



Research on Safety Evaluation and Optimization of Children's General School Environment

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Abstract

The construction of child-friendly cities is an important topic in major cities today. The 14th Five-Year Plan also mentioned the development of 100 demonstrations of child-friendly cities, and the school environment closely related to children's travel has become the focus of attention. Based on the safety perspective of the child-friendly concept, this paper integrates the special needs of children and previous research experience on children's independent travel paths and road space at home and abroad through a literature review and in-depth research. Data from the PSPL survey (map marking method, on-site counting method, on-the-spot investigation method, and interview method) were used to evaluate, analyze and propose optimization strategies from three aspects: children's health and safety, pedestrian traffic safety, and social monitoring. This was done in order to improve the urban school environment. Child-friendliness and refined design provide support to promote autonomous learning by urban children.

Subject Areas

Urban Planning

Keywords

Child-Friendly Safety Evaluation Index Optimization

1. Introduction

In recent years, urban development has shifted from focusing on material construction to returning to humanistic social life planning [1], and the construction of child-friendly cities has become a development hotspot, which is mainly reflected in urban open space planning that is more focused on children's needs. This includes the planning and design of urban open space sys-

tems as well as ensuring space safety to meet the spatial interest demands of children. For a long time, the planning and design of the universal walking system still mainly relies on traditional methods such as relevant theories, standards and subjective experience, and the real needs of children cannot be expressed [2]. Children's growth environment faces many challenges: traffic conditions and environmental conditions pollution, crime and risk avoidance, etc., especially children's travel is faced with many problems, such as traffic safety accidents and lack of atmosphere. The "Child-Friendly Urban Planning Handbook", a guide for building child-friendly cities, was translated in July 2019 (<https://www.unicef.cn/reports/shaping-urbanization-children>). It proposed that urban planning should pay attention to the needs of children. The concept, basis and technical strategy are to take into account the needs of multiple users and create an urban space suitable for children's development, as shown in **Figure 1** and **Figure 2**. From the introduction of the concept of child-friendly city construction, the linear urban public space for children's regular activities has become the focus [3]. This paper takes Mianyang Experimental Primary School as an example to explore the environmental safety evaluation system of general schools, in order to provide ideas for follow-up research.

2. Research Progress

Focus on the prominent problems of childhood obesity and travel safety caused



Figure 1. Cover of the child-friendly urban planning brochure (Source: Child-Friendly Urban Planning Handbook).

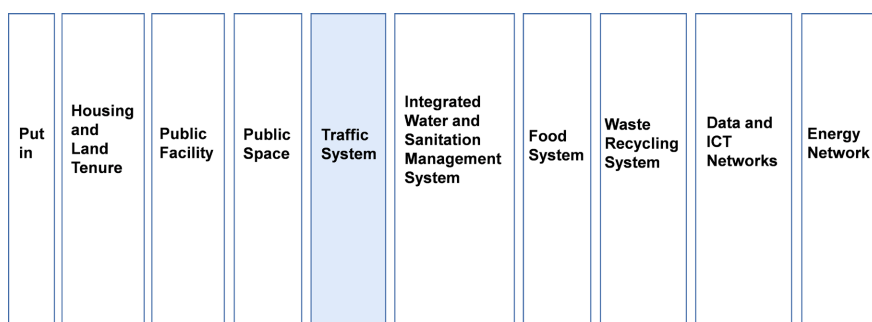


Figure 2. Child rights and urban planning principles.

