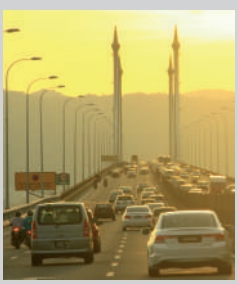
MRR No. 399



Research Report

The Safer2School App – Development of a Road Safety Data Repository and Analysis System at Vicinity of School

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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

Muhammad Marizwan Abdul Manan
The Safer2School App: Development of a Road Safety Data Repository and Analysis System at Vicinity of School / Muhammad Marizwan Abdul Manan, Hizal Hanis Hashim, Muhammad Ruhaizat Abd Ghani, Hawa Mohamed Jamil, Nur Fazzilah Mohamed Nordin, Siti Zaharah Ishak, Khairil Anwar Abu Kassim.
(Research Report; MRR No. 399)
ISBN 978-967-2988-19-9
1. Traffic surveys.
2. Roads--Safety measures.
3. Traffic safety.
4. School accidents--Prevention.
5. Government publications--Malaysia.
I. Khairil Anwar Abu Kassim. II. Nur Fazzilah Mohamed Nordin.
III. Hawa Mohamed Jamil. IV. Muhammad Ruhaizat Abd Ghani.
V. Hizal Hanis Hashim. VI. Siti Zaharah Ishak.
VII. Title. VIII. Series.
388.31

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

Typeface: Calibri
Size: 11 pt.

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Acknowledgements

The authors would like to express their sincerest appreciation to the former Director-General of the Malaysian Institute of Road Safety Research (MIROS), Professor Wong Shaw Voon, Ph.D., for providing his full support in producing this report. Our deepest gratitude goes to the former Director of Road Engineering and Environmental Research Centre, Siti Zaharah Ishak, Ph.D., who has assisted in this study. Finally, the authors would also like to express special thanks to the team members and research assistants for their contribution towards the completion of the project.

Abstract

Majority of schools in Malaysia have provided with good facilities. However, accidents still occur in the vicinity of schools. Safer2School is the first of its kind, web-based application that provides comprehensive road infrastructure safety assessment around the vicinity of schools in Malaysia. The app allows engineers, researchers and related authorities to deposit road infrastructure attributes and make general road safety assessment, which was based from the iRAP star rating for schools and the Schoolchildren Traffic Conflict (TCSchool) model developed by MIROS. Teachers, parents and school authorities can also give feedbacks and view the road safety assessment on their school vicinity. The app is also able to assign specific countermeasures based on the iRAP assessment that could be helpful for authorities to improve the safety at school. The Safer2School app is also being developed with the intention of allowing a continuous database input and update from various level of users towards continuous improvement on the road safety in the vicinity of the school in Malaysia.

1. Introduction

A study done by Abdul Manan, Alvin Poi, and Ahmad Farhan (2010) shows that the number of child pedestrian casualties in the vicinity of schools in total is found to be in a decreasing trend since 1995, but unfortunately casualties at crossing point within the vicinity show a consistent trend (see Figure 1). Therefore, it is clear that, in order to reduce the number of casualties among school children, they must be protected by means of providing road safety measure that could ensure secure and safe crossing environment around schools in Malaysia (Abdul Manan & Alvin Poi, 2010). Appropriate interventions such as engineering treatments or enforcement measures in the vicinity of schools are thus important to be incorporated as part of the national road safety strategies (Caltrans, 1996). Furthermore, it is important to stress that regardless of the school location, the safest and most effective traffic control is achieved by the uniform application of realistic policies, practices, and standards based on sound engineering principles and engineering judgment (ADOT, 2006; THINK!, 2010)

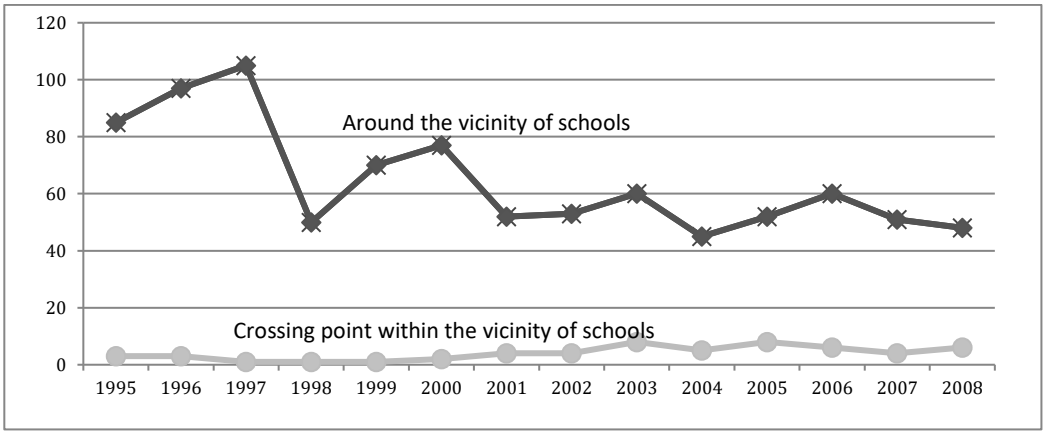

Figure 1 Child pedestrian (6 -18 years) casualties around school areas & at crossing point (Data – PDRM, Analysis - MIROS, 2008)

The government is committed to ensure that the road crash fatalities be reduced and towards achieving, one (1) of various strategies was in implementing a Road Safety Education program in primary schools within Malaysia (Kulanthayan, Hussain, Ahmad Hariza, & Law, 2016). Findings show road safety education is showing a promising sign on declining trend of road casualties over the period (Kulanthayan et al., 2016). Developed countries has shown that the most important factor in effective road safety education is that it should be practical and active and at the roadside (THINK!, 2010). Moreover, research with children has shown that they learn best when they are actively involved in their own learning about staying safer on the road (THINK!, 2009, 2010). However, the situation in Malaysian now is that there are few feedbacks and reaction received from students, teachers and parents regarding the school road environment and matters relating to road safety at their school. Thus, a mechanism is needed that would allow students, parents and teachers to give their response into this matter.

