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RESEARCH ARTICLE

Evaluation of Risk Factor for Children During Drop-off and Pick-up Time around the Primary School in Thailand

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Abstract:

Background:

Traffic accidents, hazardous behaviors, and caretakers' opinions have a strong effect on students' safety during the drop-off and pick-up period. The present research about student drop-off and pick-up behaviors and spatial analysis will be helpful for better understanding school traffic incidents and related risk factors.

Objective:

To examine the risk factors associated with school drop-off and pick-up in three dimensions: 1) risk zones, 2) risk behaviors, and 3) risk periods.

Method:

A mixed method approach was employed using 4 sets of data, consisting of 1) the statistics of accidents occurring around primary schools, 2) the student drop-off and pick-up behaviors, 3) the opinions toward risk zones and risk periods, and 4) the data obtained from the survey and interview. The spatial analysis was conducted using kernel density estimation technique. The statistical data analysis was carried out to analyze and compare the questionnaire responses given by the teachers and parents from the primary schools with the highest accident rate in 5 regions of Thailand.

Results:

Pedestrian crossing points in front of the school gates and blind spots behind the school buildings were considered the risk zones. In the morning, the parents usually dropped the students off at the pavements in front of the school gate. Some of them walked the students to the classrooms. After school, the parents parked their cars and then walked to wait for the students at the meeting points scattered inside or outside the school. The opinions of the teachers and parents regarding the risk periods were found to be significantly different ($p < 0.01$), which affected the way the teachers and parents looked out for the students' safety in the morning and after school period.

Conclusion:

The areas around pedestrian crossing points and school gates require effective transport planning in order to specifically prevent and monitor hazardous incidents. A scattering of drop-off and pick-up points are risk behaviors. Therefore, each school should clearly set up safe drop-off and pick-up points and pay close attention to the safety of students both in the morning and after school. Creating safety for students should start with improving the school environment in order to reduce anxiety and facilitate behavior change.

Keywords: Risk factor for children, Kernel density analysis, Drop-off and pick-up behavior, Parent, Teacher, School zone, Thailand.

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1. INTRODUCTION

1.1. Aims and Objectives

The development of transportation systems in Thailand has been carried out to support the expansion of cities and facilitate domestic transportation. Due to the first-car policy of Yingluck Shinawatra's government, the number of private cars increased by 169,861 during 2011-2012 [1]. Although it helped stimulated the state economy, the increase of private cars and motorcycles was found to cause traffic problems, energy wastage, and increased levels of accidents [2]. Traffic accidents are one of Thailand's main problems [3]. Student drop-off and pick-up at schools is a key cause of traffic congestion in urban areas of Thailand [4]. Thailand is a country where primary schools have varying degrees of quality and reputation [5]. In addition, drop-off and pick-up behaviors of Thai parents are different from those of parents in other countries. Thai parents tend to be concerned about traffic problems and school environment that can affect the safety of their children. These factors directly affect children safety at a national level. Apart from physical factors and drop-off and pick-up behaviors mentioned earlier, recent studies also suggested that parents' perception of hazardous environments can affect their routine behavior and opinions such as driving into school or in front of classrooms, which may cause harm to students [6, 7, 4]. This research aimed to examine the risk factors associated with school drop-off and pick-up in three dimensions: 1) risk zones, 2) risk behaviors, and 3) risk periods. The data obtained from 5 primary schools in Thailand, which were selected as the case studies, were compared and analyzed. The spatial analysis of traffic accidents was conducted using the actual accident statistics. Moreover, a questionnaire survey was carried out on the parents and teachers from Thai kindergartens and primary schools in Thailand in order to obtain data about drop-off and pick-up behaviors and opinions on children's risk factors.

1.2. Children Safety

Childhood is an important period that basically requires safety [8]. As children aged 4-12 years [9] have no abilities to care for their own safety and protect themselves from danger caused by unfamiliar environment, their parents or teachers have a responsibility to take care of them. Children will develop a sense of safety and perception of risk through learning from parents, family, and environment during the early period of their life [10 - 12]. This demonstrates that children's positive or negative perception towards self-protection from danger depends mainly on their childhood experience and environment [13, 14]. This is consistent with a Californian study about environmental improvements for walking, sidewalks and traffic control, which suggested that children walking to school are significantly more likely to feel confident when walking and cycling facilities are safe and improved [15].

1.3. Risk Zone

This study aimed to investigate the risk zones around schools by focusing on the accident-prone areas outside schools and inside-school environment based on the parents' opinions obtained from the questionnaire.

1.3.1. Accident-Prone Areas Outside Schools

Accidents are the second leading cause of death in Thailand [16]. The top two vehicles mostly involved in accidents are (1) motorcycles at 35.68%, (2) private cars at 30.68% [17]. The accident statistics occurring with early childhood students in 65 primary schools, state schools located at the center of each province with similar education quality, in Thailand in provincial level and within the radius of 500 meters around the schools show that the average number of accidents for the past four years is 54.94 cases per year, which includes children deaths and injuries on an average of 10.4 cases When comparing the accident statistics occurring with children, the accidents occurring at school zones during the drop-off and pick-up time were higher than other areas [5].

1.3.2. Inside-School Environment: Based on the Parents' Opinions

The parents' opinions were in line with the previous statistics, which stated that schools are risky places for children. Thus, school zones were considered to be risk zones, where children could go missing or have traffic accidents [18]. In addition to the danger from accidents around school zones, the inside-school environment could also cause harm to children during drop-off and pick-up time. This was because in Thailand drop-off and pick-up areas were not limited to school gates or sidewalks. Thai parents could drop their children off either inside or outside of school. This situation made children prone to various forms of dangers caused by strangers and poor school management. The present research aimed to investigate the parents' opinions about the most dangerous area at school in order to develop a risk map and analyze the following 8 components of the inside-school environment: 1) entrance, which included main

and minor school entrances, gates, and fences, 2) road crossing and sidewalk in front of schools, 3) circulation, roads, and walkways inside schools, 4) school buildings, 5) playground and activity areas, 6) blind spots behind buildings, 7) pool and landscape, and 8) toilet. The data obtained from the questionnaire were compared with the data obtained from the spatial analysis. The opinions of the parents and teachers, who were considered the primary caretakers of children, were thoroughly analyzed and compared.

1.4. Risk Behavior: Student Drop-off and Pick-up Behavior

Although Thailand has rules and regulations about land use, transportation systems, and public utility systems, there is still a lack of effective urban management and spatial planning [19] associated with public services such as schools and hospitals. There is no catchment area within residential zones [20]. Furthermore, the quality and reputation levels of primary schools in Thailand are enormously varied. Thai parents generally want to have their children study at the primary schools with higher quality. Anuban School is a provincial primary school with high academic standards and reputation. It is located in the downtown area and usually causes traffic problems in nearby areas. The parents, who are concerned about the safety of the school environment, are likely to drop-off and pick-up their children at school by themselves [21]. Thus, it can be said that the parents' drop-off and pick-up behaviors have a direct impact on the safety of children [22 - 24]. This study focused to explore the drop-off and pick-up behaviors, methods, and areas, including the types of vehicles used by the parents.

