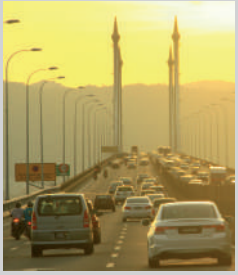
MRR No. 395



Research Report

Evaluating Road Safety Risks at Schools in Selangor: An iRAP Approach

Alvin Poi Wai Hoong
Norfaizah Mohamad Khaidir
Syed Tajul Malik Syed Tajul Arif
Ho Jen Sim
Nor Aznirahani Mohd Yunin
Nora Sheda Mohd Zulkiffli
Nusayba Megat Johari
Mohd Firdaus Ismail
Siti Zaharah Ishak
Wong Shaw Voon
Khairil Anwar Abu Kassim

MIROS
MALAYSIAN INSTITUTE OF ROAD SAFETY RESEARCH
ASEAN ROAD SAFETY CENTRE

Evaluating Road Safety Risks at Schools in Selangor: An iRAP Approach

Alvin Poi Wai Hoong
Norfaizah Mohamad Khaidir
Syed Tajul Malik Syed Tajul Arif
Ho Jen Sim
Nor Aznirahani Mohd Yunin
Nora Sheda Mohd Zulkiffli
Nusayba Megat Johari
Mohd Firdaus Ismail
Siti Zaharah Ishak
Wong Shaw Voon
Khairil Anwar Abu Kassim

MIROS
MALAYSIAN INSTITUTE OF ROAD SAFETY RESEARCH
ASEAN ROAD SAFETY CENTRE

© MIROS, 2021. All Rights Reserved.

Published by:
Malaysian Institute of Road Safety Research (MIROS)
Lot 125-135, Jalan TKS 1, Taman Kajang Sentral,
43000 Kajang, Selangor Darul Ehsan, Malaysia.

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Hoong, Alvin Poi Wai
Evaluating Road Safety Risks at Schools in Selangor: An iRAP Approach/
Alvin Poi Wai Hoong, Norfaizah Mohamad Khaidir , Syed Tajul Malik
Syed Tajul Arif, Ho Jen Sim, Nor Aznirahani Mohd Yunin, Nora Sheda
Mohd Zulkiffli, Nusayba Megat Johari, Mohd Firdaus Ismail, Siti Zaharah Ishak, Wong Shaw Voon, Khairil Anwar Abu Kassim.
(Research Report; MRR No. 395)
ISBN 978-967-2988-18-2
1. Traffic safety--Malaysia.
2. Roads--Safety measures.
3. School accidents--Prevention.
4. Government publications--Malaysia.
I. Nusayba Megat Johari. II. Nora Sheda Mohd Zulkiffli.
III. Norfaizah Mohamad Khaidir. IV. Syed Tajul Malik Syed Tajul Arif.
V. Ho, Jen Sim. VI. Nor Aznirahani Mohd Yunin.
VII. Wong, Shaw Voon. VIII. Siti Zaharah Ishak.
IX. Khairil Anwar Abu Kassim. X. Mohd Firdaus Ismail.
XI. Title. XII. Series.
363.125

Printed by:
Malaysian Institute of Road Safety Research (MIROS)

Typeface: Calibri
Size: 11 pt.

DISCLAIMER
None of the materials provided in this report may be used, reproduced or transmitted, in any form or by any means, electronic or mechanical, including recording or the use of any information storage and retrieval system, without written permission from MIROS. Any conclusion and opinions in this report may be subject to reevaluation in the event of any forthcoming additional information or investigations.

Contents

		Page
List of Tables		v
List of Figures		vi
Acknowledgements		vii
Abstract		ix
1.	Introduction	1
1.1	Aims and Objectives of the Study	3
1.2	Scope and Limitation of the Study	3
2.	Literature Review	4
2.1	Importance of Safe Road Environment Around School Areas	4
2.2	Facilities for School Children Commuting to School	5
2.2.1	Traffic Calming Measures	6
2.2.2	Marked Pedestrian Crosswalk	7
2.2.3	Sidewalk	8
3.	Methodology	9
3.1	Site Selection	11
3.2	Road and Traffic Environment Characteristics	12
3.3	Road Attribute Coding	14
3.4	Star Rating Analysis	14
4.	Results and Discussions	19
4.1	Road and Traffic Environment Characteristics	19
4.2	Star Rating Analysis	21
4.3	Effectiveness of Pedestrian Facilities	27

5. Conclusion and Recommendations 30

References 32

Appendix A 35

Appendix B 46

List of Tables

		Page
Table 1	Number of schools by locational setting	11
Table 2	Star rating bands	15
Table 3	Proportion of schools with traffic calming measures by 85th percentile speeds	20
Table 4	Proportion of schools with traffic warden by 85th percentile speeds	20
Table 5	Proportion of schools with sidewalk by 85th percentile speeds	20

List of Figures

		Page
Figure 1	Study methodology framework	10
Figure 2	Distribution of study locations (created using a web-based application at https://batchgeo.com)	12
Figure 3	Setting up of 20 m intervals using traffic cones	13
Figure 4	Lane width measurement	13
Figure 5	Star rating score equation for pedestrians (Extracted from iRAP, 2014)	16
Figure 6	Star rating score equation for motorcyclists (Extracted from iRAP, 2014)	17
Figure 7	Star rating score equation for bicyclists (Extracted from iRAP, 2014)	18
Figure 8	Distribution of 85th percentile speeds	19
Figure 9	Pedestrian star rating results for primary schools	21
Figure 10	Pedestrian star rating results for secondary schools	22
Figure 11	Example of pedestrian 1-star road (SK Tambak Jawa)	22
Figure 12	Example of pedestrian 2-star road (SK Sungai Pelek)	23
Figure 13	Example of pedestrian 5-star road (SK Ampang)	23
Figure 14	Example of pedestrian 3-star road (SK Taman Melawati 2)	24
Figure 15	Motorcyclists star rating results for secondary schools	25
Figure 16	Example of motorcyclist 4-star road (SMK Batu Laut)	25
Figure 17	Bicyclist star rating results for primary schools	26
Figure 18	Bicyclist star rating results for secondary schools	26
Figure 19	Example of bicyclist 5-star road (SK Seksyen 7, Bangi)	27
Figure 20	Distribution of pedestrian star rating scores by presence of traffic calming	28
Figure 21	Distribution of pedestrian star rating scores by presence of traffic warden	28
Figure 22	Distribution of pedestrian star rating scores by presence of sidewalk	29

Acknowledgements

The authors would like to express their appreciation to the former Director-General of the Malaysian Institute of Road Safety Research (MIROS), Professor Dr Wong Shaw Voon and the former Director of Road Engineering and Environment Research Centre, Dr Siti Zaharah Ishak for providing the grant to conduct this project (RE103117) and extending their support to produce this report. Their gratitude also goes out to all the stakeholders involved, partners, reviewers, relevant agencies/companies, research participants, etc., who have worked hard, contributed their invaluable ideas, input, energy and time towards the production of this report. The authors would also like to express special thanks to the team members and research assistants for their help and contribution in completing this project.

Abstract

A school zone that is appropriately designed not only ensures the safety of school children commuting to school but also smooth traffic operation throughout the adjacent road network. In Malaysia, the design and condition of the built environment at school vary, thus the likelihood and severity of road crashes involving school children depend on how safe a school zone is designed. The objectives of this study are to establish safety risk star rating in considering the various built environment of school in Malaysia and to propose potential safety improvement programmes. A sample of schools in the state of Selangor with various built environment was assessed for safety condition using the International Road Assessment Programme (iRAP) star rating methodology. In addition to vehicle speed measurement, data collection includes capturing images for each 20 m road section within the school zone as well as measuring several road cross section elements for star rating analysis. The results revealed that the safety condition of school zones varied greatly as indicated by the 1-star to 5-star ratings within the samples. This study also determined that the presence of traffic calming measures, traffic warden and sidewalk were very critical in ensuring the safety of school children as the likelihood for pedestrian crashes at schools with reduced by 75%, 80% and 37% respectively. In conclusion, the iRAP star rating methodology is proven to be very useful in predicting the risk of pedestrian crashes around school areas.

1. Introduction

Schools are important focal points of activity for school-aged children, and therefore a major activity center and pedestrian trip generator for them. The built environment around school areas plays an important role in the safety of pedestrian involved in various activities before, during and after school hours. Most child pedestrian crashes were attributed to their improper behaviours such as mid-block darting and playing on the road. Little research has been conducted to examine the relationship between these pedestrian crashes and the social and physical environment where these crashes occur. The relationship between the built environment and crashes is important so that appropriate engineering treatments can be formulated to address a specific problem at a specific location.

School sites and surrounding areas should be designed in such a way as to encourage safe walking trips to and from the school. For instance, roads leading to school sites should be designed with adequate and proper sidewalks so that school children are segregated from vehicles using physical barrier. Besides, a good environment in the vicinity of school includes traffic calming measures, adequate lighting, good visibility of motorized traffic and also trees to provide shade and shelter. However, these are not a common feature in most of the schools in Malaysia. We often find schools with main entrance facing a busy road, not to mention those without proper sidewalks or facilities for bicyclist. In some cases, pedestrian crossings are never provided to aid children to cross the road.

Road crashes around school areas in Malaysia have been occurring quite frequently especially on rural high-speed roads. The recent case involving a truck running over school children in Perak shows that having adequate pedestrian facilities is not good enough. In fact, the traffic operating characteristics have to be controlled to a level which is safe for every road users. Hence effort to reduce the risk of road crashes

through cost-effective treatment programmes requires examination of both the condition of pedestrian facilities and traffic operating characteristics.

The International Road Assessment Programme (iRAP) has over the past decade been adopted worldwide to assess roads and identify potential low-cost treatment programmes to minimize the risk of road users. Research organizations such as Transport Research Laboratory (TRL) in the United Kingdom, Midwest Research Institute in the United States, Research Institute of Highway in China, Institute of Road Engineering in Indonesia, Department of Public Works and Highways in the Philippines and many other road authorities in the world are adopting the model in their road assessment. Malaysia too has been undertaking the programme since 2007 on major expressways and federal roads.

One (1) important focus of the iRAP programme is the safety of vulnerable road users – pedestrians, bicyclists and motorcyclists who make up almost 50% of the total global deaths (World Health Organization, 2015). More recently, the iRAP programme worldwide has focused on assessing roads in the vicinity of schools – a place where young and vulnerable children concentrate during school hours. The risk of this road user group to be involved in a road crash is significantly high when no proper facilities are provided along the roads especially those that carry high speed traffic. Evidence has proven that most pedestrians will be killed if struck by a vehicle travelling at 50 km/h and above (Organization for Economic Cooperation and Development (OECD), 2006), the common range of speed that we can observe daily in front of schools in Malaysia!

As part of the global effort in tackling increasing road traffic injuries among school children, iRAP has initiated the development of a mobile application to facilitate risk assessment at school areas. The motivation behind this initiative is to support relevant stakeholders in identifying quick interventions that save lives and prevent injuries. The development project is funded by FedEx, a global player in the logistics industry, with support from iRAP, the Federation of International Automobile Foundation (FIA Foundation), the Global Initiative for Child Health and Mobility, and the Road Safety Fund. The SR4S tool, as the app was named, consists of an easy-to-use Android tablet app and a web-based global reporting application for processing and sharing results. In

this way, the safety level of schools worldwide can be compared using a consistent standard whilst highly effective interventions being studied.

