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A study on the Safety Evaluation System of Outdoor Children's Activity Space in Residential Area

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Abstract: With the rapid development of urban construction in China, the security issue has been increasingly concerned; Safety problems in urban traffic planning, architectural design, urban disaster avoidance and other fields have made great progress from theory to practice. As a small branch, the research on the safety of children's activity space in residential areas is relatively weak and needs further in-depth discussion. With the children as subjects, the safety of residential outdoor space as evaluation object, through the analysis of the related literature and group discussion, this paper selects the safety factors that affect children's outdoor space activities. Through expert questionnaire and the application of AHP method to determine the weight of the indexes, this paper constructs evaluation system and conducts a field survey in five communities. The results show that experts believe that the main factors affecting the outdoor space safety of children in residential areas are the surrounding environment safety, the safety of entertainment venues, and the safety of management and maintenance. Among them, vehicle interference, facility safety, site safety, facility maintenance are considered as the main influencing factors. The results of the questionnaire show that the residents are most worried about vehicle interference, site safety and facility maintenance, which is in agreement with the experts' considerations on safety issues. Three communities scored in between “satisfactory” and “average”, one community was graded “average”, and one community got the evaluation of “unsatisfactory”, indicating that there are still safety deficiencies and hidden dangers in outdoor children's activity space in residential areas, which need to be further improved.

1. Introduction

Apart from home and school, outdoor space in residential areas is the most important activity space for children. Therefore, a safe activity space for children is of vital significance for the healthy development of children [1]. Research on children has identified the potential impact of neighborhood outdoor safety on children's positive behavior [2].The establishment of children's activity space in the public space of urban residential areas is not only conducive to children's physical and mental health and intellectual development, but also can cultivate children's willpower

and personality traits, which can fully meet the needs of children's communication and interaction [3]. This article starts from the perspective of children's psychological, physiological and behavioral characteristics, and at a certain theoretical level, deeply explores the problems existing in the design of outdoor children's activities in residential areas, in order to design a more complete children's activity space, and from more Angles and larger angles meet the needs of children's healthy growth.

Many scholars have conducted research on children's activity space. Such as: Wang Pengfei, Zhang Limeng and others believe that the outdoor activity space in the residential area is responsible for the important functions of children's daily leisure and recreation activities [4]. Shi Xixia, Wang Xin and others took three communities established in different periods in Fuzhou City, Fujian Province as examples, and conducted on-site investigations on the current situation and use of children's activity space [5]. The results show that the perception of vision, hearing, touch and smell of community children's activity space have varying degrees of defects, and there are many potential safety hazards. Tian Peichun believes that the current design norms of residential areas sacrifice children's activity freedom and fun for the sake of safety instead of ensuring the safety of children's outdoor activities through excellent space design and appropriate activity arrangement. This kind of sacrifice is huge, unscientific [6]

This article will conduct a systematic analysis and research on the outdoor living space of children in residential areas, combining the behavioral and psychological characteristics of contemporary children, and initially explore a type of living space suitable for the growth and development of contemporary children. Through observation and research, this article has discovered the true needs of children, and how to improve the environment for outdoor activities of teenagers and children and create a suitable living space. This paper establishes a safety evaluation system for outdoor children's activity space in residential areas to enhance the operability of this article and provide a useful reference for the design and theoretical research of children's activity space in the future.

2. Characteristics of Children and Safety Evaluation and Design of Outdoor Children's Activity Space in Residential Areas

2.1 Analysis of Children's Psychological and Behavioral Characteristics

2.1.1 Analysis of Behavioral Psychological Characteristics of Children of Different Ages

Children under 2 years old are very dependent on their parents. During this period, for the convenience of parents to accompany or take care of, children usually play in the green space near the residential area. Children aged 3-6 have a certain degree of independent activities and thinking skills. Children in this period are very active and full of curiosity. 7-12-year-old students have gradually improved their thinking skills, have rich imagination and creativity, the amount of activity has increased rapidly, and simple game activities have decreased, replaced by various sports activities and complex intellectual games [7-8]. Due to the growth and development characteristics of children of different ages, as well as the differences in physical, intellectual and psychological development, the content of children's activities will also be different. Only by understanding and mastering children's physical and mental development and their psychological characteristics in detail can we design outdoor children's activity spaces in residential areas that meet the needs of children's physical and mental development.