1.5. Risk Periods: Comparing the Opinions of Teachers and Parents

Time and situation have an effect on the drop-off and pick-up behaviors. The parents' drop-off and pick-up behaviors and methods in the morning and after school are different. The differences in perception of danger in the morning and after school affect the way the parents and teachers take care of the children [5]. In this study, an in-depth investigation was carried out. The questionnaire was used to elicit the opinions of the parents and teachers on the risk zones and risk periods. The results would be compared and analyzed in order to identify the high-risk periods for children.

1.6. Literature Review

Based on the literature review and past studies, the scope and framework of this study can be summarized into 4 parts: 1) traffic accidents, 2) school environment, 3) children's travel behaviors, and 4) opinions of parents and teachers.

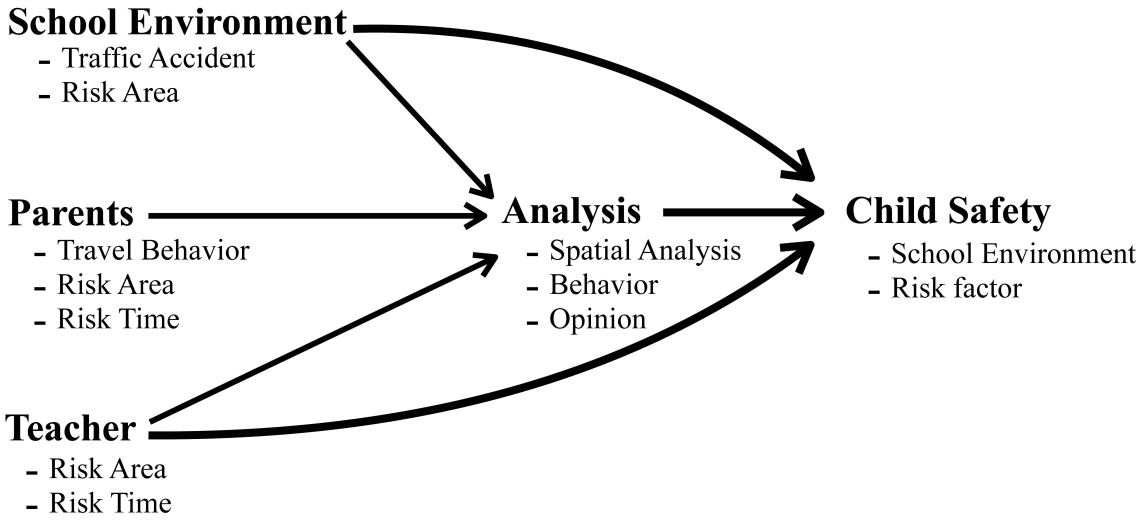

Fig. (1). The relationship between variables in the study: adapted from [6, 7, 25] designed by the authors.

Traffic accidents are empirically dangerous incidents that often occur with children around school areas. This is probably because the children spend most of their time at school, their school is located in traffic congestion area, most parents arrive and depart the school at the same time during rush hours, and the parents' perception about the danger of school environment. Moreover, there are four important variables that affect travel behavior, which are 1) socio-

economic condition: previous studies suggested that middle- to high-income families are more aware of and look out for the safety of children than low-income families, 2) individual opinions: recent studies indicated that anxiety about danger has an effect on an individual' behavior patterns, 3) lifestyle: past research revealed that the burden of family affects children's travel method, for example, the parents with burdens tend to let their children take public buses to school or have the relatives, especially grandmothers, send their children to school instead of themselves [4], and 4) school environment [6, 7, 24]. In addition, as parents and teachers are the main caretakers of children, understanding their attitudes and opinions will be helpful in identifying related risk factors. The details are shown in Fig. (**1**).

2. MATERIALS AND METHODS

2.1. Study Area: Anuban Schools (Kindergarten and Primary School)

Thailand is divided into 77 provinces in 6 regions: 1) northern region (9 provinces), 2) central region (21 provinces), 3) northeastern region (20 provinces), 4) eastern region (7 provinces), 5) western region (5 provinces), and 6) southern region (14 provinces). Early childhood education in Thailand is under the supervision of the Ministry of Education. Anuban Schools are high-quality public schools that accept both kindergarten and primary school students. They are managed as an association in the form of Provincial Anuban Association. There is only one Anuban School in each province. In order to make sure that the results could be generalized to schools across the country, the researcher selected to carry out the present study in Anuban Schools because of the following four reasons. Firstly, they are located in downtown with urban contexts. Secondly, they have a similar level of quality and reputation. Thirdly, the parents of students in Anuban Schools have the similar socio-economic background and family lifestyle. Fourthly, they offer both kindergarten and primary school education in the same school [4, 5]. The researcher selected the 5 case study schools from 5 regions, excluding the central region where Bangkok is a center because it has a completely different context from other regions. The following two factors were taken into account during the case study selection process: 1) the statistics of accidents occurring to children in each province, the statistics of accidents occurring to children within a 500-meter radius of schools, and the statistics of accidents occurring during the drop-off and pick-up time were collected from 65 Anuban Schools in order to find out the schools with the highest accident record in each 5 region [5], and 2) the physical environment of schools that could cause harm to children. The 5 Anuban Schools that were selected as the case studies consisted of Anuban Lampang School from the northern region, Anuban Nakhon Ratchasima School from the northeastern region, Anuban Phuket School from the southern region, Anuban Chonburi School from the eastern region, and Anuban Kanchanaburi School from the western region.

2.2. Data Collection

2.2.1. Accident Locations within a 500-meter Radius around School Zones

The present research was conducted to further explore the statistics of accidents occurring to children around Anuban Schools across the country. The schools with the highest accident record in each region were selected in order to collect the coordinates of accidents within a 500-meter radius around school zones. The coordinates of accident locations of 65 Anuban Schools in the past 4 years (2014-2017) were used to select 5 Anuban Schools with the highest accident record based on the database of the Road Safety Culture (RSC), a private organization. The data collection process consisted of the following 3 steps. Firstly, access the official website of the Road Safety Culture and select relevant statistical data and spatial accident locations on a map. The results would be displayed according to years, provinces, and locations of accidents (http://www.thairsc.com/shape). Second, select the year, province, and the location of an accident on the map. After that, identify the coordinate of an accident location on the map so that its location and frequency (time) of accidents could be displayed (within a 500-meter radius of the Anuban Schools in 5 provinces). Third, collect the accident locations in form of (x,y) coordinates. The data were recorded in an Excel spreadsheet and then imported into GIS. The ArchGIS program was used to process the data in the Shape File format (.shp). The Kernel Density Estimation was conducted to identify the highest critical point displayed in an aerial photography map.

2.2.2. Coordinate Map of Risk Zones Based on the Parents' Opinions

In order to investigate the parents' opinions about risk zones, the parents were asked to select the coordinates (x,y) of risk zones both inside and outside the schools from 1,230 coordinates that were provided in the questionnaire. The data was collected in form of the Shape File format (.shp) and analyzed using the Kernel Density Estimation technique.

