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Applying analytic hierarchy process for site selection of a recreational-educational children complex in Shiraz City, Iran

Abstract

The development of educational-recreational complexes for children has a significant impact on their cognitive growth and behaviour. Proper site selection is essential to ensure the success of such projects. This paper aims to identify the best location for a children's educational-recreational complex in Shiraz, Iran. The study used a descriptive-comparative and survey method to determine effective criteria for site selection. A questionnaire was administered to experts in architecture, urban design, and planning to identify appropriate sites. The Analytic Hierarchy Process (AHP) method was then employed to select the best location. The hierarchical model included three levels: goal (educational-recreational site selection), criteria (natural potential, accessibility, land size, neighbourhood and social context, expansibility, appropriate land use (the neighbourhood between proposed and master plan land use)), and three alternative sites. The results showed that a site located near residential areas, green spaces, and natural elements is suitable for the development of an educational-recreational complex for children. The study recommends the use of the SWOT (strength, weaknesses, opportunities and threats)-AHP method for site selection in children's complexes. The paper highlights the need for a reliability test or table/figure to support the research findings.

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1 Introduction

Site selection is recognized as analysing the spatial and non-spatial potential of locations to choose the best place for special land uses (Azimi Hosseini 2010), and measuring the needs of a new project against the values of potential locations. Therefore, the selection of best site improves the design and construction of projects and helps the professional designers to address issues of quality and physical proportions (UNESCO 1996), community, cost, security, appropriate accessibility (Hamedani and Huber 2012) and sustainability and natural elements (Khakighasr 2018). As children spend their most of the day in Recreational-Educational Complex, the quality of these spaces improves the personal development, social interaction, and enhance the sense of cooperation, and even their education. Since there is not enough criteria in selecting these spaces, their potential talents could not grow well (Faizi et al. 2012). However, finding an optimal location for the future among existing sites is challenging (Zaheer et al. 2022). Choosing a location is the first and most important decision in any project (Lai 2019). It is important that all development decisions be made with extensive data analysis and lead to a main location (Pekel and Kara 2019). Making the right strategic decisions in choosing the site will provide various facilities for the people most efficiently and increase public welfare (Zaheer et al. 2022). Schools are sometimes located without scientific methods, which can lead to schools being built in inappropriate places (Hussaini et al. 2018). Badri (1999) selected a suitable location, using Analytic Hierarchy Process (AHP) as an aid in allocation decisions. Making decision with multiple criteria is a complex task (Yap et al. 2018). Therefore, multi-criteria decision making (MCDM) is one of the most important branches of decision theory and is used to identify the best alternative among all available alternatives (Huang et al. 2015). In this regard, the AHP is a common method (Yap et al. 2018) that can be used independently or along with other instruments. The best justification for using AHP is that it works with small sample sizes, enjoys high level of consistency, simplicity, and availability and user-friendliness (Darko et al. 2019; Jato-Espino et al. 2014; Nassar and AbouRizk 2014).

In nations with high-income, the aspects of early social context effect on cognitive development of children such as early social interactions, housing quality and neighbourhoods', etc. (Bhutta et al. 2013; Gottfried 2013; Vollman and Richland 2020), while there is not any globally agreed index for evaluation of environmental indicators that influence on cognitive development of children in developing countries (Hamadani et al. 2010). The problem arises in translating these theoretical and empirical insights into practical applications, particularly in the context of educational facilities for children. While high-income nations often integrate aspects like early social contexts and environmental quality into cognitive development (Bhutta et al. 2013; Gottfried 2013; Vollman and Richland 2020), developing countries lack a globally agreed index for evaluating environmental indicators crucial for children's cognitive development (Hamadani et al. 2010). This gap is particularly evident in the selection of sites for educational-recreational complexes, where factors such as safety, accessibility, environmental quality, and spatial design significantly impact children's developmental outcomes (Stanković et al. 2006; Izadpanah Jahromi 2004; Mosayebzadeh and Sayed-Almasi 2010; Tabatabaian et al. 2017).

The primary problem this study addresses is the lack of comprehensive criteria and systematic methodology in selecting optimal locations for educational-recreational facilities for young children in developing countries. This study aims to determine the optimal location for developing an educational-recreational complex for children under 7 years old in Shiraz city, employing the AHP. This approach, akin to cognitive processes in the human brain, involves analysing complex issues and establishing priorities based on defined objectives and knowledge. Specifically, this study identifies the cognitive development characteristics of children under 7 years old in Shiraz and uses these insights to establish criteria for site selection. These criteria will then be rigorously evaluated to ascertain the most suitable location for the proposed complex.

2 Materials and methods

2.1 Conceptual background

Cognitive theory explains that there is an interaction between environment and personal experiences with development of human beings (Meece 2001). In this field, Piaget and Jerome Bruner presented two great cognitive theories. Piaget, the great theorist in the fields of developmental psychology and education (Byrnes 2020), asserted that intellectual development is a direct continuation of inborn biological development. That is, the ability to think springs from the physiological base" (Simatwa 2010). Also, Piaget theorized that four indicators affect cognitive development three of which including experience with the physical environment, biological maturation, and experience with the social environment are self-explanatory and one indicator like equilibration is what brings them all together (Duncan and Pratt 1997). Piaget proposed four stages of cognitive development for children: Sensory-motor stage (0 to 2 years old), pre-operational stage (2 to 7 years old), concrete operation (7 to 11 years old) and formal operational stage (11 years old and over) (Babakr et al. 2019; Martin and Wheeler 2011). All children go through these stages (Moreno, 2010), and their cognitive ability changes qualitatively during the process of moving from one stage to the next (Sigelman and Rider 2012). According to Piaget, children show certain characteristics at each stage. Some of these characteristics in the pre-operational stage are as follows:

Deferred imitation means imitating objects and events that are not present at the time. Deferred imitation can display the child's mental reproduction ability (Wadsworth 1996). Another characteristic is symbolic play. It is, by nature, a type of imitation, but it is also a form of "self-expression" with no intention to communicate with others (Piaget 1962). The symbolic play presents an arena for ideas, thoughts and interests (Wadsworth 1996). Another characteristic is centration, which refers to the child's tendency to focus on one aspect of the event and ignore all other aspects of it (Karimi 2008). At this stage, the child is unable to check all aspects of a stimulus, i.e., decentralization in visual search. As a result, a child with focalism can internalize only limited aspects of an event (Wadsworth 1996). On the other hand, researchers have found other indicators such as scale, contact with the nature, social background, clarity and readability to be important for children's spaces. Research has shown the importance of interaction children with nature (Roberts et al. 2019). Thus, if in early years the children could not experience the natural environments, they may later experience these environments as threatening. (Milligan and Bingley 2007). Contact with nature helps to improve cognitive development (Pyle 2002), reduce stress (Ohly et al. 2016), improve the health of child (Kellert 2012), facilitate social contact (Kingsley and Townsend 2006), and promote personal development (Maller 2009). Childhood is the best time for creating and development a positive relationship with nature (Roberts et al. 2019).