2.1.2 The Characteristics of Children's Outdoor Activities

Outdoor activities in residential areas can conveniently utilize natural factors, such as sunlight and air. In addition, they also carry children's desire for nature, promote the development of children's mental health, and enable children to enjoy innocent childhood happily [9-10]. However, in the planning and design of residential areas, due to the limitations and influences of certain factors, children's activities have the following characteristics: same age gathering, seasonality, timeliness, self-centeredness, continuity and closeness to nature.

2.1.3 Analysis of Children's Behavioral Psychological Characteristics and Outdoor Activities

Children's psychological characteristics and outdoor activities. The activity space designed by grasping the children's psychological characteristics is a good activity space. Children are naturally active, like to imitate, have strong curiosity, weak willpower and enjoy outdoor activities [11]. Outdoor activity spaces designed according to children's age and psychological characteristics should have the function of meeting various needs and stimulating learning, which can help children develop their motor skills, social skills and knowledge skills in the best way.

Children's behavior characteristics and outdoor activities. Childhood is not only the fastest period of intellectual development, but also the most suitable period for morality and habit formation. It determines the future character and character of a child [12]. A full understanding of the characteristics of children's behavioral development plays an important role in creating a good space environment for activities, expanding the scope of children's entertainment options, and promoting natural communication between children. It enables children with different IQ levels, different developmental stages and different personality characteristics to obtain corresponding improvements in behavioral development[13].

The influence of outdoor activities on children's growth. Compared with indoor activities, outdoor activities are unique in that they provide children with more space and optional physical exercise items and entertainment equipment, which can improve children's athletic ability. Games are children's nature, and activities are children's hobbies. This is the mainstream way to promote children's growth and development. Children's outdoor activities can not only meet children's entertainment needs, but also cultivate their healthy and optimistic attitude towards life. At the same time, it also has an important influence on the growth and development of children, the development of intelligence and the cultivation of willpower[13].

Children's play safety education. Safety education plays a pivotal role in children's play activities. It is usually carried out in the following forms: a combination of individual guidance and peer influence; a combination of praise and correction; random education and timely reminders.

2.2 Basic contents Involved in the Safety Evaluation of Outdoor Children's Activity Space in Residential Areas

Through literature analysis, the factors that influence the safety of outdoor children's activity space in residential areas include: interruption of motor vehicles, location, clarity of warning signs, safety of recreation facilities, site safety, barrier-free facilities, waterscape safety, plant safety, lighting coverage, monitoring coverage, guardian visibility, pet management, facility maintenance.

2.3 Design of Outdoor Children's Activity Space in Residential Area

Design considerations. The key to the design of children's activity space depends on whether the designer can view the world from the perspective of children, so as to meet the development needs of children in growth, emotion, behavior and thinking. Therefore, the planning of children's activity

space in residential areas needs to pay attention to the following aspects: meeting the requirements of children's growth, paying attention to children's emotional needs, adapting to children's behavior characteristics, adapting to children's thinking characteristics, and considering the impact of objective conditions and climatic factors.

Principles of planning and design. Planning and designing an outdoor children's activity space in a residential area requires the following principles: the principle of integrity; the principle of accessibility; the minimum area; the principle of zoning design; the principle of compatibility; the principle of safety.

3. An Empirical Study on Outdoor Children's Activity Space in Residential Area

3.1 The Purpose about Evaluation

The establishment of a safety evaluation system for outdoor children's activity spaces in residential areas mainly has the following three purposes: to understand the design and construction status of outdoor children's activity space in residential areas in China, and find out the existing problems in its construction. to promote the construction and transformation of outdoor children's activity spaces in residential areas, and apply the content of theoretical research to design practice, strengthen the operability of the subject research; point out the deficiencies and safety hazards of its space design, and then strengthen the maintenance and management of the space.