2.2.3. Questionnaires for Parents and Teachers

Two sets of questionnaires were used to collect data in the present research. The first one consisted of 1,257 questionnaires, which aimed to gather the opinions of the parents from 5 Anuban Schools in 3 aspects: 1) the drop-off and pick-up behaviors, 2) the opinions about risk zones for children, and 3) the opinions about risk periods for children. The second set of questionnaires consisted of 312 questionnaires, which intended to gather the opinions of the teachers in 2 aspects: 1) the opinions about risk zones for children, and 2) the opinions about risk periods for children. The obtained data would be analyzed and compared. The spatial analysis would also be conducted. The questionnaires were distributed to the case study schools, homeroom teachers, students, and parents. The parents were asked to respond to the first set of questionnaires and send them back to the homeroom teachers within 15 days. The homeroom teachers answered the second set of questionnaires, gathered the questionnaires from the parents, and sent all the questionnaires back to the researcher.

2.2.4. Survey and Interview

The present research intended to survey the environment of the schools and interview the schools' administrators in order to find out actual problems about physical environment, school safety management, and student drop-off and pick-up behaviors. The survey process consisted of the following 2 steps: 1) conducting a primary survey of the environment and traffic safety facilities around the schools, using Google Street View [5] to understand the overall environment before the actual survey and; 2) carrying out a survey of the schools' environment during the drop-off and pick-up time in actual situations.

2.3. Data Analysis

Kernel Density Estimation, which is a nonparametric spatial analysis using Geographic Coordinate Systems (GIS), was used to find out the frequency of coordinates [26 - 28] that could identify the intensity of accident factors or spatial opinions. This technique is highly popular in urban planning, transportation planning and spatial studies [29 - 34]. The spatial data analyzed by ArcGIS will be shown in form of raster. The principle of this method is to calculate the radius of each point and link that point to another using bandwidth. The radius of the circular neighborhood has an effect on the resulting density map. If the radius is increased, there is a possibility that the circular neighborhood may include more feature points, which results in a smoother density surface [35, 36]. The cell size chosen was 1 m × 1 m.

The Road Safety Culture is a private organization that deals with road accident reports for 24 hours and keeps a detailed report that shows the statistics of accidents occurring at different time throughout the country. This data is highly accurate since it is referred from the database of insurance companies and car accident insurance firms [37]. Every registered car is required to have insurance. The statistical data of accidents have been continually collected for years. The most important issue is that the accident coordinates are identified in form of GIS geographic maps [26, 27], which were presented only at the national level. In previous research studies, most statistical data analyzed included the statistics of accidents occurring to children, accidents occurring to children within a 500-meter radius around schools, and accidents occurring to children during the drop-off and pick-up time. However, the GIS data of accident locations have not yet been spatially analyzed to identify the risk factors that can harm children [5]. Thus, Kernel Density Analysis was applied to analyze the collected data in the present research.

In addition, the data was divided into 2 parts, consisting of the coordinates of accidents occurring around the school zone within a 500-meter radius and the coordinates of risk zones in the parents' opinions. The parents were asked to identify the highest risk zones and risk periods using the questionnaire. The data obtained from 1,230 questionnaires were compared and analyzed to find out actual accident-prone locations based on the parents' opinions. The resulting coordinates were shown in the Shape File format (.shp). The data were divided into 10 equal layers. Bilinear Interpolation was applied to demonstrate the results. The image quality was set to normal with 30% transparency. The criteria for identifying the children's risk zones were 1) the overall condition of the accident locations, including both the highest and lowest accident areas. This was because an accident could cause more severe and dangerous impacts on children than adults, due to the children's physical weakness; 2) the dangerous areas based on the parents' opinions, and 3) the overlapping areas between 1 and 2. The spatial results would be used to monitor the safety of children through the safety designing, management, and prevention. The quadratic Kernel function was applied in the present research as follows [35].

$$f(x,y) = \frac{1}{nh^2} \sum_{i=1} k\left(\frac{d_i}{h}\right) \quad (1)$$

where:

$f(x, y)$: the density estimates at the accident location (x, y),

n: the number of observations,

h: the bandwidth or kernel size,

k: the kernel function, and

d_i: the distance between the accident's location (x, y) and the location of the i observation.

The descriptive statistical analysis was used to analyze the data obtained from the questionnaires such as frequency, mean, percentage, standard deviation. The inferential statistical analysis was used to analyze the opinions of the parents and the teachers in order to find the differences between the results with t-test and Anova. The empirical data obtained from the physical environment survey and the interview were used to examine and discuss the results of the spatial analysis and the statistical analysis of the data obtained from the questionnaires as shown in Fig. (**2**).

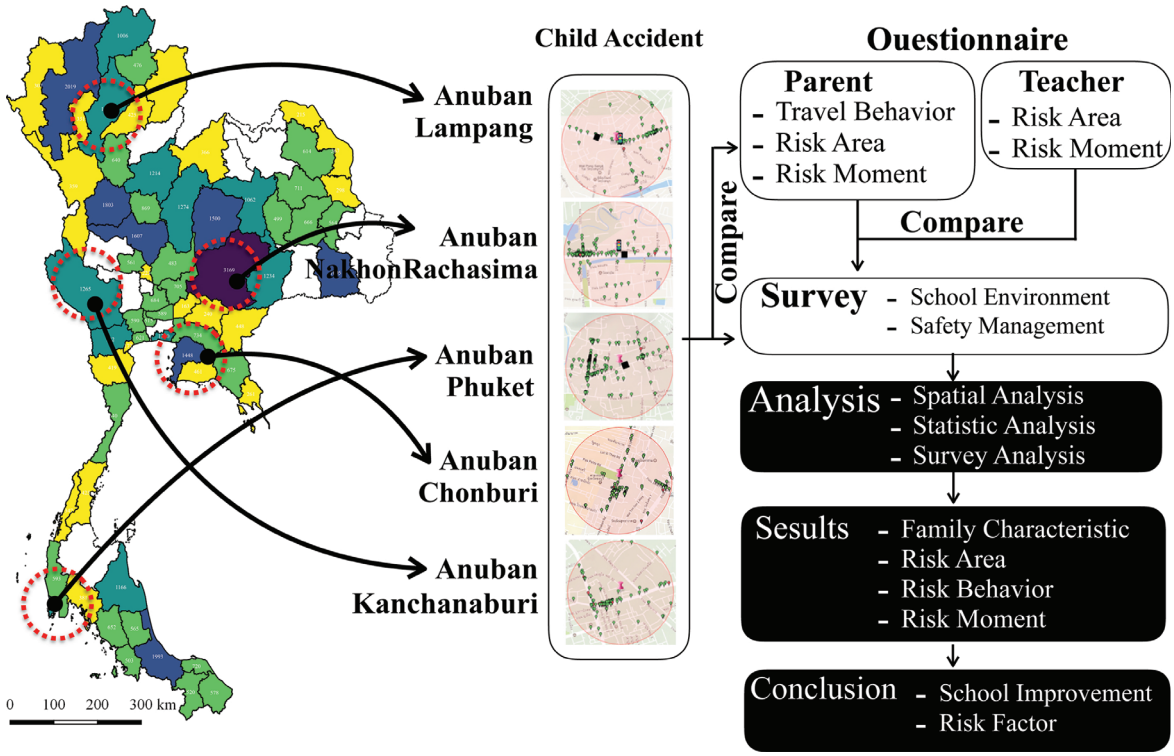

Fig. (2). The research methodology.

