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Walaa A. AlHyari[1], Othman M. Ghnaim[2]

IDENTIFYING AND SELECTING THE OPTIMAL SITE FOR KINDERGARTEN PROJECTS IN THE CITY OF AS-SALT USING SPATIAL SUITABILITY ANALYSIS AND GEOGRAPHIC INFORMATION SYSTEMS

Abstract: The study aimed to identify the optimal kindergarten site in As-Salt using Geographic Information Systems (GIS). Data was collected from various sources and experts, and three alternatives were selected from Batna neighborhood, Wadi Al-Halabi neighborhood, and Al-Naqab neighborhood. The spatial suitability method was used to analyze the data, determining the most suitable neighborhood for kindergartens. The study adopted a descriptive approach and analyzed the data using GIS to ensure the optimal site selection.

The study found that the Batna neighborhood is the optimal site for establishing a kindergarten project, ranking eighth in the classifications . The most important criteria for site selection were distance from main roads and proximity to residential roads, which ranked up to 18%. The study also highlighted the effectiveness of GIS and the spatial suitability method in achieving optimal site selection for educational facility projects. The study recommends selecting Batna neighborhood for kindergartens due to its high suitability for most proposed criteria and suggests enhancing GIS technology in other educational projects. Future studies should evaluate and improve the process of selecting kindergarten sites using GIS and the spatial suitability method.

Keywords: Selecting Optimal Site, Spatial Suitability, Geographic Information Systems (GIS), Multi-Criteria Analysis, Kindergarten Projects

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[1] Al- Balqa' Applied University (BAU), Faculty of Business, Department of Project Management, As Salt, Jordan, ORCID ID: https://orcid.org/0009-0001-2115-7440, email: alhyariwalaa@gmail.com
[2] Al- Balqa' Applied University (BAU), Faculty of Business, Department of Project Management, As Salt, Jordan, ORCID ID: https://orcid.org/0009-0008-3737-1338, email: othmanghnaim@yahoo.com

Introduction with analysis of the state of the problems

Selecting the geographical site of the project is considered a fundamental factor that balances the needs of the project itself and the advantages it provides to those around it, so that it greatly affects the course of operations and achievement of goals in the future (Yap et al., 2019). Selecting a suitable site for the project is one of the most important factors that determine its success. This is evident in achieving the maximum effectiveness of the project, meeting all the needs of the surrounding community, and supporting its operational economy represented by managing its operations and resources. Since the available options are not always completely ideal, it is necessary to balance the advantages and disadvantages of each potential site against the unique goals and requirements of the project, since the wrong selection of site leads to huge losses at the level of the project and the national economy (Al-Husseini, 2022).

Kindergarten projects in general and in the city of As-Salt in particular are of great importance because they focus on the early stages of a child's life, seek to establish and follow up on the child, and create an educational environment that stimulates healthy emotional growth and supports intellectual growth (Al-Sayed, 2024). In order to achieve the best selection of kindergarten project sites, it is necessary to adopt the latest technologies and contemporary technical methods for this purpose, as is the case with GIS technology, which is one of the latest modern technological means used in planning and developing local communities (Okasha et al., 2022). Which in turn provides many tools that can be used to collect and analyze data effectively, which improves the decision-making process regarding the most suitable site for the project (Casella, 2023).

Study area. As-Salt city is located in the Balqa Governorate in Jordan, and the city is located at the crossroads between Jerusalem and Amman (Alamoush & Kertész, 2022). The city is (80) km east of Jerusalem, and (28) km west of the capital. Its astronomical coordinates are (33.2) north, (35.44) east (Arabeyyat, 2021). The area of the city is (48) km^2 (Qtaishat et al., 2021). The number of families in Qasaba As-Salt District reached (38953) families by the end of 2023, including (25975) families in the city of As-Salt. The population of the city of As-Salt reached (120505) by the end of 2023. The population of Qasaba As-Salt District, according to the report issued by the Department of Statistics for the year until the end of 2023, is (183,520) (Department of Statistics, 2024).

Study problem. Kindergarten is an educational stage that is no less important than other educational stages, as it forms the basis for subsequent educational stages such as the primary stage. Its importance also stems from its close connection to early childhood, especially in the first three years of a child's life, which form the child's personality in various aspects. Therefore, it necessary to select the appropriate site for kindergarten projects so that they can play their role effectively and influentially. Studying the selection of appropriate sites for kindergarten facilities projects is one of the main factors that contribute to enhancing the performance of kindergartens and ensuring the provision of their services with the highest quality (Abdul Qader, 2018).

