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RANKING PARENTS CONCERNS ABOUT ROAD SAFETY AT SCHOOL USING AN ANALYTIC HIERARCHY PROCESS

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Abstract

School road safety concerns include the drop-off location for children at the school entrance, traffic congestion around the school, and road safety amenities. Most research is done by analyzing data with descriptive statistics, but these don't give a clear order of the factors that lead to these incidents. So, the Analytic Hierarchy Process (AHP) has been used to help figure out which ways of intervening are the most effective at cutting down on accidents. The following objectives have been outlined: (i) to identify the most critical factors that contribute to road safety measures in the school area, such as high traffic volume, speeding, or a lack of pedestrian infrastructure, and (ii) to prioritize potential interventions for improving road safety. The study's methods include four main steps: making an instrument, collecting data, analyzing the data with AHP, and coming up with a list of actions to take based on priority. Results show that the most significant outcome was 33% peak hour management, and 33% of the needs of parent car management are equally critical. The other concerns are on the children's path. The outcome presented herein gives an insight into how to prioritize roads for safety mitigation, which is expected to be useful to various decision-makers.

***Keywords**:* Road safety, traffic congestion, multi-criteria analysis, AHP, school children

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INTRODUCTION

The number of child pedestrians killed or seriously injured (KSI) on roads is a major global issue, and road traffic injuries are the leading cause of death for children and young adults aged 5 to 29 years old (Global Status Report, 2018). Along with being the second leading cause of death in Malaysian children aged 5–14 years (Norainy et al., 2020), MIROS responded to this issue by making a Guideline for Pedestrian Facilities in School Areas to help keep schoolchildren safer on the roads. This is a preventive strategy meant to find potential safety problems for everyone who uses the road and make sure that solutions to get rid of or lessen the problems are thoroughly looked at. The most vulnerable road users, particularly kids, will suffer the most if the emphasis of road environmental design remains on motorized traffic (Alvin et al., 2021). This is shown on the roads near schools, where the safety of pedestrians is sometimes put at risk so that other vehicles can pass. Besides that, the type of route also plays a big role in the occurrence of conflict (Akmalia et al., 2021). Aside from all of that, there are also no safety concerns for schoolchildren, such as the use of helmets and reflective clothing, how to ride bicycles and motorbikes safely, and how to use walkways correctly. Also, the way other drivers act when they are near a school can affect how safe it is for kids to be there (Nur Zarifah Harun, 2020).

Based on these scenario, three concerns arise among parents in safeguarding children at school are on the drop-off location for children at school entry, traffic congestion around school, and road safety amenities such as traffic signs and signals around a school (Rothman et al., 2017). Even though the concerns are well-known, there has been little research in Malaysia to ascertain parental concern about the measures. Furthermore, if research is undertaken and data is analyzed, descriptive statistics are used to provide information on the frequency and distribution of road accidents, but they do not provide prioritize insight into the underlying variables that contribute to these incidents. Thus, Analytic Hierarchy Process (AHP) needs to be employed to perform this kind of analysis. It can analyze road safety data in order to assist decision-makers in prioritizing intervention mechanisms that are most effective in reducing the number of accidents. To conduct the study, the following objective have been outlined: (i) to identify the most critical factors that contribute to road safety measures in the school area, such as high traffic volume, speeding, or a lack of pedestrian infrastructure, and (ii) to prioritize potential interventions or solutions for improving road safety based on their relative impact and feasibility using an analytical hierarchy process. The outcome of this study helps to identify the most important factors concerned with the school area.

LITERATURE REVIEW

Road Safety Among School Children

Students in school are safe if they are not injured, in pain, or in danger (Gregory, Cornell, & Fan, 2012). Accidents and injuries on school grounds are no longer a strange concept in any country, including Malaysia. Schools are considered low-risk places, but ironically, accidents, injuries, and deaths still happen to children at school. According to Sivasankar et al. (2016), traffic accidents are the leading cause of death and injury among young people. Commonly, parents' have the most concern for the safety of their children. In addition, road safety emerged as a major issue for all parents, as they may have had bad driving experiences from both passing traffic and school traffic. A study showed that parents claimed that they had witnessed numerous instances of cars failing to stop at pedestrian crossings on their way to school and cars driving down the wrong side of the road to avoid stationary traffic (Nikitas, 2019). To address this issue, the government is committed to improving child safety, particularly in traffic. Aside from providing decent road amenities to its residents, the Malaysian government has taken numerous initiatives to educate both adults and schoolchildren about road safety (MOE, 2023).

Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) can be used to prioritize actions to be taken in improving road safety at school. It is a structured method for breaking down actions into smaller, more manageable chunks and measuring the relative relevance of the criteria in the decision-making process. It builds a hierarchical model of the road safety concerns, with the top level representing the overall aim, which is the action to be taken, and lower levels representing criteria and sub-criteria. Then, using pairwise comparisons, AHP assigns weights to the criteria based on their relative importance and compares the alternatives based on the criteria. According to Panchal and Shrivastava (2021), AHP has been widely employed in a variety of industries, including business, engineering, and healthcare, to assist decision-makers in making more informed and reasonable choices (Nejad, Mansour, & Karamipour, 2021). Moreover, it has been frequently employed, particularly for complicated challenges with several criteria and highly subjective choice selection (Dewi & Putra, 2021). Figure 1 depicts how the AHP develops goals based on stated criteria in order to make the best judgments (Putra, 2019; cited in Dewi & Putra, 2021). Overall, AHP provides a more thorough and nuanced approach to analyzing data than descriptive statistics alone, allowing decision-makers to make more educated and effective decisions to minimize and improve road safety.

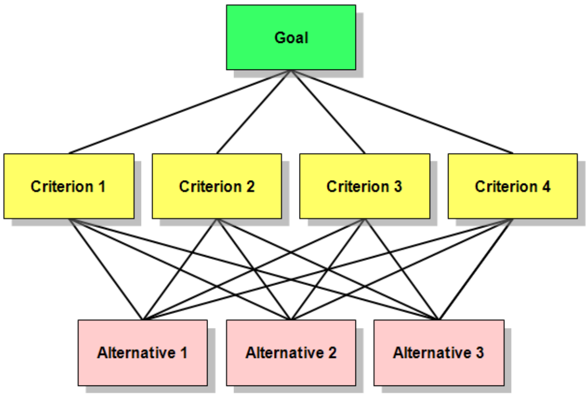

Figure 1: AHP hierarchy of goals, objectives and alternatives.

Exploration of Contributing Criteria for Road Safety at School

The contributing criteria for road safety at school focused in this study are as follows:

Drop-off space for children at the school entry

Pedestrian motor vehicle collisions (PMVC) commonly occur during school drop-off and pick-up times, with on-site parking being identified as a significant risk factor (Rothman et al., 2017; SMR, 2020). La Vigne et al. (2017) also noted that parents dropping off and picking up their children are the primary cause of traffic congestion around schools. The most frequent behaviors that contribute to PMVCs include uncontrolled mid-block crossings, blocked vision from parked cars, and double parking (Rothman et al., 2016). The added congestion during peak travel times in the morning increases safety risks for both students and drivers (Adams et al., 2017). To address these concerns, many schools have implemented drop-off and pick-up procedures that require vehicles to line up and drop off or pick up students at a marked location in front of the school, where an attendant is present. While some argue that such procedures create additional congestion and may not be effective, the potential risks of PMVCs around schools demand immediate attention and action (Rothman et al., 2017). Therefore, a comprehensive approach involving collaboration between schools, parents, and transportation agencies is essential for improving student safety.

Traffic congestion around the school

To ensure children's safety, congestion around schools has been identified as a significant risk factor (Hiep 2020). La Vigne et al. (2017) explained that the crowded streets due to cars during pick-up and drop-off times pose a grave threat to safety. Parents' convenience is often cited as the reason for their behavior, despite the risks involved. This traffic congestion is a significant issue in Malaysia and other places around the world, affecting students, teachers, parents, residents, and drivers (Mohd Yusoff *et. al*, 2022). Finding solutions to this problem and promoting safer ways for children to get around is crucial for ensuring safety in and around schools.

Facilities relates to Road Safety

The safety of schoolchildren traveling to and from school also depends on the design of the area around the school and the availability of necessary facilities. Narrow streets or those with parking on both sides can lead to congestion and a lack of space for automobiles to manoeuvre (La Vigne et al., 2017). Al-Metwali et al. (2019) emphasized the importance of an appropriate environment with adequate road design, geometry, signboards, pathways, and zebra crossing intersections. Poorly timed traffic lights, entry and exit routes, and a lack of temporary parking spots can also contribute to congestion. The planning of new school construction should include the design of pedestrian crossings, speed restrictions, parking, drop-off, and pick-up areas, as well as procedures to ensure children's safe transportation. Improving road infrastructure, promoting road safety education, and enforcing traffic laws could help reduce the number of child-related road traffic accidents (Hiep, 2020).