3. RESULTS

3.1. Spatial Analysis for Analyzing Risk Zone for Children

The case study schools could be divided into 2 groups according to the location: 1) Anuban Schools located in the downtown areas with traffic congestion during the drop-off and pick-up time, and 2) Anuban Schools located in the government office areas with advantages of facilities such as Anuban Chonburi School that is located next to a public park and a city hall and Anuban Phuket School that is located next to a temple, where the parents could park their cars in during the drop-off and pick-up time.

In addition, the case studies could be divided into the following 3 groups based on the types of roads surrounding their location: 1) Anuban Schools located on the high way, where the traffic was heavy and full of high-speed vehicles; 2) Anuban Schools located on the main road; and 3) Anuban Schools located on the local road, where the traffic is light and difficult to access such as Anuban Kanchanaburi School.

Considering the frequency of accidents occurring around schools and the spatial results of the Kernel Density

Analysis regarding, it was found that the accidents took place in 2 forms, which were 1) cluster: the accidents occurred in cluster, and 2) linear: the accidents occurred in longitudinal distribution. When analyzing the highest accident areas together with the school environment and the behaviors, the results could be summarized as follows: 1) the accidents usually occurred at the junction or a roundabout near the schools, and 2) speed, traffic density, sizes of roads have an impact on the occurrence of accidents around the drop-off and pick-up areas (Fig. **3** and Table **1**).

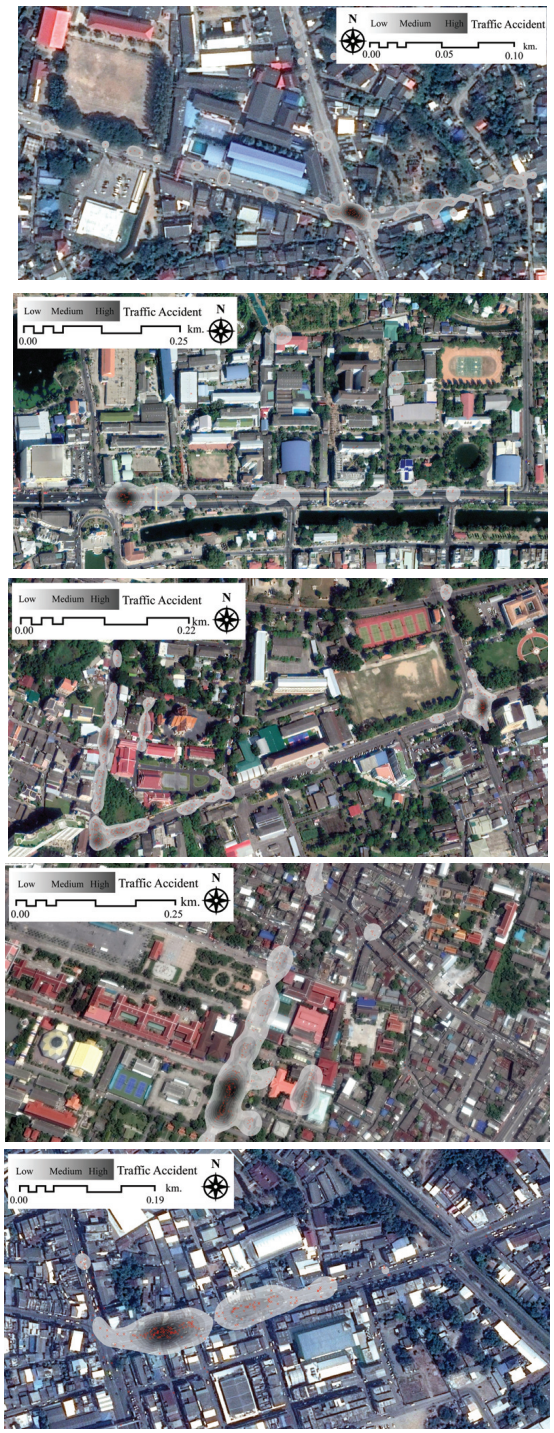

Fig. (3). Accident crash zone within school zone.

Table 1. Frequency of the past 4 years accidents occurring around schools and the spatial pattern.

School	Child Accidents / Accidents in pick-up and drop off time				Pattern
	2014	2015	2016	2017	
Anuban Lampang	17 / 42	27 / 86	17 / 30	34 / 32	Cluster
Anuban Nakhon Ratchasima	4 / 29	37 / 36	43 / 75	10 / 32	Cluster
Anuban Phuket	101 / 244	88 / 230	65 / 162	61 / 63	Cluster
Anuban Chon Buri	8 / 35	6 / 27	12 / 47	13 / 69	Linear
Anuban Kanchanaburi	21 / 44	12 / 38	12 / 17	3 / 21	Linear

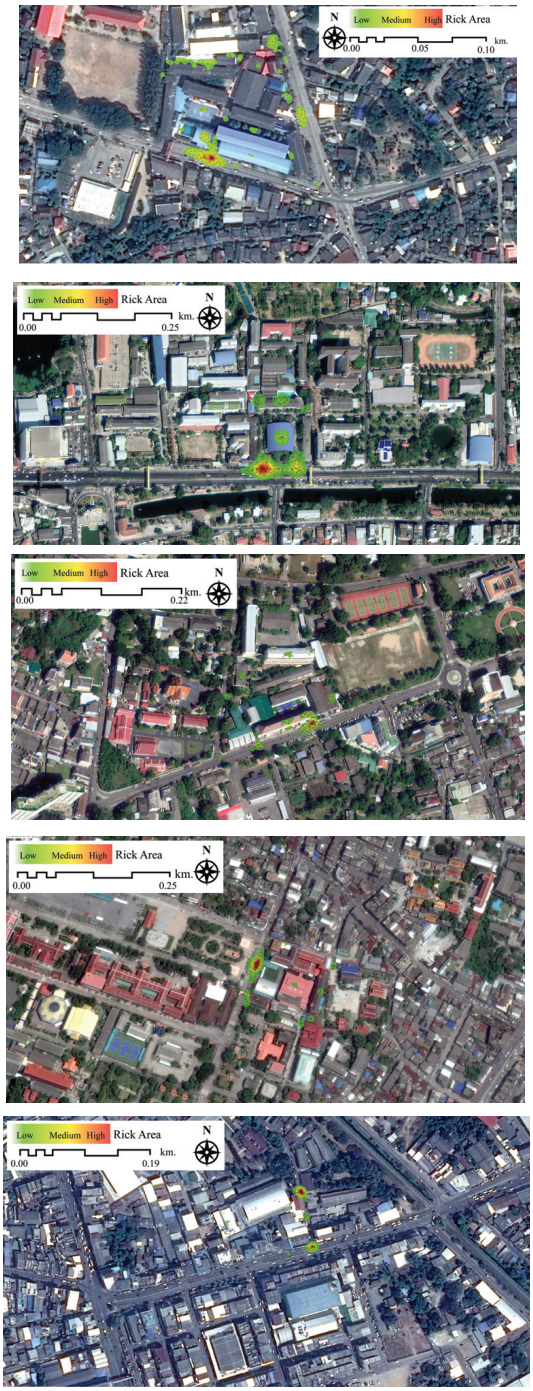

Fig. (4). The parents' opinions toward risk zone.