Although in most schools facilities, i.e. zebra crossing, pedestrian bridge, traffic warden and traffic signals, are provided to help these school children cope with the tasks of crossing the road as well as cycling on the road, it does not fully protect the lives of those who failed to make use of them. Moreover, accidents still occur in the vicinity of schools (see Abdul Manan and Alvin Poi (2010)), which may be caused by the inappropriate actions taken by school children, the inabilities of drivers to notice the presence of school children crossing the road, the poorly maintained pedestrian facilities or the combination of each of these.

In order to make a road safety strategies and policies pertaining to the safety of our school students sustainable, a road safety data system must be establish in order to assess and monitor the road safety at school area. The data that are required in order to establish a road safety database for schools in Malaysia are for example: number of traffic crashes in the vicinity of the school, information regarding the availability of traffic calming infrastructure around the school, presence of pedestrian crossing, availability of sidewalks and handrail, presence of traffic warden, travel exposure data to the school, etc. (iRAP, 2014a; RISMET, 2011).

A road safety related data are used by a variety of stakeholders, for example the police, transport departments, health facilities, insurance companies, as well as policymakers and practitioners (WHO, 2010). These data can also be used in the media to make the general public more aware of legislation and changes in behaviour that will improve students'' safety around school areas (Queensland, 2011). A reliable road safety data pertaining schools for example, are important in persuading political leaders that road traffic injuries within school area are a priority issue not just to parents but also to the country's national wealth (WHO, 2010).

1.1 Aim and Objectives of the Study

The objective of this research project is to develop a web-based application that allows engineers, researchers and road authorities to deposit road infrastructure attributes and make general road safety assessment while giving access to teachers, parents and school authorities give feedbacks and view the road safety assessment on their school vicinity.

1.2 Scope and Limitation of the Study

The project limitation was to develop a database application focusing on storing road infrastructure data, perform simple analysis, assign countermeasures and receive feedbacks from by various level of users and stakeholders of schools in Malaysia.

2. Literature Review

There are many road inventory database system available in the market for the purpose of road maintenance planning and execution and also in the subject of understanding how roadway design factors (e.g. curvature, lane width, roadside design) affect the level of safety (RISMET, 2011). These databases include data such as crash data, roadway inventory data, road attributes data, traffic flow data, etc.

Complementing crash data or surrogate to it is the iRAP, or the International Road Assessment Program, which is a form of risk mapping program utilising star rating as indicator (iRAP, 2014b). Star ratings are an internationally recognised measure of risk on roads which have been developed by iRAP (Lawsona, Barlowb, Poranc, Petrosyand, & Ševroviće, 2016). Star Ratings are an objective measure of the likelihood of a road crash occurring and its severity (iRAP, 2014b). The focus is on identifying and recording the road attributes which influence the most common and severe types of crash, based on scientific evidence-based research (Lawsona, et al., 2016). Research shows that a person's risk of death and serious injury is highest on a one-star road and lowest on a five-star road (Harwood, Bauer, Gilmore, Souleyrette, & Hans, 2009; iRAP, 2014b; Lawsona, et al., 2016). Recently, iRAP have introduce the iRAP Star Rating for school which harness the power of the iRAP Star Ratings to measure the risk children are exposed to on their journey to school (iRAP, 2014a).

Road (network) inventory studies serve to collect data describing the road network in terms of the actual cross-sectional elements and the vertical and horizontal alignment (RISMET, 2011; WHO, 2010). These data are essential for network (Asset) management and are extensively used for managing road rehabilitation programs, maintenance of signing and marking (incl. Inventory management) etc. (WHO, 2010). Furthermore, descriptive data of the road network is also extensively used in traffic safety analysis and road safety management, more specifically in describing the relationship between geometric criteria, traffic volumes, road crashes and/or driver behaviour (Elvik, 1988; RISMET, 2011).

3. Methodology

The language and server used to develop this software are open sources based by which no license of maintenance fee was required. Table 1 shows the Safer2School software specification. The language and server used to develop this software are open sources based on which no license of maintenance fee was required. All coding and software interface in Safer2School were developed in-house at MIROS. The only third-party application applied in web-system was the Google Maps, and the reason behind applying it into Safer2School is that the map is regularly being updated.

Table 1 Safer2School web based application software specification

No.	Technical specification	Web system
1	Scripting language	PHP 5.5.34, HTML
		Cascading Style Sheet (CSS)
		JavaScript
2	Web server	Apache
3	Framework	CodeIgniter 3.1.2
4	3rd-party Application Program Interface (API)	Google Maps
5	Tools/Integrated Development Environment (IDE)	-
6	Database	MySQL
7	Hardware	-

Figure 1 shows the process flow of the Safer2School web-based application. There are five (5) modules or functions of the app: **Authentication, Dashboard, Risk Assessment, Data Query and Data Input**. Safer2School app was developed with the intention of allowing three different user type accesses certain module function (see Figure 1). User 1 can access all modules, and they are **researchers, engineers** and **road authorities** who are familiar with road traffic engineering. User 2 can access up to four (4) modules and

they are **teachers, parents** and **school authorities.** As for User 3, they are the **public** or **road users** and can only access up to three (3) modules only.