Amidst the development process, MIROS is conducting similar effort to study efficient ways to collect data around school areas which is suited to local needs and best practices which considers the existing policies of the school authorities. As part of the effort, a pilot study was carried out to evaluate the design and condition of the road environment in a sample of schools in Selangor using the iRAP Star Rating Model. This study paves way for school authorities to propose road safety improvement programmes in a proactive approach, thereby assisting the road authorities in justifying allocation for such programmes.

1.1 Aims and Objectives of the Study

This study aims to identify road environment risk factors in relation to the safety of commuting pedestrians, bicyclists and motorcyclists around school areas. These can be achieved by:

i. Compiling road infrastructure and traffic inventory in the vicinity of selected schools with different built environment.
ii. Calculating the risk for pedestrian, bicyclist and motorcyclist in each type of built environment based on the International Road Assessment Programme (iRAP) star rating model for schools.

1.2 Scope and Limitation of the Study

i. This study was limited to assessing 60 schools in the state of Selangor due to budgetary and resources constraints.
ii. The assessment was carried out during school peak hours where significant pedestrian flow is present. The risk outside school hours (when vehicle speeds are higher) were not assessed.

2. Literature Review

This section provides an overview of the safety of school children in relation to the road environment design and facilities. The effect on the safety of school children for different types of road design and facilities were highlighted.

2.1 Importance of Safe Road Environment around School Areas

Schools are an important focal point of activity for school-aged children, and therefore a major activity center and pedestrian trip generator for children. The built environment around school areas plays an important role in the safety of pedestrian involved in various activities before, during and after the school hours. However, the built environment around schools in Malaysia varies in terms of the road and traffic environment. There are schools which are located along wide, high traffic volume and high operating vehicle speed, whilst other schools are located along narrow roads with a very low volume of traffic and low operating vehicle speed. In addition, pedestrian facilities found in most schools are of various types and qualities. Most of the primary schools have zebra crossings and traffic wardens whilst there are schools with no crossing facilities or even sidewalks. The risks of being involved in road crash associated with the different types of road environment somehow reflect the various safety levels for school children in the vicinity of schools in Malaysia.

Although most child pedestrian crashes have been attributed to their improper behaviours such as mid-block darting and playing on the road, the manner in which the road is designed affects the likelihood and severity of a crash. Little research has been conducted to examine the relationship between pedestrian crashes and the social and physical environment where these crashes occur. The relationship between the built environment and crashes is important so that appropriate engineering treatments can be formulated to address a specific problem at a specific location.

As pedestrians, school children need a safe environment to walk or cycle to and from schools. Since many of the roads have been designed exclusively with automobiles in mind, the road environment needs to be reclaimed for pedestrians. Traffic calming is needed at schools so as to encourage lower vehicle speeds. The starting point for the implementation of traffic calming measures is the knowledge that a reduction in travel speeds has a substantial effect on both the crash likelihood and severity (Elvik et al., 2004).

Whilst enforcement is crucial to ensure traffic laws are abide by, it is governed by human elements that depend on the resources available. Unlike education or enforcement strategies in which the effects could only be seen along with time, engineering and environment aspects, on the other hand, involve alteration to the physical environment that has an immediate impact on pedestrian safety. Once designed properly, the built environment (facility) is something which is all the time in a place and is ready to be used immediately. Therefore, a safe built environment for child pedestrian is equally important to minimize incidences of child pedestrian-related injuries. Traffic engineering approaches must fully address concerns about the safety of child pedestrian walking along or crossing the road to schools.

Safety is a key concern for many parents when deciding whether or not to let their children walk to schools on foot. A school environment that is safe for pedestrian will usually consist of a proper walking facility such as sidewalk, proper crossing facilities such as zebra crossing, overhead bridge and traffic warden, and traffic calming measures such as road hump and speed zone. Children have limitations in their abilities to gauge whether a traffic situation is safe (Ampofo-Boateng et al., 1991; Connelly et al., 1998; Dunbar et al., 2001; Velde et al., 2005; Rosenbloom et al., 2008). Therefore, these facilities should be in place around the vicinity of schools to guide and protect child pedestrian during their activities on the road.

2.2 Facilities for School Children Commuting to School

In order to reduce the risk of collisions between school children (pedestrians, bicyclists or motorcyclists) and other vehicles, the road environment around school areas is

usually designed to provide safe travel path to the former. Provided facilities include those that segregate them from motorized traffic (sidewalk and overhead bridge), designate the safe crossing path (zebra crossing), encourage lower speed (speed hump and speed table), traffic management control (traffic warden and traffic signal) as well as those that control pedestrian (pedestrian fence). The absence of these facilities plays a major role in contributing to crashes involving school children, particularly when vehicles are driven beyond the safe speed in school areas. The following highlights some facilities which are crucial to the safety of school children and how they influence the likelihood and severity of a crash.

2.2.1 Traffic Calming Measures

Measures that are intended to lower vehicle speeds and volumes are classified as traffic calming measures such as speed humps, raised tables, roundabouts, kerb build-outs and chicanes. The most commonly found traffic calming measures around schools in Malaysia are speed humps and warning signs. The roads surrounding a school with such measures can be considered to be environmental roads where they are built in such a way that it leads to low speed and a high degree of alertness and consideration with regard to local traffic. Such roads have been proven to be effective in reducing the number of injury accidents by 30 – 50% and speed from 54.9 to 46.0 km per hour (Elvik et al., 2004). Although no specific results have been shown on the effects of such measures on pedestrian-vehicle crashes, speed is found to be effectively reduced on such roads. Therefore, it is a good practice to implement speed reducing measures in the vicinity of schools to create an environment which is safer for pedestrian activities.

The use of traffic calming measures in the vicinity of schools is solely aimed at reducing the risk of school children to high-speed traffic. According to Elvik et al. (2004), the severity of pedestrian injury increases with the square of vehicle speed and the probability of pedestrians receiving fatal injuries when hit by a car is 3.5% at 24 km/h, 37% at 48 km/h and 83% at 71 km/h. In addition, traffic calming measure such as raised crosswalk can indeed provide school children with a shorter distance to cross while at the same time increase the visibility of their presence to drivers. Therefore, traffic calming measures are indeed a good investment in saving the lives of child pedestrian.

In the iRAP Star Rating model, the presence of traffic calming measures that could have the ability to reduce the operating speed 10 km/h below the speed limit (in this context the speed humps) is expected to reduce the risk of crash by 25% (iRAP, 2013). This estimate was used considering the various findings obtained from worldwide studies on the effectiveness of traffic calming measures which ranged from 10% to 33%.

2.2.2 Marked Pedestrian Crosswalk

Marked pedestrian crossing location such as the zebra crossings is aimed at demarcating the right of way for pedestrians crossing the road and is usually supplemented with road signs. The use of this facility has been controversial as proven in many studies worldwide were depending on the design, the risk of crashes can be lower or higher. This is particularly a problem for children whereby crosswalks may create a false sense of security by inducing them to believe that the driver sees the child and will stop.

Studies in the European countries and the United States have shown that marking an ordinary crossing were not helping the pedestrians as the number of pedestrians crashes increased by 28% (Elvik et al., 2004) and a quarter of pedestrian injuries were sustained during crossing at the crosswalk (Harruff et al., 1998) respectively. In addition, a study by Rivara, 1990 had shown that pedestrians using marked crosswalk have twice the risk of being struck by a car than those in unmarked crosswalks. These literature suggest that marked pedestrian crossings do not guarantee the safety of pedestrian and in fact, have been shown to increase the incidences of pedestrian crashes. One (1) explanation for this might be that marked crossings give a false sense of security to the pedestrians, making them feel safer and thus less cautious when entering the crosswalk (Mueller et al., 1990; Stevenson et al., 1995).

The iRAP Star Rating model captured these effects under two (2) scenarios: with and without a traffic warden. In the absence of a traffic warden, the likelihood of a pedestrian involved in a crash at an unsignalized marked crosswalk increased 3.8 (with refuge) and 4.8 times (without refuge) compared to at a signalized unmarked crosswalk. In the presence of traffic warden, the likelihood increased 1.25 times at marked crosswalk without refuge compared to one with refuge (iRAP, 2014). The best pedestrian crosswalk

considered in the model is any grade-separated facility (with pedestrian fencing) where pedestrians are segregated from the motorized traffic.

2.2.3 Sidewalk

The presence of sidewalk in the vicinity of school areas provide a safe walking path to school children as they are segregated from the travel lane. Many types of sidewalk can be seen in Malaysia – those with fence as separator, those kerbed and raised walkway without fence and those unpaved shoulders without fence. School areas without proper walking space for school children may lead to the more vulnerable road users mixing with other motorized traffic, thereby increasing the risk of crashes.

The effectiveness of sidewalk has been proven through numerous studies where crash rates were found to be lower on roads with sidewalk (Haruff et al., 1998; McMahon et al., 2002; Retting et al., 2004). At intersections, wider sidewalks have been proven to increase visibility of pedestrians, especially children between 5 and 10 years old; reduce oncoming vehicle speeds and reduce distance that pedestrians have to walk on the carriageway (Oxley et al., 2004). In the same study by Alvin Poi et al., 2010, schools with sidewalk observed up to 30% reduction in the conflict rates.

The iRAP Star Rating model for pedestrian among others modelled that a pedestrian using an informal path less than 1 m is three (3) times less likely to be hit by vehicles compared to one who walks on the travel lane; whereas a pedestrian using the paved shoulder is about three (3) times more likely being hit compared to one walking on an informal path (iRAP, 2013).

3. Methodology

This study involved extensive data collection exercise due to the various road attributes information required in the iRAP star rating analysis. Prior to generating star ratings using the iRAP web-based toolkit (*Vida*), the road attributes for each 20 m section was coded based on the relevant categories under the star rating model version 3.02. This section discusses the methodology of the study and is divided into three (3) subsections; identification of study location, data collection process and data analysis. Figure 1 shows the overall process of this study.