Selecting appropriate sites for kindergarten project is a crucial step that

achievestheir stability and sustainability. Since the decision-making process for selecting sites for kindergarten projects by any organization involves multiple criteria and alternatives, they should be evaluated using a set of multi-criteria decision methods (Yap et al., 2019). It is necessary to carefully select the appropriate site, in order to enhance the chances of success in these projects. GIS helps improve the decision-making process and select the optimal site, through the maps and information it provides (Okasha et al., 2022). Based on the above, this study came in an attempt to answer the following questions:

- What is the importance of identifying and selecting the optimal site for kindergarten projects in the study area?
- What are the criteria that affect the selection of kindergarten project sites in the study area?
- How are the spatial suitability method and GIS used in identifying and selecting the optimal sites for kindergarten projects in the city of As-Salt?

Study objectives. This study sought to achieve a set of objectives as follows:

- Demonstrate the importance of identifying and selecting the optimal site for kindergarten projects in the study area.
- Identify the criteria that affect the selection of kindergarten project sites in the study area.
- Apply the mechanism of using the spatial suitability method in the GIS environment to identify appropriate sites for kindergarten projects in the study area.

Literature review. The study (Köse et al., 2023) evaluated the sites of primary schools in Afyon province in Turkey based on geospatial analysis, and the results showed that this type of analysis provides reliable evidence to support decision-making processes in identifying and allocating needs related to service facilities. The study (Mahdi and Al-Rawe, 2023) sought to evaluate and study the reality of educational facilities in Al-Faw city and activate the role of the spatial organization method in policies and planning aspects in distributing educational facilities in the city using GIS technology and spatial analysis tools.

The results of the study (Zuqoni et al., 2022) showed that GIS technology can effectively visualize the distribution of education quality for each region, which facilitates visual analysis. The analysis results showed that many criteria, especially infrastructure criteria, have the highest number of categories that do not meet national education standards in each region drawn on the map. The study (Falih & Alyaqoobi, 2021) recommended building new schools according to distance and access criteria as well as population and school criteria to meet the actual need for educational services in some neighborhoods of the study area. It also recommended that school spaces be compatible with their grades and student numbers, and recommended that typical designs be taken into account in terms of population, green spaces, and all other requirements.

The study (Mohieldeen et al., 2021) aimed to evaluate and study the current status of the spatial distribution of schools and assess whether it is fair and subject to existing standards or not in the Red Sea State. The study concluded the importance of applying

GIS tools in service areas, especially those related to the scope of education. While the study (Utomo et al., 2020) aimed to determine the conditions of community needs for facilities, spatial distribution and capacity of educational facilities in Palu City, and the study used the survey method with the spatial approach as the basis for its analysis and the neighborhood unit approach as the basis for mapping educational facilities using GIS technology in data processing, the study (Xiao et al., 2019) sought to provide a quantitative assessment of the suitability of the residential environment in Pengshi County, and provide evidence to support development and planning based on GIS technology. The study adopted the analytical hierarchy process (AHP).

Theoretical framework. Geographic Information Systems (GIS) are defined in different ways by different researchers. It is the science of using GIS software and technologies to represent and predict spatial relationships (Abubakar & Bello, 2024). It is also an information system that performs the functions of collecting, storing, processing, and presenting information to the user in an integrated manner after it is obtained through site-based observations (Şahin et al., 2024). GIS technology has become more popular and widely used nowadays. It is also rapidly growing all over the world, and there is a great demand for GIS software, products, data, and information. It has even caught the attention of many project managers, environmental scientists, activists, and others, as it helps them in completing work and projects and increases their efficiency (Jebur, 2021).

This study considers that GIS technology is a system that allows for many operations to be performed on spatial data, such as storage, analysis and display operations either in the form of maps or in the form of spatial tables, which contributes to making informed decisions in many areas, such as choosing the optimal site for projects.

GIS technology supports site-specific decision-making processes by facilitating the collection, analysis, and integration of spatial data. It is also of great importance in urban planning processes, as it enables planners to make decisions and allocate resources efficiently (Sharifinia, 2014), and contributes to identifying the most appropriate sites according to specific criteria and preferences. It is also used to understand, analyze, and manage spatial data effectively in simplifying planning processes by storing and analyzing data, including data related to sites, and spatial relationships between facilities and population distribution appear through mapping, which helps in identifying areas with high demand for services and areas where access is not available and helps in improving the efficiency of services by improving the spatial distribution of facilities and providing a database for spatial planning as well as non-spatial data (Falih & Alyaqoopi, 2021). GIS technology provides a suitable environment for monitoring and inventorying sites, equipped with spatial databases through spatial suitability analysis and satellite images (Haq & Panduardi, 2020).