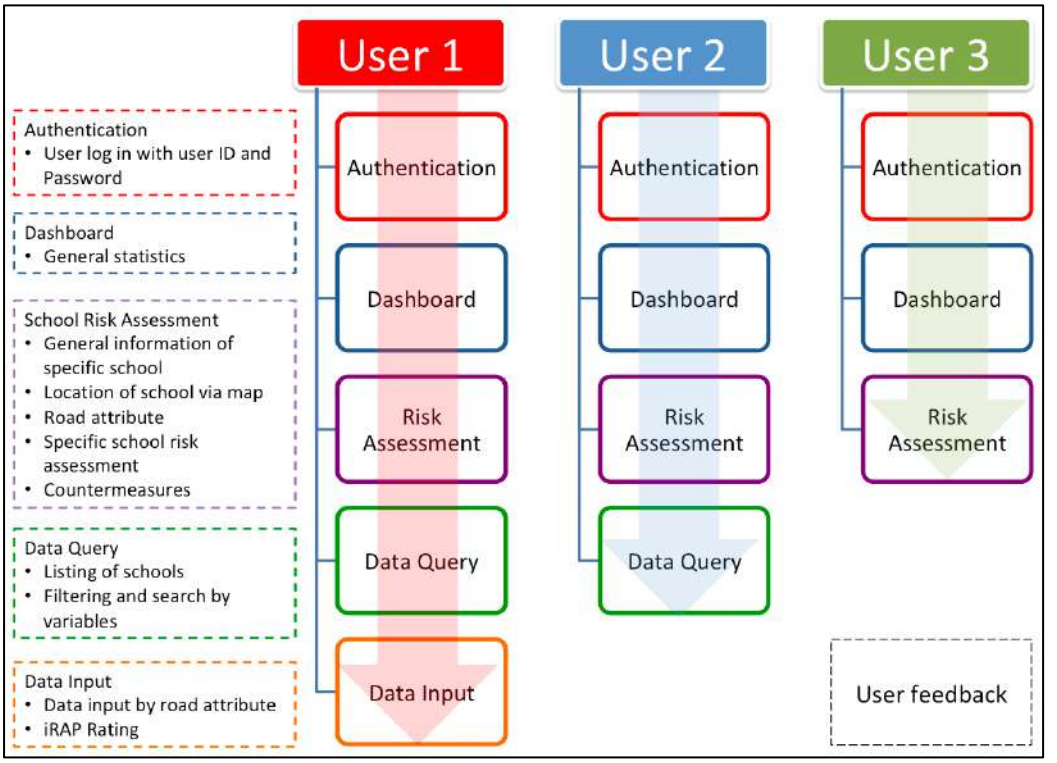

Figure 2 The process flow of the Safer2School web-based application

The main function of the app is to stores and retrieve basic information (i.e. school name, location, type, etc.) and road safety data (i.e. road attributes and risk assessment) for every school in Malaysia. The basic information of all schools in Malaysia was obtained from the Ministry of Education (MOE) of Malaysia. The second function of the app assesses the road safety level around the school vicinity, and this is done in the **Risk Assessment** module. This module allows user to see the overview information of the school, the road attributes associated with the schools, the risk assessment results and the proposed road safety countermeasures for the school. The risk assessment was based on the iRAP star rating for school and the newly developed Schoolchildren Traffic

Conflict (TCSchool) model by MIROS. The roads in the vicinity of the schools examined and rated by experts (i.e. iRAP trained personnel) and the focus of the rating was on the Pedestrian Star Ratings (iRAP, 2014a). Currently, the exercise of giving star rating is carried out by the Malaysian Institute of Road Safety Research (MIROS), which is one of the iRAP Centre of Excellence (iRAP, 2017). The third module of the app is the **dashboard**, which allows users to view the location of each school in Malaysia, general statistics and the assigned countermeasures. As for the TCSchool model, users allows users to view the estimated number of schoolchildren-vehicle conflict count around the school vicinity, computed from the formula below:

$$Log\ \hat{\mu} = -0.479 + 0.004X_1 + 0.645X_2 + 1.206X_3 \quad (1)$$

Where:

$\hat{\mu}$: Estimated number of schoolchildren-vehicle conflict count around the school vicinity
X_1: Schoolchildren volume (count)
X_2: Primary road
X_3: Secondary road

The third module is the **Data Query** module, which allows users to make searches and filter on relevant schools. The last module, i.e. **Data Input**, caters for specific users' need to enter new information pertaining to school infrastructure properties (measurements, description, type, etc.) and input road safety information such as iRAP Star Rating and schoolchildren count. These inputs from the experts are also being used for the iRAP star rating for schools. The expert users are **researchers, engineers or road authorities** who are well versed with road engineering attributes and elements. A part from these modules, there is a section in the application where the general **public** or **road users** give any road safety feedbacks (reports of incident or crash, reports of inappropriate student behaviour, etc.) on the designated school.

4. Results

This section demonstrates the web-based application capabilities in performing its module (i.e. Database, Analysis, Dashboard and User input). For this section, we have use school data from the state of **Selangor** for demonstration.

