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To cite this article: M M H Rosli *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **572** 012115

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Study of unattended child presence detection system for ASEAN NCAP safety rating

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Abstract. Cases regarding children death due to the entrapment in the vehicles during hot weather is increased. Our research aims are to study the opinions amongst parents regarding the safety awareness on the child safety in the vehicles and to investigate the preferred operations of child presence detection system in the vehicles. A quantitative research was carried out with surveys of audience awareness while driving with children inside vehicles and the preferred operating child presence detection system in the vehicles. Results found that many parents in Malaysia are aware of the need of the safety for their children because most of the parents are aware to prepare the child seat in the car. They also alert with the safety measurement taken while carrying the children in the car and proposed to all parents in Malaysia to have children car seat in the car. The survey results also found that the majority of the parents preferred to have better sound indicator for child detection system in the vehicles from the car reminder system. Based on the information obtained, 70% of the parents also are willing to pay higher priced for the child detection system in the car because they believed that leaving their children in the car for more than 30 minutes can caused death. Therefore, child presence detection system should be design and applied to all vehicles in Malaysia by applying a smart reminder system while considering the affordable price for the market.

1. Introduction

Vehicle-related injury and death remains an overwhelming challenge to the general health of society. Design safety improvements within the automotive sector have grown markedly in recent years, and yet not much has been accomplished with respect to safety in stationary vehicles. Vehicular hyperthermia (heat strokes) are the devastating effects of children being left unattended for too long in vehicles [1], the great nightmare of most parents, for several incidents occur every year. Based on safety organisation Kids and Cars reporting, some 37 children die on average each year due to entrapment in vehicles. These include cases where children have been forgotten inside vehicles, who accidentally lock themselves inside vehicle cabins or trunks, or in a very few instances, where children have been deliberately left behind in vehicles. Although the adults leave their children just for a minute, children are tends to face such a risks [2]. Such incidents draw increased entrapment awareness among people. Nevertheless, the count is comparatively small in comparison with the 117



passenger cabin entrapment deaths that were reported from 1998 to 2002 [3, 4]. It would therefore be good to deploy safety devices that monitor passenger cabins and installed child seats, in order to reduce deaths and injuries from non-traffic-related fatal incidents that involve a child, which in such cases involve child entrapment incidents. Most parked vehicle-related deaths involve a child of age 5 and below, with the majority of such left unattended, in which some 45% were still restrained in their seats. Given certain conditions, such incidents can lead to oxygen deprivation that results in death. This bodily response to excessive heating ultimately results in heat-related deaths in the worst incidents. Hyperthermia involves complex physiological processes that depend on various factors [4, 5]. McGeehin and Mirabelli (2001) reported that heat-related health risks for the young as well as elderly remain higher for heatstroke whenever body temperatures exceed 40.5°C [4]. Based on NCAP roadmap 2025, a technological remedy is available that could be deployed by the year 2022, towards monitoring the presence of children within vehicles and thereby alerting vehicles owners and/or emergency services whenever such situations become dangerous. NCAP plans to incentivise manufacturers who offer such automotive systems as standard equipment [6, 7].

Smart safety-seat configuration is accomplished using a few component parts that basically comprise a smart system, including air vents, occupant sensors, and thermistor/logic controllers. The regional rise of child death numbers related to children left entrapped in vehicles has influenced research into smart safety-seat systems (S4). These systems are designed to save the lives of entrapped children, thus promoting awareness among parents regarding parked vehicle safety and influencing higher standards for caregivers via mandates for child-non-attendance systems. The success of such safety systems could encourage further research into entrapment incidents and thereby bring further innovations in transportation safety. Given the non-chaotic nature of stationary vehicles and also the relatively simple ways by which children tend to be entrapped, such lifesaving scheme should become increasingly successful. Generally, these devices as with the S4 child restraint can all reduce entrapment death rates, through intuitive approaches that warn parents whenever their children are in danger of entrapment. The development of smart automotive mechatronic systems in advanced engine, chassis, and transmission controls has enabled improved performance, lowered fuel consumption, decreased exhaust emissions, and increased passenger safety [8]. Among the enabling mechanisms available are low-cost automotive sensors and actuators along with advanced control electronics that enable greater integration in real-time automotive monitoring and control [9]. The component parts that comprise basic smart safety-seat systems have been separately examined. These smart safety seats are designed to signal their on-board controllers as to whether they remain occupied or otherwise. If occupied, the control unit checks localised temperature sensors to determine the level of threat to young passengers. If the control unit determines that the passenger is being exposed to amounts of heat that is dangerous to a child, it will output appropriate alarms. Varied warning levels can be indicated similarly in accordance with the speed of rising temperatures. The level of danger is confirmed from the collection of experimental information [4]. This research proposes a system of smart safety seating for very young children entrapped in stationary automobiles.