3.2 Construction of the Evaluation System

Principles for determining evaluation indicators. To conduct a safety evaluation system of outdoor children's activities in residential areas, we must first establish a complete evaluation index system, which should cover as far as possible all aspects of the environmental safety of outdoor children's recreation space in residential areas. When determining the evaluation index system, the following principles are mainly considered: pertinence; independence; comprehensiveness; operability.

The choice of consulting experts. The research in this article is based on the establishment of evaluation indexes, the determination of index weight coefficients, and the results of comprehensive evaluation, which are all established on the basis of expert survey and user survey, combined with mathematical statistics. Therefore, the selection of consultants greatly affects the results of the evaluation. In order to ensure the operability of the evaluation system and the accuracy of the evaluation results, the wideness and authority of the selection of consultants should be ensured. In this paper, 22 experts were consulted, whose research fields involve architectural planning, landscape planning and design, community management, environmental art, kindergarten education, etc. In view of the importance of evaluation indexes, 9 experts were consulted by questionnaire, including 3 professors, 3 senior engineers, 2 architects and planners, and 1 primary school teacher.

Construction of the evaluation system. There are many factors that influence the safety of of children’s outdoor recreation space in residential areas. If these factors are involved in the evaluation, the workload will be large and complicated. At the same time, it will affect the observation and analysis of main environmental factors, and affect the decision-making and improvement of children's outdoor recreation space environment in residential areas. Therefore, it is necessary to find out the important factors affecting the space environment, so as to establish a more scientific evaluation system. The evaluation system of this article is mainly established through the following steps: Determine the preliminary evaluation indicators. In the research process, this article collects data through investigations, interviews, and observation of outdoor activities for children in residential areas. Combining the research content of the previous papers, choose the factors that have a decisive impact on the space are used as preliminary evaluation

indicators, and are designed into a table to solicit opinions; distribute resident questionnaires, conduct a questionnaire survey among residents of the residential area with the designed preliminary evaluation indicators, grasp the residents' feelings about the children's outdoor recreational space environment in the residential area, and find out the indicator factors that reflect strongly, and provide for the establishment of a comprehensive evaluation system reference; carry out expert consultation and survey, send the determined preliminary evaluation indicators to expert consultation, screen and summarize the preliminary evaluation indicators according to the opinions given by experts, statistically analyze the screening results, determine the final evaluation indicators, and establish outdoor recreational spaces for children in residential areas comprehensive evaluation system. Shown in Table 1:

Table 1: Safety evaluation system of children's outdoor activity space in residential area

evaluation target	Evaluation index (weight)	security element(weight)
Safety of children's outdoor activity Space in residential areas	Safety of surrounding environment (0.188)	Interruption of motor vehicles(0.101)
		location(0.058)
		clarity of warning signs(0.029)
	Safety of Recreation area (0.507)	safety of recreation facilities(0.150)
		site safety(0.113)
		barrier-free facilities(0.056)
		waterscape safety(0.094)
		plant safety(0.056)
		lighting coverage(0.038)
	Management of maintenance (0.305)	monitoring coverage(0.040)
		guardian visibility(0.093)
		pet management(0.066)
		facility maintenance(0.106)

3.3 Weight Coefficient of Evaluation Index

Weight refers to the proportion of an indicator in all evaluation indicators. In the environmental quality assessment, because the various evaluation indicators have different impacts on environmental quality, different evaluation indicators should be assigned different weights, which reflect the relative importance of the evaluation indicators. In the comprehensive evaluation system, the distribution of evaluation weights will directly affect the evaluation results, and reasonable evaluation index weights are of great significance for improving the accuracy and sensitivity of environmental quality evaluation.