Regarding the risk zones for children, the results obtained from 1,230 questionnaires revealed that the parents thought that the most dangerous areas for children were the crossing points, the drop-off and pick-up points at the school entrance, and the sidewalk in front of the schools. The risk areas tended to cluster together (Table **2**). The drop-off and pick-up of kindergarten students and primary school students were carried out at different time and places, depending on the policy of each school. The number of dangerous areas in each school seemed to correlate with the number of drop-off and pick-up points. The drop-off and pick-up pattern of all case study schools were similar except Anuban Kanchanaburi School. With only one main entrance, Anuban Kanchanaburi School allowed the students to freely go out of the school and wait for their parents outside because of 2 reasons: 1) the school was located in a narrow alley that was difficult for cars to access, and 2) the students needed to buy snack and food outside the school. Based on the parents' opinions, there were two risk zones for children, which included the area in front of the school on the local road and the main drop-off and pick-up point nearby the junction. It could not be ensured that the students of Anuban Kanchanaburi School would be safer than the students in other schools (Fig. **4**).

Table 2. Frequency of parents' opinions and the spatial pattern.

No.	School	Parents' Risk Point Frequency (N=1,230)	Pattern
1	Anuban Lampang	284	Cluster
2	Anuban Nakhon Ratchasima	207	Cluster
3	Anuban Phuket	287	Cluster
4	Anuban Chonburi	305	Cluster
5	Anuban Kanchanaburi	147	Cluster

When comparing the actual accident locations around the schools (Fig. **3**) with the risk zones for children in the parents' opinions (Fig. **4**), it was found that the accident locations overlapped with the risk zones, especially in the areas around the drop-off and pick-up points. The accidents often occurred when the students crossed the road. This indicated that the traffic signs warning vehicle users to be more careful and use appropriate speed were ineffective (Figs. **5-9**).

Fig. (5). Overlap of external and internal risk zones around Anuban Lampang.

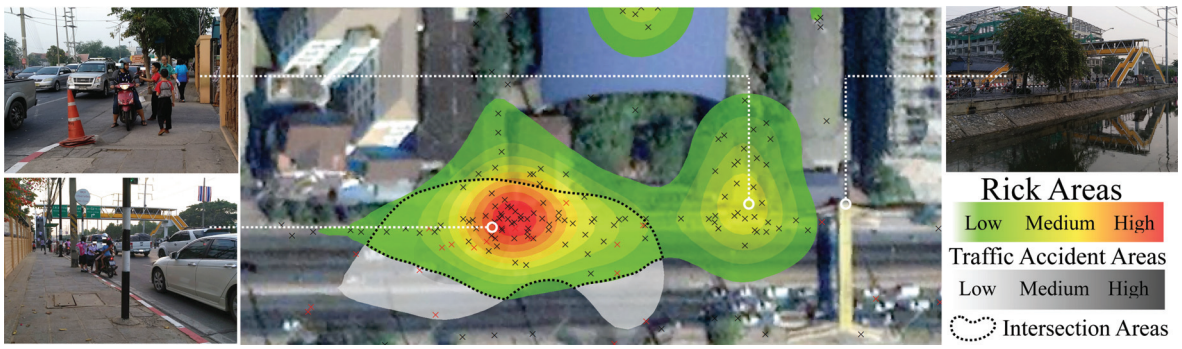

Fig. (6). Overlap of external and internal risk zones around Anuban Nakhon Ratchasima.

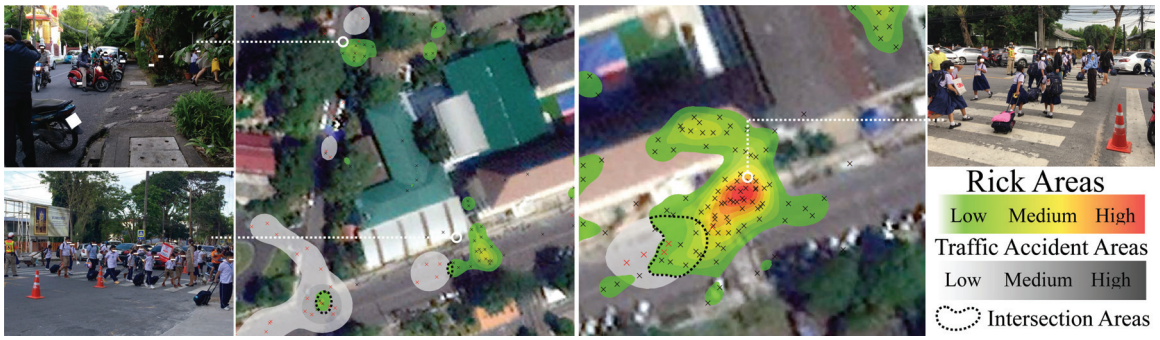

Fig. (7). Overlap of external and internal risk zones around Anuban Phuket.

Fig. (8). Overlap of external and internal risk zones around Anuban Chonburi.

Fig. (9). Overlap of external and internal risk zones around Anuban Kanchanaburi.

3.2. Student Drop-off and Pick-up Behavior

3.2.1. Drop-off and Pick-up Persons

The pattern of student drop-off and pick-up in Thailand is different from that of other countries because of the differences in environment, danger, family lifestyle, and anxiety about children safety. According to previous studies, the drop-off and pick-up is normally a female's responsibility [4]. This is consistent with the results of the present study, which suggested that 72.44 percent of those who came to drop the students off and pick the students up were females (mother/grandmother). In addition, the females often had more anxiety about the environment than males so they were likely to take care of their children in a very careful way, which might make the children lack the skills to help themselves.

3.2.2. Vehicles

It was found that 81.24 percent of the parents came to drop-off and pick-up the students by themselves. Most of them gave the reason that they were worried about the children safety. The top two vehicles used by the parents were cars (59.89 percent) and motorcycles (25.10 percent). As most of the parents were well-off, they supported their children to study at the schools with high reputation and were willing to send their children to school by themselves. If there was a better school in the same area as Anuban School, the students of that Anuban School were found to come from other districts. For example, many of the students in Anuban Kanchanaburi School lived in other districts so they had to travel to school by public bus (21.84 percent). Furthermore, it was found that only 0.27 percent of the students living in the city center near the school came to school by themselves.