Children left trapped inside vehicles can die as a result of heat stroke. In 2014, at least 30 heat-stroke deaths of children in vehicles were reported, based on information gathered by a researcher from San Jose State University [10, 11]. Null argued that starting from 1998 until 2014, an average of 38 children die each year as a result of vehicle-related heat stroke within the USA. Heat stroke in the vehicles is usually happened due to the radiation from the exhaust, convection from the air around vehicle body and conduction from engine [12]. NHTSA reviews of non-traffic-related incidents in 2007 discovered that heat strokes represent the third most widespread, non-traffic-related fatality scenario among motor vehicles, for children of ages 14 and below [13].

In general, children's bodies feature increased surface area to body mass ratios over adults that lend to faster heat absorption in more extreme environmental settings. The smaller blood volume present acts to limit the ability of their bodies to transfer heat from their core to bodily peripheries, wherein heat is then transferred to their surroundings. A further major difference in thermal regulation in children's bodies is in the sweating mechanisms, for theirs are not too effective in comparison with

that of adult bodies [14, 15]. Such factors render children far more susceptible to a fast progression of heat stroke in hotter environments, especially those that can arise in the enclosed compartments of parked vehicles.

In certain cases, children would be intentionally left trapped inside parked automobiles. According to a review of case information gathered by Null, almost half of all heat-stroke deaths inside vehicles involving children are due to their being inadvertently left inside, about 29 percent involve children who were playing in unattended automobiles, while 18 percent involve children deliberately left behind by caregivers [10].

In 2011, NHTSA began investigations of potential technological solutions to the problem of forgotten children problem, with funding of research that assessed market conditions and evaluated available products that provided reminders to caregivers whenever children were left in vehicles. NHTSA identified a number of devices designed to prevent a child from being entrapped that have entered the markets by 2014. Additionally, certain previously evaluated devices have been updated by their manufacturers in order to enhance performance.

2. Methodology

An online survey questionnaire was designed based on two categories and were then analysed:

- a) The initial section regards the investigation of safety awareness among parents and contains enquiries made on the types of child safety seats they might employ for securing children, as well as their attitudes on child safety in vehicles.
- b) The second section regards the investigation of child detection systems in terms of preferred operating options, which includes preferences for vehicular system responses to detections of children within vehicles, as well as the willingness of the parents to buy vehicles at increased prices given the addition of child-non-attendance safety features.

3. Results and discussion

The survey presents 205 respondents who completed the questionnaire. The majority were 21-30 years of age (39%), then 31-40 years of age (37%), followed by respondents beyond 40 years of age (19%). Table 1 depicts profiles regarding opinions in Malaysia on child safety awareness and child detection systems, according to gender and age.

Table 1. Profile of respondents.

Variables	Number of subjects	Percentage (%)
Age		
<20	10	5
21-30	80	39
31-40	75	37
>40	40	19
Gender		
Male	120	58.5
Female	85	41.5

The majority of parents have one or more children below 5 years of age. As depicted by Figure 1, the analysis showed that only some 52% of parents installed child seats inside their vehicles and preferred to purchase new models for ensuring the safety of their children. From either chart, it can be assumed that numerous parents desire to ensure their children's safety all the time.