Related Research

Yannis et al. (2020) did a study and used AHP to look at the data to find out what factors affect the severity of pedestrian injuries in cities. The study analysed data from pedestrian accidents in Greece between 2009 and 2015. They found that several factors, including pedestrian age, gender, and behaviour, as well as the type of road and time of day, significantly influence the severity of pedestrian injuries. However, the research was carried out in a specific urban area in Greece and may not be applicable to other cities with different characteristics and road infrastructure. It also relied on police reports, which may not contain accurate information about the factors that contributed to pedestrian injuries. Only a few variables, such as age, gender, and accident location, can influence the severity of pedestrian injuries. Other variables, such as vehicle speed, weather conditions, and pedestrian behaviour, were not considered. The use of a cross-sectional design limits the ability to establish causality between the identified factors and the severity of pedestrian injuries. Li et al. (2021) present a comprehensive approach to reducing the subjective influence of expert experience judgment in traditional methods for highway traffic safety evaluation using the analytic hierarchy process, the entropy weight method, and fuzzy mathematics theory. Their work, however, lacks discussion of how these methods were used and their effectiveness in reducing subjectivity in evaluation. The study provides some useful insights into computation but lacks sufficient detail and analysis to fully evaluate the approach's effectiveness and validity. Nanda and Singh (2018) picked seven accident causes and created a table indicating the number of accidents associated with each factor. They then used AHP to calculate a weight for each factor. They generated a ranking of the states with the highest accident rate using the weighting and the number of accidents. In the case of Keymanesh et al.'s (2017) research, they identified nine factors that contribute to accidents on a single road. They then divided the road into eight sections and identified potential black spots in each. Five experts used AHP to weight the most important factors and the most dangerous potential black spots in each section. The identification and prioritization of black spots were compared to data collected from police accidents. In addition, the Analytic Hierarchy Process (AHP) approach within Multi-criteria Decision Analysis was used for the study's analysis, which revealed accidents involving child falls that can be avoided by creating proper policies and regulations (Yusuf *et. al*, 2021).

MATERIALS AND METHODS

This study of four major activities, which are instrument development, data collection, data analysis using AHP, and finally the outcome, which recommends action be taken based on priority, the flow of activities is illustrated in Figure 2. Data was collected using a questionnaire, and random sampling was applied in selecting 30 respondents, who were parents who came to pick up their children, and they filled in the questions manually. The data collection has been done at a school on the outskirts of Klang that only has one class in the morning. Apart from normal children, there are also 19 visually impaired children in year 1–6 at the school. The questionnaire was divided into five sections. The first section focuses on the demographic information of the respondents.

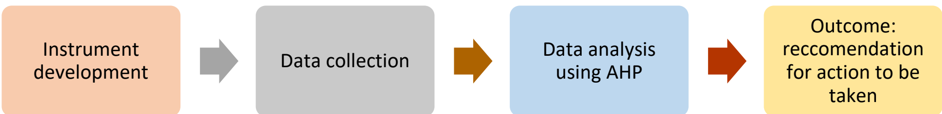

Figure 2: Flow of activities

Followed by three sections that comprise questions that used Five Likert-scales were used in the questionnaire, ranging from "Strongly Agree" (SA), "Agree" (A), "Disagree" (D), and "Strongly Disagree" (DA). The three sections gathered respondents' concerns about drop-off and pickup points, traffic, and facilities, but the descriptive statistical analysis of the Likert scale construct will not be discussed in this paper. For Section 5, our enumerators guided respondents to select their road safety concerns in a pairwise manner. The criteria that focused in the analysis are shown in Table 1.

Table 1: The description of criteria.

