

ORIGINAL ARTICLE

A STUDY OF ROAD HAZARDS FACED BY MALAYSIAN SCHOOL CHILDREN USING HIRARC

Ahmad Rasdan Ismail¹, Noor Adilah Hamzah¹, Nor Kamillah Makhtar², Nurul Husna Che Hassan³, Darliana Mohamad¹ and Baba Md Deros⁴

¹Faculty of Creative Technology and Heritage, Universiti Malaysia Kelantan, Campus Bachok, Bachok, Kelantan, Malaysia

²Department of Teacher Professionalism Research and Innovation, Institute of Teacher Education, Campus Kota Bharu, Kota Bharu, Kelantan, Malaysia

³Faculty of Earth Sciences, Universiti Malaysia Kelantan, Campus Jeli, Jeli, Kelantan, Malaysia

⁴Department of Mechanical & Materials Engineering, Faculty of Engineering & Built Environment, Universiti Kebangsaan Malaysia, Bangi Malaysia

ABSTRACT

Road transport is the movement of passengers or goods on the road. To date, issues concerning the safety of students and school institutions have continued to attract public attention. The recent spate of incidents inside and outside the school compound has brought the issue of children safety into our attention. These include the escalating number of road casualties. This study was conducted to observe road hazard outside the school compound and analyse the safety risks faced by school children by using the risk matrix. The risks are calculated to include likelihood and severity of hazard as identified in the Guideline of HIRARC 2008. The area selected was the East Coast state of Peninsular Malaysia, with over 111 schools randomly selected in Kelantan. Results were then analysed and six highlighted hazards were discussed. The results show that the main road posed the highest risk due to speeding vehicles. These vehicles failed to slow down when approaching the school area. The school administration must enhance the safety of the staff, students, and public while in the school area. In conclusion, road safety awareness must be instilled among teachers, students, parents and road users alike.

Keywords: hazard, road transport, school, children, teacher, safety, hazard identification, risk analysis

INTRODUCTION

The Malaysian education structure can be categorized into pre-tertiary and tertiary levels. Previously, there were two governing authorities in education: the pre-tertiary education sector (from pre-school to secondary education and teacher education) was placed under the Ministry of Education (MOE), while the higher education sector came under the purview of the Ministry of Higher Education (MOHE). In May 2013, the two ministries were merged as one entity, placed under the Ministry of Education. The Malaysian education system has been shaped to reflect the needs and identity of a multicultural society. There are at least eight broad categories of educational institutions (which include both government or public-funded institutions and private institutions) to meet the needs of the people as well as international community¹. This study has been conducted in schools across Kelantan, an East Coast state of Peninsular Malaysia and the schools were picked through random selection.

Injuries due to road accidents account for the bulk of the world's major health problem. In addition, road injuries bring a huge impact on the society, economy, as well as a country's development. According to reports by the World Health Organization (WHO), road traffic accident is the leading cause of deaths in the world in 2002. In Malaysia, a total of 6,915 road fatalities were recorded in 2013². Statistics of road

accidents showed an increase in the period from 2014 (476,196 cases) to 2015 (489,606 cases). However, the number of road injuries recorded a drop from 13,030 (2014) to 11,552 (2015). The number of road deaths totaled to 6,674 cases in 2014 and 6,706 cases in 2015³.

Motor vehicle accidents happen not just because of a driver's carelessness, but also due to road hazards. Road hazards can include animals, rough road surface, gravel, bumpy edges, uneven expansion joints, slick surface, ponding, debris, snow, ice, or objects that have fallen onto the road from a construction site or another vehicle⁴. NIOSH Chairman, Lee Lam Thye said 65% of road traffic accidents were caused by human errors such as road user attitudes when on the road, including reckless driving and speeding. Road infrastructure and mechanical factors, however, were also the contributing factors⁵.