by urban sprawl and car dependence after the origin of general studies research in the 1980s, the earlier intervention field is public health, and it is believed that improving the built environment can promote positive Active transportation mode [4] [5] [6]. One of the 12 specific contents of the Child-Friendly Cities Initiative (CFCI) proposed in 1996 is that “children can safely walk on the streets alone”, and street safety has become a common international concern [7]; Japan, which has a serious aging population of young children, attaches great importance to the issue of children’s access to education. In 2001, the concept of “access to education” was proposed for follow-up and inclusion in the draft plan [8]. Attaching great importance to the issue of children’s schooling [9], Walking Bus [10], Kindlnt [11], etc., it has formed rich experience. My country’s research on general schooling in Taiwan started earlier, and the evaluation research on School Road Mainly, with the increase of attention, Shenzhen, Changsha and other places in my country have formed rich experience in advance [12] [13], and gradually formed pilots in many places. Subsequently, not only at the practical level, scholars have used a variety of theoretical methods to conduct in-depth research on general school safety issues, using CPTED theory (Crime prevention through environmental design) to enhance child care and ensure child safety [14]; The special “Kid Street Scan” (KISS 2.0) street child-friendliness evaluation tool was used for evaluation [15]; the use of GPS tracking, pedestrian simulation, and space-time prism diagrams were used to visualize and analyze children’s school paths [16] [17]. However, there are few explorations of quantitative assessment and precise construction strategies for space safety, and insufficient understanding and analysis of the needs of children’s end users. To sum up, the following revelation can be drawn. It is necessary to improve the evaluation system, focusing on the consideration of children’s safety needs from the perspective of space and design, and presenting the temperature of planning [18].

3. Interpretation of Children’s Psychological Behavior

During the 3rd United Nations Conference on Housing and Sustainable Urban Development, a survey from the “Child-friendly Urban Planning Manual”—what is the city in the eyes of children? Mentioned that if we can build a successful city for children, we are building a successful city for all. The results of an online survey of 35,000 children and adolescents from 65 countries revealed safety and protection issues—25% of children are insecure in the cities where they live. One in two children said their main safety concern was crime. More than 40% of children report feeling unsafe when sharing transportation and walking outside their residential areas, and today’s unsustainable built environments reduce the effectiveness of services for children, if not nearly impossible.

3.1. Children’s Psychology

Children’s psychology has different characteristics at different ages in terms of intellectual development and urban road space understanding, as shown in **Figure 3**, and their interest tendencies are also different; 0 - 3 years old like

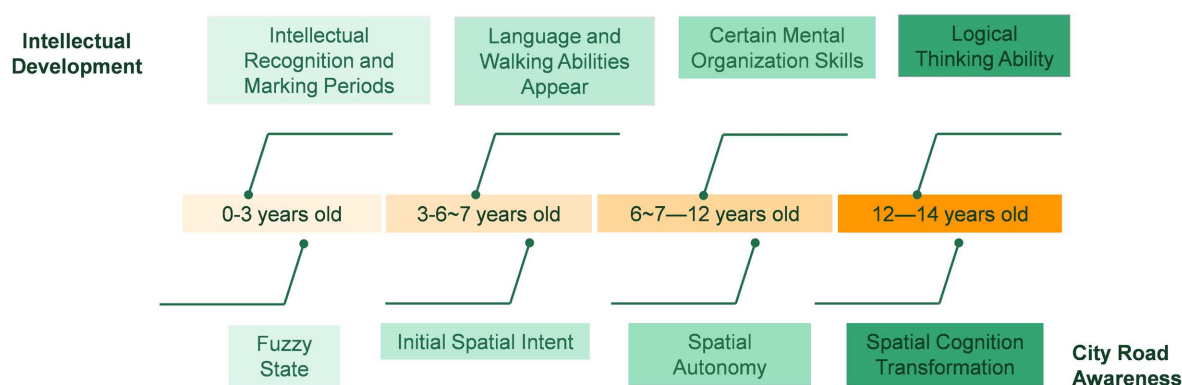


Figure 3. Children’s intellectual development and city road awareness at different stages (Source: Arranged according to the literature [20]).

repetitive games, can’t take care of themselves and need the company of parents. Color objects are more sensitive; 3 - 6~7 years old like to play with each other, can complete simple cooperative games, and begin to have their own favorite items, preferring bright colors; 6 - 7 to 12-year-old children begin to play independently Activities, their curiosity and demand for activities are strong; 12 - 14 years old like group activities, tend to carry out sports games and intellectual activities, and show the characteristics of a wide range of interests. To varying degrees, they manifest psychological characteristics such as stimulation-seeking, imitation, egocentricity, thirst for knowledge, exploration, curiosity, risk-taking, and self-display [19], which all need to ensure the safety of the road environment.