The use of GIS technology allows for calculating network distances and nearby distances, and utilizing spatial data to accurately and effectively assess the accessibility of the site, as network distances provide a more realistic representation of data within urban areas by integrating the actual road network (Yenisetty & Bahadure, 2020). The application of the spatial suitability method, which is one of the most prominent

functions of GIS, allows for clarifying the current distribution of phenomena and choosing the optimal site for them. The mechanism of the spatial suitability method is manifested by its reliance and establishment on Criteria compatible with the nature of the project, and it is one of the stages that takes time and effort because it is concerned with aspects, whether theoretical, applied or scientific, in addition to requiring a group of experts and specialists to set the criteria that are compatible with the nature of the project (Al-Kaabi, 2023).

This study believes that GIS technology has a decisive role in determining the optimal sites for projects according to a set of different criteria, and this is attributed to the ability of GIS technology to understand and analyze spatial data efficiently, which enhances the ability to make appropriate decisions regarding appropriate project sites and planning.

Materials and methodology

The primary study data included: consulting a number of (8) experts regarding the relative weights of the criteria, and the secondary data represented electronic and library sources such as books, university theses, published and unpublished research, research articles, and reports.

The study relied on the descriptive approach in achieving its objectives by employing the spatial suitability method in the GIS environment in analyzing the study data, where the spatial suitability model was built through spatial analysis tools, and the criteria used in the comparison between the proposed alternatives were identified, and appropriate weights were given to each of these criteria.

To achieve the study objective, the following research steps were adopted to create and develop a model with an organized workflow that includes:

First: The aim of the study: The problem and aim of the study revolve around identifying and selecting the optimal site for kindergarten facilities projects in the city of As-Salt.

Second: Determining the criteria: The study used a set of previous literature that examines the criteria for selecting the most appropriate site for kindergarten projects to determine the criteria and a group of experts specialized in this field to determine the relative weights of the criteria.

Third: Consulting experts: The study identified a group of experts working in the field of projects, municipalities, private kindergartens, and the Ministry of Education. Their number reached eight experts and they were consulted to determine the relative weight of the set of criteria proposed to be adopted in the comparison between alternatives in the study area.

Fourth: Determining alternatives: The study proposed three sites (alternatives) within the city of As-Salt to be compared among them according to the criteria that were identified, and the alternatives for the sites of kindergarten facilities in the study area were represented as follows (Qatishat et al., 2021; Wishah, 2020):

- The first alternative is Batna neighborhood, where the area of each Batna neighborhood is 360.5 km^2, and the number of families in Batna neighborhood reached 194 families.

- The second alternative is Wadi Al-Halabi neighborhood, where the area of Wadi- Al-Halabi neighborhood is is 310.0 km^2, and the number of families reached 534 families in Wadi Al-Halabi neighborhood.
- The third alternative is Al-Naqab neighborhood, where the area of Al-Naqab neighborhood is 420.2 km^2, and Al-Naqab neighborhood contains 1390 families.

Fifth: Preparing the hierarchical model for the study: In light of the above, the criteria that the study will use were determined, as well as the alternatives that were chosen to compare between them and select the most appropriate among them. The analytical hierarchical model was built, which includes the study objective, the proposed main and sub-criteria, and the three alternatives that were determined to choose the best among them, Fig. 1.