An accident can be defined as an unexpected turn of event culminating in injuries or a complex outcome including trauma, fracture, poisoning and burn that require immediate attention⁶. On 21 Sept 2016, a pupil of Sekolah Kebangsaan (SK) Teluk Medan, Bagan Serai, Perak, was killed after being run over by a trailer while crossing the road to get to school. In a separate tragedy, a Year 4 student from SK Santong, Dungun, Terengganu was also killed upon being bulldozed by a car while crossing the road to enter the school area⁷. Meanwhile, based on statistics of road deaths

involving high school students from January to July 2016, some 48 fatal cases have been reported. Thus, the probability of risk and hazard at school is relatively high and may negatively affect the health and behaviors of students. In order to prevent dangerous situations in schools, the school safety aspects must be considered and they include the school physical environment as well as its surrounding social environment⁸.

Apparently, a school is deemed as one of the largest categories of workplace where children, young people, teachers and the staff spend a lot of time partaking in various activities. The risks and hazards which are present include both physical and social that may negatively affect school occupants' health and wellbeing⁹. Additionally, the school area is not just for teachers, management, and staff; as parents must also be protected when sending or accompanying their children to school. According to Japan Sports Council pertaining to the largest set of school injury data in Japan, approximately one million injuries take place in elementary, junior high and high schools each year and the number remains relatively stable year by year. Unfortunately, school accidents leading to injuries have not been as widely investigated as those occurring in residential or other areas such as the highway¹⁰. This is due to the general belief that children are relatively safe and protected in school because of the guarded environment and supervision from adults.

Despite the school compound which is deemed a safe environment for children, the area outside of the school presents risks that can cause accidents to children. In towns and cities across Malaysia, a lot of vehicles for example school buses and cars can be seen around the school areas especially during peak times such as the start and end of a school session¹¹. This remains a major issue in most studies revolving around traffic accidents among school children. Weiss stated that road traffic accidents involving children crossing the road are due to several factors such as drivers being unaware of the presence of children in the middle of the road and the drivers did not follow certain rules especially the speed limit¹². On the other hand, researchers believe that such accidents occur because some stall operators/food sellers block the sidewalks thus forcing pedestrians to use the carriageway¹³.

Travelling to and from school

Shokoohiet al.¹⁴ identified that school children mode of transport includes walking either with friends or alone, walking with an adult or elder sibling, being sent by their parents and taking the school bus. According to Alhort¹⁵, students in most parts of the world tend to walk to and from

school independently during the past few decades. However, parents have become more reluctant to allow their children to walk to school on their own mainly due to concern about traffic, road conditions and lack of supervision.

The previous study mentioned that there were several factors contribute to the student choice of transportation in urban areas including the distance between the home and school, car ownership, the increasing number of working mothers, urban form, and complex family schedules^{16,17}. Safe travel from home to school is always linked to the quality of pedestrian and bicycle track facilities. According to the transportation research board, a report on relative risks of traveling to school found that pedestrians and cyclists traveling to school face the highest risk of injury and fatality on a per mile basis¹⁸. Therefore, parents tend to ask their children to take the school bus or be driven to school instead of walking.

However, the situation where parents chauffeur their children to school could cause traffic congestion, especially during peak hours. Traffic congestion can also lead to environmental problems and traffic jams along the streets near schools and this could pose danger to people especially those walking or cycling. The study stated that encouraging children to walk to school could be more beneficial to parents and children. This is because parents can avoid traffic jams and also will save time and gas. In addition, children also will benefit from walking to school by developing a sense of responsibility and independence¹⁷.

In a study mentioned that children walking to and from school in Tehran, parents, and children were asked about the most convenient mode of transportation to school for their children and a majority of parents agreed that walking was the best mode of transport for their children only if the parents could escort children to school¹⁹. Only a few parents thought that children walking with their peers, or on their own to school was acceptable. On behalf of children, over 36% of them reported they would prefer to walk to school with their friends, and the rate increased slightly on their return trip from school. Approximately 43% of parents reported lack of personal safety in the neighborhood as the main reason why they prefer their children not to walk to and from school¹⁴.

The main objective of this study is to identify the type of road hazards posed to children and teachers at school and calculate the risk by using risk matrix. Numerous generic risk evaluation methods are available for defining the extent of the danger. Falling presents another major risk. A hazard assessment is an initial step in devising a waterway safety management program¹². The

HIRARC model (Figure 1) consists of a complete series of stages for the identification of hazards, assessment of risk and the determination of control measures for the implementation of safety and health in the operations¹². Besides, HIRARC is one of the general prerequisites as prescribed under the Occupational Safety and Health Act 1994 (Act 514) for the employer to provide a safe workplace to their employees and other related persons.