3.2.3. Student Drop-off Zone and Process (In the Morning)

Regarding the student drop-off process in the morning (6.00 a.m. - 8.00 a.m.), it was found that the parents mostly parked their cars and dropped their children off in front of the school gate (35.06 percent) and at the sidewalk in front of the school (24.28 percent) because the parents needed to send their children to school in time before going to work during the rush hours. In addition, more than 24 percent of the parents had anxiety about the children safety so they parked their cars and walked their children to the classroom. Among all the case study schools, Anuban Kanchanaburi School had a different pattern of student drop-off and pick-up. This was because the road to the school was narrow and one-way. There were also many food stalls blocking the sidewalk. Therefore, most of the parents had to drop their children off at the sidewalk in front of the school (29.31 percent). This is in line with the data of the student drop-off and pick-up time in the morning, which stated that the school gate (54.02 percent) and the sidewalk in front of schools (14.60 percent) were the drop-off and pick-up areas where safety should be the first priority. Moreover, it was found that more than 20 percent of the parents in 3 out of 5 schools often walked their children to the classroom because they were worried about the children safety. Unfortunately, this could increase risks from outsiders [5].

3.2.4. Student Pick-up Zone and Process (In the Afternoon)

The student pick-up process in the afternoon (4.00 p.m. - 6.00 p.m.) was different from the drop-off process in the morning. It was found that the parents often parked their cars and walked to pick their children up inside the school (29.33 percent). Especially at Anuban Chonburi School (51.15 percent), the parents parked their cars at a public park with sufficient parking space in front of the school. Some parents preferred picking the students up at their classroom (23.47 percent), especially at Anuban Lampang School (33.10 percent). The percentage of this method was two times higher than that of picking the students up at the school gate and sidewalk in front of the school. For Anuban Nakhon Ratchasima School, the parents often parked their cars and picked the students up at the school gate (22.71 percent). This was because the school did not allow the parents or any outsiders to enter the school. In terms of the pick-up zone, even though the parents mostly picked the students up at the school gate (26.74 percent) and the classroom (21.96 percent), there were pick-up points scattered across different areas. For example, at Anuban Nakhon Ratchasima School, as the parents mostly picked the students outside the school (24.64 percent), the public park, where the parents temporarily parked their cars, became a pick-up point for the parents and the students.

3.3. A Comparison between the Parents' and Teachers' Opinions about Risk Zones and Risk Periods

Regarding the parents' opinions about the risk zones associated with 8 components of the school environment, the parents stated that the sidewalks and the crossing points were the highest risk zone (49.80 percent), which was in line with the spatial analysis results (Figs. **5**-**10**). The drop-off and pick-up points, school gates, and school fences were the areas with the second highest risk (18.08 percent). Moreover, 9.89 percent of the parents stated that the circulation route within the schools, including the roads, pavements, and stairs, was also one of the risk zones. The opinions of the parents from each individual school were consistent (Fig. **11**). Only the parents from Anuban Kanchanaburi School stated that the sidewalks and the crossing points were the highest risk zones (63.22 percent) because the drop-off and pick-up points were outside the school, which was very dangerous for the students both in the morning and afternoon.

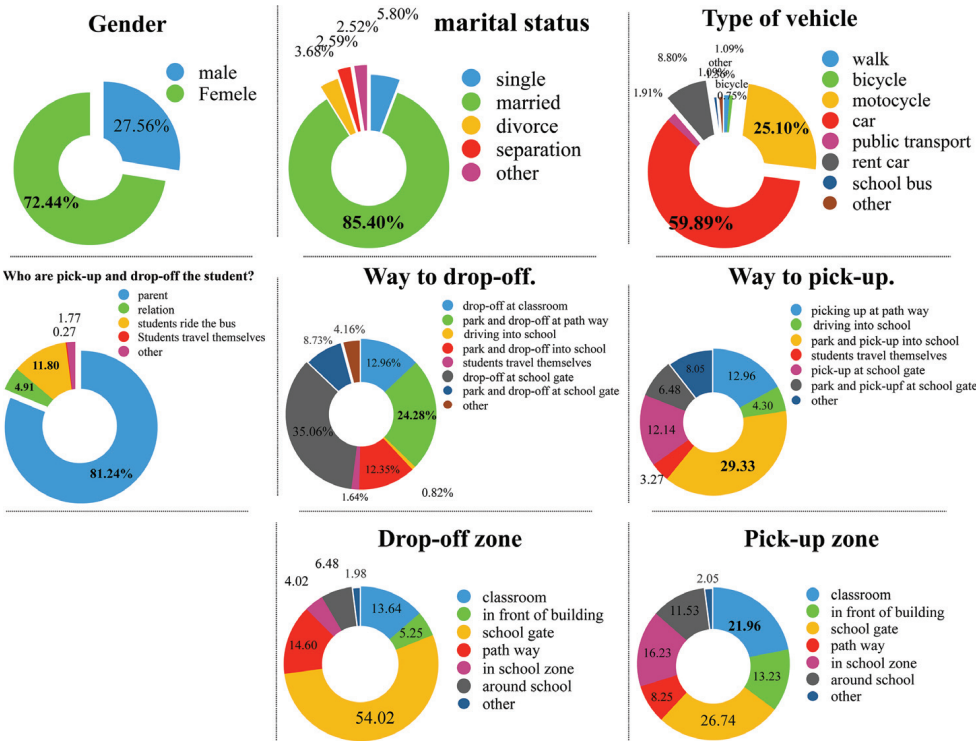

Fig. (10). Families characteristics and the drop-off and pick-up behaviors of the parents.