Social interaction is one of the aspect of daily life that is important in emotional and physical health (Cook et al. 2010). Social emotional competencies, such as social behaviours, responsible decision making, and problem solving are also important (Lewis et al. 2021). The opportunity for social interactions with others is very important for the development of all children. Through social interactions, children begin to establish a sense of self and to learn what others expect of them. Having involved in practices that promote constructive interaction among peers, children gain more positive social skills and better academic achievement (Ortega et al. 2009). Children grow and develop, they become more and more interested in playing and interacting with other children (educational office of Stanislaus County). In addition, pre-school period is considered a transition stage to formal education, which is vital in children's lives for social, emotional, and behavioural functioning. Acquiring social skills is a prerequisite for learning (Pirskanen et al. 2019). People with stronger social relations have significantly higher health psychological levels (Askarizad and Safari 2020). Therefore, "the environment should offer children opportunities to actively explore, to work independently and with others, to make decisions and follow through with their ideas, to solve problems, to engage in real activities and to experience co-operative, symbolic, dramatic or pretend play"

(French 2007). Research has shown that the quality of the pre-school education depends on the social environment and organization of the environment. Also, the design of facilities in the pre-school environment affects the development and behaviour of children (Stanković et al. 2006).

Children have a feeling of weakness, powerlessness and fear when facing spaces fitting for adults. Thus, they prefer to be placed in an environment with small scales according to their height and size, where they can play more complex games with higher accuracy and concentration and for a longer period of time (Izadpanah Jahromi 2004). Children like large spaces because they can move, run, jump, etc. The children's space can be designed in such a way to be suitable and large enough for the activities of children to help their physical (Mosayebzadeh and Sayed Almasi 2010). The clarity and readability of the environment for the child is another important issue that is effective in maintaining the connection of the child with the environment and creating a sense of psychological security for them (Tabatabaian et al. 2017). Young children should be able to find their way to understand their surroundings without needing to read a word and decide in which space or activity to play. It should also be clear how to use the space, rules, entry and exit places, and boundaries between activities and boundaries between playing spaces (Izadpanah Jahromi 2004).

The education programs that persuade children to engage with environmental issues can be encourages them to create an emotional bond with place (Lane et al. 2005), Schools need be located on safe places; these safe locations should also be optimal and economical to the public in terms of accountability (Talam and Ngigi 2015). Vollman and Richland (2020) showed that one of the influential mechanisms in the early childhood development was the structured environment. According to the model of Counter, the process of education is related to the physical, conceptual, and behavioural elements in the surrounding environment (Mahdavinejad et al. 2014). Psychologists believe that the sociocultural context, where social interactions take place, leads to the cognitive development of the child (King 2016; Shaffer and Kipp 2013).

Selecting an appropriate educational environment significantly influences students' academic achievements (Hossain et al. 2009). Finding the appropriate for the school is important and challenging to ensure long-term success and sustainability (Zubaidah et al. 2012). Different criteria should be prioritized and evaluated in choosing the location (Talam and Ngigi 2015). Therefore, local governments should not choose it carelessly, but they should consider guidelines in locating school sites (Moussa and Abou Elwafa 2017). Since the main concern of many stakeholders is to maximize income (Lai et al. 2019), population density becomes important (Zhu et al. 2021) because higher population density means providing services to more people (Yap et al. 2018). Schools must be properly located for the students they serve. Therefore, population distribution based on the target age group is an important criterion (Ahmed Ali 2018). In addition, "access to public transportation" and "parking space" are among the site selection criteria (Yap et al. 2018). Another important factor in choosing a location is the distance from the main road. Any traffic noise around the site risks safety issues that adversely affect the education program (Ahmed Ali 2018). Thus, the noise pollution index is important (Hussaini et al. 2018). The distance from the main road also affects the air pollution index (API) (Zubaidah et al. 2012). Several studies have shown that living or studying in schools near major roads increases the risk of heart and lung problems (Salvesen et al. 2008), but this risk decreases significantly at a distance of at least 150 meters (Green et al. 2004). Moreover, the school should be located in an area that reduces the commuting time for parents and students (Ahmed Ali 2018). Therefore, a site with less distance from other sites attracts people (Yap et al. 2018). The site should be on relatively flat ground and in certain types of use (Ahmed Ali 2018). According to the guidelines of JPBD (1997), site dimensions are important for educational spaces. This index has been considered by Moussa and Abou Elwafa (2017) and Kito and Thomas (Kito and Thomas 2011). Kito and Thomas (2011) also considered other criteria such as access/traffic, facilities, landscape, security/safety, costs, spaces, noise level, topography/drainage and soil conditions/plant life, which cover other criteria mentioned by (Moussa and Abou Elwafa 2017). In this regard, Analytic Hierarchy Process (AHP) as a structured and hierarchical decision making process is used in solving complex decisions for site selecting (Jamal 2016).

2.2 Study area

This study was conducted in three distinct locations within Shiraz city, Fars province, Iran, situated at a geographical coordinate of 29°61′ N longitude and 52°53′ E latitude, at an elevation of 1545 meters above mean sea level (refer to Figure 1 for a detailed geographic representation).

- Niayesh Site, District 6: This site encompasses an area of approximately 2534 hectares, with a population density amounting to 124,323 inhabitants. Educational facilities, including kindergartens and schools, are located in the vicinity, providing essential services to the community. The site offers panoramic views of the surrounding mountains and gardens, enhancing its aesthetic value. Notably, the site forms part of the local garden landscape, possessing inherent potential for infrastructural development. However, it has been observed that economic incentives have led to the degradation of numerous garden areas within Shiraz, resulting in their transformation into residential zones. This project aims to mitigate environmental impacts, specifically preventing deforestation and arboreal destruction. The site is development-friendly and benefits from the proximity of Chamran roadside park. Chamran Boulevard and a newly constructed road facilitate improved access, although the site experiences minimal traffic congestion. A metro station in the area enhances connectivity, albeit with a notable distance for pedestrian access.
- Besat Site, District 1: Spanning an area of 2567 hectares, this district hosts a population of 157,624. The site is strategically located near Besat Park and Afif-Abad Garden, the latter of which includes significant historical landmarks such as a royal palace and an ancient weapons museum. Afif-Abad Garden is a recognized Persian garden, recorded in Iran's National Works list, with origins tracing back to 907 AD. While the site benefits from satisfactory access routes, the absence of a nearby metro station poses a limitation. The area is char-

Figure 1. Locations of the selected sites in Shiraz: 1) Be'sat, 2) Niayesh, 3) Ghoddosi.