4.1 The Authentication Module

The **Authentication** module initiates the application via user log in with user identification and password (see Figure 3). The user id determines the user type and the level of access into the modules. After the user authentication process, all users can access the **Dashboard** module, which allows users to view information on the general statistics on number of schools being access and the overall assessment of schools.

Figure 3 Screenshot of the main page for user authentication

4.2 The Dashboard Module

When one (1) access the web-based application, all users can access the dashboard module which consists of 5 function tabs, which are: 1) Dashboard, 2) Risk assessment, 3) Data Query, 4) Data Input and 5) Feedback (see Figure 4). The dashboard module performs basic and simple statistical analysis from the database. In this case, the result from the analysis shows that 70% (n=244+411) of the schools in Selangor are categorised as Primary school (Rendah) while only 51.4% (n=478) of schools in Selangor have been star-rated by iRAP (see Figure 4). The analysis also shows the number of schools based on the different district (Bandar Surat) and the number of schools received number of stars.

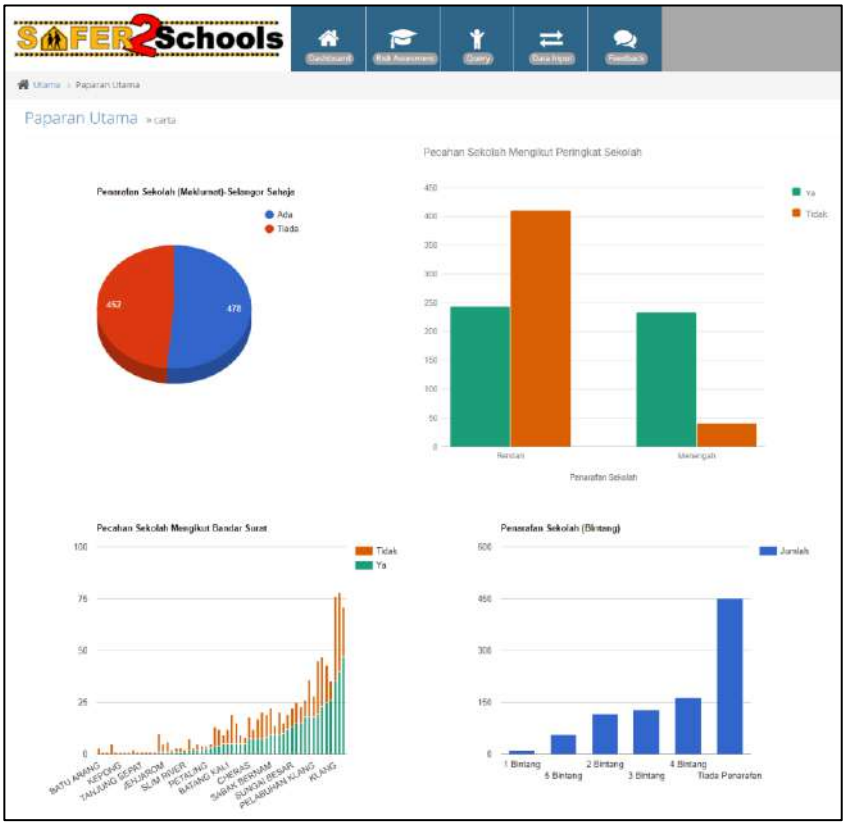

Figure 2 Screenshot of the main dashboard tab of Safer2School app

4.3 Risk Assessment Module

The Risk Assessment module allows all user type to view general information of the specific schools and its location in a map, and information on the road attributes nearby the school vicinity in the sub-tab (See Figure 5). The map also shows the location of each school in Selangor (via colour coded pin-markers), with their respected iRAP star-rating labels (Petunjuk).