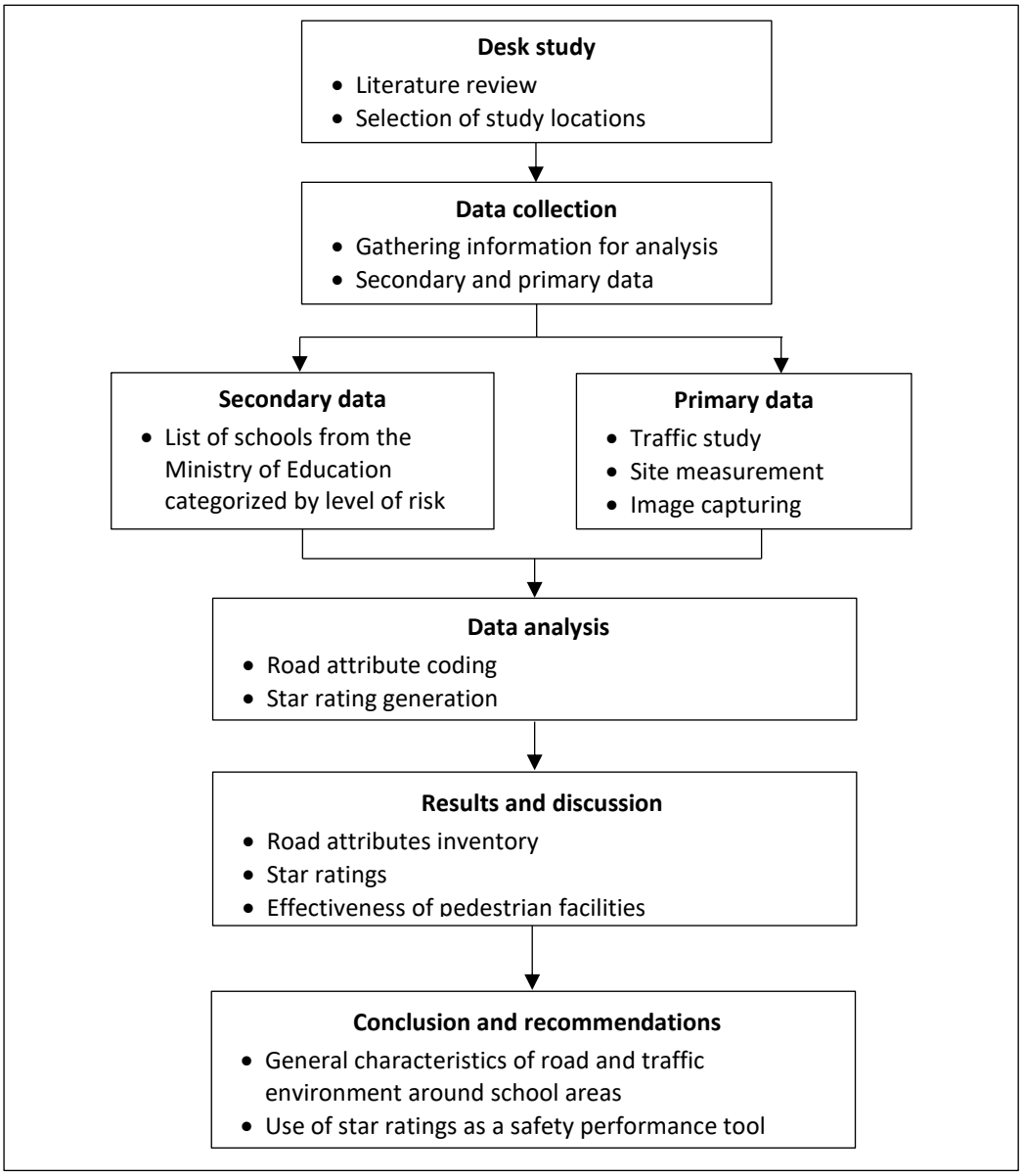


Figure 1 Study methodology framework

3.1 Site Selection

This study was limited to a sample size of 60 schools within the state of Selangor due to limitation in resources. Moreover, the environment around school areas was generally believed to be the same across all the states in Peninsular Malaysia. Based on information on the list of schools provided by the Ministry of Education, the sampling process took into consideration the different risk categories of schools – high and low risk. These categories were developed by the ministry to reflect the risk due to factors among others the frequency of crashes involving school children, proportion of school children riding motorcycles and no traffic warden assistance (Ministry of Education, 2017). In addition, in order to reflect the various site conditions of the rural and urban road environment, the selection of schools was made by locational setting as shown in Table 1.

Schools were selected for different road categories to reflect the range of traffic speeds travelling around the school areas. The rural highway speed limit in Malaysia is set at 90 km/h (maximum), and 60 km/h to 70 km/h in urban areas. Lower speed limits were set for other road categories based on the functions. The primary and secondary roads refer to the minor arterials and municipal roads respectively, which serve shorter trips between developments in a township. The rural secondary roads also include local access roads where traffic volumes are low due to isolated developments. Figure 2 shows the distribution of schools on different road types in the state of Selangor.

Table 1 Number of schools by locational setting

Primary schools			Secondary schools		
	Urban	Rural		Urban	Rural
Highway	5	5	Highway	5	5
Primary roads	5	5	Primary roads	5	5
Secondary roads	5	5	Secondary roads	5	5

In this study, various traffic speed environment were included to examine the risk faced by school children, 90% of whom will be fatally injured if hit by a vehicle travelling at 80 km/h and above (OECD, 2006). The iRAP star rating model incorporates the risk factors

for different speed environment based on a power model in which five (5) sets of curves are used to represent the risk faced by different road user groups on different road types (iRAP, 2014).

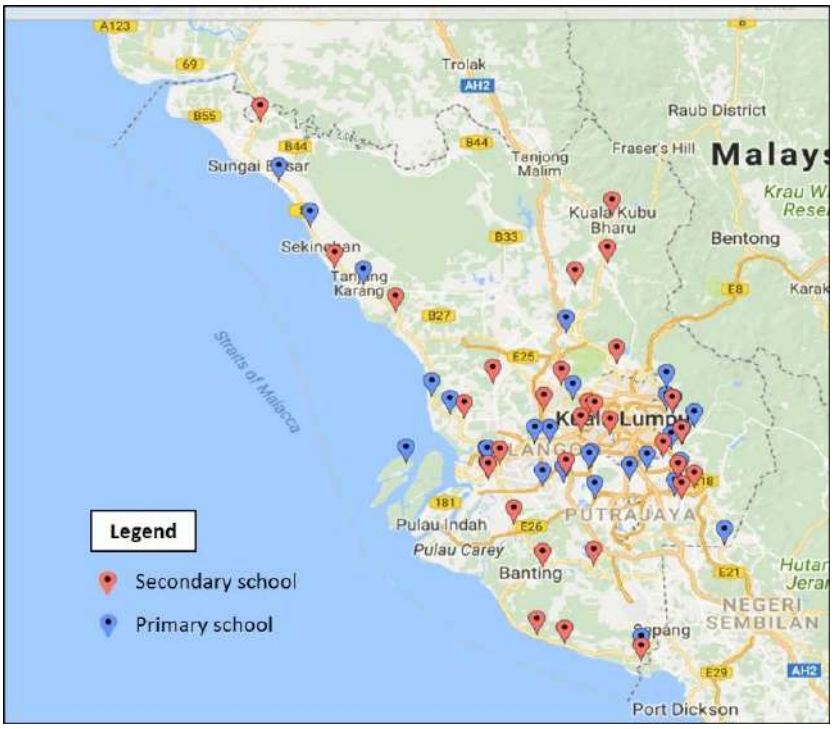


Figure 2 Distribution of study locations (created using a web-based application at https://batchgeo.com)

3.2 Road and Traffic Environment Characteristics

The scope of study for each school location lies between 300 m and 500 m in the vicinity of the school access points. For schools with more than one (1) access point on different roads where school children are present, the road with higher traffic volumes and operating speeds were selected. As the road network within school areas was dense, images for every 20 m section were captured manually on foot. Traffic cones were used

to mark every 20 m intervals (Figure 3). Figure 4 shows an exercise of data collection at one (1) of the study sites.

Figure 3 Setting up of 20 m intervals using traffic cones

Figure 4 Lane width measurement

The pedestrian and traffic volumes during school peak hour was collected using video recordings for further analysis. The number of school children walking and crossing within the study areas was derived from the recordings. Traffic speeds were collected during off-peak hours using a laser speed detector to estimate the mean and operating speeds. The mean and 85th percentile speeds were derived for star rating analysis.

3.3 Road Attribute Coding

Examination of the road attributes for each 20 m section was done manually on a spreadsheet designed to be compatible with the iRAP *Vida* processing web application. Appropriate codes were keyed in each row and column by a group of trained coders. Since the Vida application can only process road sections in 100 m length, dummy latitude and longitude were used instead of the actual location of the roads. The list of road attributes and the relevant codes are included in Appendix A.

In total, the upload file contains 78 columns with 60 of them related to the road and traffic attributes. The others were some data on the road location and coding activity information as well as several default variables reserved for future model development. Out of the 60 road attributes, four (4) of them were traffic variables i.e. traffic volume, percentage of motorcycles, mean speed and 85th percentile speed. These were added to the upload file after the coding activity as that information could not be captured through images.

3.4 Star Rating Analysis

This study employed the iRAP Star Rating model version 3.02 to calculate the risk (termed as star rating score) and generate star ratings for pedestrians, motorcyclists and bicyclists. The star rating bands are different for each user group and were set by iRAP based on the likelihood and severity components of crash risk. Table 2 shows the star rating bands for each road user group. Specifically, the bands were set based on the following five (5) inter-related issues (iRAP, 2015):

i. The safe system context and the role of speed;

ii. The expected injury severity;
iii. The role of star ratings in setting targets;
iv. The relationship between star ratings and crash rates; and
v. The distribution of star ratings across a typical road network.

Table 2 Star rating bands

Star rating	Star rating score				
	Vehicle occupants and motorcyclists	Bicyclists	Pedestrians		
			Total	Along	Crossing
5	0 to < 2.5	0 to < 5	0 to < 5	0 to < 0.2	0 to < 4.8
4	2.5 to < 5	5 to < 10	5 to < 15	0.2 to < 1	4.8 to < 14
3	5 to < 12.5	10 to < 30	15 to < 40	1 to < 7.5	14 < to 32.5
2	12.5 to < 22.5	30 to < 60	40 to < 90	7.5 to < 15	32.5 to < 75
1	22.5 +	60 +	90 +	15 +	75 +

The scores are calculated using different models which contain different combination of attributes. Figure 5, Figure 6 and Figure 7 show the star rating model used for pedestrians, motorcyclists and bicyclists respectively.

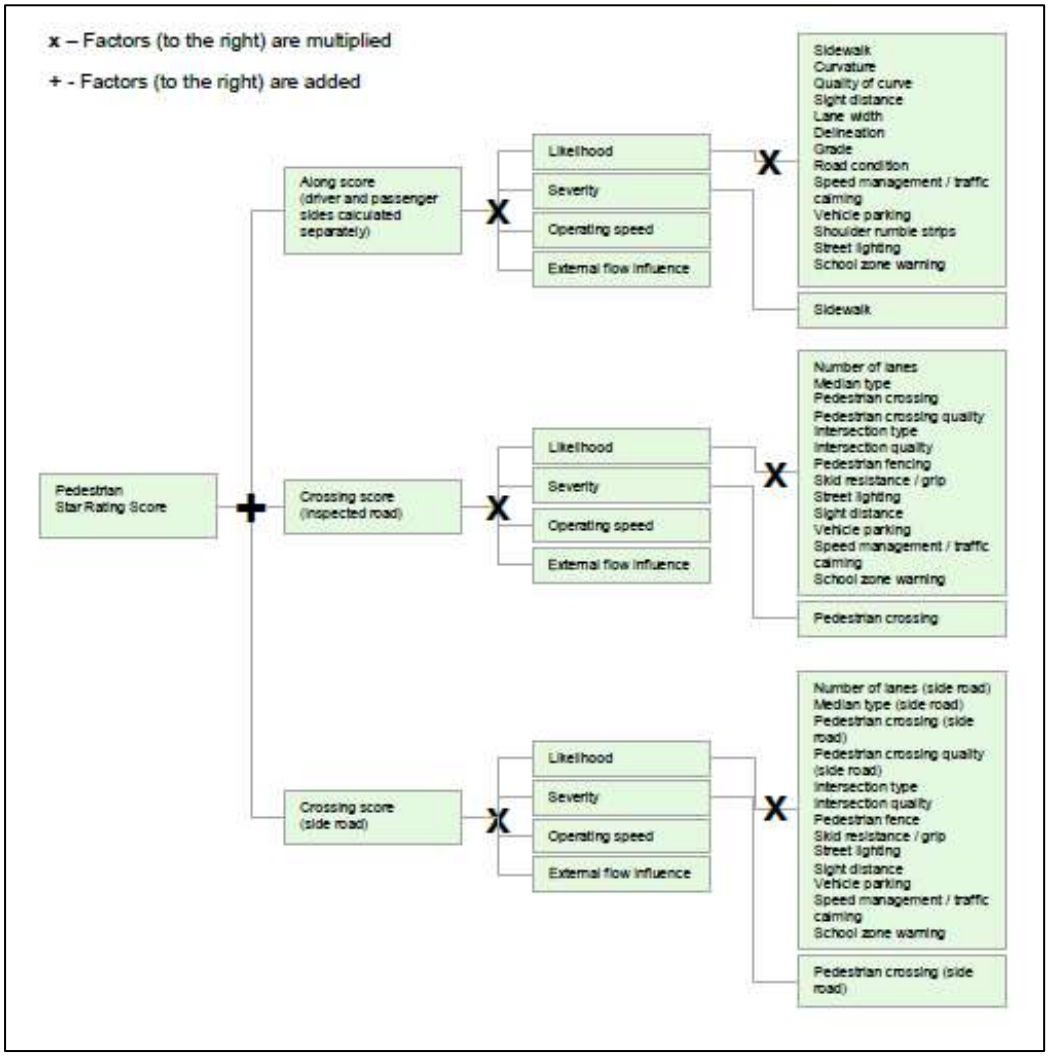


Figure 5 Star rating score equation for pedestrians (Extracted from iRAP, 2014)