Application of Analytic Hierarchy Process. At present, the most commonly used methods for determining the environmental quality of residential areas are analytic hierarchy process, fuzzy weighting method, and Delphi method. Among them, analytic hierarchy process can effectively deal with those that are difficult to be determined by quantitative methods. Whether it is consulting investigation or theoretical analysis, the analytic hierarchy process is easy to achieve pairwise comparison of evaluation indicators, and is not affected by geographic location and local environment, and it is easier to obtain basic data for calculating weights. Therefore, this article uses the analytic hierarchy process to determine the weights of the indicators. The calculation steps are: the first step is to establish a judgment matrix; the second step is to calculate the corresponding weight; the third step is to check the consistency.

3.4 Overview

Evaluation method. After determining the index weight of the safety evaluation system of children's outdoor activity space in residential area by expert questionnaire, this paper adopts the comprehensive scoring method to evaluate and analyze the safety of the target community. Firstly, a safety evaluation scale (with a 9-point scale) was designed, and questionnaires were sent to experts. Then, the index weight was obtained through SPSS analysis, and the index evaluation system was constructed after passing the consistency test.

Evaluation object. In this paper, 5 communities around several primary schools in W City were selected as the comprehensive evaluation objects, and a questionnaire survey was conducted among users (including children and parents, with children aged over 9 years old). The questionnaire adopted a 5-level grading system, and these 5 communities were different in terms of building time, style, area and size.

Statistical results. The comprehensive scoring method was adopted to calculate the score of the safety of outdoor children's activity space in each community. The specific score was calculated according to the following mathematical model:

$$V_{ij} = S_{ij} * W_i \tag{1}$$

$$V_i = \sum_{j=1}^{n} S_{ij} * W_i \tag{2}$$

In the formula, V represents the comprehensive score of children's outdoor activity space in the residential area, S represents the score given by users of a certain evaluation factor, W represents the weight value of a certain evaluation factor, i represents the i-th index, and j represents the j-th evaluation unit(community). According to the value of V, the quality of outdoor children's activity space in the residential area can be determined.

4. Experimental Analysis of Outdoor Children's Activity Space Research in Residential Area Based on Safety Evaluation System

4.1 Research on the Comprehensive Evaluation of Children's Outdoor Activity Space in Residential Area——Analysis of Weight Coefficient

It is mainly obtained through the scoring of safety evaluation indicators and impact factors by 9 expert consultants. Counseling score values range from 1-9. The larger the number, the more important the overall target level. The greater the impact. The analysis results are shown in Table 2:

Table 2: Weight coefficient analysis

Evaluation factors	Experts serial Number								
	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9
Safety of Recreation venue	9	8	7	9	9	8	9	7	9
Surrounding Environment	3	4	2	3	4	3	4	3	3
Management	7	5	4	6	5	6	5	5	4