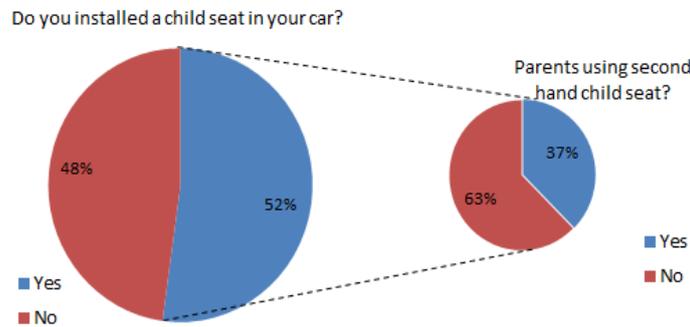


Figure 1. Child seat opinion amongst parents.

Some 76% of respondents demonstrated positive findings for safety awareness, as depicted by Figure 2. The majority of parents, or around 52%, firmly agree that every Malaysian parent should use child safety seats for children aged 4 years and below. Some 65% also firmly agree on continually wearing seat belts and on reminding children to do the same.

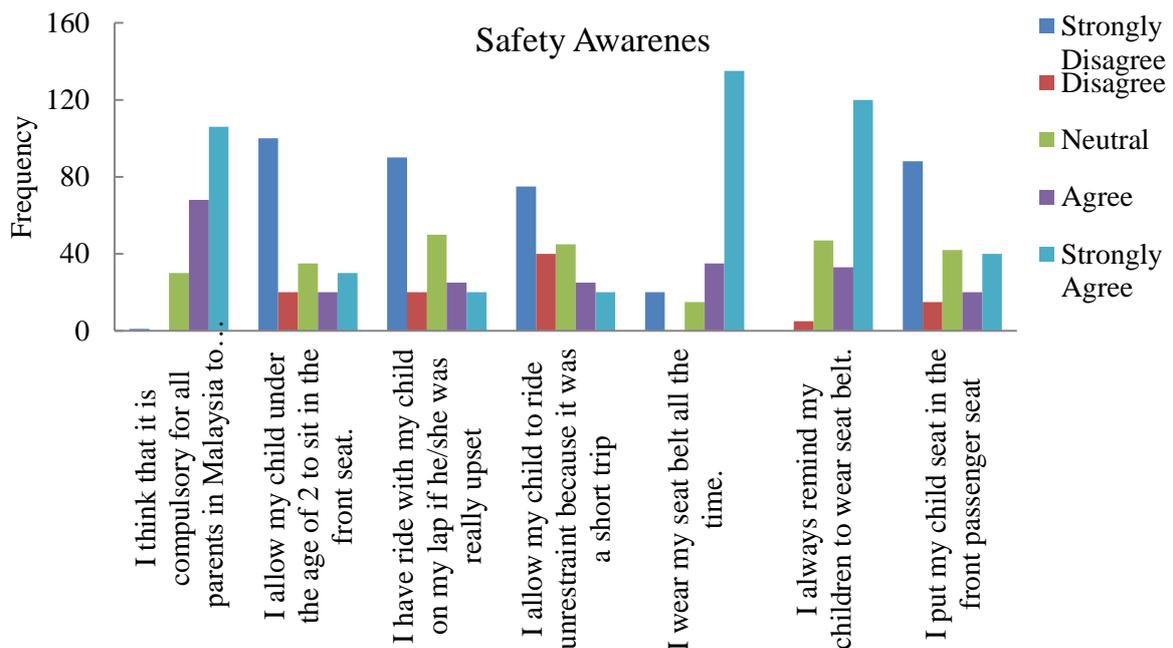


Figure 2. Safety awareness opinions amongst parents.

As depicted by Figure 3, 85% of respondents supported the development and use of child detection systems within Malaysia. Although numerous parents have claimed they have very good memories and would remember leaving their children in vehicles, the majority would still prefer having a system of reminders that detects left-behind children and sends alarms. As numerous parents hear reports about the deaths of children trapped inside vehicles, the majority of parents would firmly agree that the use of child detection systems should be made compulsory. Most have indicated they would purchase child safety seats irrespective of pricing. Most also firmly agree that the use of child detection systems will enable parents to be reminded of the presence of children endangered in their vehicles.