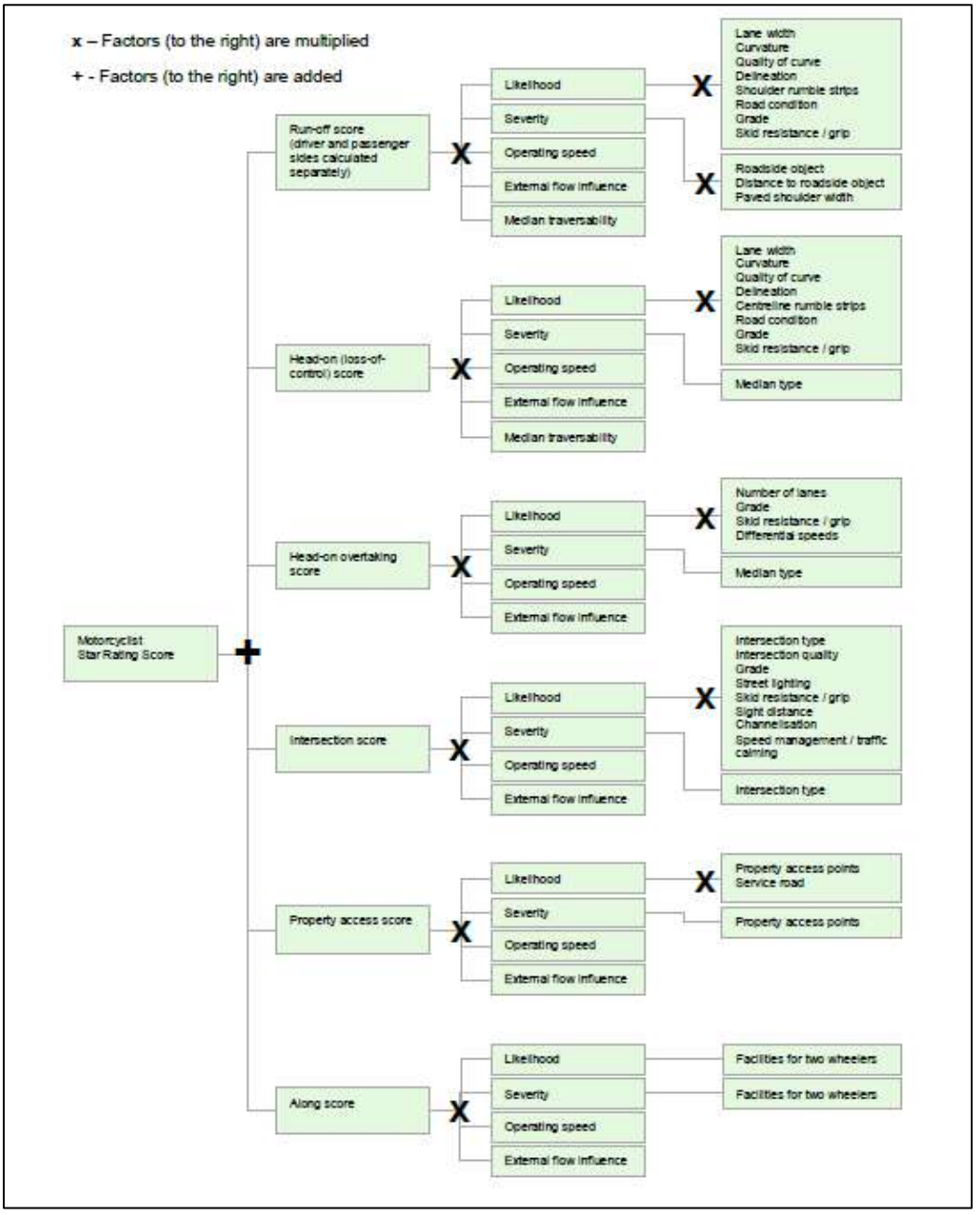


Figure 6 Star rating score equation for motorcyclists (Extracted from iRAP, 2014)

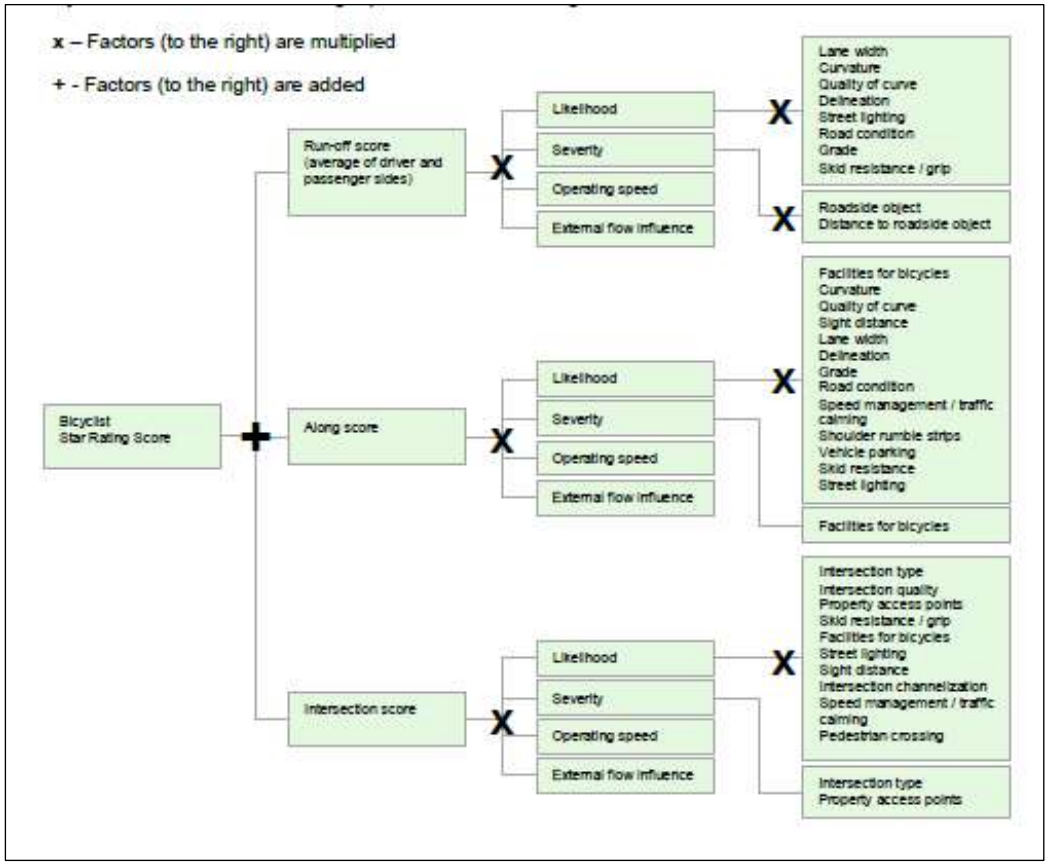


Figure 7 Star rating score equation for bicyclists (Extracted from iRAP, 2014)

4. Results and Discussions

This section provides the evaluation findings with regard to the condition of the built environment around the study sites and the influence of certain road design have on the risk (star ratings). This section is divided into two (2) subsections; analysis of road attributes and analysis of star ratings.

4.1 Road and Traffic Environment Characteristics

Based on the analysis of the collected data, the total number of study sites was reduced to 58 as there were two (2) sites with two (2) schools located along the same road. Figure 8 shows the distribution of 85th traffic operating speeds for the study sites. The highest speed was observed to be 97 km/h, which was recorded at a school located along the rural highway. The lowest was 26 km/h, measured at a school located on an urban residential road. The average 85th percentile speed was found to be 47 km/h.

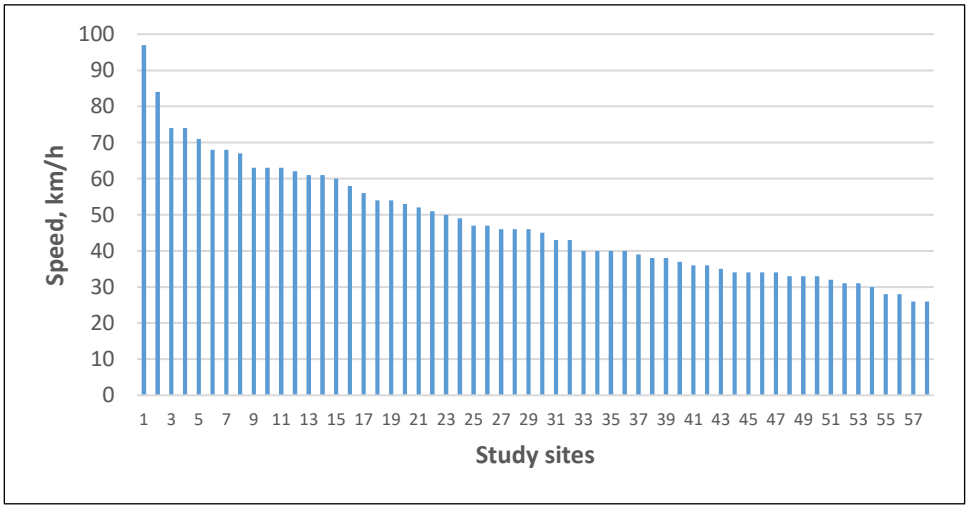


Figure 8 Distribution of 85th percentile speeds

The speed study revealed that school children or any pedestrians who walk or cross the road at 40% of the study sites during any time of the day (especially during off-peak hours) were exposed to high risk of sustaining fatal injuries. The operating speeds at these schools were measured to be exceeding the safe speed for pedestrians (50 km/h) despite having traffic calming measures (6 of them). In the event of any collisions, most probably the pedestrians will be killed (OECD, 2006).

Table 3 – 5 show the proportion of schools with traffic calming measures, traffic warden and sidewalk, the three (3) main facilities governing the likelihood and severity of crashes involving pedestrians. Table 3 shows that 40% of the schools were not having any traffic calming measures, and five (5) of them are located on roads carrying high speed traffic (85th percentile speeds > 70 km/h), of which two (2) are primary schools. Moreover, traffic warden was observed at only 20 schools, of which 17 are primary schools. Similarly, only a quarter of the study sites were found to have sidewalk, a rather worrying situation when school children were not encouraged to walk safely.