Table 1. Features of proposed sites in terms of strengths (S), weaknesses (W), opportunities (O) and threats (T).

Site	Proposed land use in master plan	Adjacent	Site analysis			
			S	W	O	T
1	Educational-cultural spaces	Afif-abad garden, Be'sat park and Residential neighbourhood	Afif-abad garden, Be'sat park and residential neighbourhood Outlook garden	Noise	-	Lack of expansibility
2	Green space	Residential neighbourhood and green space	Residential neighbourhood, green space Outlook garden and mountain Roadside Park Chamran Access to different parts of city Public transportation) taxi, bus, subway)	Risk of Chamran Highway	Stop the destruction of green space Expansibility For other age groups	Infectious waste hospitals
3	Educational and green space	Residential neighbourhood, school and Ghasr-o-dasht gardens	Residential neighbourhood, school and Ghasr-o-dasht gardens	Noise air pollution High traffic	Stop the destruction of green space	Lack of expansibility

acterized by high traffic volumes, yet pedestrian access is relatively unimpeded.

- Ghasrodasht West Site, District 1: Occupying a substantial area of 4235 hectares and housing a population of 159,500, this site is located near the Ghasrodasht gardens. Educational institutions are accessible in the area. Despite being a high-traffic zone, pedestrian access is conveniently facilitated.

Each site presents unique geographical and infrastructural characteristics, thereby offering a diverse range of environments for this study.

In addition, SWOT (strength, weaknesses, opportunities and threats) table was presented in Table 1 to analyse the current features and characteristics of each site (See table 1).

2.3 Research approach

The last step was to create a recommended course of action for the execution of such reports. In principle, the scheme supposed to guide the analyse through the entire assessment process and enable it to be adapted to a specific place and the specifics of the project (described in section 3.2 – Recommendations).The applied method allowed us to review the most important sections of reports, considering in particular the descriptive part and graphic presentation of consequences for the landscape. Their level of detail and type of applied methodology were verified. The authors also checked whether the assessment included references to cultural landscape, including immaterial elements of space. Another important criterion was verifying whether the assessment analysed more than one variant of the planned development. This allowed us to verify all the most important aspects of landscape impact assessment for each report. The obtained results were then the basis for creating sample recommendations and guidelines with the aim to improve the process of assessing the landscape impact of developments.

The research methods utilized in this study involved a mixed-methods approach, combining semi-structured expert interviews, SWOT analysis and AHP questionnaire. Due to the lack of comprehensive studies on Site Selection for Recreational-Educational Children Complex, primary data collection was deemed necessary. Initially, a set of 50 semi-structured expert interviews were conducted in Shiraz from February to September 2018. Experts who had professional or research experience in the topic, as well as those from various domains in the field of architecture, urban planning and design were invited for participation in the interviews.

SWOT technique is used as a strategic planning method to determine the opportunities, threats, internal strengths, and weaknesses of any organization (Learned et al. 1965). In the SWOT analysis the identified indicators are evaluated without quantification (Görener et al. 2012). To overcome this technical limitation, the combined AHP/SWOT technique is used (Bouraima et al. 2020). A key point is that decision criteria are evaluated according to their relative importance to allow trade-offs between them. AHP consists of three steps: (1) forming a hierarchy, (2) pairwise comparisons, often based on a nine-point scale, and (3) verifying consistency. Since AHP allows subjective evaluation for decision makers, consistency of judgment is not automatically guaranteed. Therefore, compatibility verification is essential to ensure an optimal outcome (Saaty 1987). Saaty pointed out that to control the consistency of pairwise comparisons, the consistency ratio should be calculated. At this stage, decision makers are required to revise their initial judgment if the calculated compatibility ratio exceeds a threshold of 0.1 (Saaty 1994)

AHP is a decomposition multiple-attribute decision-making (MADM) method that was developed by Saaty (1977) to represent human decision-making process and achieve better judgments based on hierarchy, pair-wise comparisons, judgment scales, allocation of criteria weights, and selection of the best alternative from a finite number of variants by calculation their utility functions (Franek and Kresta 2014). AHP has three primary functions: structuring complexity, measurement, and synthesis which make it a general methodology with a wide variety of applications (Forman 1990; Gass 1983). AHP has been used by many individuals and groups in various fields due to its user-friendly interface for multi-criteria decision-making" (Vargas 1990). Moreover, AHP is used for consistency checking. In other words, it allows the decision makers to check the quality of the results in comparison matrix. Consistency is concerned with the compatibility of a matrix of the ratios constructed from a principal right eigenvector with the matrix of judgments from which it is derived. The consistency ratio is calculated for the maximum eigenvalue and should be less than 0.1 for acceptable consistency" (Abu-Sarhan 2011). Schneider and Wilsey (1961) described a systematic method for school planners to identify and analyse indicators relevant to site selection. They conducted a comprehensive examination of site selection techniques and objectives and identify twenty-five major criteria to consider when comparing potential sites (Baas 1973).

2.4 Questionnaire and interviews

The questionnaires (Appendix 1) consisted of multiple open-ended question (e.g., "What are the three most important problems/potentials of these sites for selecting as an education- recreational children's complex?) as well as closed-ended questions with 5-point Likert scales for investigating the most important indicators for selecting site as an education-recreational child complex, in second part. In the first part of the questionnaire, the experts' opinions of the site features such as the general problems and potentials, were recorded through interviews. In the second part of the questionnaire the main indicators including accessibility, Land size, Neighbourhood, Natural potential, social context, Expansibility, and Appropriate land use, were identified and then analysed with AHP method. The interviews were concurrently transcribed, and a three-step process consisting of open, axial, and selective coding was adopted to prepare for the qualitative data analysis.

The categories in the interview guide represent the themes of strengths (S), weaknesses (W), opportunities (O) and threats (T). As shown in Table 1, strengths, weaknesses, opportunities and threats, were identified for all three sites. Subsequently, appropriate sites were selected and analysed using the AHP method. Within the framework of Table 1, a typical AHP questionnaire was used to identify the main indicators for selecting the best location for a children's complex design in Shiraz, the fifth most populous city of Iran. In the second part of the research, based on the theoretical basis and observation of children's behaviours and activities in educational spaces, primary questions were proposed about the effective indicators in site selection for an educational-recreational children's complex. Observation of children's behaviours and activities in educational spaces played an important role in formulating the primary questions about effective indicators for site selection in the research process. All indicators that seem to influence children's perception of the environment include availability, location, environment, accessibility, size, shape, topography, cost of land, acquisition, soil condition, sub-surface condition, site preparation, orientation, master planning indicator, political implications, maintenance implications, undesirable elements, outdoor activities desired, community use, public services, utilities, site development, educational adaptability, flexibility and expansibility.