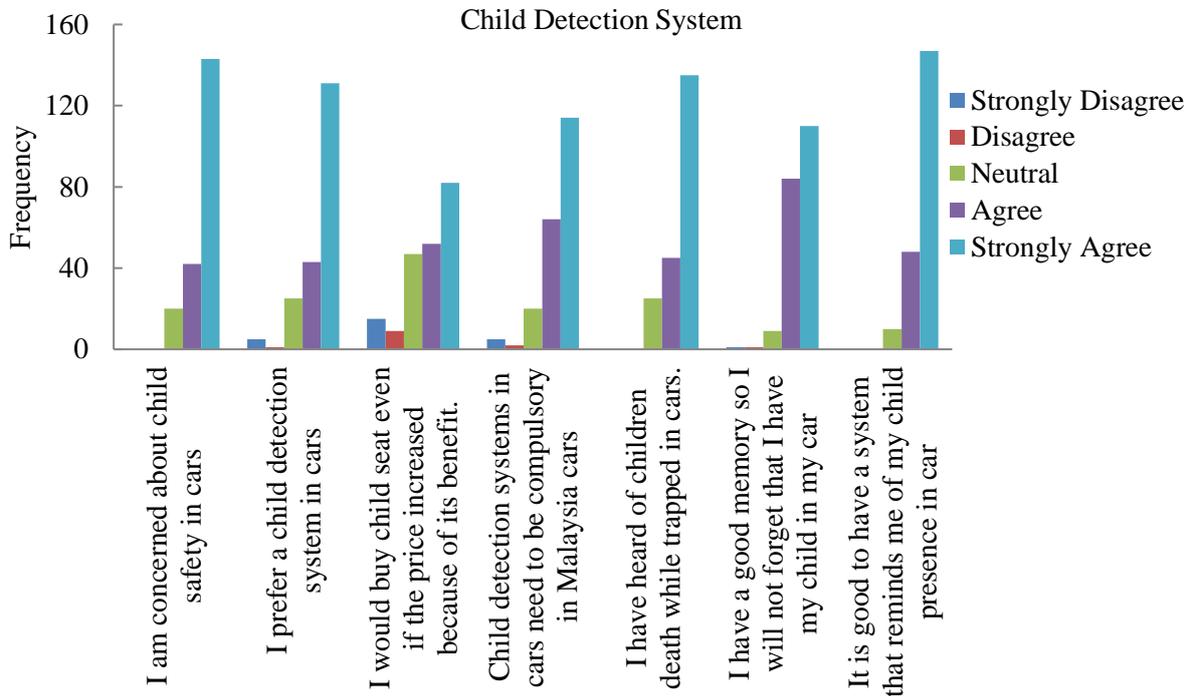


Figure 3. Child Detection system opinions amongst parents.

Figure 4 depicts the results regarding system indicator preferences for child-presence detection and reminder systems. The majority of respondents preferred audio indicators emanating from vehicle reminder systems (41%), then audio indicators from phone reminder systems (23%), audio indicators from device reminder systems (19%), lighted indicator reminder systems (10%), and automotive locking indicators (7%). The majority of parents are agreed on using reminder systems in automobiles that would alert them on leaving children in vehicles unattended.

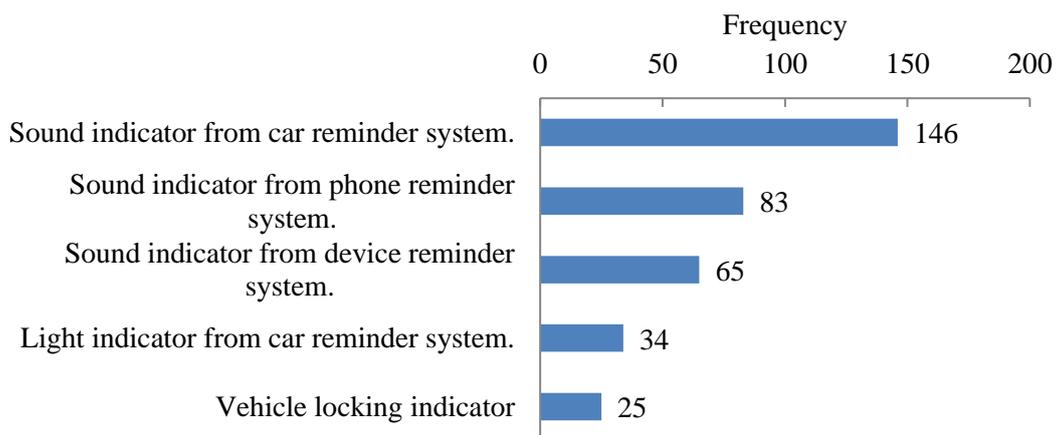


Figure 4. Indicator preference for child detection system.