3.2. Children’s Behaviors

The school environment is the most important range of activities for children. For the attendance walking activities that occupy most of the children’s time, it often presents a kind of “home-school/activity space-home, or home-school-activity space-home” and other three-point or four-point line activities, follow the guidance of the pedestrian space on the street to reach the destination, during this process, there will be necessary activities, spontaneous activities, and social activities [20] (Table 1), which promotes these three types of activities for children. The key is to create a safe outdoor overall environment, so that children have the opportunity to independently go out of the house to carry out necessary activities to create a series of interesting spatial sequences, so that children can find their favorite small bases, and carry out spontaneous activities to create a good walking and walking distance. Cycling network, so that more children in the vicinity can come to play and promote the development of more advanced social activities. Children also have the same age aggregation, randomness and variability in behavioral activities. To sum up, this paper selects 6 - 12-year-old children as the research objects. Children’s game behavior has obvious age group characteristics. Children between 6 - 12 years old use outdoor space most actively, and children have mature acceptance of concepts and self-reaction ability.

Table 1. Analysis of behavioral activities and environmental needs in children’s general school environment (Source: Arranged according to the literature [18]).

Type of Activity	Activities	Environmental Needs
Necessary activities	To and from school, shopping, games, sports, etc.	Safe outdoor environment
Spontaneous activities	Watching, sitting, eating, playing on the road, etc.	Interesting spatial sequence
Social activities	Conversation with people, group play, imitation, etc.	Accessible walking and cycling network

4. Construction of the Environmental Safety Evaluation System for General Learning

Most of the data in this research comes from the CNKI database. The research first selects child-friendly spaces, streets, blocks, paths, etc. as keywords for retrieval, and the time is limited to nearly ten years from 2010 to 2021. A total of 301 valid documents were retrieved, including 48 evaluation index documents and 78 helpful documents for index extraction. Through horizontal comparison, the frequency of occurrence of various attributes in the paper was summarized as shown in **Figure 4**. High-frequency hot research: security. When researching related papers, it was found that security is the basic guarantee of other attributes, and it is the most important indicator for parents. In the travel chain from home to school, families who travel through school have higher demands for safety and spatial continuity. Parents’ recognition of environmental safety and children’s own sense of security determine whether children travel independently and go to school independently. Almost all the evaluation index papers propose to use safety as a key indicator to measure the child-friendliness of children’s activity spaces, and safety also occupies a relatively high weight when assigning values. Similarly, through literature classification and comparison, summarization, expert consultation, combined with the PSPL pre-investigation of children’s general school environment, an attempt is made to form a hierarchical scale of influencing factors, and the four dimensions of the general school environment safety are shown in **Table 2**.

In the general school environmental safety evaluation system, most of them are objective indicators. Environmental safety indicators are mainly the objective safety perception of the surrounding environment, including plant species and whether there are polluted and toxic areas around; facility safety is mainly about the shape of facilities when children are playing and the maintenance of facilities at ordinary times; pedestrian traffic safety focuses on children’s walking. Environmental elements are related to walking design, setting road speed limits, traffic guidance signs, intersection density, etc., and it is necessary to provide children with safe walking support tools and guarantees; the construction of social safety is mainly based on the CPTED theory (crime prevention). Sex and the concept of “street eye” proposed by Jane Jacobs for street social security [21],

