4.2.3 Passenger Airbag Availability

Table 7 tabulates the child seating location with child weight, type of CRS and airbag availability. By seating location and regardless of CRS, one-third of children (34.8%) was seated in the front passenger seat and the balance was in second-row seats (mostly behind the front passenger seat, possibly for easy driver checking). 31% of the children were seated in the front seat with an active airbag. By CRS type, half of the rear-facing CRS was located at the front passenger seat.

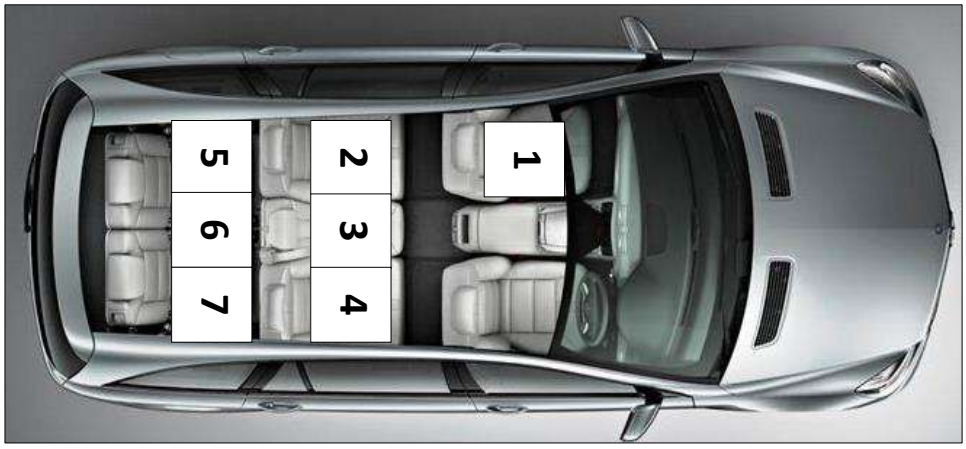

Figure 5 Seating location numbering reference

Table 7 CRS type with seating location with regards to passenger airbag availability

Passenger airbag availability		Seating location (Refer Figure 4)				Total
		1	2	3	4	
Child weight (kg)	0–9.0	32 (55.2)	18 (31.0)	1 (1.7)	7 (12.1)	58
	9.1–18.0	47 (29.6)	53 (33.3)	33 (20.8)	26 (16.4)	159
	18.1–36.0	8 (16.7)	20 (41.7)	6 (12.5)	14 (29.2)	48
	>36.0	-	2 (100)	-	0	2
Airbag availability	Yes	62 (31.0)	72 (36.0)	29 (14.5)	37 (18.5)	200
	No	25 (37.3)	21 (31.3)	11 (16.4)	10 (14.9)	67
CRS type	Rear facing	16 (51.6)	11 (35.5)	1 (3.2)	3 (9.7)	31
	Front facing	19 (37.3)	19 (37.3)	4 (7.8)	9 (17.6)	51
	Booster Seats	2 (16.7)	8 (66.7)	0	2 (16.7)	12
	Seat belt	10 (47.6)	2 (9.5)	5 (23.8)	4 (19.0)	16
	Unrestrained	40 (26.3)	53 (34.9)	30 (19.7)	29 (19.1)	152

4.2.4 Quality of CRS Usage

In short, only 12.7% of the children optimally used the CRS, in which the CRS was used appropriately and correctly without any of the misuses. About one-third of the children were restrained in suboptimal condition, which the usage of CRS and adult seat belt may not appropriate or correct. Lastly, more than half of the children were unrestraint when they were travelling in the vehicle. The appropriateness and correctness of the CRS usage are tabulated in Table 8.

Table 8 The appropriateness and correctness of CRS usage

	Frequency	Percent
Optimal	34	12.7
Suboptimal	81	30.3
Unrestraint	152	56.9

Table 9 shows the cross-tabulation of quality of CRS usage and parents demographics. It was found that only parent's educational level has a direct relationship with the quality of CRS usage. In contrast with other studies, this study recorded that there was no significant relationship on driver seatbelt wearing with regards to CRS use.

Table 9 Crosstab analysis of demographics with the quality of CRS usage

Variables	CRS usage (%)			Total	Chi-square, p-value
	Optimal	Misuse	Unrestraint		
Driver age					
<=25	1 (10)	2 (20)	7 (70)	10	4.85, 0.563
26-35	27 (14.6)	57 (30.8)	101 (54.6)	185	
36-45	5 (7.8)	18 (28.1)	41 (64.1)	64	
>45	1 (12.5)	4 (50)	3 (37.5)	8	
Driver gender					
Male	13 (16.3)	21 (26.3)	46 (57.5)	80	1.74, 0.418
Female	21 (11.2)	60 (32.1)	106 (56.7)	187	
Education level					
Illiterate	1 (100)	-	-	1	15.33, 0.018
Secondary	5 (14.3)	14 (40.0)	16 (45.7)	35	
Tertiary	18 (17.3)	24 (23.1)	62 (59.6)	104	
Degree	10 (7.9)	43 (33.9)	74 (58.3)	127	
Household monthly income					
<RM3,000	7 (15.2)	14 (30.4)	25 (54.3)	46	8.28, 0.218
RM3,001-RM5,000	13 (15.1)	32 (37.2)	41 (47.7)	86	
RM5,001-RM10,000	7 (8.6)	18 (22.2)	56 (69.1)	81	
>RM10,000	7 (13.0)	17 (31.5)	30 (55.6)	54	
Relationship with the child					
Mother	18 (10.5)	54 (31.4)	100 (58.1)	172	3.04, 0.552
Father	13 (18.6)	19 (27.1)	38 (54.3)	70	