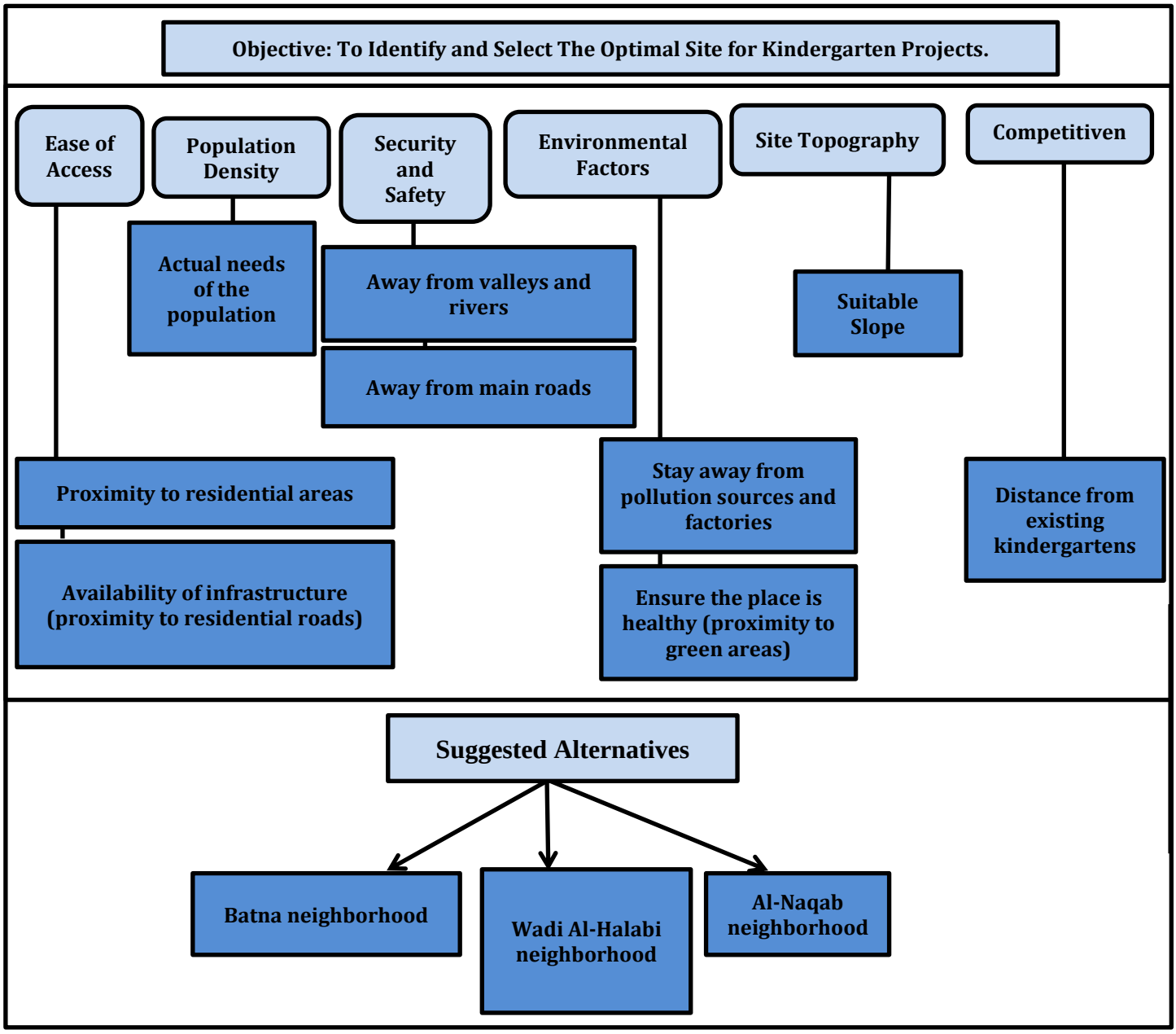

Fig. 1. Hierarchical study model
Source: Own elaboration

The process of identifying both criteria and alternatives and consulting experts regarding the weights of the criteria is followed by spatial suitability analysis using the study model with the aim of identifying the optimal sites for establishing kindergarten projects.

The spatial suitability method was applied according to the following steps:

1. Finding the Euclidean distance: The Euclidean distance is the direct line between two elements or the minimum distance between two objects, and is the most straightforward way to represent the distance between two points in two-dimensional space. (Ghazal et al., 2021). The first step in modeling involves calculating the Euclidean distance, where ArcMap converts all points to a spatial extent and calculates distances from the desired phenomenon. This requires that all layers be spatial in order for the modeling to be complete (Al-Mahdawi & Hadi, 2024). The study chose to use Euclidean distance for all criteria, as it is a straightforward and simple method for measuring proximity or distance between sites, facilitating spatial analysis without the need for complex data. Furthermore, this approach ensures a unified analysis methodology for all criteria, which contributes to their smoother integration into the weighted overlay model, yielding consistent and accurate results.
2. Reclassify study data: The data that has been worked on is reclassified into categories from (1 to 10), where the number ten represents the best value of the classified data, while the number one represents the lowest value of the preferred data. The reclassify process is carried out using the spatial analysis tools within the GIS environment in ArcMap.
3. Determining the relative weights of the criteria: The relative importance of the criteria is represented using weights for each criterion represented by a degree or category, where the weights are determined to complete the process of selecting the most suitable site for selecting to establish the project in it (Kuru & Terzi, 2018). This process is implemented via Weighted Overlay using the spatial analysis tools available within ArcMap, where the sum of the weights of all layers is 100%, and this percentage is distributed over all the results of the layers that have been reclassified.