Figure 5 depicts the results regarding opinion on the regulation of child-presence detection systems within Malaysia. Based on the result, some 75% of respondents supported the idea that the government must regulate child detection systems for vehicles, while some 25% did not support the

idea. This has become the case where awareness has arisen towards addressing the problem. Figure 6 depicts the percentages of Malaysians who are ready to purchase vehicles that integrate child detection systems but for higher prices. The percentage of those ready to purchase vehicles that integrate detection systems but for higher prices was found to be 5% less than that for respondents who agree that the government must regulate child detection systems for vehicles. If regulated well, we believe that manufacturers will be incentivised to consider reasonable pricing for detection systems, given that numerous parents are concerned regarding safety but are not likely to buy such systems if prices remain too high. Certain parents, irrespective of the prices they remain willing to pay for vehicles that protect children, may feel that their children are really sensitive, such that leaving them inside automobiles may readily cause their deaths.

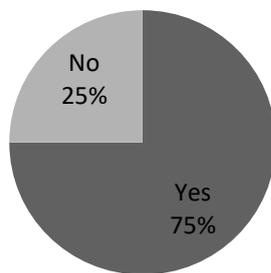


Figure 5. Opinion on regulations of child detection system for cars in Malaysia.

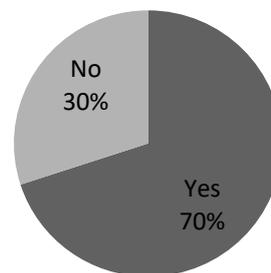


Figure 6. Opinion on buying car with child detection system but higher priced.

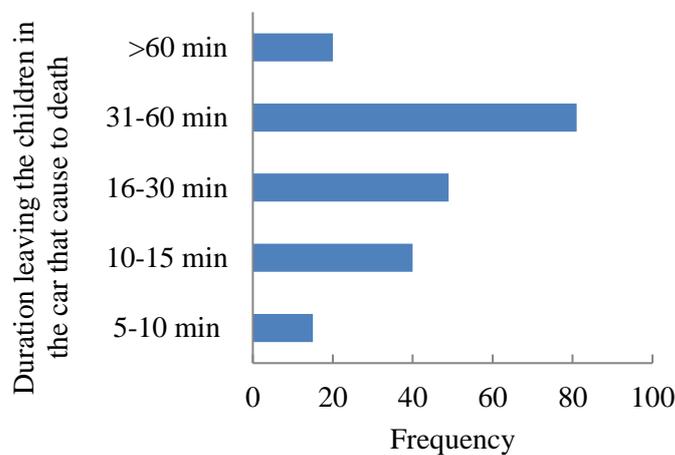


Figure 7. Respondents' opinion on duration of leaving the children in the car, which causes death.

Figure 7 is a bar graph that presents opinions about the severity of effects from leaving children in vehicles for various durations. The graph depicts a majority of parents believing that leaving children trapped for longer periods can increase the risk of death. The survey shows that some 72% of parents would never leave children in vehicles, would never leave children unattended beyond 15 minutes, and would always power up the engine and unlock doors before leaving them.

4. Conclusion

In this research, the majority of Malaysian respondents showed positive findings on questions concerning child safety in vehicles and the development of child detection systems. There are no meaningful differences regarding safety awareness according to age and gender within Malaysia. No meaningful differences exist regarding child presence detection preferences according to age and gender. It can be shown that child detection systems are suitable for implementation within Malaysia. The research objective was therefore achieved, which involved studying the feasibility of deploying child detection systems in Malaysia with regards to ASEAN NCAP. According to the results, the majority of respondents preferred child detection systems with audio indicators issued by vehicle reminder systems, and then audio indicators issued by phone reminder systems.

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Acknowledgement

This work was supported by the ASEAN NCAP Collaborative Holistic Research (ANCHOR) Grant [Grant number KK-2018-001].