No.	Criteria	Description
1	*Drop off and pick up points (DOP)*	*School drop off and pick up points are designated areas near schools where parents can safely drop off and pick up their children. These areas are often marked with signs and may have special lanes or parking spaces to facilitate the smooth flow of traffic.*
2	*Traffic Congestion (TC)*	*School traffic congestion refers to the high volume of vehicular and pedestrian traffic that occurs around schools during drop off and pick up times. This congestion can be caused by a number of factors, including parents parking illegally or inappropriately, inadequate school infrastructure or facilities, and insufficient planning for the movement of people and vehicles.*
3	*Road safety facilities (RSF)*	*Road safety facilities such as crosswalks, speed humps, traffic signs and signals, sidewalks, school zone signs and crossing guards are designed to safeguard children and other vulnerable road users from accidents and injuries on the road by providing safe and regulated traffic flow.*

DATA ANALYSIS

Data from Section 5 selected for AHP calculation. An example of its input scale for pairwise matrix is shown in Figure 3 and the multi-level constructed for the AHP analysis is shown in Figure 4.

Criteria	Scale									Scale								Criteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
DOP																		TC
DOP																		RSF
TC																		RSF

Figure 3: Input scale for pairwise comparison

The scale as shown in Table 2 is used to compare the importance of each criterion and sub-criterion to one another. For example, if a decision maker wants to compare the importance of two criteria, they would assign one of them a rating on the scale relative to the other. The rating would indicate how much more important one criterion is over the other, with a rating of 1 indicating equal importance, and a rating of 9 indicating extremely strong importance. By using the Scale for Relative Importance, a structured and systematic approach to evaluating and prioritizing criteria and sub-criteria in order to make more informed decisions.

Table 2: Scale for Relative Importance (Source: (Mohammed & Daham, 2021).

Intensity	Definition of importance	Intensity	Definition of importance
1	Equal	2	Weak
3	Moderate	4	Moderate plus
5	Strong	6	Strong plus
7	Very strong	8	Very, very strong
9	Extreme		

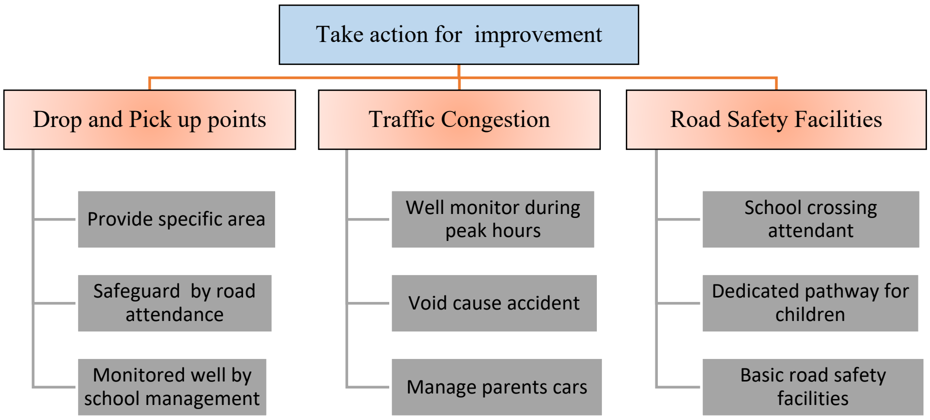

Figure 4: Multi-level analytical structure

To execute the AHP analysis, the following steps have been taken: Step 1: Define decision criteria based on the hierarchy of objectives. A standardized comparison scale for relative importance is shown in Table 2. Step 2: Development of judgment matrices A by pairwise comparisons Step 3: After a judgment matrix is calculated, a priority vector to weight the elements of the matrix is calculated. Step 4: After the generation of the priority vector, inconsistency in pair-wise comparison may occur due to subjective human judgment error. Therefore, it is important to check the consistency of the response through a consistency index (*CI*) by using the following equation:

$$CI = (\lambda max \ - n)/(n - 1) \quad (1)$$

Step 5: Finally, the consistency ratio (*CR*) is calculated as the ratio of the *CI* and the random consistency index (RCI), which is shown in Table 3.

$$CR = CI/RCI \quad (2)$$

Table 3: Random Consistency Index

Matrix	1	2	3	4	5	6	7	8
RI	0.0	0.0	0.58	0.90	1.12	1.24	1.32	1.41

Repeat steps 3–5 for each criterion to re-evaluate the pairwise comparisons. If the CR value for all the criteria is less than 0.10, the process is absolutely consistent as long as the weight is acceptable. By using the same prioritization method, the local weights of sub criteria are calculated as in Figure 5.