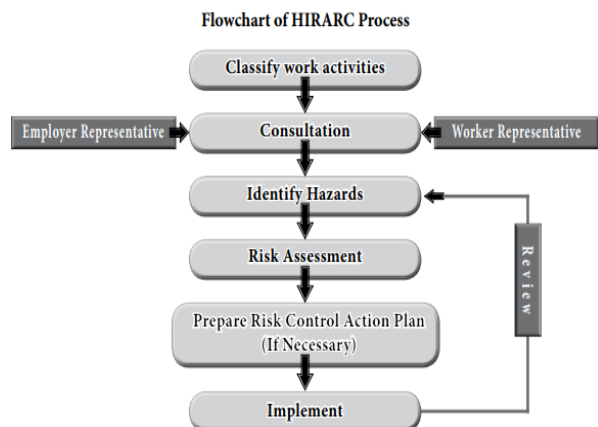


Figure 1- HIRARC Model Process

METHODS

Data were collected according to the HIRARC Process whereby walkthrough observation was required and pictures of identified hazard were taken. Such hazards were identified and calculated using risk matrix. A total of 111 schools in Kelantan, which lies in the East Coast of Peninsular Malaysia, were selected randomly. The focus was on road hazards in the observed school area. The six hazards identified include the main road, pedestrian bridge, and zebra crossing, peak hours, waiting for area or bus stop and road signs. The risk level of each hazard was measured using the formula ‘risk=likelihood (Figure 2) x severity (Figure 3)’. By referring to the Guidelines of HIRARC 2008, Table C, page 12, the risk levels were obtained by multiplying the severity and likelihood. The likelihood and severity outcome will be categorized as shown in Figure 4; which are High, Medium and Low. The relative value can be used to prioritize necessary actions needed to improve the effectiveness of managing road hazards in the school area. The possible hazards will be discussed further.

LIKELIHOOD (L)	EXAMPLE	RATING
Most likely	The most likely result of the hazard / event being realized	5
Possible	Has a good chance of occurring and is not unusual	4
Conceivable	Might be occur at sometime in future	3
Remote	Has not been known to occur after many years	2
Inconceivable	Is practically impossible and has never occurred	1

Figure 2- Likelihood of an occurrence

SEVERITY (S)	EXAMPLE	RATING
Catastrophic	Numerous fatalities, irrecoverable property damage and productivity	5
Fatal	Approximately one single fatality major property damage if hazard is realized	4
Serious	Non-fatal injury, permanent disability	3
Minor	Disabling but not permanent injury	2
Negligible	Minor abrasions, bruises, cuts, first aid type injury	1

Figure 3 - Severity of hazard

RISK	DESCRIPTION	ACTION
15 - 25	HIGH	A HIGH risk requires immediate action to control the hazard as detailed in the hierarchy of control. Actions taken must be documented on the risk assessment form including date for completion.
5 - 12	MEDIUM	A MEDIUM risk requires a planned approach to controlling the hazard and applies temporary measure if required. Actions taken must be documented on the risk assessment form including date for completion.
1 - 4	LOW	A risk identified as LOW may be considered as acceptable and further reduction may not be necessary. However, if the risk can be resolved quickly and efficiently, control measures should be implemented and recorded.

Figure 4 - Risk Matrix

RESULTS

Studies have shown that workplace accidents leading to fatality and injury had been a major concern for the government even before Malaysia gained independence. Initially, the issue only revolved around heavy industries such as mining and petroleum^{19,20}. Later, attention turned toward the agricultural industry as well as the construction and industrial sectors. Results of the research showed that safety management failure at the workplace mainly involves construction and industrial sectors²¹. Safety inspections in other sectors indicated the hazard of machinery, transportation, materials and mechanical, electricity and electrical maintenance²². Other factors causing workplace accidents included unsafe behavior and environment.