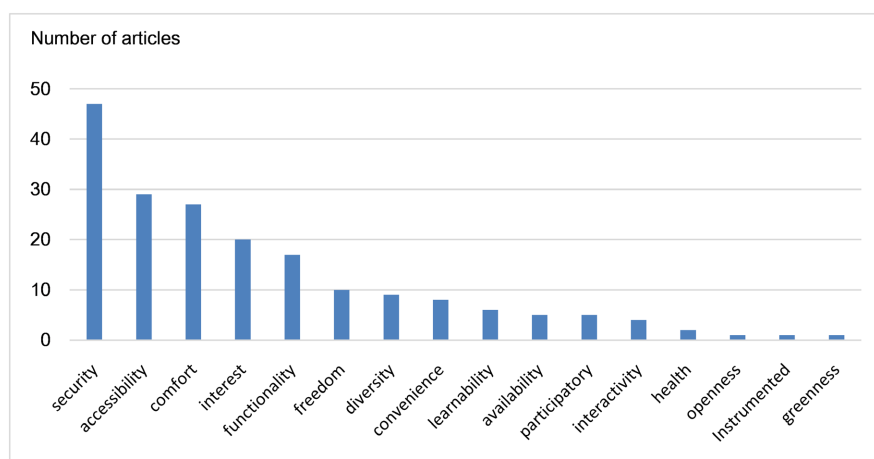


Figure 4. The situation of each indicator (Source: Author).

Table 2. Children's school environment safety indicators and descriptions (Source: Author).

First-Level Indicators	Second-Level Indicators	Indicators Description
Environment safety	Plant species safety	Poisonous, thorny, fluffy and irritating plants
	Sound environment safety	Noise level of children's school road
	Pollution source, toxic area	Basic survival requirements (if any)
Facility safety	Facility sketch modeling safety	The facilities are strong, and there are no safety hazards such as sharp corners and pinching (whether there are)
	Facility protection and management	The maintenance and management of facilities have a direct safety impact on children's activities (manhole covers, utility poles, etc.)
Pedestrian traffic safety	Road speed limit	The overall speed limit of children's travel paths should not be greater than 30 km/h, and the speed limit should be less than 15 km/h in sections with intensive children's activities (whether there is)
	Sidewalk width	Average width of sidewalks on both sides of the street (m)
	Walking obstacles	Bicycles, battery cars, and vendors occupy sidewalks (places)
	Pavement quality	Pavement damage, smoothness, number of rough, fall-prone places/street length
	Walking continuity	The smoothness of the sidewalk, the effective length/actual length of the sidewalk
	Intersection density	Intersection density = (total number of intersections/street length) * 100%
	Traffic guidance sign	The completeness and conspicuousness of the guide signs, etc., whether the children's signs conform to the physical characteristics of the children
Social guardianship	Monitoring settings	Monitoring facility density = (monitoring equipment/street length) * 100%
	Avoid crime and threats	dark corners, blindness
	Security agency	Density and number of police stations, security booths and other institutions
	Peripheral business	Density and number of commercial POIs along the street, from informal surveillance from the street (street eye)

surveillance includes natural surveillance, electronic surveillance and human surveillance. Among them, natural surveillance refers to the improvement of space visibility and space utilization rate through design to ensure the safety of the space; electronic surveillance refers to surveillance through electronic surveillance; artificial surveillance refers to the conduct of police, security, surrounding businesses, etc., mainly aimed at the psychological safety of children and their parents—their perception of social streets and their familiarity with the environment.

5. Evaluation of the Study Area

The service radius of primary schools should not be greater than 500 meters. Most of the primary school students' paths after school are concentrated in the 500m action circle, and rarely exceed the 800 m action circle [22]. This paper firstly selects the radiation area of primary school service radius for basic research. Traffic safety and social monitoring are targeted for improvement and optimization. The data mainly comes from PSPL survey, street view map, GIS road network and POI point data, mainly including road network map, distribution core density of public service facilities and other information needed to support this article, so as to intuitively reflect the agglomeration and dispersion of some facilities. (Figure 5)