Table 3 Proportion of schools with traffic calming measures by 85th percentile speeds

	< 35 km/h	35 km/h to 70 km/h	> 70 km/h	Total
Yes	15	20	0	**35**
No	1	17	5	**23**
Total	16	37	5	**58**

Table 4 Proportion of schools with traffic warden by 85th percentile speeds

	< 35 km/h	35 km/h to 70 km/h	> 70 km/h	Total
Yes	8	11	1	**20**
No	8	26	4	**38**
Total	16	37	5	**58**

Table 5 Proportion of schools with sidewalk by 85th percentile speeds

	< 35 km/h	35 km/h to 70 km/h	> 70 km/h	Total
Yes	3	11	1	**15**
No	13	26	4	**43**
Total	16	37	5	**58**

4.2 Star Rating Analysis

Based on the coded data, star ratings were generated using the iRAP *Vida* web-based software. Figure 9 and 10 show the pedestrian smoothed ratings for primary schools and secondary schools respectively, which were calculated from the average risk scores for all the 20 m section risk scores within a site. As expected, schools with high operating speeds were rated 2-star and below, except for SK Hulu Kelang where there were an overhead bridge and pedestrian fencing to channelize pedestrians to a safer crossing point. These 1-star and 2-star schools (Figures 11 and 12) were typically located on high-speed roads, without traffic warden and proper sidewalk. On the other hand, those schools that were rated 4-star and 5-star (Figure 13) were located on low-speed roads (< 50 km/h), with traffic calming measures, with traffic warden and with sidewalk. A 3-star (Figure 14) school in this study was determined to be having almost the same characteristics of the 4-star and 5-star group, except that the operating speed is higher.

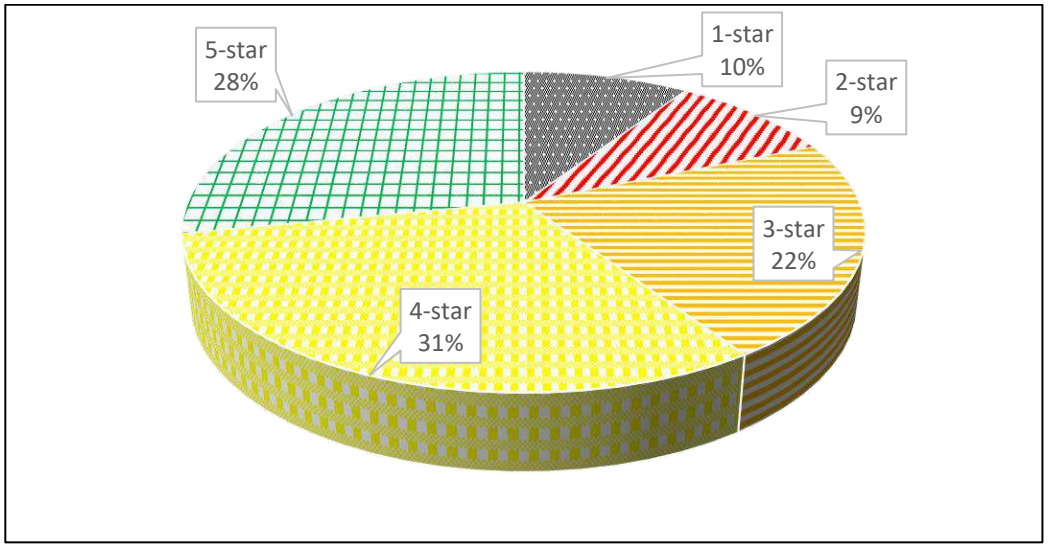


Figure 9 Pedestrian star rating results for primary schools

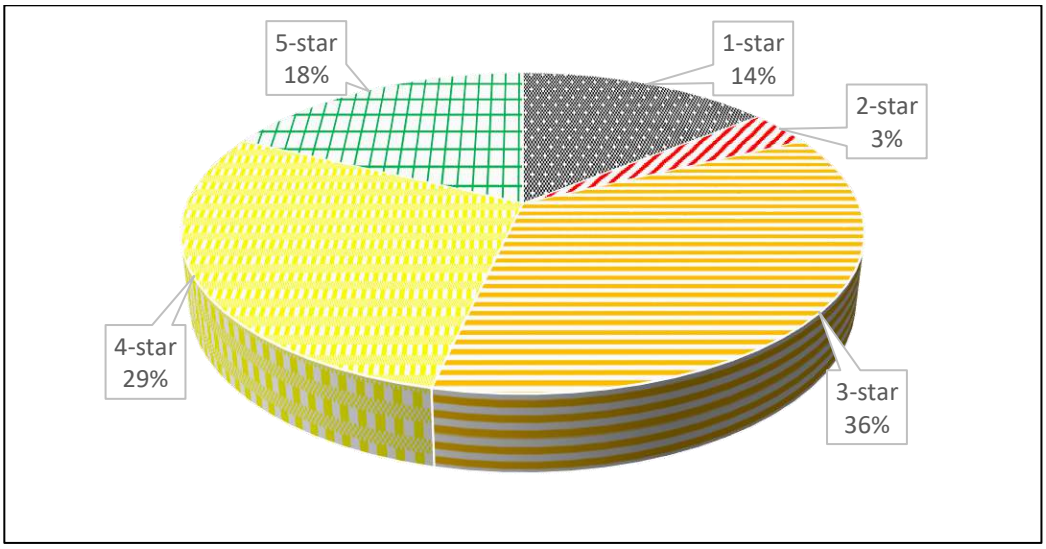


Figure 10 Pedestrian star rating results for secondary schools

Figure 11 Example of pedestrian 1-star road (SK Tambak Jawa)

Figure 12 Example of pedestrian 2-star road (SK Sungai Pelek)

Figure 13 Example of pedestrian 5-star road (SK Ampang)

Figure 14 Example of pedestrian 3-star road (SK Taman Melawati 2)

As for motorcyclists, due to low operating speeds, good road surface condition and presence of paved shoulder, 80% of the secondary schools were rated 4-star and above (Figure 15). This is despite there was no dedicated lane for motorcyclists as the main influential factor is the operating speed. Coupled with good road surface condition and wide lane, the probability of a motorcycle crash was low. Figure 16 shows an example of a 4-star road for motorcyclist.

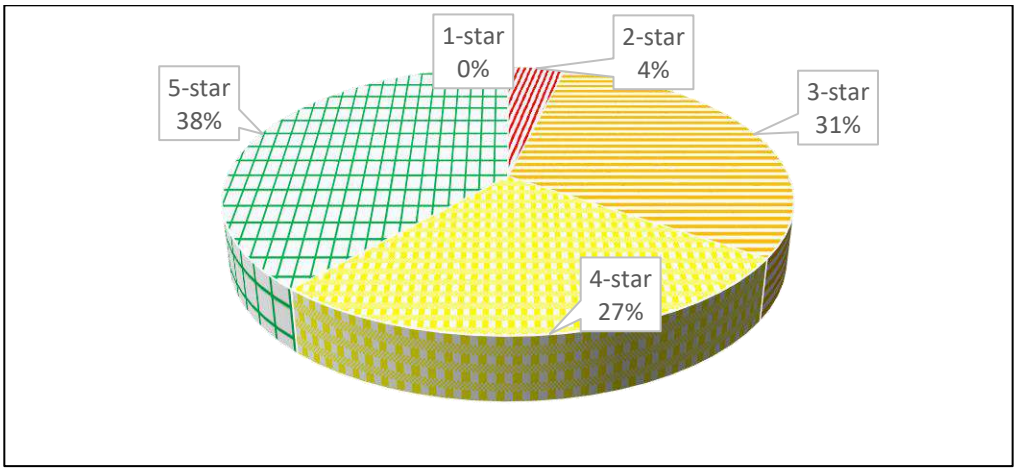


Figure 15 Motorcyclists star rating results for secondary schools

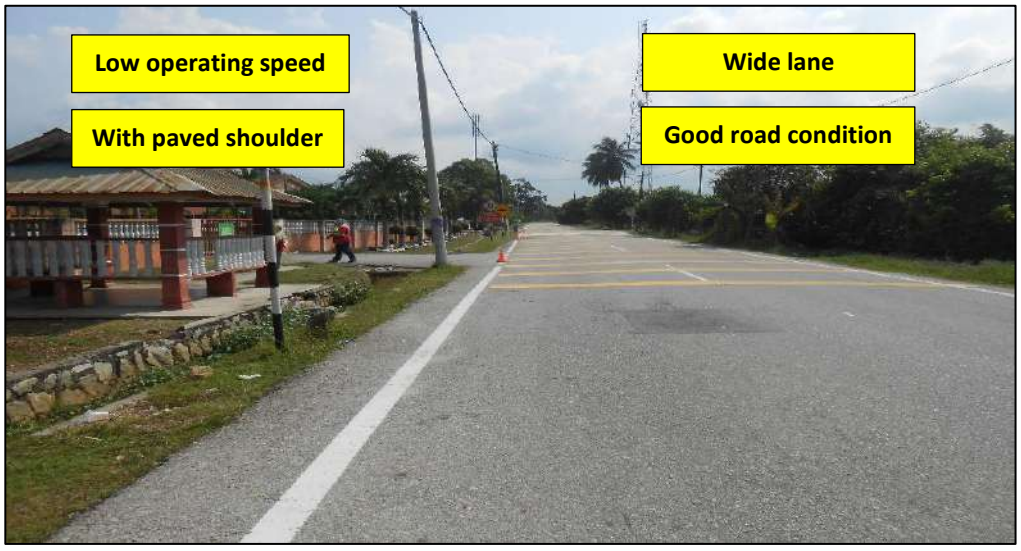


Figure 16 Example of motorcyclist 4-star road (SMK Batu Laut)

On the other hand, many primary and secondary schools were rated 4-star and above with regard to the safety of bicyclists (Figure 17 and Figure 18). The same explanation for motorcyclist applies here whereby low vehicle operating speeds reduce the likelihood of collision involving bicyclists. A good road surface coupled with wide lane provides a safe and comfortable path for bicyclists (Figure 19).