Nowadays, accidents resulting in injury have become an important issue in the public health domain. Most people believe school is a safer place for children due to supervision from the teachers. Nevertheless, children are not faced with hazards in the school area only, but the area outside school can also bring harm to the school children. Table 1 presents the identification of road hazards outside the school area, risk analysis and risk ranking for each hazard. The finding is tabulated in Table 1 where the data were analysed using formula, the rating of severity multiply with the likelihood rating. There were 5 groups of severity rating; namely catastrophic-5, fatal-4, serious-3, minor-2, negligible-1 and likelihood rating; comprising most likely-5, possible-4, conceivable-3, remote-2, and inconceivable-1. The ranking hazard is represented by the number.

Table 1 - Hazard identification and risk analysis of road safety

No	Road safety	Percentage of schools numbers applying road safety	Possible hazards	Consequences	L	S	LXS	Risk ranking
1.	Zebra crossing (<i>Figure 5</i>)	85%	<ul style="list-style-type: none"> • Parents park on zebra crossing while waiting for their children • Running around • Knocked down by motorcyclist • Blocked by parked vehicles 	<ul style="list-style-type: none"> • Students and others crossing road without using the zebra crossing • Injured • Death 	5	5	25	High (2)
2	Main road (<i>Figure 6-a</i>)	60%	<ul style="list-style-type: none"> • Speeding vehicles; lorry, car, motorcyclist • Too late to slow down when approaching school area 	<ul style="list-style-type: none"> • Hit by speeding vehicles • Collision • Fractured, injured • Death 	5	5	25	High (1)
3	Pedestrian bridge (<i>Figure 6-b</i>)	45%	<ul style="list-style-type: none"> • Distant from school gate and students taking shortcut while crossing the road • Falling while climbing the stairs 	<ul style="list-style-type: none"> • Shortcuts • Falls and injured 	5	4	20	High (3)
4	Peak hour	100%	<ul style="list-style-type: none"> • Student walking in groups and ignoring road safety rules • Running at roadside (<i>Figure 7-a</i>) 	<ul style="list-style-type: none"> • Hit by vehicles • Falling and being injured 	3	4	12	Medium (4)
5	Waiting area or bus stop	70%	<ul style="list-style-type: none"> • Not well maintained • Rusty bench 	<ul style="list-style-type: none"> • Collapsed and hitting students and others 	2	4	8	Medium (5)
6	Road Sign (<i>Figure 8</i>)	99%	<ul style="list-style-type: none"> • Faded and missing • Sharp corner • Rusty 	<ul style="list-style-type: none"> • Driver did not notice school area • Banging head 	3	2	6	Medium (6)

There were 3 hazards indicating the high risk; namely (1) school located on the main road, (2) parents parking or blocking zebra crossing and (3) pedestrian bridge.



Figure 5- Parents Parking their car on zebra crossing

Almost 18% of the death toll on our streets involved 'running over' of pedestrians. Zebra crossings are designed to guarantee a safe passage for pedestrians. Motorists are deemed in the stronger position while pedestrians are in the most vulnerable position, especially at zebra crossings without traffic lights²³. The Malaysian Transport Law stated that when there are no zigzags markings, vehicles cannot park, or load/unload goods or passengers, or overtake when approaching a 'Zebra' crossing line². Figure 5 shows parents stopping and parking their car on zebra crossing line while waiting for their children. This may obstruct children or students or anyone else wishing to cross the road and they are left without the zebra crossing.

"Negligent Behaviour" related to road-crossing is significantly associated with higher pedestrian collision severity, with predictors of "Negligent Behaviour" including the lack of pedestrian safety knowledge and greater exposure to traffic in terms of time spent walking²⁴. Road user behavior is regarded by many authors as being important for explaining why pedestrian collision occurs²⁵. Besides, traffic accidents that occur while children cross the main road are sometimes caused by drivers who could not see the presence of children in the middle of the road¹².

According to researcher, pedestrians have the right of way and vehicles must stop before the zebra crossing to allow them to cross the road. As such, it is imperative for vehicles to slow down when approaching zebra crossings. Drivers and motorcyclists must be considerate of others at all times, especially pedestrians as they are the most vulnerable party on the road. In fact, pedestrian fatalities ranked the third highest among all the category of road user fatalities in 2012²⁶.

Clearly identified the purpose of a person crossing the road or walking in general, were not directly provided information in planning to provide pedestrian crossings and space in certain areas²⁵. WHO stated that the design of pedestrian walkways should be based on consumer characteristics along the route²⁷. For example, walking in the area of the elderly group would be different than walking in the area of school children.