According to the evaluation and analysis of the general school environment safety of this research topic, the service radius of 500 meters in Mianyang Experimental Primary School meets the sample requirements of this research. Use POI data and ArcGIS to visualize the research space as shown in Figure 6 and Figure 7. First, visualize the distribution of POIs near the primary school, such as police offices, public security bureaus, police stations, etc. It can be seen from the figure that the distribution of security agencies near the primary school is 500 meters away. Non-uniform, mainly concentrated in Hongxing Street, which can reflect the distribution of residential areas around the street. Secondly, the core density analysis of the interest points of various commercial facilities in the primary school research area shows that the commercial facilities are evenly distributed along the street, and the concentrated areas are Hongxing Street, Jianshe

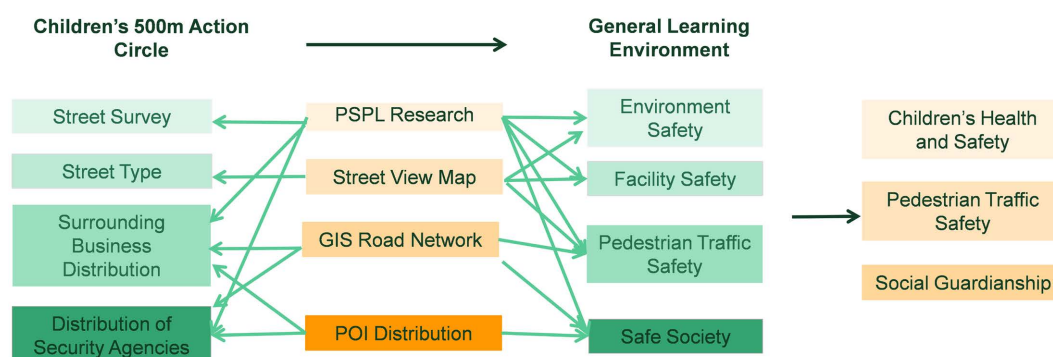


Figure 5. Research analysis and data sources (Source: Author).

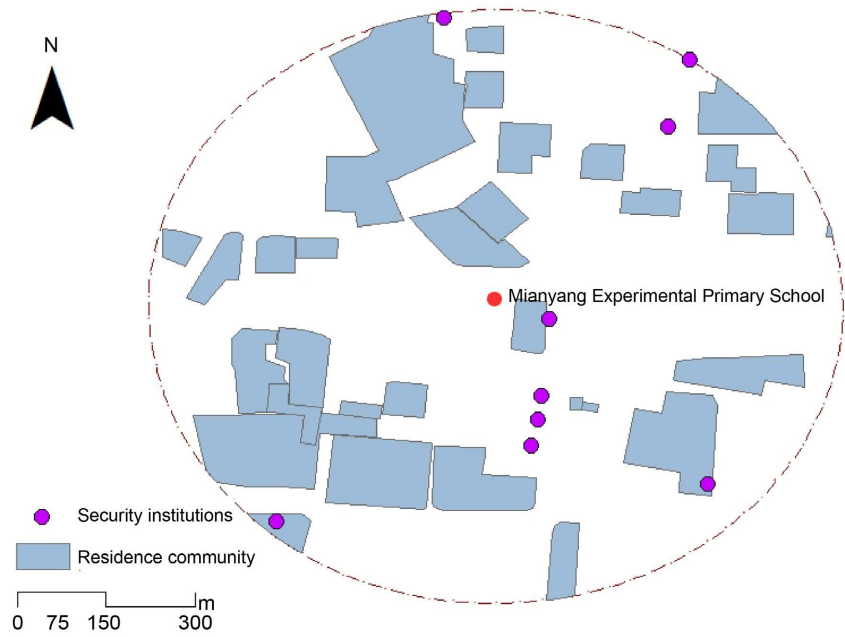


Figure 6. Distribution of public security agencies.