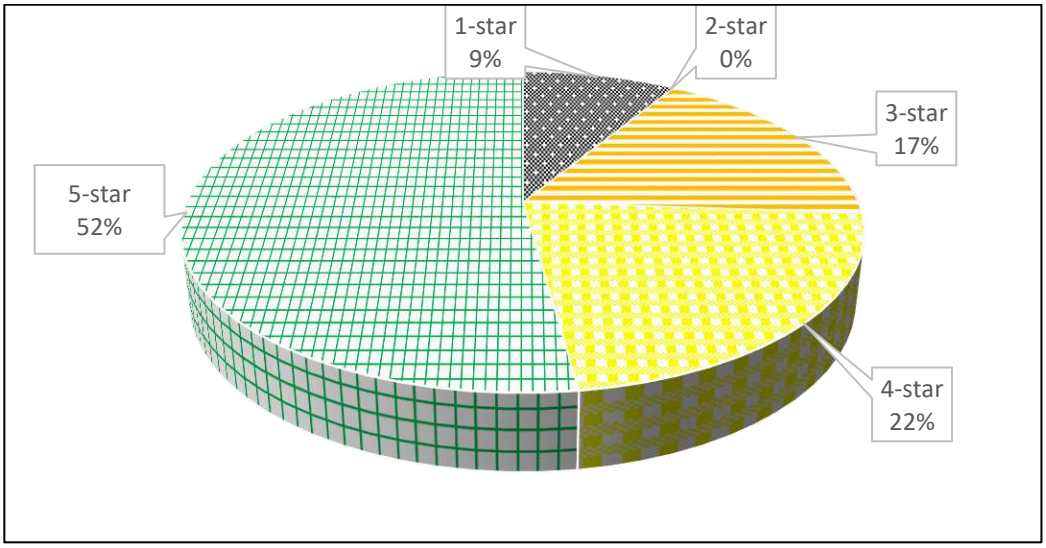


Figure 17 Bicyclist star rating results for primary schools

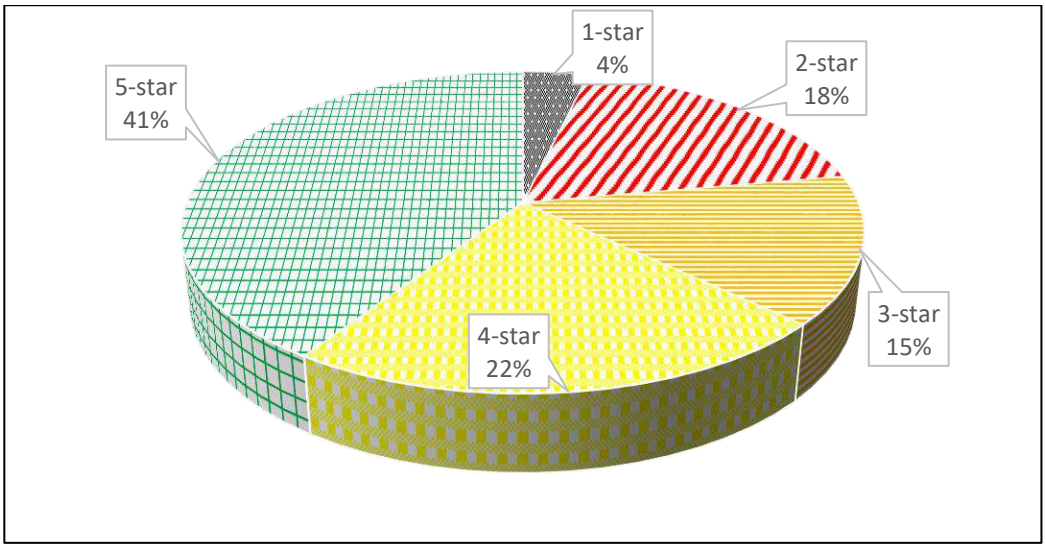


Figure 18 Bicyclist star rating results for secondary schools

Figure 19 Example of bicyclist 5-star road (SK Seksyen 7, Bangi)

4.3 Effectiveness of Pedestrian Facilities

An analysis was carried out on the average risk for group of schools with and without several road attributes related to the risk of pedestrian crashes. These facilities were identified from the list of road attributes in the pedestrian star rating model that affect the likelihood and severity of pedestrian crashes. However, the effectiveness of these facilities as revealed applies to the road environment of schools selected in this study, which was aimed at providing stakeholders with a quantifiable figure to justify improvement programmes. The use of similar figures for schools not covered in this study should be treated with caution as the road and traffic environment varies from location to location.

As far as the risk of getting hit by vehicle when crossing the road, the analysis revealed that the average risk of crossing of schools with traffic calming measures was 75% lower compared to those without. Figure 20 shows the distribution of crossing star rating

scores for schools with and without traffic calming measures. Likewise, the average risk for schools with traffic warden was 80% lower compared to those without (Figure 21). In terms of risk when walking along with the school areas, the risk for schools with sidewalk could be reduced by 37% (Figure 22).

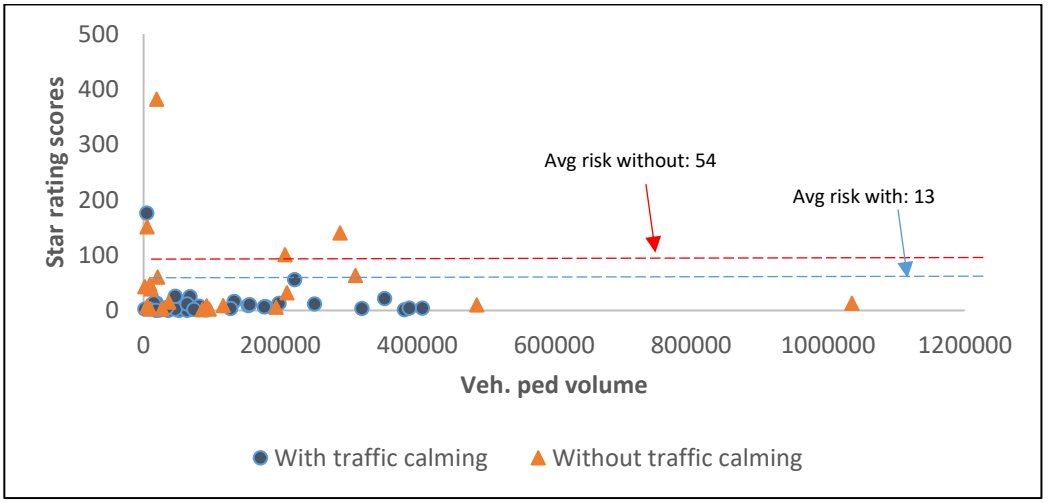


Figure 20 Distribution of pedestrian star rating scores by presence of traffic calming

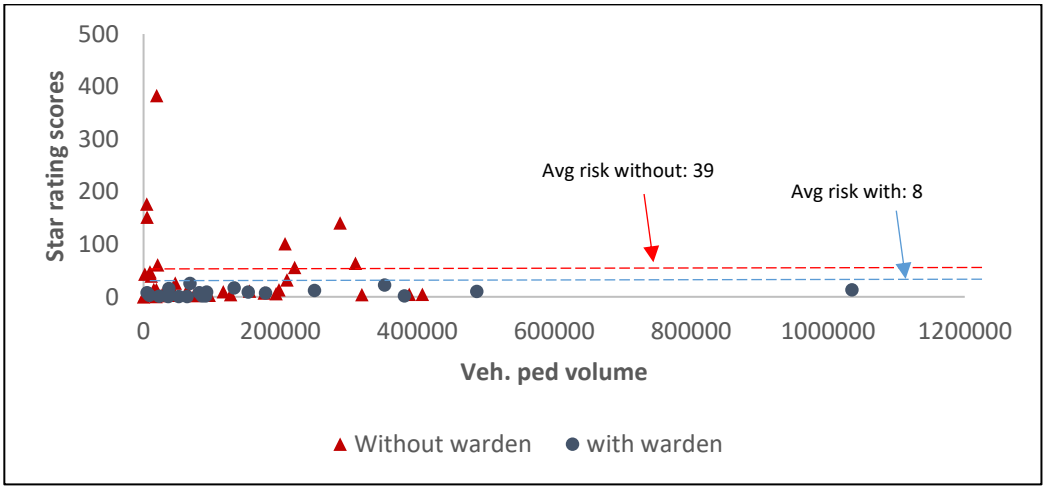


Figure 21 Distribution of pedestrian star rating scores by presence of traffic warden

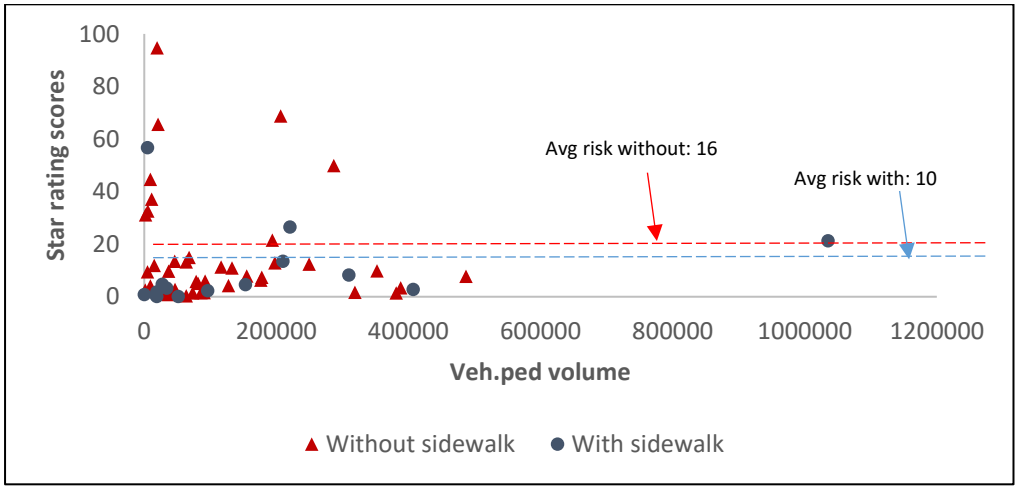


Figure 22 Distribution of pedestrian star rating scores by presence of sidewalk

5. Conclusion and Recommendations

Based on the global road casualty statistics, someone dies every 30 seconds somewhere as a result of road traffic crashes, and the number is rising. As a nation with rapid motorization and population growth for the last three (3) decades, Malaysia does observe such a worrying scenario though at a lower scale. Without an increased effort to counter such a trend, the country will see road traffic crashes be at par with HIV/AIDS as a cause of death by 2030. The vulnerable road users, specifically the pedestrians will suffer the most as the focus of road environment design is still expected to be on motorized traffic.

The road environment around school areas in this study for, example, exemplifies such a scenario where the safety of the pedestrians is compromised to a certain extent in order to provide high mobility to other motorized traffic. Several sites were found with no traffic calming measures, which could cause congestion during peak hours. Others were found without proper sidewalk, often the case when no consideration was given during the road development stage. In some cases, roadside furniture such as road signs and street lights were installed on the sidewalk due to space constraints.

The star ratings developed for each of the school sites portrayed the risk faced by the school children walking along, crossing the road, bicycling and riding motorcycles around the schools. The most critical factor was determined to be the vehicle operating speeds where school sites with higher speeds were typically rated with low star ratings. On top of segregating them by providing sidewalk, traffic calming measures and traffic warden should be in place to manage the risk during the peak hours. Higher star-rated school sites typically have any two (2) of these facilities. The average risk for school sites with traffic calming measures, traffic warden and sidewalk were found to be lower by 75%, 80% and 37% respectively compared to those without.

The iRAP star rating method used in this study to evaluate the risk faced by school children is objective enough for the relevant authorities to initiate improvement programmes. A school facing a 1-star or 2-star road for example, should be given priority for safety upgrades – as simple as providing a traffic warden or installing speed humps. School sites with 3-star and above ratings are considered acceptable but more measures should also be done to improve further due to changes in the road traffic environment from time to time – increase in vehicular volume.

References

Ampofo-Boateng, K., & Thomson, J. A. (1991). Children's perception of safety and danger on the road. *British Journal of Psychology, 82,* 487 – 505.

Connelly, M. L., Conaglen, H. M., Parsonson, B. S., & Isler, R. B. (1998). Child pedestrians' crossing gap thresholds. *Accident Analysis and Prevention, 30*(4), 443 – 453.

Dunbar, G., Hill, R., & Lewis, V. (2001). Children's attentional skills and road behaviour. *Journal of Experimental Psychology: Applied, 7*(3), 227 – 234.

Elvik, R., & Vaa, T. (2004). The handbook of road safety measures. Oxford, The United Kingdom: Elsevier Ltd.