Based on these indicators, appropriate sites were selected and analysed using the AHP method. The evaluation results identified accessibility, neighbourhood (between proposed and adjacent land uses), natural potential, social context, expansibil-

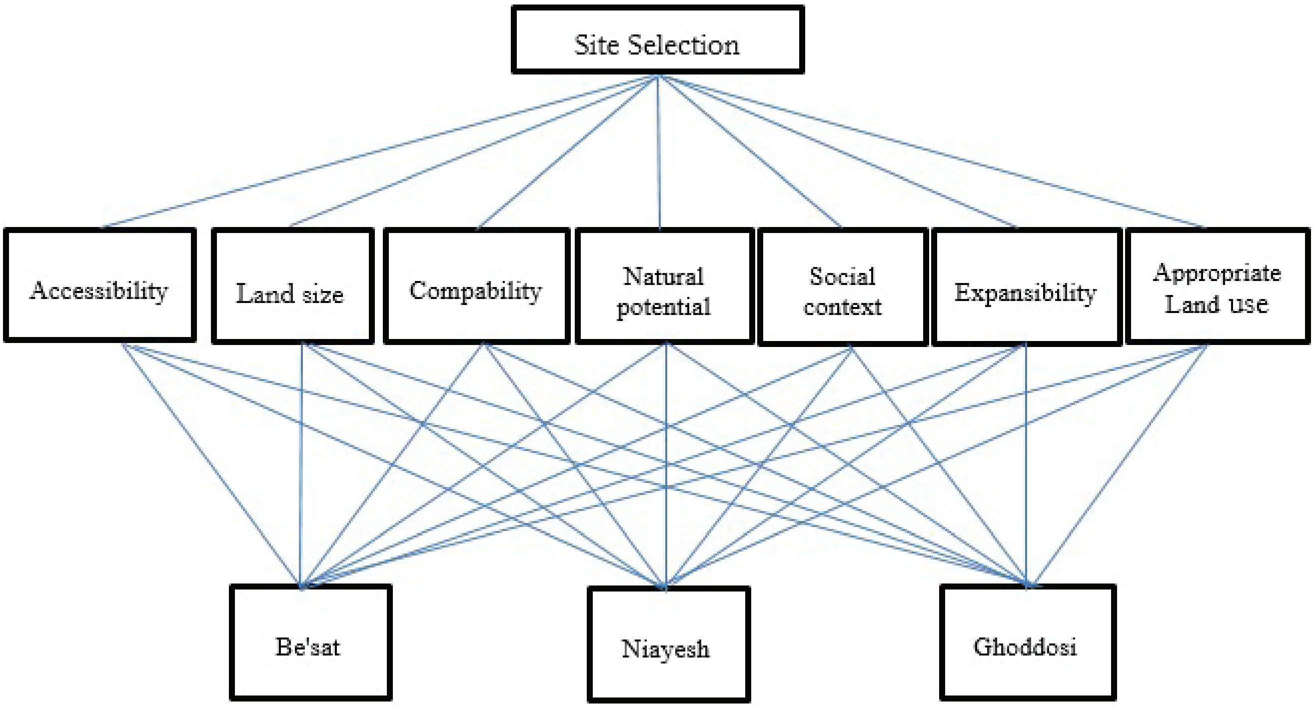

Figure 2. Hierarchical tree.

ity, appropriate land use (neighbourhood between proposed and master plan land use) and recognized as effective indicators in site selection for children educational- recreational complex. Three appropriate sites were then selected with the consultation of experts and considering these indicators. Finally, AHP was used to present the best alternative for the selection of an educational- recreational site for children.

2.5 Analysis

To achieve the above mentioned goal, we first created a decision tree hierarchy (Figure 2), which include the goal (selecting an educational or recreational site), criteria (the seven criteria mentioned above), and alternatives (the three sites mentioned above). The current analysis recognized the varying levels of significance among different criteria. As Hosseini et al. (2018) suggest, while some criteria hold high importance, others are less significant depending on the study's objectives. This was corroborated by expert opinions as noted by Zabideh et al. (2012). It is important to note that in the second step of AHP, the criteria were compared with each other to determine their relative importance in achieving the objective (Minhas 2015). This study employed these insights for our assessment, where criteria were prioritized in consultation with experts (Table 2).

Table 2. Criteria priorities.

Criteria	Ratio
Accessibility	4
Land size	5
Neighbourhood	2
Natural potential	3
Social context	2
Expansibility	1
Appropriate Land use	3

Using the pairwise comparison priority table (Table S1), this study performed pairwise comparisons between the indices. The next step involved normalizing the values in the pairwise comparison matrix for indices (Table S2). The performance of each site was then numerically assessed from 1 to 5, considering the characteristics of each criterion (Table S3). This study also conducted pairwise comparisons of options for each index. The relative weights of the indices were factored into the matrix of relative weight of options for each index for ranking of the options. Finally, the Inconsistency Ratio (IR) was calculated to determine the consistency between the pairwise comparison matrices. To compute this ratio, the main values of the pairwise comparison were multiplied in the system priorities to calculate the weight sum vector (Equation 1).

(1) WSV = D*W

After calculating the weight sum vector, the consistency vector (CV) was computed. It is important to note that the eigenvalue method, which is a weight evaluation method (Equation 2), was suggested by Saaty (1996):

(2) $A..W = \Lambda_{max} W$

The eigenvalue method for weight evaluation is expressed by Equation 2, where A is the square matrix resulting from pairwise comparison, Λ_{max} is the maximum eigenvalue, and w is the eigenvector. The measurement of consistency is developed using two characteristics. Firstly, matrix A has greater consistency as Λ_{max} gets closer to n. Secondly, Λ_{max} values are always equal to or greater than n", as shown in Equations (3) (Kim et al. 2013):

(3) Consistency Index (CI) = $\Lambda_{max-n/n-1}$

Equation 4 shows that "the Consistency Ratio (CR) is the rescaled version of CI. For a matrix of order n, CR can be obtained by dividing CI by the Random Index (RI), which is an estimation of the average CI obtained from a sufficiently large set of randomly generated matrices of size n" (Brunelli 2015):

(4) Consistency Ratio (CR) = CI (Consistency Index)/ RI (Random Index)

It is evident that if the value of Consistency Ratio is equal to or smaller than 10%, the inconsistency is considered acceptable according to Saaty (1980, 1990, 2003).

3 Results

The current study engaged in a comprehensive evaluation process. Pairwise comparisons between the indices are documented in Table 3 and site option scores are reported in Table 4. Pairwise comparisons of options for each index are detailed in Table 5, and the weighting of these is evident in Table S4. The relative weights of the indices were factored into the matrix of relative weight of options for each index. This resulted in a ranking of the options, where the Nayesh site emerged as the top priority; followed by the Bessat site and the Ghodousi site (Table 6). The results showed that Niayesh Be'sat and Ghoddosi were the first, second and third priority, respectively.