Figure 6 (a) - School behind the main road and pedestrian bridge located far from school gate



Figure 6 (b) - Pedestrian bridge far from the school gate.

In Malaysia, the pedestrian is one of the elements in the system paths. Pedestrian bridges are built, for the use of pedestrians to cross busy roads teeming with vehicles. In addition, pedestrian bridges can be considered as a tool or crossing facility in the safest and most efficient manner. It provides segregation between pedestrians and vehicles on the road. But Hidayati found out that the impact of a school located on the main road was related to the presence of side friction. This stems from private vehicles stopping or parking and public transport stopping around the school²⁸.

Meanwhile, the result showed that students did not use the pedestrian bridge to cross the road due to the distance of pedestrian bridge from the school gate. In fact, parents also lead their child across the main road. Here, the likelihood of being killed as a pedestrian is more than twice for children compared to adults²⁹.



Figure 7 (a) - Large number of students exiting at the end of school session



Figure 7 (b) - Students running at the roadside.

More than half of the reported pedestrian collisions involved the presence of bicycle, and older boys were most at risk of experiencing severe pedestrian injury. The high proportion of running and crossing and not looking before crossing showed that children were mentally immature and lacked concentration, and they could not react correctly to traffic condition³⁰. Children who walk to or from school were younger and showed riskier road-crossing behavior, although children who walk accompanied by another person tend to have higher pedestrian collision severity.

Figure 7-a and Figure 7-b show parents waiting for their children outside the school area and the children's behavior on the roadside. In urban areas of Malaysia, school areas are teeming with vehicles, for example, school buses and cars especially during peak times such as the start and end of school session¹¹. The situation where parents drive and wait for their children entering or leaving school could cause traffic congestion, especially during peak times.



Figure 8 - Road Safety Measures or School Zone

Based on the observation, almost all schools have erected road sign and placed zebra crossing and road bump. They are displayed in a section of the road directly facing the school where pedestrians, vehicle, cycling and public transport activities are concentrated³¹. Generally, the speed limit sign is placed at the start and end of the school boundaries. A school zone that significantly exceeds school boundaries tends to result in poor driver compliance. However existing road sign, which is not well-maintained can cause confusion to road users. Based on HIRARC calculation, the safety zone indicates the medium risk with a low number of risk. Safety zone becomes medium due to drivers not being alert and following the rules. The Road Transport Department pointed that 80% of road users failed to comply with road laws and regulations²⁷.

CONCLUSION

As a conclusion, the results indicate road hazard can pose a serious danger when users and pedestrians intentionally violate road safety regulations. Unfortunately, road safety or safety zone cannot be effective due to several factors such as people being less disciplined when it comes to speed limit and the physical barrier before and after a zebra crossing is not built according to specifications, or the zebra crossing is only a marking on flat surface pavement⁶. Therefore, public awareness is vital when it comes to complying with the rules which are in place to protect the road users. In addition, redesigning the facility needs to be done to achieve the expected goals. Researchers have often suggested that pedestrian walkways and cycle tracks around the school areas should be upgraded in order to provide more secure and comfortable facilities for children and to encourage parents to consider the safety of their children walking or cycling to school.

The results also show that both parents and adults play an important role in order for children to emulate good attitudes and behaviors. Parents should be given guidelines on how to accurately appraise their child's readiness to cross independently. In addition, information on the best practices for teaching children how

to cross safely may facilitate road safety practices, particularly if this is coupled with public advocacy highlighting the important role parents could play to reduce the risk of child pedestrian injury.

A School is considered as 'a place of work', in Occupational Safety and Health Act (ACT 514), section 15. The act stipulates that each employer must furnish a workplace that is free from recognized hazards which can cause death or serious physical harm. Therefore, the school administration plays an important role in order to ensure the safety of the staff, teachers, students, and visitors in the school area. The School administration should also provide road safety program to the staff, teachers, students, and parents in an attempt to increase their awareness and inculcate good road safety behavior.

ABBREVIATIONS

HIRARC stands for Hazard identification, risk assessment, and risk control.

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COMPETING INTERESTS

There is no conflict of interest.

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