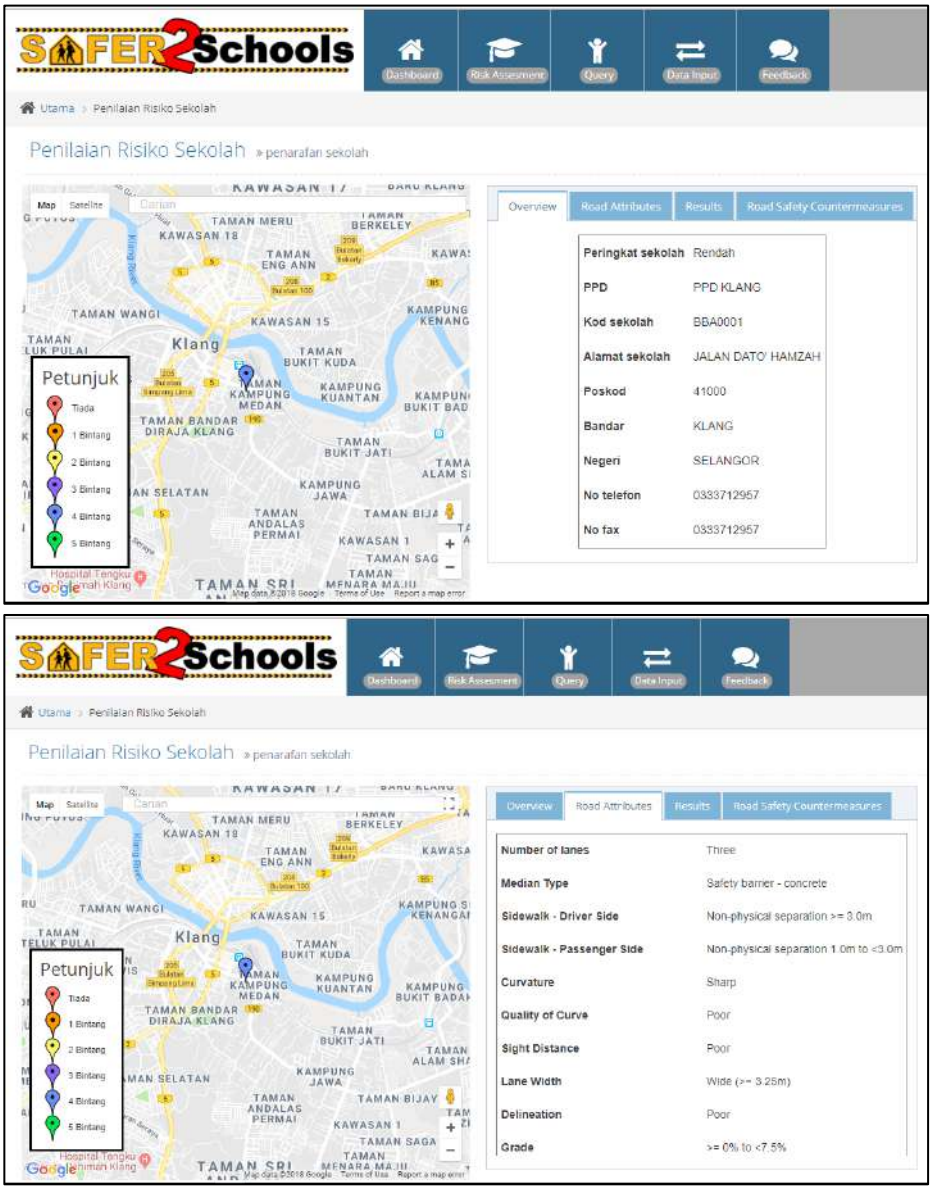

Figure 5 Screenshot of the risk assessment module – Overview & road attributes

The result tab presents the Risk Assessment findings, which is based on three (3) assessments: the iRAP Star Rating, the estimated number of Schoolchildren-vehicle

conflict around the school vicinity, and the Pedestrian Facility Utilization Rate (see Figure 6). The more star is given to a school may indicate that the school road environment has a low risk of a crash to occur among schoolchildren. While if the pedestrian facility utilisation rate is high (e.g. > 50%), then the risk of schoolchildren being to exposed to the road or being hit by a vehicle in the vicinity of school is low.

The Road Safety Countermeasure tab will allow the user to view the proposed countermeasures, which was based on the iRAP Star Rating (see Figure 6). The recommendation of each countermeasure is based on road elements, such as curvature, road delineation, road condition, street lighting, etc.

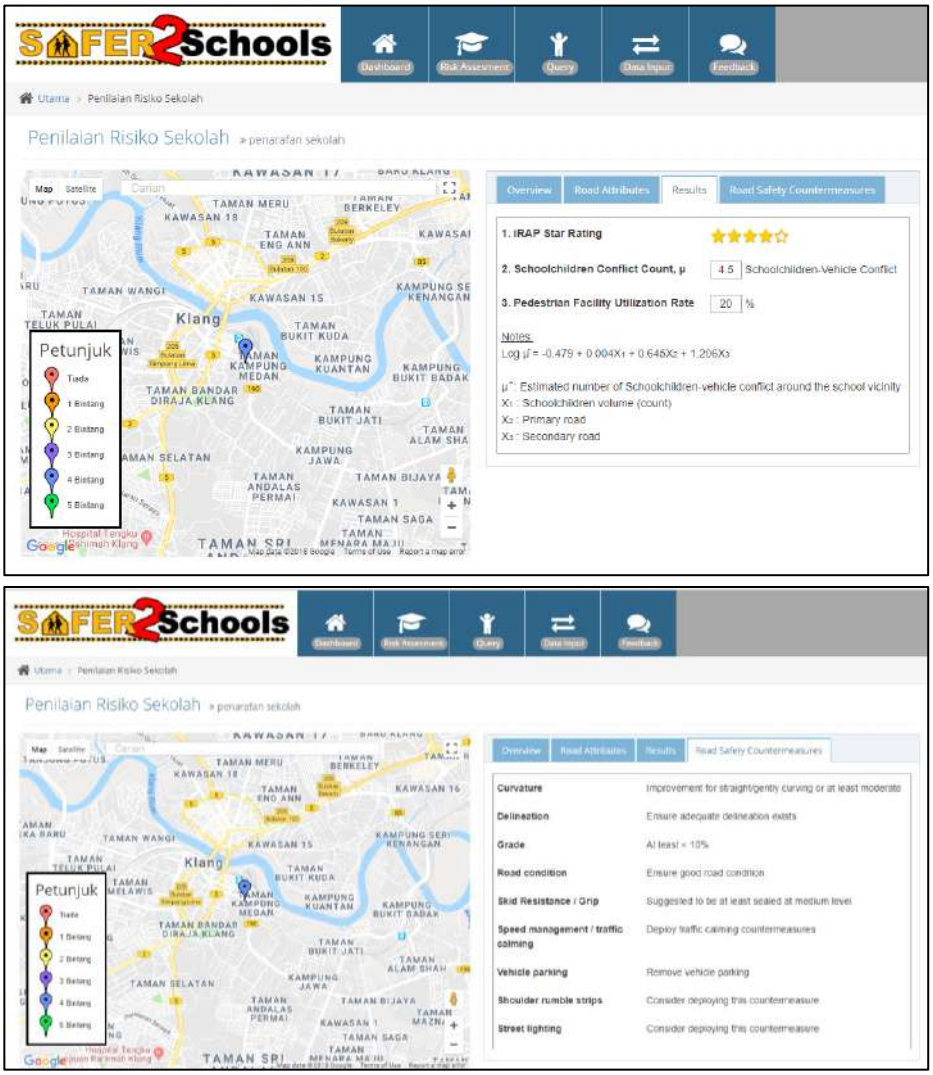

Figure 6 Screenshot of the Risk Assessment module – Results & Road Safety Countermeasures