After analysing the obtained scores, it was determined that Site 2, located at the end of Niyayesh Boulevard, was the top priority. In order to validate the initial scores, the inconsistency rate was calculated for each indicator (Table 7). It was found that there was an acceptable level of consistency in the pairwise comparisons, thus supporting the initial scores. Consequently, Niyayesh Boulevard site was selected as the optimal option for the project when compared to other alternatives. As the calculated IR

Table 3. Pairwise comparison matrix for criteria.

Criteria	Accessibility	Land size	Neighbourhood	Natural potential	Social context	Expansibility	Appropriate land use
Accessibility	1	1/5	1/3	1/3	1/5	1/7	3
Land size	5	1	3	3	1	1/3	7
Neighbourhood	3	1/3	1	1	1/3	1/5	5
Natural potential	3	1/3	1	1	1/3	1/5	5
Social context	5	1	3	3	1	1/3	7
Expansibility	7	3	5	5	3	1	9
Appropriate land use	1/3	1/7	1/5	1/5	1/7	1/9	1
Sum	24.33	6	13.53	15.53	6	2.31	37

Table 4. Site options' scores for each criterion.

Criteria / Site option	Accessibility	Land size	Neighbourhood	Natural potential	Social context	Expansibility	Appropriate land use
Be'sat	4	3	5	3	4	2	4
Niayesh	5	4	4	5	5	4	4
Ghoddosi	4	3	2	3	2	2	4

Table 5. Pairwise comparison matrix for site options based on each criterion.

Accessibility	**Be'sat**	**Niayesh**	**Ghoddosi**
Be'sat	1	1/3	1
Niayesh	3	1	3
Ghoddosi	1	1/3	1
Sum	5	1.66	5
Land size	**Be'sat**	**Niayesh**	**Ghoddosi**
Be'sat	1	1/3	1
Niayesh	3	1	3
Ghoddosi	1	1/3	1
Sum	5	1.66	5
Neighbourhood	**Be'sat**	**Niayesh**	**Ghoddosi**
Be'sat	1	3	7
Niayesh	1/3	1	5
Ghoddosi	1/7	1/5	1
Sum	1.47	4.20	13
Natural potential	**Be'sat**	**Niayesh**	**Ghoddosi**
Be'sat	1	1/5	1
Niayesh	5	1	5
Ghoddosi	1	1/5	1
Sum	7	1/4	7
Social context	**Be'sat**	**Niayesh**	**Ghoddosi**
Be'sat	1	1/3	5
Niayesh	3	1	7
Ghoddosi	1/5	1/7	1
Sum	4.20	1.47	13
Expansibility	**Be'sat**	**Niayesh**	**Ghoddosi**
Be'sat	1	1/5	1
Niayesh	5	1	5
Ghoddosi	1	1/5	1
Sum	7	1/4	7
Appropiate land use	**Be'sat**	**Niayesh**	**Ghoddosi**
Be'sat	1	1	1
Niayesh	1	1	1
Ghoddosi	1	1	1
Sum	3	3	3

is within the acceptable range (i.e., <0.1), the results are considered acceptable, and Niayesh is identified as the best site for locating and designing a children's complex in Shiraz.

4 Discussion

The conducted comprehensive literature review and expert interviews have identified several crucial criteria for selecting an optimal location for children's educational and recreational spaces. These criteria encompass various aspects such as neighbourhood characteristics, population density, facilities, security and safety, social background, usability, distance from the main road, access to public transportation, develop ability, parking space, traffic, land dimensions, accessibility, natural potential, topography, air pollution index, and noise pollution. Three potential sites in Shiraz were selected based on these criteria, considering the lack of comprehensive studies available. This study advances the existing literature by providing a nuanced understanding of these criteria in the specific context of Shiraz, Iran. Unlike previous general studies, our findings underscore the importance of integrating local cultural and social nuances in site selection, which is often overlooked in broader analyses. To further refine the selection process, child psychologists were consulted to identify criteria that contribute effectively to the cognitive and social development of children. Seven criteria were identified, including accessibility, land size, natural

Table 6. Priorities determination.

Criteria	**Accessibility**	**Land size**	**Neighbour-hood**	**Natural potential**	**Social context**	**Expansibility**	**Appropriate land use**				
Be'sat	0.199	0.199	0.644	0.142	0.282	0.142	4		0.064 0.157		0.295
Niayesh	0.600	0.600	0.282	0.714	0.644	0.714	4	x	0.157 0.064 0.157	=	0.628
Ghoddosi	0.199	0.199	0.072	0.142	0.072	0.142	4		0.364 0.143		0.172

Table 7. Inconsistency Ratio for each criterion.

Criteria	**Accessibility**	**Land size**	**Neighbour-hood**	**Natural potential**	**Social context**	**Expansibility**	**Appropriate land use**
IR	-0.586	-0.586	-0.043	-0.005	-0.043	-0.005	0.000

potential, social context, land use, neighbourhood characteristics, and development potential. These criteria were then analysed using the AHP method. The approach here is novel, as it integrates psychological perspectives into urban planning, a combination not extensively covered in existing literature. This integration highlights the need for interdisciplinary approaches in such decision-making processes.

The inclusion of symbolic play and its importance in children's development, as identified in this study, provides a new dimension to school site selection. This criterion, while recognized in developmental psychology, has not been adequately factored into urban planning decisions for educational spaces, as evidenced in the literature. Also, according to psychologists, the social platform supports the cognitive development of children as it provides social interactions. Creating variety and visual details through different colours, sounds, textures, flooring and changing the topography and slopes in spaces and areas and generating a contrast in form, feeling are an exercise to develop the five senses of the child. Therefore, the natural potentials in the site will be no longer a threat to the child; seeing trees with different colours and shapes strengthens the child's sense of sight, touching their skin and the feeling of roughness and softness bolsters their sense of touch, smelling them boosts their sense of smell and eating their fruits improves their sense of taste. Deferred imitation plays a vital role in children's cognitive development. Thus, it is imperative to consider the availability of suitable social contexts within the surrounding spaces, as children tend to imitate what they observe in these environments.

Although children are affected by the environment within the site, the surrounding neighbourhood also plays a significant role. Considering the emotional security and safety of each child is essential prior to entering the space; therefore, the characteristics of the site's neighbourhood must also be taken into consideration. Additionally, the proper dimensions and size of the land are important criteria for selecting a suitable location for two reasons. First, the child usually avoids a giant space because there is no sense of belonging in that space, so the chosen land should not be very large. On the other hand, the small size of the land makes it difficult to design an open flexible space which is necessary for children's spaces. With regard to "one-dimensional thinking" in children aged 2 to 7, spatial design with a hierarchical and linear spatial structure with minimum complexity is recommended. Thus, clarity and readability can be created for the child by means of appropriate and convenient access. By considering all these factors and incorporating expert opinions and empirical research, a thorough evaluation process has been conducted to guide the decision-making process for selecting the most appropriate site.