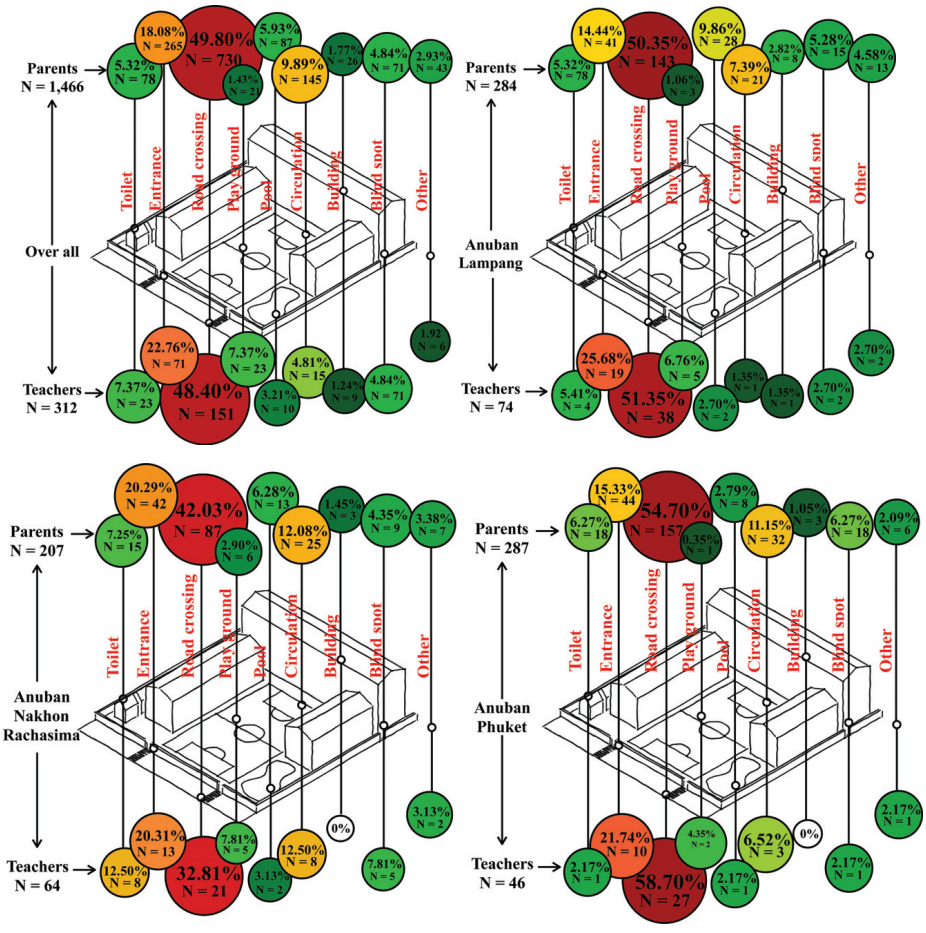

Fig. 11 cont.....

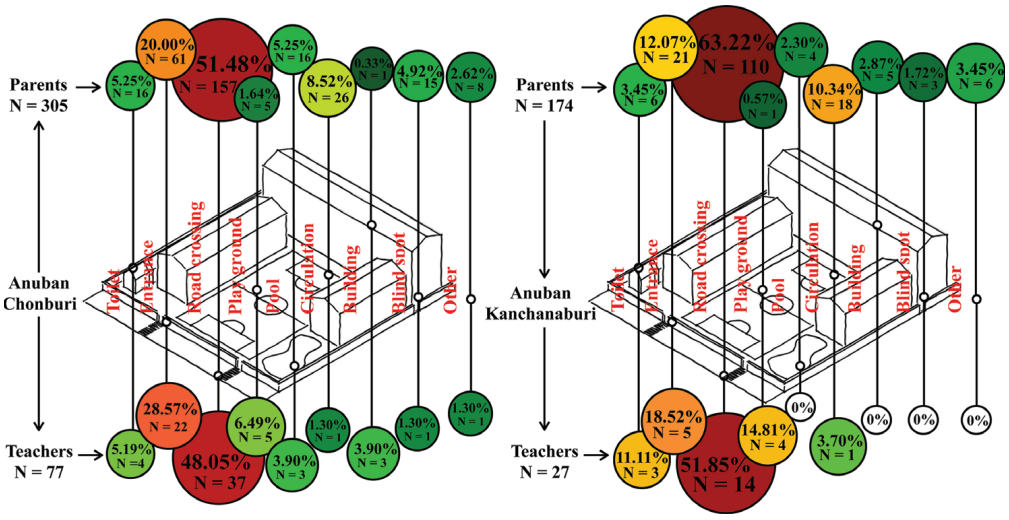

Fig. (11). A comparison between the parents' and teachers' opinions about the risk zones.

Considering the teachers' opinions about highest risk zones, it was found that the teachers' opinions were consistent with the parents' opinions (Fig. **12**). However, the parents' opinions were different from the teachers' opinions in 2 aspect as follows. First, some parents were worried about the blind spots behind the school buildings (4.83 percent), whereas the teachers thought that those blind spots were not dangerous (1.28 percent) because the teachers were more familiar with those areas. When separately comparing the opinions of the parents and the teachers in each individual school, it was found that 3.90 percent of the teachers at Anuban Chonburi School stated that the blind spots behind the school buildings were the risk zones while only 0.33 percent of the parents thought that those areas were dangerous. This was probably because there were a lot of blind spots in the school. Second, in the afternoon the teachers allowed the students to play and wait for the parent freely, which could be the cause of accidents and child missing. Due to a large number of children, it might difficult to find and identify the missing child. Therefore, the teachers stated that the open-playgrounds were one of the risk zones (7.37 percent), whereas the parents did not thought that such areas were the risk zones (1.43 percent).

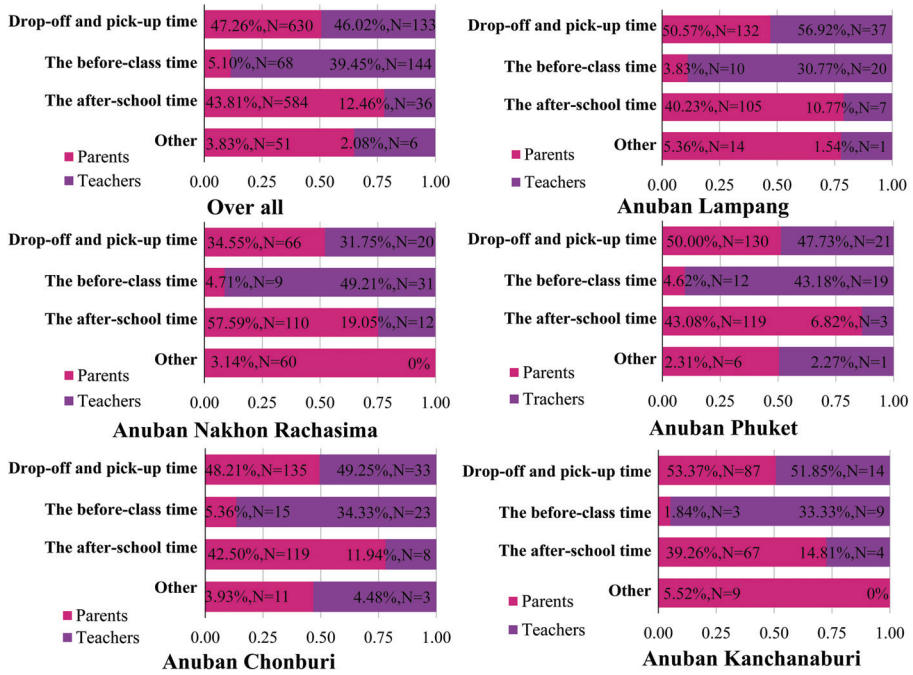

Fig. (12). A comparison between the parents' and teachers' opinions about the risk periods.

3.4. A Comparison of Parents' and Teachers' Opinion Toward Risk Moment

In terms of the parents' opinions about the risk periods for children, it was found that the highest risk period for children was during the drop-off and pick-up time (42.97 percent). The second highest risk period for children was the after-school time or during 04.00 p.m. - 06.00 p.m. (39.87 percent). It was found that the opinions of the parents from each 5 schools were consistent. However, the parents of Anuban Nakhon Ratchasima School stated that the after-school time was the highest risk period for children (53.14 percent). This was because Anuban Nakhon Ratchasima School was the largest school among the case studies. There was a main road with heavy traffic in front of the school and a limited space for the drop-off and pick-up activity.