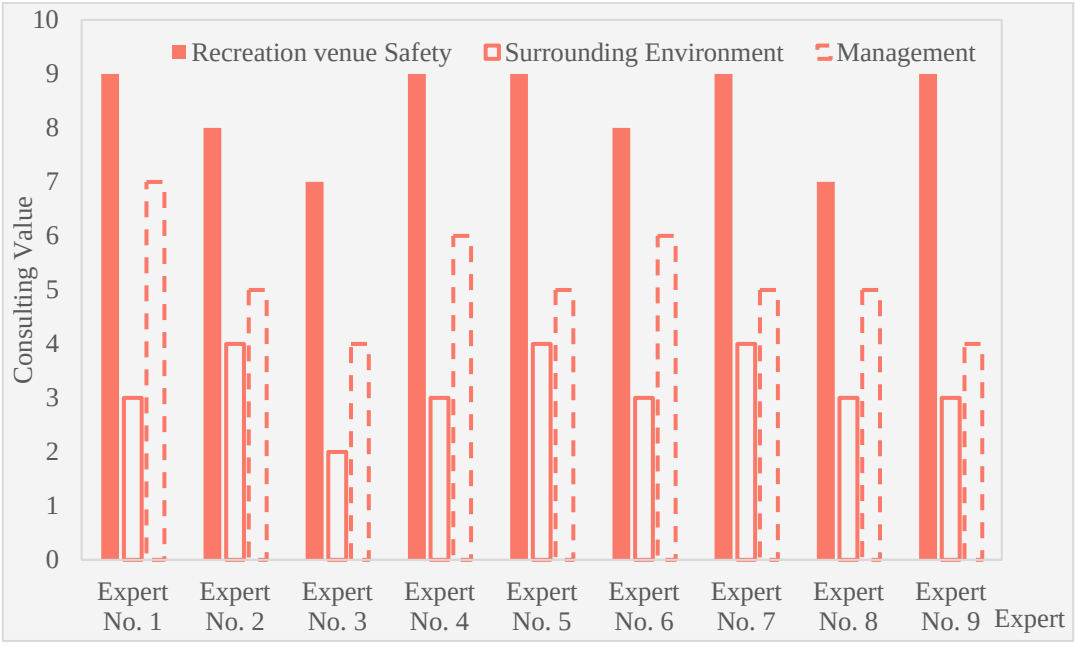

Figure 1: Weight coefficient analysis

It can be seen from Figure 1 that the 9 experts believe that the safety of recreation area is the most important index affecting the safety of outdoor children's activity space in residential areas, with the highest level of 9, followed by management, and the last is surrounding environment. The above results indicate that the safety of the recreation area should be paid attention to in the construction of children's outdoor activity space in residential areas, but the safety of the surrounding environment and the management and maintenance of the environment should not be ignored.

4.2 Research on Safety Evaluation of Outdoor Children's Activity Space in Residential Areas——Analysis of Evaluation Results

In this section, we mainly analyze the first-level evaluation indicators and overall evaluation scores of the five communities in the safety evaluation system. The analysis results are shown in Table 3:

Table 3: Evaluation result analysis

Evaluation factors	Community serial Number				
	No.1	No.2	No.3	No.4	No.5
Safety of Recreation area	0.7	0.6	0.5	0.8	0.7
Surrounding Environment	2.0	1.8	1.3	2.1	2.0
Management	1.0	0.8	0.7	1.3	1.2
Total	3.7	3.2	2.5	4.2	3.9

Figure 2: Evaluation result analysis

It can be seen from Figure 2 that among the five communities studied, the overall evaluation of the No. 3 district is the lowest, which is less than 3 points, and the overall evaluation of the No. 4 district is the highest, reaching 4 points or more. The overall rating for safety in the other three communities was between 3 and 4, somewhere between “average” and “satisfactory”. The above results show that children's outdoor activity space in the community near the primary school in W City still has a lot to be improved, especially in the old community represented by Community 3, where the separation of persons and vehicles is ineffective and the facilities are decaying. The activity area is dominated by hard decoration, lacking in buffer materials, in pet raising control, and effective property management, all of which bring huge safety risks to children's outdoor space in residential areas.

5. Conclusions

Safety is the most basic human needs. It is more important for children, who lack the ability of self-protection. Outdoor environment of residential areas is the most accessible places for children, thus it exerts great influence on their psychology, intelligence, behavior, cognition and social interaction. Under the precondition of safety, the designer must think carefully to create space suitable for use by children. The evaluation system constructed in this study, starting from the survey questionnaire of experts and users, points out that the safety and management and maintenance of environmental facilities in the surrounding environment of the activity area is the key index that affects the safety of children's outdoor activity space in the community, rather than just a series of children's entertainment facilities. From the empirical results of safety evaluation, the evaluation results and user satisfaction are highly consistent, indicating that the system has good applicability and can be used as an evaluation tool for the reconstruction of outdoor space in old communities and the construction of new communities. From the point of empirical results, in the design of residential outdoor space, designers should plan from the perspective of children in order

to create a space that can attract children's attention. We must give full consideration to interruption of motor vehicles, water safety, plant safety, crime monitoring, pet management, facility maintenance and other important factors affecting the safety of the space, to ensure the safety of children's outdoor activity space.

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