Several studies have addressed different aspects of school location criteria, providing valuable insights into the factors influencing the decision-making process. Salvesen et al. (2008) and Zubaidah et al. (2018) focused on the distance from the main road as an important dimension. The selected sites in this study have different distances from main roads, resulting in varying levels of noise and air pollution. Hence, comparing the dimensions of accessibility and pollution simultaneously becomes a critical factor in determining the superiority of selecting sites for schools. Zou and Li (2010) and Yap et al. (2018) examined the significance of population density in school location decisions. In line with the population density criterion, this study selected sites that encompassed a larger population sample while ensuring a relatively equal distribution of population among the three selected sites. This approach allowed the researchers to consider the social dynamics and demographics of the areas under investigation. In the first phase of selecting dimensions, three sites with similar population densities were chosen.

In terms of environmental factors, this study corroborates the findings of Zubaidah et al. (2018) and Hussaini et al. (2018) regarding the impact of air and noise pollution. However, we extend their work by demonstrating how varying distances from main roads in Shiraz directly influence the suitability of sites for children's developmental needs, an aspect less explored in previous studies. Moussa and Abou Elwafa (2017) conducted a comprehensive analysis of site dimensions, form, topography, access/traffic, safety/security, noise level, utilities, cost, and soil/plant conditions. Considering those dimensions, one of the selected sites in this study demonstrated a higher vegetation coverage, which can serve as a natural potential to mitigate noise pollution and enhance soil/plant conditions, which is vital in Shiraz, Iran. Ahmed Ali (2018) considered factors such as traffic, land use, neighbourhood, noise pollution, distance from main roads, and population density, and particularly emphasized the importance of relatively flat land. However, since Shiraz does not exhibit significant variations in topography, the three selected sites in this study had similar topographical characteristics. Therefore, this dimension was not specifically considered in the analysis. Kito and Thomas (2011) studied site dimensions, access/traffic, facilities, shape, safety/security, cost, locations, noise levels, topography/drainage, and soil/plant conditions. Given that facilities were mentioned in various studies, this study also considered sites with different facilities to analyse this dimension. Building upon these previous studies, the current study identified key indices to be examined for selecting school sites. These indices include neighbourhood characteristics, population density (which was considered in the first phase), facilities, security and safety, social background, usability, distance from the main road, access to public transportation, develop ability, parking space, traffic, land dimensions, accessibility, natural potential, topography, air pollution, and noise pollution. The selected sites in this study were evaluated based on these factors, considering the specific characteristics of each location.

In terms of methodology, this study incorporated both SWOT and AHP methods, represents a significant departure from the GIS techniques predominantly used in the literature (Moussa and Abou Elwafa 2017; Zaheer et al. 2022; Hussaini et al. 2018; Ahmed Ali 2018). This innovative approach allowed for a more comprehensive evaluation of the factors influencing cognitive and social development in children, a perspective that has been underrepresented in previous research. The current study considered the seven selection criteria identified by experts, which focused on the cognitive and social development of children. These criteria (accessibility, land size, natural potential, social context, land use, neighbourhood characteristics, and development potential) were evaluated using the AHP method. Additionally, future research could concentrate on exploring the potential effects of diverse topography on the cognitive learning of students in different school sites. By analysing the relationship between topography and cognitive development, researchers can gain insight into the impact of environmental factors on educational outcomes. Furthermore, the implications of these findings extend beyond academic research into practical decision-making in urban planning. By highlighting specific criteria relevant to Shiraz, this study offers a template for city planners and policymakers in similar urban contexts, emphasizing the need for child-centric approaches in educational infrastructure development. Lastly, the suggestion to explore neural networks in future research introduces a cutting-edge perspective to the field, advocating for the incorporation of advanced technological tools in urban planning. This recommendation points to an exciting direction for future research, potentially revolutionizing the school site selection process.

5 Conclusions

In conclusion, the selection of an optimal location for children's educational and recreational spaces requires a thorough evaluation process based on various criteria. The literature review and expert interviews have provided valuable insights into the factors that influence this decision-making process. By considering neighbourhood characteristics, population density, facilities, security and safety, social background, usability, distance from the main road, access to public transportation, develop ability, parking space, traffic, land dimensions, accessibility, natural potential, topography, air pollution, and noise pollution, three potential sites in Shiraz were selected. The criteria for cognitive and social development of children, identified through consultations with child psychologists, were further analysed using the AHP method. This integration of approaches aimed to enhance the decision-making process and ensure that the selected site is conducive to the holistic development of children.

Future research opportunities include exploring the use of neural networks to enhance the selection process for optimal school locations and investigating the potential effects of diverse topography on students' cognitive learning. Analysing the relationship between topography and cognitive development can provide valuable insights into the impact of environmental factors on educational outcomes. Overall, this study has contributed to the understanding of the criteria and methodologies involved in selecting suitable locations for children's educational and recreational spaces.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

'Yotti'Kingsley, J., & Townsend, M. (2006). 'Dig in'to social capital: Community gardens as mechanisms for growing urban social connectedness. Urban Policy and Research, 24(4), 525–537. https://doi.org/10.1080/08111140601035200

Abu-Sarhan, Z. (2011). Application of analytic hierarchy process (AHP) in the evaluation and selection of an information system reengineering projects. International Journal of Computer Science and Network Security, 11(1), 172–177. https://doi.org/10.1109/icoiact.2018.8350707

Ahmed Ali, K. (2018). Multi-criteria decision analysis for primary school site selection in Al-Mahaweel district using GIS technique. journal of kerbala university, 14(1), 342–350. Retrieved March 20, 2024, from https://api.semanticscholar.org/CorpusID:58293495.

Askarizad, R., & Safari, H. (2020). The influence of social interactions on the behavioral patterns of the people in urban spaces (case study: The pedestrian zone of Rasht Municipality Square, Iran). Cities, 101, 102687. https://doi.org/10.1016/j.cities.2020.102687

Baas, A. M. (1973). Site Development. Educational Facilities Review Series Number 19.