4.4 Data Query Module

Figure 7 shows the screen shot of the Data Query module of the Safer2School app. This module can be accessed at the third tab at the dashboard, “Query”. The module function allocates a column for the school code (Kod Sekolah), the school name (Nama sekolah), the school address (Alamat), district which the school lies in (Bandar Surat) and the current iRAP Star Rating for school (Penarafan). Each column has a sort function, which allows user to sort school, especially by its iRAP star rating. The database module also allows user to make searches and filter on relevant schools. Currently for this study, the database holds information on 930 schools in Selangor.

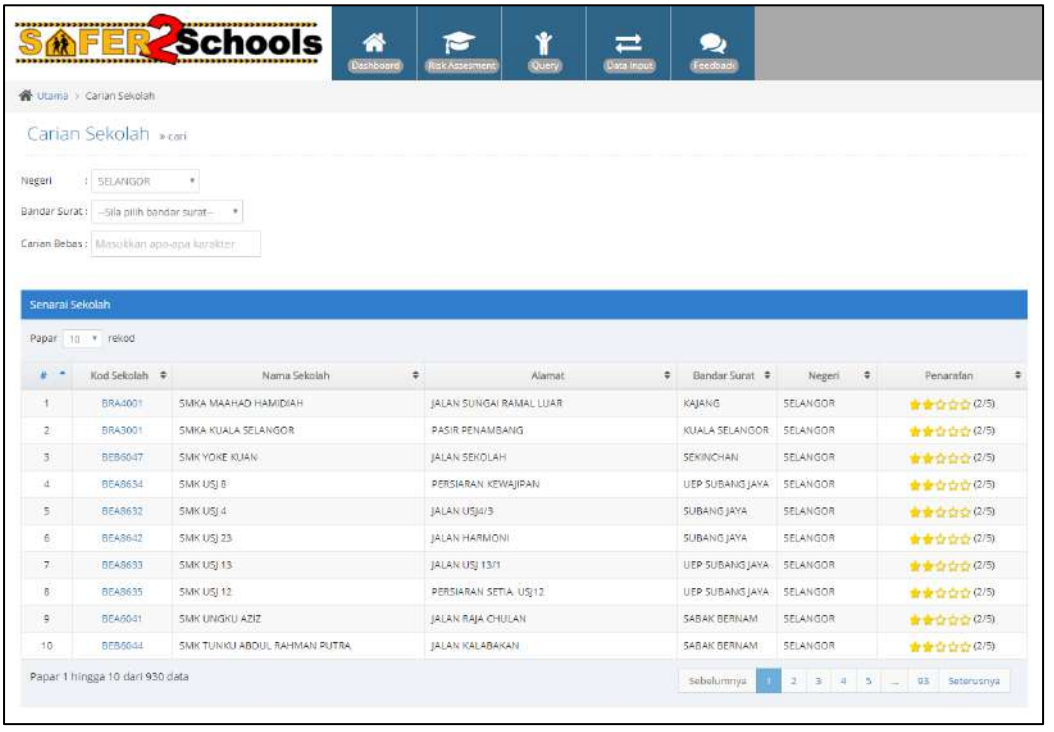

Figure 7 Screen shot of the Data Query module of Safer2School app

4.5 Data Input Module

The Data Input module (accessed at the 'Data Input' tab) exclusively for users type 1 has four (4) sections of assessment, i.e. General info, Road Environment, Road Geometry and Road Infrastructure (see Figure 8). These options were based on the iRAP assessment module and were integrated into the module in order standardised with international standards and also to ease the users. Furthermore, some of the categories are assisted with pop-up pictures for better understanding (see Figure 8). Table 2 and Table 3 show the entire options for the respective assessment section for Road Environment, Road Infrastructure and Road Geometry.