Guardian	3 (12.0)	8 (32.0)	14 (56.0)	25	
Driver seat belt wearing					
Never	1 (33.3)	1 (33.3)	1 (33.3)	3	5.37, 0.717
Rarely	-	1 (25.0)	3 (75.0)	4	
Some of the time	1 (6.3)	4 (25.0)	11 (68.8)	16	
Most of the time	4 (14.8)	5 (18.5)	18 (66.7)	27	
All of the time	28 (12.9)	70 (32.3)	119 (54.8)	217	

5. Discussion

The finding of this observation showed that the rate of using CRS is still at a low level. It is very likely due to the absence of mandatory CRS usage law. It has been proven that child restraint law can effectively increase the use rate of CRS. The introduction of CRS law in New Zealand has increased the usage of CRS by 15% and reached 89% in 2015 (Koppel et al., 2008). In Australia, the implementation of CRS law has increased the use rate to 99% (Brown et al., 2010). Nonetheless, the implementation of CRS law did not contribute to optimal usage of CRS.

Even though the use rate of CRS is high in Australia, it was found that 79% of inspected CRS has at least one misuse and inappropriate use issues (Koppel & Charlton, 2009). Iwase et al. (2003) has found that increment of CRS usage does not significantly reduce child casualties in motor vehicle accidents after the implementation of the CRS law. One of the main factors of this phenomenon is because of incorrect use of CRS. Previous study also found that incorrect and inappropriate installation of CRS may reduce or nullify the safety benefits of CRS (Paine & Vertsonis, 2001).

From the result, it shows that most parents are not aware of CRS type especially for older children aged around 5 to 8 years old. Most of them stated the main reason for not wearing CRS for their children are due to the child had outgrown the CRS. It is proven to highlight that parents did not become aware of the existing of a booster seat. Even for those who acquire the booster seats (12 children), recorded zero optimal usage. Moreover, 21 children were too soon to use adult seat belt which is dangerous but better than no restraint at all. Seat belts are designed to protect an adult in a vehicle in the event of a motor vehicle crash. It could not properly fit young children due to their small stature, which can lead to more serious injury in a crash. Children should be restrained in child safety seats or booster seats until the lap and shoulder seat belt fit correctly; the lap portion of the belt rides low over the hips and held in place by the pelvic bone while the shoulder portion crosses the sternum and shoulder (Winston, 2000). Children are

usually ready for the adult seat belt when they can sit with their back against the back cushion with knees bent over the seat edge and their feet on the floor (Fong et al., 2017). Early graduation of CRS into adult seat belt may increase the severity of injury during car accidents due to delicate children body structure (Winston, 2000). Thus, education on CRS type and how to choose the correct CRS are very crucial at this stage (Durbin, 2011; Zaza, 2001).

A number of international road safety guideline for child occupant safety worldwide suggested that no child under the age of 13 should sit in the front seat. Some countries do not specifically list age, height or weight requirements for sitting in the front seat, but they do specify that children should reach 145 cm before using an adult seat belt. Airbags can kill young children riding in the front seat. Placing rear-facing car seat in front of an airbag could cause CRS to topple and lead child suffocated from the impact.

6. Conclusion

The low rates of child restraint system use represent a dispute to preventive medicine in Malaysia, requiring consideration and attention to promote it's across the board use. In order to accelerate the widespread of CRS usage, a comprehensive promotion of awareness activities should be conducted amongst both children and guardians regarding safety benefits associated with correct and appropriate restraint use and seating position.

On the other hand, a high rate of CRS misuse may promote further injury risk towards children car passenger. Thus, awareness and education on the correct usage of CRS by having periodic CRS inspection clinics program are crucial. By minimising or eliminating the chances of incorrect CRS usage and misuse, perhaps could further increase parents aware of the benefits of CRS usage.

In addition, the awareness and educational intervention program for parents and new regulations on mandatory CRS use are urgently needed in Malaysia. Government agencies, road authorities, healthcare provider and NGOs must be included and work in harmonisation on the child restraint usage intervention program.

Lastly, this study could be further enhanced the future study of a socio-economic issue related to CRS use among parents in Malaysia, especially on parents' willingness to pay.

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Research Report

Proper Installation and Optimal Usage of Child Restraint System (CRS)

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