Babakr, Z., Mohamedamin, P., & Kakamad, K. (2019). Piaget's cognitive developmental theory: Critical review. Education Quarterly Reviews, 2(3). https://doi.org/10.31014/aior.1993.02.03.84

Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., et al. (2013). Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? The lancet, 382(9890), 452–477. https://doi.org/10.1016/s0140-6736(13)60996-4

Bouraima, M. B., Qiu, Y., Yusupov, B., & Ndjegwes, C. M. (2020). A study on the development strategy of the railway transportation system in the West African Economic and Monetary Union (WAEMU) based on the SWOT/AHP technique. Scientific African, e00388. https://doi.org/10.1016/j.sciaf.2020.e00388

Byrnes, J. P. (2020). Piaget's cognitive-developmental theory. The Curated Reference Collection in Neuroscience and Biobehavioral Psychology, (April), 543–552. https://doi.org/10.1016/B978-0-12-809324-5.23519-0

Cook, D. J., Crandall, A., Singla, G., & Thomas, B. (2010). Detection of social interaction in smart spaces. Cybernetics and Systems, 41(2), 90–104. https://doi.org/10.1080/01969720903584183

Darko, A., Chan, A. P. C., Ameyaw, E. E., Owusu, E. K., Pärn, E., & Edwards, D. J. (2019). Review of application of analytic hierarchy process (AHP) in construction. International journal of construction management, 19(5), 436–452. https://doi.org/10.1080/15623599.2018.1452098

Duncan, R. M., & Pratt, M. W. (1997). Microgenetic change in the quantity and quality of preschoolers' private speech. International Journal of Behavioral Development, 20(2), 367–383. https://doi.org/10.1080/016502597385388

Faizi, M., Azari, A. K., & Maleki, S. N. (2012). Design Principles of Residential Spaces to Promote Children's Creativity. Procedia - Social and Behavioral Sciences, 35(December 2011), 468–474. https://doi.org/10.1016/j.sbspro.2012.02.112

Forman, E. H. (1990). AHP is intended for more than expected value calculations. Decision Sciences, 21(3), 670–672. https://doi.org/10.1111/j.1540-5915.1990.tb00343.x

Franek, J., & Kresta, A. (2014). Judgment scales and consistency measure in AHP. Procedia Economics and Finance, 12, 164–173. https://doi.org/10.1016/s2212-5671(14)00332-3

French, G. (2007). Children's early learning and development: A research paper. Commissioned by the National Council for Curriculum and Assessment, NCCA.

Gass, S. I. (1983). Decision-aiding models: validation, assessment, and related issues for policy analysis. Operations Research, 31(4), 603–631. https://doi.org/10.1287/opre.31.4.603

Görener, A., Toker, K., & Ulucay, K. (2012). Application of combined SWOT and AHP: a case study for a manufacturing firm. Procedia-social and behavioral sciences, 58, 1525–1534. https://doi.org/10.1016/j.sbspro.2012.09.1139

Gottfried, A. W. (2013). Home environment and early cognitive development: Longitudinal research. Academic Press.

Green, R. S., Smorodinsky, S., Kim, J. J., McLaughlin, R., & Ostro, B. (2004). Proximity of California public schools to busy roads. Environmental Health Perspectives, 112(1), 61–66. https://doi.org/10.1289/ehp.6566

Hamadani, J. D., Tofail, F., Hilaly, A., Huda, S. N., Engle, P., & Grantham-McGregor, S. M. (2010). Use of family care indicators and their relationship with child development in Bangladesh. Journal of health, population, and nutrition, 28(1), 23. https://doi.org/10.3329/jhpn.v28i1.4520

Hamedani, A. Z., & Huber, F. (2012). A comparative study of DGNB, LEED and BREEAM certificate systems in urban sustainability. The sustainable city VII: Urban regeneration and sustainability, 1121. https://doi.org/10.2495/sc120111

Huang, T. C.-K., Chen, Y.-L., & Chang, T.-H. (2015). A novel summarization technique for the support of resolving multi-criteria decision making problems. Decision Support Systems, 79, 109–124. https://doi.org/10.1016/j.dss.2015.08.004

Hughes, E. N. (2006). BC children and youth review: An independent review of BC's child protection system. British Columbia Ministry of Children and Family Development. Retrieved March 20, 2024, from https://cwrp.ca/sites/default/files/publications/BC-HuguesReviewReport.pdf

Hussaini, A., Amerudin, S., Tang, K. K. W., & Musa, S. I. (2018). Integration of GIS and Multicriteria Evaluation for International School Site Selection. In The 39th Asian Conference on Remote Sensing (pp. 39–48).

Jamal, I. (2016). Multi-criteria GIS analysis for school site selection in Gorno-Badakhshan Autonomous Oblast, Tajikistan. Master Thesis in Geographical Information Science. Department of Physical Geography and Ecosystem Science Centre for Geographical Information Systems Lund University.

Jato-Espino, D., Castillo-Lopez, E., Rodriguez-Hernandez, J., & Canteras-Jordana, J. C. (2014). A review of application of multi-criteria decision making methods in construction. Automation in construction, 45, 151–162. https://doi.org/10.1016/j.autcon.2014.05.013

Kellert, S. R. (2012). Building for life: Designing and understanding the human-nature connection. Island press.

King, L. A. (2016). The science of psychology: An appreciative view. McGraw-Hill Education.

Kito, S., & THOMAS, S. (2011). Site selection criteria and Evaluation Handbook. State of Alaska Department of Education Juneau, Alaska–USA.

Lai, C.-M. (2019). Integrating simplified swarm optimization with AHP for solving capacitated military logistic depot location problem. Applied Soft Computing, 78, 1–12. https://doi.org/10.1016/j.asoc.2019.02.016

Lai, C.-M., Chiu, C.-C., Liu, W.-C., & Yeh, W.-C. (2019). A novel nondominated sorting simplified swarm optimization for multi-stage capacitated facility location problems with multiple quantitative and qualitative objectives. Applied soft computing, 84, 105684. https://doi.org/10.1016/j.asoc.2019.105684

Lane, R., Lucas, D., Vanclay, F., Henry, S., & Coates, I. (2005). "Committing to place" at the local scale: The potential of youth education programs for promoting community participation in regional natural resource management. Australian Geographer, 36(3), 351–367. https://doi.org/10.1080/00049180500325736

Learned, E., Christensen, R., Andrews, K., & Guth, W. (1965). Business Policy: Text and Cases. Homewood, Illinois: Richard D. Irwin. Inc. https://doi.org/10.1177/002194368101800208

Lewis, K. M., Holloway, S. D., Bavarian, N., Silverthorn, N., DuBois, D. L., Flay, B. R., & Siebert, C. F. (2021). Effects of Positive Action in elementary school on student behavioral and social-emotional outcomes. The elementary school journal, 121(4), 635–655. https://doi.org/10.1086/714065

Mahdavinejad, M., Ansari, M., Samadzadeh, S., Mousavi, K., Abbasian, A., & Rafiei, S. (2014). Contemporary Architectural Schools and Efficiency of Learning Systems in Educating Environments Paradigm. Procedia - Social and Behavioral Sciences, 131, 436–441. https://doi.org/10.1016/j.sbspro.2014.04.144

Maller, C. J. (2009). Promoting children's mental, emotional and social health through contact with nature: a model. Health education. https://doi.org/10.1108/09654280911001185

Martin, J. J., & Wheeler, G. (2011). Psychology. The Paralympic Athlete: Handbook of Sports Medicine and Science, 116–134. https://doi.org/10.1002/9781444328356.ch7

Meece, J. L. (2001). Child and Adolescent Development for Educators with Free Making the Grade. McGraw-Hill Humanities, Social Sciences & World Languages.