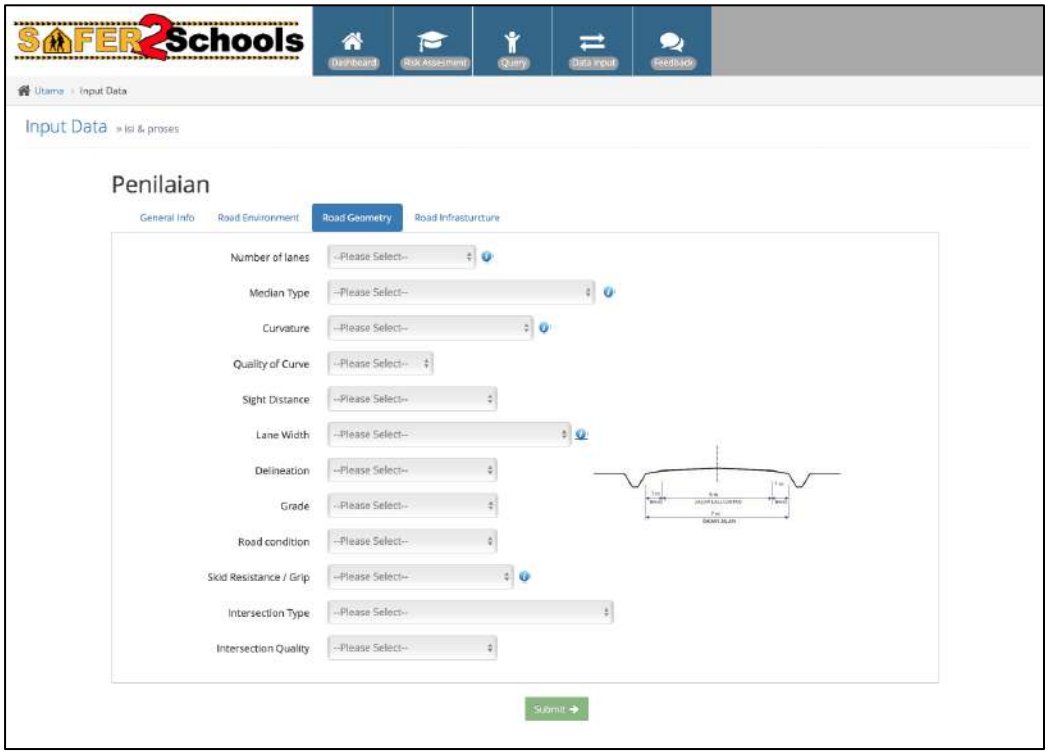

Figure 8 Screenshot of the expert user safety assessment with picture assisted

Table 2 List of options for road environment and infrastructure assessment section

Road environment category	Options	Road infrastructure category	Options
External flow influence	0 to 2,000 AADT	Sidewalk - Driver side	Physical Barrier
	2,000 to 4,000 AADT		Non-physical separation ≥ 3.0 m
	4,000 to 6,000 AADT		Non-physical separation 1.0 m to < 3.0 m
	6,000 to 8,000 AADT		Non-physical separation 0 m to < 1.0 m
	8,000 to 10,000 AADT		None
	10,000 to 12,000 AADT		Informal path ≥ 1.0 m
	12,000 to 14,000 AADT		Informal path 0 m to < 1.0 m
Operating speed (85th percentile)	14,000 to 16,000 AADT	Sidewalk - Passenger side	Physical barrier
	16,000 to 18,000 AADT		Non-physical separation ≥ 3.0 m
	> 18,000 AADT		Non-physical separation 1.0 m to < 3.0 m
	< 30 km/h		Non-physical separation 0 m to < 1.0 m
	35 km/h		None
	40 km/h		Informal path ≥ 1.0 m
	45 km/h		Informal path 0m to < 1.0 m
	50 km/h	Speed management/Traffic calming	Not present
	55 km/h		Present
	60 km/h	Vehicle parking	Two sides
	65 km/h		One side
	70 km/h		None

	75 km/h	Shoulder rumble strips	Not present
	80 km/h		Present
	85 km/h	School zone warning	School zone flashing beacons
	90 km/h		School zone static signs or road markings
	95 km/h		No school zone warning
	100 km/h		Not applicable (no school at the location)
	105 km/h	Street lighting	Not present
	110 km/h		Present
	115 km/h	Pedestrian crossing facilities	Grade separated facility
	120 km/h		Signalised with refuge
	125 km/h		Signalised without refuge
	130 km/h		Unsignalised marked crossing with refuge
	135 km/h		Unsignalised marked crossing without a refuge
	140 km/h		Refuge only
	145 km/h		No facility
	>= 150 km/h		Unsignalised raised marked crossing with refuge
			Unsignalised raised marked crossing without refuge
			Raised unmarked crossing with refuge
			Raised unmarked crossing without refuge
		Pedestrian crossing quality	Adequate
			Poor
		Pedestrian fencing	Not present
			Present

Table 3 List of options for road geometry assessment section

Road geometry	Options	Road geometry	Options
Number of lanes	One	Delineation	Adequate
	Two		Poor
	Three	Grade	>= 0% to < 7.5%
	Four or more		>= 7.5% to < 10%
	Two and one		>= 10%
	Three and two	Road condition	Good
Median type	Safety barrier- metal		Medium
	Safety barrier- concrete		Poor
	Physical median width >-= 20 m	Skid resistance/ grip	Sealed-adequate
	Physical median width 10 to < 20 m		Sealed-medium
	Physical median width 5 to < 10 m		Sealed-poor
	Physical median width 1 to < 5 m		Unsealed-adequate
	Physical median width 0 to < 1 m		Unsealed-poor
	Continuous central turning lane	Intersection type	None
	Flexible posts		Merge lane
	Central hatching (> 1 m)		Roundabout
	Centre line		3-leg unsignalised with protected turn lane
	Safety barrier-motorcycle friendly		3-leg unsignalised with no protected turn lane
	One way		3-leg signalised with protected turn lane
	Wide centre line (0.3 m to 1 m)		3-leg signalised with no protected turn lane
	Safety barrier-wire rope		4-leg unsignalised with protected turn lane
Curvature	Straight or gently curving		4-leg unsignalised with no protected turn lane

	Moderate		4-leg signalised with protected turn lane
	Sharp		4-leg signalised with no protected turn lane
	Very sharp		Railway crossing-passive (signs only)
Quality of curve	Adequate		Railway crossing-active (flashing lights/boom gates)
	Poor		Median crossing point-informal
	Not applicable		Median crossing point-formal
Sight distance	Adequate		Mini roundabout
	Poor	Intersection quality	Adequate
Lane width	Wide (>= 3.25 m)		Poor
	Medium (>= 2.75 m to < 3.25 m)		Not applicable
	Narrow (>= 0 m to < 2.75 m)		

4.6 Feedbacks

The last module for the Safer2School app is for all type of users to give their feedbacks (see Figure 9). The feedback falls into two (2) categories (Kategori), i.e. complaint and suggestions. After the non-expert users identify their school, type out their name and contact details, they can give their feedback in the 'Maklum Balas' box and categorised the feedback. All of the feedbacks will be stored in the designated school and will be displayed in the analysis sections (see Figure 8), only to be access by the administrator or expert users.