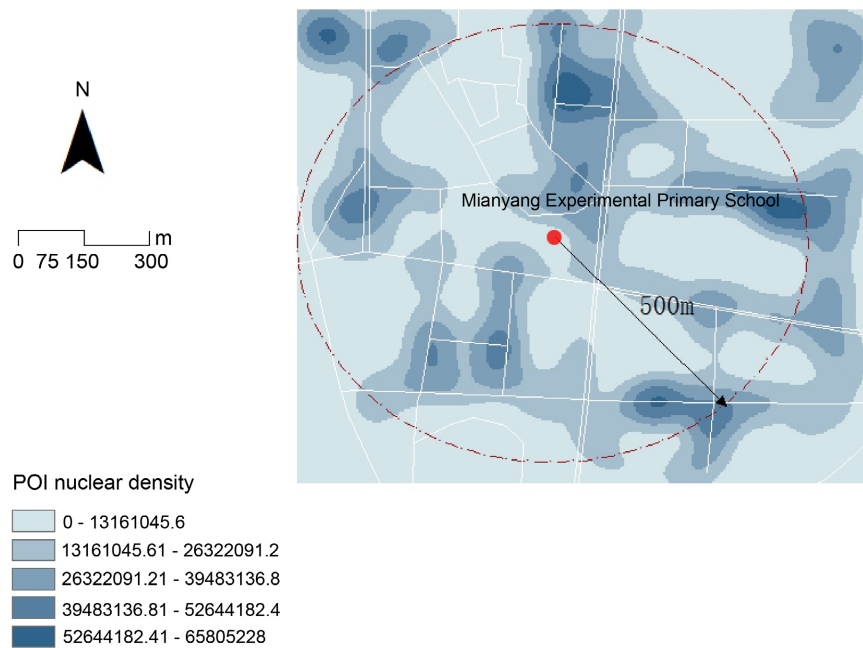


Figure 7. Distribution of business (Source: Author).

Street, Nanhe Road, Tiycun Road. At the same time, the characteristics of distribution along the street can also be seen in other areas, so that the children’s schooling path can be preliminarily identified within the scope of the study area, and further analyzed and selected on this basis.

6. Selection and Analysis of School Road Sections

School Road is located near primary and secondary schools, and is the main dis-

tribution channel for children when they go to and from school. Children mainly carry out high-frequency independent travel activities in School Road. Through the above visual analysis of the observation within the service radius, as well as the preliminary investigation of School Road and children's schooling activities, and according to the children's description and drawing of the schooling path, spatial observation and behavioral tracking, the high-frequency activity paths within the service radius of the experimental primary school are obtained. , there are abundant residential areas in the surrounding area, and 4 typical road sections carrying children's street activities are selected as shown in **Figure 8** and **Table 3**.

On-the-spot investigation, questionnaire distribution, and big data analysis were carried out on the 4 routes to study, so as to make a more objective evaluation of each individual indicator. The article adopts the entropy weight method, which is widely used in urban development and index evaluation, that is, the index weight is calculated according to the characteristics of the data itself, so as to ensure the objectivity of the weighting as much as possible. The basic idea of the entropy weight method is to determine the objective weight according to the variability of the index. Generally speaking, if the information entropy of an index is smaller, it indicates that the degree of variation of the index value is greater, the amount of information provided is greater, and the role it can play in comprehensive evaluation is greater, so its weight is greater. According to the principle of entropy weight method, the index with larger entropy has a higher



Figure 8. Street distribution and street pictures (Source: Author).

Table 3. Street situation table (Source: Author).

Street Name	Street Level	Street Type	Spatial Scale	Has Unlimited Speed Tips
Nanhe Road	Main road	Comprehensive street	Larger	None
Hongxing Street	Main road	Comprehensive street	Larger	None
Jianan Street	Second road	Life service street	General	None
Weishengng Lane	Branch road	Life service street	Smaller	Limit line

weight, which can magnify the difference of the index, which is more conducive to comparing the differences between the research objects. In the entropy weight method operation, the data standardization calculation is carried out first, then the information entropy of each group of indicators is obtained from the standardized data according to the definition of information theory, and finally the weight of each indicator is comprehensively generated through the information entropy.