Milligan, C., & Bingley, A. (2007). Restorative places or scary spaces? The impact of woodland on the mental well-being of young adults. Health & place, 13(4), 799–811. https://doi.org/10.1016/j.healthplace.2007.01.005

Moussa, M., & Abou Elwafa, A. (2017). School site selection process. Procedia Environmental Sciences, 37, 282–293. https://doi.org/10.1016/j.proenv.2017.03.059

Nassar, N., & AbouRizk, S. (2014). Practical application for integrated performance measurement of construction projects. Journal of Management in Engineering, 30(6), 4014027. https://doi.org/10.1061/(asce)me.1943-5479.0000287

Ohly, H., Gentry, S., Wigglesworth, R., Bethel, A., Lovell, R., & Garside, R. (2016). A systematic review of the health and well-being impacts of school gardening: synthesis of quantitative and qualitative evidence. BMC Public Health, 16(1), 286. https://doi.org/10.1186/s12889-016-2941-0

Ortega, R., Romera, E. M., & Monks, C. P. (2009). The impact of group activities on social relations in an early education setting in Spain. European Early Childhood Education Research Journal, 17(3), 343–361. https://doi.org/10.1080/13502930903101545

Pekel, E., & Kara, S. S. (2019). Solving fuzzy capacitated location routing problem using hybrid variable neighborhood search and evolutionary local search. Applied Soft Computing, 83, 105665. https://doi.org/10.1016/j.asoc.2019.105665

Pirskanen, H., Jokinen, K., Karhinen-Soppi, A., Notko, M., Lämsä, T., Otani, M., et al. (2019). Children's emotions in educational settings: Teacher perceptions from Australia, China, Finland, Japan and Spain. Early Childhood Education Journal, 47, 417–426. https://doi.org/10.1007/s10643-019-00944-6

Pyle, R. M. (2002). Eden in a vacant lot: Special places, species, and kids in the neighborhood of life. Children and nature: Psychological, sociocultural, and evolutionary investigations, 305–327. https://doi.org/10.7551/mitpress/1807.003.0013

Roberts, A., Hinds, J., & Camic, P. M. (2019). Nature activities and wellbeing in children and young people: a systematic literature review. Journal of Adventure Education and Outdoor Learning, 00(00), 1–21. https://doi.org/10.1080/14729679.2019.1660195

Saaty, T. L. (1994). Fundamentals of decision making and priority theory with the analytic hierarchy process. RWS publications.

Salvesen, D., Zambito, P., Hamstead, Z., & Wilson, B. (2008). Safe Schools: Identifying Environmental Threats to Children Attending Public Schools in North Carolina. The Center for Sustainable Community Design, Institute for the Environment University of North Carolina at Chapel Hill.

Schneider, Raymond C., & Wilsey, Carl H. (1961). School Site Selection--A Guide. Stanford, California: School Planning Laboratory, Stanford University. ED 015 631 Document not available from EDRS

Shaffer D. R. & Kipp K. (2013). Developmental psychology: childhood and adolescence (9th ed.). Wadsworth; Cengage Learning distributor.

Sigelman, C. K., & Rider, E. A. (2012). Life− span human development. 7th Editon. Thomson− Wadsworth, Cengage Learning: Belmont, USA.

Simatwa, E. M. W. (2010). Piagets theory of intellectual development and its implication for instructional management at pre-secondary school level. Educational Research and Reviews, 5(7), 366–371.

Stanković, D., Milojković, A., & Tanić, M. (2006). Physical environment factors and their impact on the cognitive process and social behavior of children in the preschool facilities. Facta universitatis-series: Architecture and Civil Engineering, 4(1), 51–57. https://doi.org/10.2298/fuace0601051s

Tabatabaian, M., abbasalizadehrezakolai, S., and Fayaz, R. 2017. Analysis the effect of the built environment on children's creativity (Review the effect of the environmental characteristics on children's creativity in Tehran children centers). The Monthly Scientific Journal of Bagh-e Nazar, 13(43), 17-36.

Talam, P. K., & Ngigi, M. M. (2015). Integration of gis and multicriteria evaluation for school site selection a case study of belgut constituency. In Proceedings of Sustainable Research and Innovation Conference (pp. 138–149). URI: http://repository.dkut.ac.ke:8080/xmlui/handle/123456789/7798

Vaidya, O. S., & Kumar, S. (2006). Analytic hierarchy process: An overview of applications. European Journal of operational research, 169(1), 1–29. https://doi.org/10.1016/j.ejor.2004.04.028

Vargas, L. G. (1990). An overview of the analytic hierarchy process and its applications. European journal of operational research, 48(1), 2–8. https://doi.org/10.1016/0377-2217(90)90056-h

Vollman, E., & Richland, L. (2020). Beyond Wealth and Health: The Social Environmnt as a Protective Factor feor Cognitive Development of Children in Nicaragua. Journal of Cognition and Development, 21(2), 149–165. https://doi.org/10.1080/15248372.2020.1717493

Yap, J. Y. L., Ho, C. C., & Ting, C.-Y. (2018). Analytic Hierarchy Process (AHP) for business site selection. In AIP Conference Proceedings (Vol. 2016, p. 20151). AIP Publishing LLC. https://doi.org/10.1063/1.5055553

Zaheer, N., Hassan, S.-U., Ali, M., & Shabbir, M. (2022). Optimal school site selection in Urban areas using deep neural networks. Journal of Ambient Intelligence and Humanized Computing, 1–15. https://doi.org/10.1007/s12652-021-02903-9

Zhu, J., Liu, W., Liu, Y., Wang, D., Qu, S., Duan, Y., & Yao, J. (2021). Smart city oriented optimization of residential blocks on intensive urban sensing data based on fuzzy evaluation algorithm. Journal of Ambient Intelligence and Humanized Computing, 12, 911–921. https://doi.org/10.1007/s12652-020-02104-w

Zou, P. X. W., & Li, J. (2010). Risk identification and assessment in subway projects: case study of Nanjing Subway Line 2. Construction Management and Economics, 28(12), 1219–1238. https://doi.org/10.1080/01446193.2010.519781

Zubaidah, B., Ahmad Rodzi, M., & Noordin, A. (2012). Spatial multi-criteria decision analysis for safe school site selection. International Geoinformatics Research and Development Journal, 1 (2). pp. 1-14.