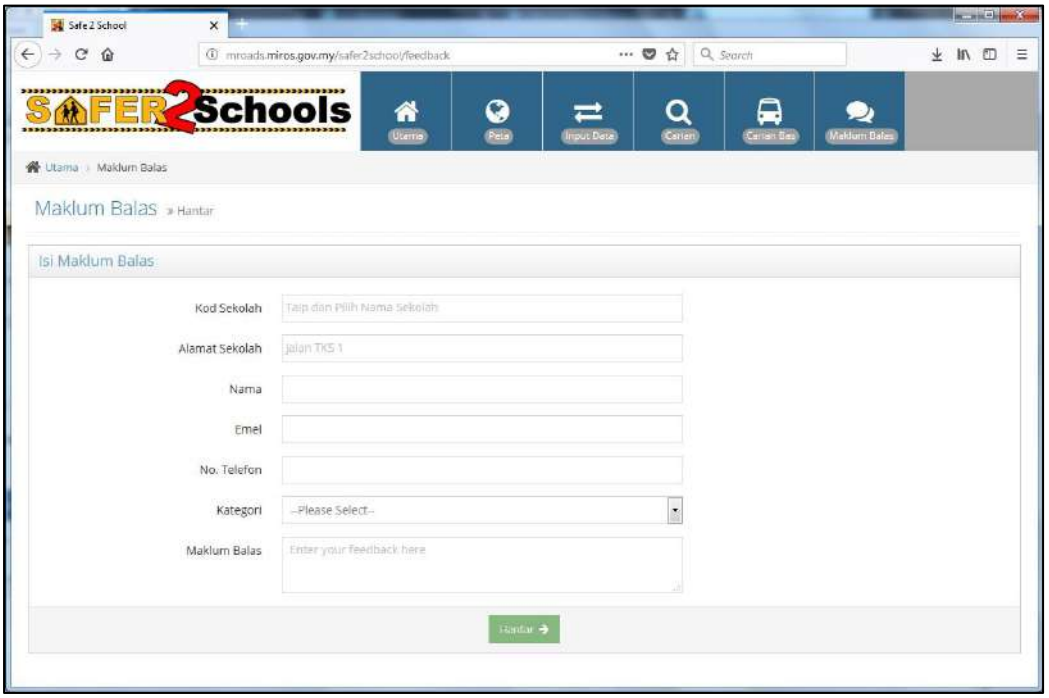

Figure 9 Screenshot of the non-expert user safety assessment

5. Discussion

We have developed a web-based application called Safer2School that provides comprehensive road infrastructure safety assessment around the vicinity of schools in Malaysia. The app allows engineers, researchers and related authorities to deposit road infrastructure attributes and make general road safety assessment. The app also allows teachers, parents and school authorities give feedbacks and view the road safety assessment on their school vicinity. The app is also able to assign specific countermeasures based on the iRAP assessment that could be helpful for authorities to improve the safety at school. Safer2School app consists of five modules (i.e. **Authentication, Dashboard, Risk Assessment, Data Query and Data Input**), which can be accessed by different type of users.

The general idea of developing this app is to provide a tool for road stakeholders to improve the road safety in the vicinity of schools in Malaysia. Improving the road safety is to make it safe, convenient, and fun for children, including those with disabilities, to bicycle and walk to school (Caltrans, 1996; Kulanthayan et al., 2016). When routes are safe, walking or biking to and from school is an easy way to get the regular physical activity children need for good health (WHO, 2009).

A road infrastructure database such as this app can serve as an effective tool for decision making with respect to the improvement of road safety in the vicinity of schools in Malaysia. This app offers stakeholders and school authorities a quick look at the level of safety with the help of the iRAP star rating. They can prioritise installing countermeasures for schools that have low star rating (i.e. 1 or 2 stars). Moreover, the app offered specific and proven road safety countermeasures (which was based on iRAP) for the stakeholders to choose and strategise its implementation, either for short or long term measures.

The limitation of this study was more towards ensuring accurate data entry by engineers, researcher or road authority using the iRAP road attributes categorisation. Inaccurate data such as wrongly classifying the type of median, type of pedestrian facilities or judgement on the sight distance, may affect the star rating of the school. Moreover, the app does not control the variation of expert users utilising this app, which in turn may have a variety of assessment when entering the data.

6. Conclusion and Recommendations

The Safer2School app is the first of its kind, web-based application that provides comprehensive road infrastructure safety assessment around the vicinity of schools in Malaysia. Due to its potential as a tool for improving road safety, we are recommending that:

- The app to be introduced nationwide to all school authorities with the supervision of the Ministry of Education and MIROS.
- The app to be further developed in catering to big data analysis and data verification.

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Research Report

The Safer2School App – Development of a Road Safety Data Repository and Analysis System at Vicinity of School

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ISBN 978-967-2988-19-9
9 789672 988199