Harruff, R. C., Avery, A., & Alter-Pandya, A. S. (1998). Analysis of circumstances and injuries in 217 pedestrian traffic fatalities. *Accident Analysis and Prevention. 30*(1), 11 – 20.

International Road Assessment Programme. [iRAP]. (2014). *iRAP road attribute risk factors: Operating and mean speeds*. United Kingdom.

International Road Assessment Programme. [iRAP]. (2013). *iRAP road attribute risk factors: Sidewalk provision*. United Kingdom.

International Road Assessment Programme. [iRAP]. (2013). *iRAP road attribute risk factors: Speed management/traffic calming*. United Kingdom.

International Road Assessment Programme [iRAP]. (2014). *iRAP road attribute risk factors: Pedestrian crossing facilities*. United Kingdom.

International Road Assessment Programme. [iRAP]. (2014). *iRAP methodology fact sheet #6: Star rating score equations*. United Kingdom.

International Road Assessment Programme. [iRAP]. (2015). *iRAP methodology fact sheet #7: Star rating bands*. United Kingdom.

McMahon, P. J., Zegeer, C. V., Duncan, C., Knoblauch, R. L., Stewart, J. R., & Khattak, A. J. (2002). *An analysis of factors contributing to 'walking along roadway' crashes: Research study and guidelines for sidewalks and walkways* (FHWA-RD-01-101). Federal Highway Administration.

Ministry of Education. (2016). Mesyuarat keselamatan murid di jalan raya semasa pergi dan balik dari sekolah. *Slides presented during a meeting with stakeholders on school children safety*. Putrajaya.

Mueller, B. A., Rivara, F. P., Lii, S. M., & Weiss, N. S. (1990). Environmental factors and the risk for childhood pedestrian-motor vehicle collision occurrence. *American Journal of Epidemiology, 132,* 550 – 560.

Organization for Economic Cooperation and Development. (2006). *Speed management report*. Paris.

Oxley, J., Corben, B., & Fildes, B. (2004). *Older vulnerable road users: Measures to reduce crash and injury risk* (MUARC Report No. 218). Melbourne, Australia.

Rivara, F. P. (1990). Child pedestrian injuries in the United States. *American Journal of Diseases of Children, 144*(6), 692 – 696.

Rosenbloom, T., Nemrodov, D., Ben-Eliyahu, A., & Eldror, E. (2008). Fear and danger appraisals of a road-crossing scenario: A developmental perspective. *Accident Analysis and Prevention, 40*(4), 1619 – 1626.

Stevenson, M. R., Jamrozik, K. D., & Spittle J. (1995). A case-control study of traffic risk factors and child pedestrian injury. *International Journal of Epidemiology, 24*, 957-964.

Velde, A. F., Kamp, J. V. D., Barela, J. A., & Savelsbergh, G. J. P. (2005). Visual timing and adaptive behaviour in a road-crossing simulation study. *Accident Analysis and Prevention, 37*(3), 399 – 406.

World Health Organization. (2015). *Global status report on road safety*. Geneva.

Appendix A

No.	Road attribute	Code	Category
1.	Carriageway	1	Carriageway A of a divided road
		2	Carriageway B of a divided road
		3	Undivided road
		4	Carriageway A of a motorcycle facility
		5	Carriageway B of a motorcycle facility
2.	Upgrade	1	Low
		2	Medium
		3	High
3.	Motorcycle observed flow	1	None
		2	1 motorcycle
		3	2 to 3 motorcycles
		4	4 to 5 motorcycles
		5	6 to 7 motorcycles
		6	8+ motorcycles
		1	None
		2	1 motorcycle
4.	Bicycle observed flow	1	None
		2	1 bicycle
		3	2 to 3 bicycles
		4	4 to 5 bicycles
		5	6 to 7 bicycles
		6	8+ bicycles
5.	Pedestrian observed flow across the road	1	None
		2	1 pedestrian along driver-side
		3	2 to 3 pedestrians along driver-side
		4	4 to 5 pedestrians along driver-side
		5	6 to 7 pedestrians along driver-side
		6	8+ pedestrians along driver-side
6.	Pedestrian observed flow along the road driver-side	1	None
		2	1 pedestrian along driver-side
		3	2 to 3 pedestrians along driver-side
		4	4 to 5 pedestrians along driver-side

		5	6 to 7 pedestrians along driver-side
		6	8+ pedestrians along driver-side
7.	Pedestrian observed flow along the road passenger side	1	None
		2	1 pedestrian along passenger-side
		3	2 to 3 pedestrians along passenger-side
		4	4 to 5 pedestrians along passenger-side
		5	6 to 7 pedestrians along passenger-side
		6	8+ pedestrians along passenger-side
8.	Land use – drivers side	1	Undeveloped areas
		2	Farming and agricultural
		3	Residential
		4	Commercial
		5	Not recorded
		6	Educational
		7	Industrial and manufacturing
9.	Land use – passenger side	1	Undeveloped areas
		2	Farming and agricultural
		3	Residential
		4	Commercial
		5	Not recorded
		6	Educational
		7	Industrial and manufacturing
10.	Area type	1	Rural
		2	Urban
11.	Speed limit	1	< 30 km/h
		3	40 km/h
		5	50 km/h
		7	60 km/h
		9	70 km/h
		11	80 km/h
		13	90 km/h
		15	100 km/h
		17	110 km/h
		19	120 km/h
		21	130 km/h
		23	140 km/h
		25	>= 150 km/h
12.	Motorcycle speed limit	1	< 30 km/h
		3	40 km/h

		5	50 km/h
		7	60 km/h
		9	70 km/h
		11	80 km/h
		13	90 km/h
		15	100 km/h
		17	110 km/h
		19	120 km/h
		21	130 km/h
		23	140 km/h
		25	>= 150 km/h
13.	Truck speed limit	1	< 30 km/h
		3	40 km/h
		5	50 km/h
		7	60 km/h
		9	70 km/h
		11	80 km/h
		13	90 km/h
		15	100 km/h
		17	110 km/h
		19	120 km/h
		21	130 km/h
		23	140 km/h
		25	>= 150 km/h
14.	Differential speed limits	1	Not present
		2	Present
15.	Median type	1	Safety barrier - metal
		2	Safety barrier - concrete
		3	Physical median width >= 20 m
		4	Physical median width 10 to < 20 m
		5	Physical median width 5 to < 10 m
		6	Physical median width 1 to < 5 m
		7	Physical median width 0 to < 1 m
		8	Continuous central turning lane
		9	Flexible posts
		10	Central hatching (> 1 m)
		11	Centre line
		12	Safety barrier - motorcycle friendly
		13	One way

		14	Wide centre line (0.3 m to 1 m)
		15	Safety barrier - wire rope
16.	Centreline rumble strips code	1	Not present
		2	Present
17.	Roadside severity – drivers side distance	1	0 to < 1 m
		2	1 to < 5 m
		3	5 to < 10 m
		4	>= 10m
18.	Roadside severity – drivers side object=	1	Safety barrier – metal
		2	Safety barrier – concrete
		3	Safety barrier – motorcycle friendly
		4	Safety barrier – wire rope
		5	Aggressive vertical face
		6	Upwards slope – roll over
		7	Upwards slope – no roll over
		8	Deep drainage ditch
		9	Downwards slope
		10	Cliff
		11	Tree >= 10 cm
		12	Non-frangible sign/ post./pole >= 10 cm
		13	Rigid structure/bridge or building
		14	Semi-rigid structure or building
		15	Unprotected safety barrier end
		16	Large boulders >= 20 cm high
		17	No object
19.	Roadside severity - passenger side distance	1	0 to < 1 m
		2	1 to < 5 m
		3	5 to < 10 m
		4	>= 10 m
20.	Roadside severity - passenger side object	1	Safety barrier – metal
		2	Safety barrier – concrete
		3	Safety barrier – motorcycle friendly
		4	Safety barrier – wire rope
		5	Aggressive vertical face
		6	Upwards slope – roll over
		7	Upwards slope – no roll over
		8	Deep drainage ditch
		9	Downwards slope
		10	Cliff

		11	Tree >= 10 cm
		12	Non-frangible sign/post./pole >= 10 cm
		13	Rigid structure/bridge or building
		14	Semi-rigid structure or building
		15	Unprotected safety barrier end
		16	Large boulders >= 20 cm high
		17	No object
21.	Shoulder rumble strips	1	Not present
		2	Present
22.	Paved shoulder – drivers side	1	Wide (≥ 2.4 m)
		2	Medium (≥ 1.0 m to < 2.4 m)
		3	Narrow (≥ 0 m to < 1.0 m)
		4	None
23.	Paved shoulder – passenger side	1	Wide (≥ 2.4 m)
		2	Medium (≥ 1.0 m to < 2.4 m)
		3	Narrow (≥ 0 m to < 1.0 m)
		4	None
24.	Intersection type	1	Merge lane
		2	Roundabout
		3	3-leg unsignalised with protected turn lane
		4	3-leg unsignalised with no protected turn lane
		5	3-leg signalised with protected turn lane
		6	3-leg signalised with no protected turn lane
		7	4-leg unsignalised with protected turn lane
		8	4-leg unsignalised with no protected turn lane
		9	4-leg signalised with protected turn lane
		10	4-leg signalised with no protected turn lane
		12	None
		13	Railway crossing - passive (signs only)
		14	Railway crossing - active (flashing lights/boom gates)
		15	Median crossing point – informal
		16	Median crossing point – formal
		17	Mini roundabout
25.	Intersection channelisation	1	Not present
		2	Present
26.	Intersecting road volume	1	≥ 15,000 vehicles
		2	10,000 to 15,000 vehicles
		3	5,000 to 10,000 vehicles

		4	1,000 to 5,000 vehicles
		5	100 to 1,000 vehicles
		6	1 to 100 vehicles
		7	Not applicable
27.	Intersection quality	1	Adequate
		2	Poor
		3	Not applicable
28.	Property access points	1	Commercial access ≥ 1
		2	Residential access ≥ 3
		3	Residential access < 3
		4	None
29.	Number of lanes	1	One
		2	Two
		3	Three
		4	Four or more
		5	Two and one
		6	Three and two
30.	Lane width	1	Wide (≥ 3.25 m)
		2	Medium (≥ 2.75 m to < 3.25 m)
		3	Narrow (≥ 0 m to < 2.75 m)
31.	Curvature	1	Straight or gently curving
		2	Moderate
		3	Sharp
		4	Very sharp
32.	Quality of curve	1	Adequate
		2	Poor
		3	Not applicable
33.	Grade	1	≥ 0% to < 7.5%
		4	≥ 7.5% to < 10%
		5	≥ 10%
34.	Road condition	1	Good
		2	Medium
		3	Poor
35.	Skid resistance / grip	1	Sealed – adequate
		2	Sealed – medium
		3	Sealed – poor
		4	Unsealed – adequate
		5	Unsealed – poor
36.	Delineation	1	Adequate