7. Thoughts on the Optimization of the General School Environment Based on the Results of Safety Evaluation

It can be seen from the evaluation results of the general school environment that pedestrian traffic safety and social safety are relatively low, and a large amount of traffic also increases the degree of unsafety. The design of guiding children to walk safely and increasing the density of social supervision should be added to fully ensure the safety of children. Taking Nanhe Road as an example, the street has high traffic flow and noise pollution, which threatens the safety of children. Children's special lanes with clear routes can be designed on the pedestrian paths to guide children to pass efficiently and safely; children's recognizable traffic signs can be placed at the crossings to reduce the phenomenon of crossing the road, and the brightly painted zebra crossings can encourage children to develop the awareness of crossing the road and walking on the crosswalk. , and at the same time prompt the driver to be courteous to children through brightly colored patterns.

7.1. Children's Health and Safety

Children's health and safety is a solid foundation for ensuring the operation of children's bodies. It mainly comes from the health threats brought by the external environment that children can feel physically and mentally and experience when they go to school and after school. Through evaluation and analysis, the streets should increase the number of planting Harmless and non-irritating safe green plants can absorb vehicle exhaust and traffic noise, and create a healthy and safe walking environment.

7.2. Pedestrian Traffic Safety

Children mainly carry out high-frequency independent travel activities in School Road, which requires the street to provide a safe and convenient slow-moving environment and public transportation facilities to provide a stable traffic environment. Speed limits should be imposed on the road section leading to school. Excessive speed will cause unsafe factors. Speed limit signs should be set up around the school; road obstacles should be removed, the passage space should be returned, the openness of public space should be improved, and the visibility and accessibility of some parts should be improved. The spaces with poor sex are open and used for parking; ensure the quality of the road surface, uneven, chao-

tic, broken bricks will cause children to fall and be injured; improve traffic signs, and set up traffic guidance and identification signs that meet children. Pay attention to the rectification and planning of walking roads, and guide children's travel directions by drawing corresponding pattern signs.

7.3. Facility Safety

Strengthen the maintenance and management of facilities, especially the facilities that have a direct safety impact on children's activities, such as manhole covers, telephone poles, high-voltage electricity, etc., and set up fences or reminder facilities around them. Elementary school students have weak awareness of their own safety behavior, and the walking process is often accompanied by behaviors such as running, jumping, and playing; and they lack sufficient ability to predict possible dangerous accidents in space, and there are certain hidden dangers in facilities.

7.4. Social Guardianship

If School Road uses Internet technology to fully cover the street smart monitoring system, infrared sensing system, voice automatic broadcast system, etc., it can realize the monitoring of children's group street activities and safety early warning. It also benefits from the monitoring of "street eyes". Some monitoring coverage is insufficient, there are monitoring dead corners and dark and dangerous areas, and there are some extremely bad safety injuries to children in the society, so there is a high demand for monitoring in the general school space.

8. Conclusions and Shortcomings

The construction of a child-friendly city is imperative. Child-friendly cities cover a wide range, and the safety of children's general education must be guaranteed. Based on the safety of children's general education environment, this paper deeply interprets children's psychology and behavior, and on this basis builds a complete children's general education, and conducts field research on the safety evaluation system of urban campus road environment and child safety. Through the comprehensive evaluation of the survey results, the current situation of children's safety in urban street pedestrian space is analyzed, and on this basis, the corresponding planning, design and transformation methods and strategies are put forward. The results are as follows: establish an evaluation system for environmental safety, facility safety, pedestrian traffic safety, and social safety to conduct evaluation research. From the evaluation results, suggestions are put forward to protect the environment, improve facilities, plan walking, and improve social safety. The shortcomings of research are that the evaluation object is relatively simple and the evaluation method is relatively traditional. It should integrate emerging methods, conduct research from multiple perspectives and disciplines, make full use of big data and artificial intelligence, and strive to form a special and obvious road traffic safety space for children.

Conflicts of Interest

The author declares no conflicts of interest.

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