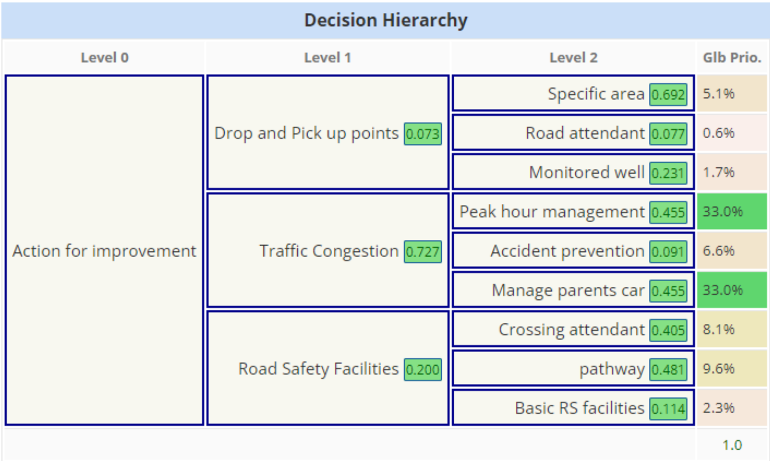

Figure 5. Results from Judgment Matrices of Sub-Criteria

RESULT AND DISCUSSION

The outcome is shown in Figure 6 as it depicts that there is a significant pattern in parents' concerns where 33% indicated that peak hour management to oversees public vehicles passing by and around the school. The usage of cars by parents with small children exacerbates the problem of excessive traffic volume (Shamsul Harumain *et. al*, 2022).The other concerns which is 33% are concern on oversees and management of parents car which considered as equally critical. The other concerns are on the children's pathway. To mitigate school traffic congestion, many schools have implemented a variety of measures, such as designated drop-off and pick-up areas, staggered start and end times, and encouraging parents to use alternate forms of transportation, such as walking or biking. Local governments and transportation authorities may also work with schools to improve traffic flow and safety around schools by calming traffic and making infrastructure improvements. It can also cause delays and frustration for parents, students, and other commuters who may be passing through the area. Another concern is on the road safety facilities, where it's important to help safeguard children and other vulnerable road users. It is important for both drivers and pedestrians to be aware of and follow these safety measures in order to promote safe and responsible use of the roadways at school.

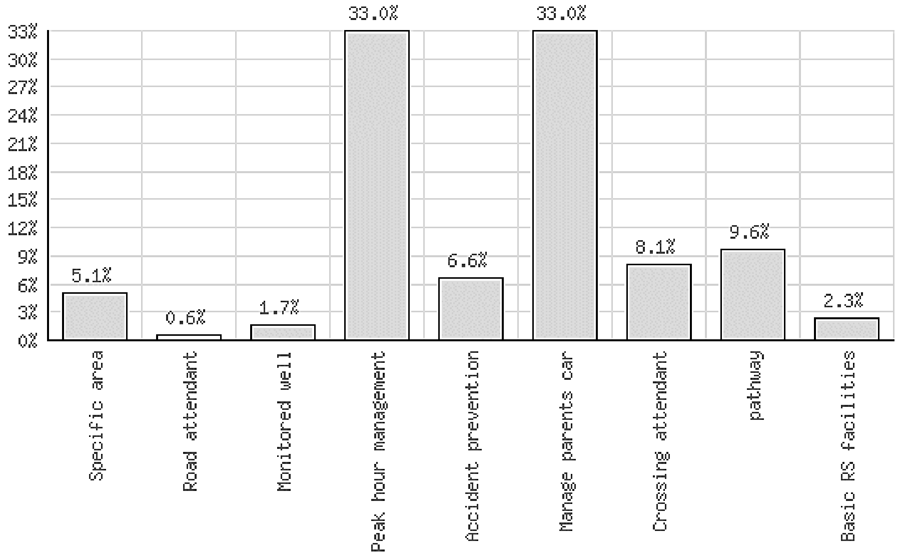

Figure 6: Results from the analysis

The areas of least concern are at the drop-off and pick-up points, where the space is normally set by the school. Even if the space is provided, but it still requires parents to be aware of and follow the rules and procedures at these points.

CONCLUSION

This study analyses road safety concerns among parents at a school on the outskirts of town where most of the parents are from low-income families (B40). The parents are also those who have visually impaired children in grades 1-6 at the school. The significant outcome has been obtained from the analysis, where peak hour management that involves public cars around the school areas and effective management of parent vehicles are equally to be considered the most critical. The other concerns are on the children's pathway, which is insignificant but helps the visually impaired children. Overall, AHP managed to help produce an outcome that could help schools and responsible bodies identify the most important action to be taken.

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