		2	Poor
37.	Street lighting	1	Not present
		2	Present
38.	Pedestrian crossing - inspected road	1	Grade separated facility
		2	Signalised with refuge
		3	Signalised without refuge
		4	Unsignalised marked crossing with refuge
		5	Unsignalised marked crossing without a refuge
		6	Refuge only
		7	No facility
		14	Unsignalised raised marked crossing with refuge
		15	Unsignalised raised marked crossing without refuge
		16	Raised unmarked crossing with refuge
		17	Raised unmarked crossing without refuge
39.	Pedestrian crossing quality	1	Adequate
		2	Poor
		3	Not applicable
40.	Pedestrian crossing facilities - side road	1	Grade separated facility
		2	Signalised with refuge
		3	Signalised without refuge
		4	Unsignalised marked crossing with refuge
		5	Unsignalised marked crossing without a refuge
		6	Refuge only
		7	No facility
		14	Unsignalised raised marked crossing with refuge
		15	Unsignalised raised marked crossing without refuge
		16	Raised unmarked crossing with refuge
		17	Raised unmarked crossing without refuge
41.	Pedestrian fencing	1	Not present
		2	Present
42.	Speed management/traffic calming	1	Not present
		2	Present
43.	Vehicle parking	1	Two sides
		2	One side
		3	None
44.	Sidewalk - drivers side	1	Physical barrier
		2	Non-physical separation ≥ 3.0 m

		3	Non-physical separation 1.0 m to < 3.0 m
		4	Non-physical separation 0 m to < 1.0 m
		5	None
		6	Informal path ≥ 1.0 m
		7	Informal path 0m to < 1.0 m
45.	Sidewalk – passenger side	1	Physical barrier
		2	Non-physical separation ≥ 3.0 m
		3	Non-physical separation 1.0 m to < 3.0 m
		4	Non-physical separation 0 m to < 1.0 m
		5	None
		6	Informal path ≥ 1.0 m
		7	Informal path 0m to < 1.0 m
46.	Service road	1	Not present
		2	Present
47.	Facilities for motorised two wheelers	1	Exclusive one way motorcycle path with barrier
		2	Exclusive one way motorcycle path without barrier
		3	Exclusive two way motorcycle path with barrier
		4	Exclusive two way motorcycle path without barrier
		5	Inclusive motorcycle lane on roadway
		6	None
48.	Bicycle facility	1	Off-road path with barrier
		2	Off-road path without barrier
		3	On-road lane
		4	None
		5	Extra wide outside (≥ 4.2 m)
		6	Signed shared roadway
		7	Shared use path
49.	Roadworks	1	No road works
		2	Minor road works in progress
		3	Major road works in progress
50.	Sight distance	1	Adequate
		2	Poor
51.	Vehicle flow (AADT)	NA	NA
52.	Motorcycle %	1	Not recorded
		2	0%
		3	1% – 5%
		4	6% – 10%
		5	11% – 20%
		6	21% – 40%

		7	41% – 60%
		8	61% – 80%
		9	81% – 99%
		10	100%
53.	Pedestrian peak hour flow across the road	1	0
		2	1 to 5
		3	6 to 25
		4	26 to 50
		5	51 to 100
		6	101 to 200
		7	201 to 300
		8	301 to 400
		9	401 to 500
		10	501 to 900
		11	900+
54.	Pedestrian peak hour flow along the road driver-side	1	0
		2	1 to 5
		3	6 to 25
		4	26 to 50
		5	51 to 100
		6	101 to 200
		7	201 to 300
		8	301 to 400
		9	401 to 500
		10	501 to 900
		11	900+
55.	Pedestrian peak hour flow along the road passenger-side	1	0
		2	1 to 5
		3	6 to 25
		4	26 to 50
		5	51 to 100
		6	101 to 200
		7	201 to 300
		8	301 to 400
		9	401 to 500
		10	501 to 900
		11	900+
56.	Bicycle peak hourly flow	1	none
		2	1 to 5

		3	6 to 25
		4	26 to 50
		5	51 to 100
		6	101 to 200
		7	201 to 300
		8	301 to 400
		9	401 to 500
		10	501 to 900
		11	900+
57.	Operating speed (85th percentile)	1	< 30 km/h
		2	35 km/h
		3	40 km/h
		4	45 km/h
		5	50 km/h
		6	55 km/h
		7	60 km/h
		8	65 km/h
		9	70 km/h
		10	75 km/h
		11	80 km/h
		12	85 km/h
		13	90 km/h
		14	95 km/h
		15	100 km/h
		16	105 km/h
		17	110 km/h
		18	115 km/h
		19	120 km/h
		20	125 km/h
		21	130 km/h
		22	135 km/h
		23	140 km/h
		24	145 km/h
		25	>= 150 km/h
58.	Operating speed (mean)	1	< 30 km/h
		2	35 km/h
		3	40 km/h
		4	45 km/h
		5	50 km/h

		6	55 km/h
		7	60 km/h
		8	65 km/h
		9	70 km/h
		10	75 km/h
		11	80 km/h
		12	85 km/h
		13	90 km/h
		14	95 km/h
		15	100 km/h
		16	105 km/h
		17	110 km/h
		18	115 km/h
		19	120 km/h
		20	125 km/h
		21	130 km/h
		22	135 km/h
		23	140 km/h
		24	145 km/h
		25	>= 150 km/h
59.	School zone warning	1	School zone flashing beacons
		2	School zone static signs or road markings
		3	No school zone warning
		4	Not applicable (no school at the location)
60.	School zone crossing supervisor	1	School zone crossing supervisor present at school start and finish times
		2	School zone crossing supervisor not present
		3	Not applicable (no school at the location)

Appendix B

No.	School name	85th percentile speed (km/h)	Pedestrian SRS	Pedestrian star rating	Motorcyclist SRS	Motorcyclist star rating	Bicyclist SRS	Bicyclist Star Rating
1.	SK Tambak Jawa	97	184.4	1	23.4	1	67.8	1
2.	SK Sungai Haji Dorani	28	1.35	5	0.83	5	0.63	5
3.	SK Sungai Leman, Sekinchan	31	1.5	5	0.66	5	0.55	5
4.	SK Ampang, Ampang	28	3.42	5	1.2	5	1.3	5
5.	SK Tanjung Karang	60	75.1	2	5.33	3	20.48	3
6.	SK Seksyen 13, Shah Alam	33	0.58	5	0.61	5	0.34	5
7.	SK Seksyen 6, Shah Alam	30	1.06	5	1.04	5	NA	NA
8.	SK Sungai Pelek	62	93.13	2	6.91	3	28.11	3
9.	SK Taman Kosas, Ampang	35	5.6	4	1.18	5	1.83	5
10.	SK Taman Melawati 2, KL	46	15.98	3	2.33	5	6.55	4
11.	SK Teluk Gadong & SK Sg Udang	40	24.59	3	2.4	5	7.84	4
12.	SK Bukit Rimau	43	13.83	4	2.68	4	NA	NA
13.	SK Hulu Klang	84	18.12	4	16.14	2	142.54	1
14.	SJK Tamil Castlefield	34	3.06	5	0.8	5	1.06	5

15.	SJK Cina Ying Wah	71	17.23	3	1.96	5	NA	NA
16.	SK Batu 9, Cheras	47	14.58	4	NA	NA	5.92	4
17.	SK Bandar Puchong 2	61	26.03	3	4.27	4	NA	NA
18.	SK Pulau Meranti	40	7.45	4	1.6	5	NA	NA
19.	SK Putra Heights 2	63	40.55	3	4.63	4	13.85	3
20.	SK Seksyen 9, Kota Damansara	53	15.94	4	3.32	4	NA	NA
21.	SK Sinaran Budi	46	34.54	3	3.42	4	7.8	4
22.	SK Jalan Semenyih 1	38	28.49	3	2.62	4	7.29	4
23.	SK Saujana Impian	31	3.19	5	1.15	5	1.14	5
24.	SK Sungai Binjai	63	77.37	2	5.78	3	27.15	3
25.	SK Taman Sg. Besi Indah	34	3.47	5	1.13	5	1.55	5
26.	SK Dusun Nanding, Hulu Langat	40	4.87	5	1.47	5	2.14	5
27.	SK Taman Universiti	49	10.59	4	3.39	4	4.68	5
28.	SK Tun Abd Aziz Majid	67	126.35	1	10.4	3	NA	NA
29.	SK Seksyen 7, Bangi	47	12.33	4	2.97	4	4.82	5
30.	SJK Cina Pandamaran B	46	14.77	4	1.91	5	4.67	5
31.	Kolej Vokasional Sultan Abd Samad	58	234.7	1	8.92	3	39.24	2

32.	SMK Alam Megah, Shah Alam	33	3.72	5	0.96	5	1.54	5
33.	SMK Batu Laut, Tanjung Sepat	45	26.6	3	4.86	4	8.51	4
34.	SMK Bukit Changgang	52	40.56	3	3.98	4	10	4
35.	SMK Convent, Klang	56	34.82	3	5.07	3	24.66	3
36.	SMK Pandamaran Jaya, Klang	43	25.31	3	2.68	4	8.52	4
37.	SMK Pantai Sepang Putra	38	5.22	5	1.58	5	2.22	5
38.	SMK Pengkalan Permatang	74	192.14	1	10.04	3	42.97	2
39.	SMK Puncak Alam	50	26.92	3	3.82	4	8.65	4
40.	SMK Sungai Burung	32	5.81	4	1.09	5	NA	NA
41.	SMK Tanjung Sepat, Banting	61	46	2	5.58	3	17.76	3
42.	SMK Teluk Panglima Garang	68	166.97	1	9.51	3	49.36	2
43.	SMK Bandar Baru Sg. Buloh	74	480.23	1	16.15	2	75.44	1
44.	SMK Bandar Utama Damansara 2	54	35.18	3	4.81	4	10.37	3
45.	SMK Bukit Sentosa 2	36	21.01	3	4.76	4	7.15	4
46.	SMK Damansara Utama	33	3.29	5	1.07	5	1.54	5
47.	SMK Kelana Jaya	54	8.83	4	3.27	4	6.06	4
48.	SMK Syed Mashor, Batang Kali	51	35.14	3	6.53	3	28.54	3

49.	SMK Tengku Idris Shah, Kapar	63	61.91	3	7.64	3	34.7	2
50.	SMK Bandar Tun Hussein Onn 2	36	13.32	4	1.79	5	4.37	5
51.	SMK La Salle, PJ	26	0.92	5	0.65	5	0.43	5
52.	SMK Selayang Bharu	34	7.44	4	1.56	5	2.7	5
53.	SMK Dato Hj. Kamaruddin	37	5.14	5	1.65	5	1.83	5
54.	SMK Dusun Nanding	40	8.84	4	1.45	5	4.06	5
55.	SMK Jalan Reko Kajang	26	8.07	4	NA	NA	2.83	5
56.	SMK Sultan Abdul Aziz Shah	34	7.98	4	NA	NA	2.49	5
57.	SMK Taman Kosas, Ampang	39	4.86	5	1.94	5	2.08	5
58.	SMK Setia Alam	68	83.85	2	6	3	33.61	2

Note:

1. SK – Sekolah Kebangsaan
2. SMK – Sekolah Menengah Kebangsaan
3. SJK – Sekolah Jenis Kebangsaan
4. NA – Not Applicable (no observed flow)

Research Report

Evaluating Road Safety Risks at Schools in Selangor: An iRAP Approach

Designed by: MIROS

MIROS
MALAYSIAN INSTITUTE OF ROAD SAFETY RESEARCH
ASEAN ROAD SAFETY CENTRE

Malaysian Institute of Road Safety Research
Lot 125-135, Jalan TKS 1, Taman Kajang Sentral
43000 Kajang, Selangor Darul Ehsan
Tel: +603 8924 9200 **Fax:** +603 8733 2005
Website: www.miros.gov.my **E-mail:** dg@miros.gov.my

ISBN 978-967-2988-18-2
9 789672 988182