Considering the teachers' opinions about the risk periods for children, it was found that most of the teachers stated that the highest risk period for children was during the drop-off and pick-up time (42.63 percent), which was consistent with the parents' opinions. The teachers also thought that the before-class time (06.00 a.m. - 08.00 a.m.) was the second highest risk period for children (36.54 percent). Moreover, it was found that the teachers from all schools had consistent opinions, except the teachers from Anuban Nakhon Ratchasima School. They stated that the before-class time was the highest risk period for children (48.44 percent). Some teachers from Anuban Kanchanaburi School stated that the after-school time was the risk period for children due to the children's behaviors that wanted to buy snacks and wait for their parents at the meeting points outside the school.

A comparison between the parents' and the teachers' opinions about the risk zones and the risk period could be summarized as follows. It could be seen that the parents' and the teachers' opinions about the risk zones for children were consistent. They stated that the sidewalks and the crossing points were the highest risk zones for children. As for the parents' and the teachers' opinions about the risk periods for children, it was found that their opinions were significantly different at $p < .01$ (Table **3**).

Table 3. The parents' and the teachers' opinions toward the risk moment Comparison.

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
The risk moment for children	19.489	< .01	4.009	695.859	< .01**

** $p < .01$ / * $p = .05$

The parents stated that the after-school time was the risk period for children because it was in the evening and the pick-up points were scattered across different areas both inside and outside the school. It was the parents' responsibility to look out for the safety of children when returning home from school. The teachers clearly believed that the before-class time was the risk period for children because it was during the rush hours and the traffic was heavier than in the evening. Furthermore, the teachers were the main persons responsible for the children during school time.

DISCUSSION AND CONCLUSION

This research aimed to analyze the risk factors associated with the student drop-off and pick-up in 3 aspects, including risk zones, risk behaviors, and risk period of drop-off and pick-up time. The results can be summarized as follows.

Risk zones: according to the survey of accident locations around the schools and the spatial analysis using Kernel Density Estimation, it was found that the accidents occurred both in cluster and in a linear form on the roads in front of the schools. The high density of accidents often occurred at a junction. In addition, some accidents occurred in front of the schools might be caused by road sizes, vehicle speeds and school locations [38]. It could be obviously seen that the environment [7], the vehicle speed [39], and the driving behaviors had an effect on the children's risk factors [27, 40, 41]. In addition, when investigating the parents' opinions about the risk zones using the frequency analysis of coordinates, it was found that the risk zones were in a cluster form. The highest density area was in front of the school gates, roadsides, and blind spots behind school buildings, which were involved with the school environment planning.

When analyzing the accident locations together with the risk zones, it was found that there was the overlapping area between the risk zones in the parents' opinions and the accident locations before the crossing points in front of the schools. The overlapping depended mainly on the school locations. When the school's location was near a junction, the vehicles cannot move fast. Therefore, the accidents usually occurred in cluster near the junction far away from the drop-off and pick-up zone, resulting in less overlapping areas. On the other hand, when there was a main road in front of the school, the vehicle normally moved with high speed, leading to the distribution of accidents across the road, especially

at the areas before the drop-off and pick-up zone. Ineffective traffic signs around the schools were the cause of accidents [42].

It can be clearly seen that the accident locations around the schools could help identify the risk zones for children because the accident statistics are the empirical data that actually occurred to both children and adults. Although the high density area is far away from the school gate but the accidents in children often cause death and serious damage since the children tend to have vulnerable bodies. Related organizations should pay attention to accidents occurring to children and take account of the transport planning. Moreover, the overlapping area resulting from the comparison between the accident statistics and the parents' opinions indicated that there should be a safety measure to monitor the area before the drop-off and pick-up points.

Risk behaviors: the parents' drop-off and pick-up behaviors affects the safety of children [22]. There was a study suggested that most parents in Thailand had anxiety about the safety of their children. A convenience- based lifestyle [6], lacks of safe public transportation systems, and varying degrees of school quality and reputation made the female parents have a higher level of anxiety than the male parents [43]. They chose to send their children to school by themselves using private cars or motorcycles, which resulted in increased traffic congestion in front of the schools and in the center of city, especially during the rush hours in the morning. The parents usually pulled off their cars in front of the school gates or the sidewalks in order to send their children to school in time. Due to the limited space of the sidewalks and the school gates, the traffic became heavier, causing more accidents. In the afternoon, the parents often parked their cars and walked to pick up the students at the classroom inside the school. These are all behavioral factors that can cause risk to children [6, 21]. Being aware of danger can be helpful in taking good care of the children. On the other hand, it may make the children lack self-reliance skills and easily get harmed when being alone.

Risk periods: the significant findings of this research were the opinions of the parents and the teachers about the risk periods for children. The parents considered the after-school time as the risk period. In contrast, the teachers thought that the before-school time was the risk period for children. Their opinions were different at a statistical significance level, which had an effect on the way they look out for the safety of children. During the rush hours in the morning, the teachers were aware of the risks and attend to the safety of students while the parents only aimed to drop their children off in front of the school and go to work in time. During the pick-up period in the afternoon, the teachers often allowed students to go outside the school or let outsiders to pick up students inside the school, whereas the parents were very worried about the safety of their children. They parked their cars and walked to pick their children up inside the school or at the meeting point. Therefore, there were many the drop-off and pick-up points across different areas, which was very risky and hard to monitor and manage.

RECOMMENDATION

The responsibility of ensuring children safety comes together with caretakers' anxiety. In addition to hazards from school environment, parents' anxiety indirectly affects the safety of children in Thailand, a country in need of effective urban planning. In order to solve the issue of children's safety, safer environment should be built to reduce the anxiety of caretakers. This will consequently lead to a change of behavior and opinion towards safety. Based on the findings of this research, the following 7 recommendations were made: 1) transport planning should be carried out so as to monitor the areas around the crossing points and school gates such as creating serious traffic signs, modifying road surface to make vehicle drivers become more careful, and letting traffic police volunteers give warnings to vehicle drivers; 2) sidewalks and crossing points in front of each school should be improved so that they are safe to use as the drop-off and pick-up points during the rush hours and can make parents avoid dropping their children off inside the school; 3) the pick-up points after school should be clearly defined, young children should not be allowed to go outside the school, all students should gather together so that it is easy for teachers to take care of them; 4) snack and food should be allowed to be sold within provided areas so that students have no need to go outside the school; 5) the safest way to drop-off and pick-up students is parking a car outside the school and walk to pick up or send the students off at a meeting points or school gate, sufficient parking space should be provided, the government areas around the school should be used as parking area, and each school should discuss the parking issue with governmental agencies at the city level; 6) the school should encourage parents to drop-off and pick-up their children only at the designated area, avoid going to the children's classroom, and driving into the school, which are the behaviors that can cause harm to children; and 7) children should be carefully taken care of both in the morning and after school. Parents should pay more attention to the drop-off process in the morning while teachers should care for the children during the pick-up time in a more attentive way.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICTS OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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