   The study sought the assistance of a group of experts working in the field of projects, municipalities, private kindergartens, and the Ministry of Education, numbering (8) experts, who were consulted with the aim of determining the most appropriate relative weight for the proposed set of criteria used in the comparison between alternatives, with the aim of choosing the optimal site for kindergarten facility projects, as the sum of the criteria weights equals 100% and was distributed to the criteria based on the extent of their impact and importance, as listed in Table 1.
4. Spatial Suitability Model: The study established a model for the spatial suitability workflow in an organized and sequential manner based on all the previous data that were identified, collected, sorted and classified with the aim of selecting the optimal site for kindergarten facilities projects. The process was carried out through the

ArcMap program, as the ArcGIS environment includes many advanced spatial analysis models. Various geographic data can be extracted, including analysis of suitable sites. The suitability model is represented through the flow chart in the Model-Builder graphical user interface, which allows users to build, visualize, edit, and implement the geoprocessing workflow, in addition to using, sharing, and applying it to other areas (Al-Mahdawi & Hadi, 2024). The Model-Builder tool contains all the operations that were performed on the layers that represent the criteria for selecting the optimal site for kindergarten facilities projects, as in Fig. 2.

Table 1. Criteria weights

Criteria	Relative weight
Site slopes.	3%
Distance from main roads.	18%
Proximity to residential roads.	18%
Distance from waterways and water channels.	14%
Proximity to residential neighborhoods.	8%
Distance from polluted areas.	14%
Proximity to green areas.	5%
Distance between competing projects.	13%
Actual population needs (children under five years old).	7%
Total	100%

Source: Own elaboration

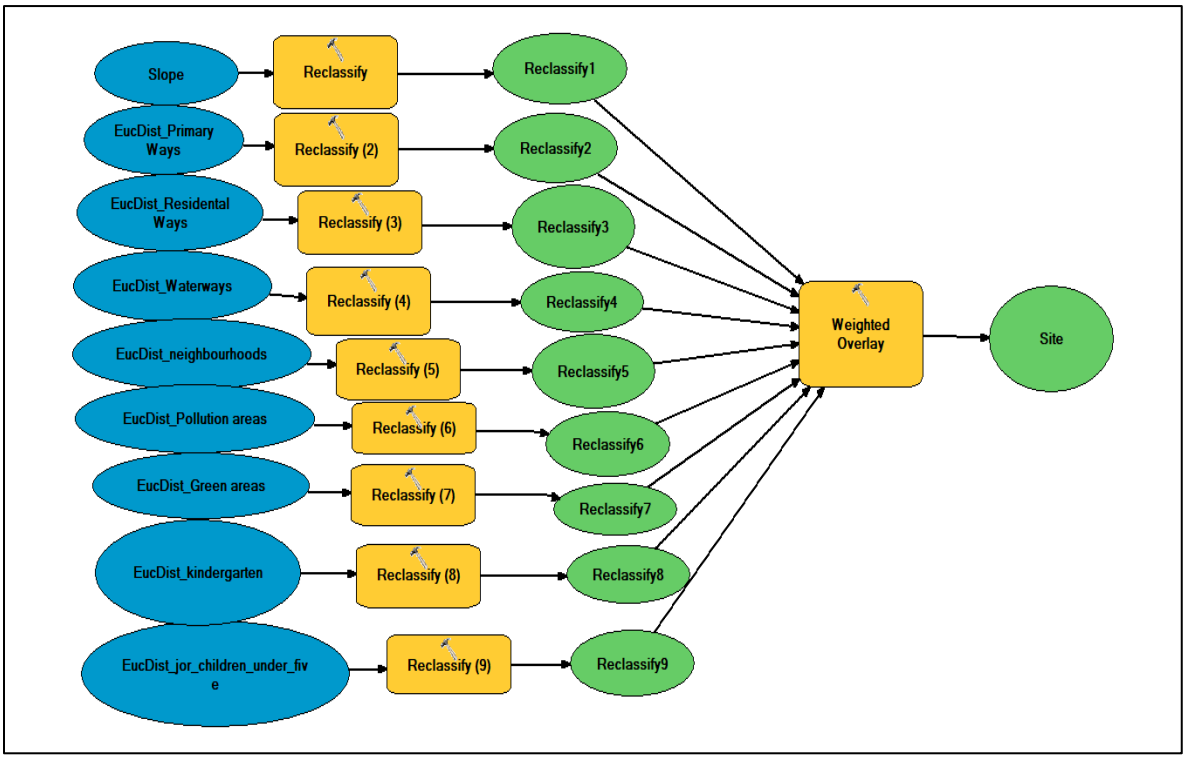

Fig. 2. Spatial suitability model
Source: Own elaboration

Results and discussion

The results of the spatial suitability analysis are presented in the Fig. 3.

1. **The results of the reclassification process are as follows:**

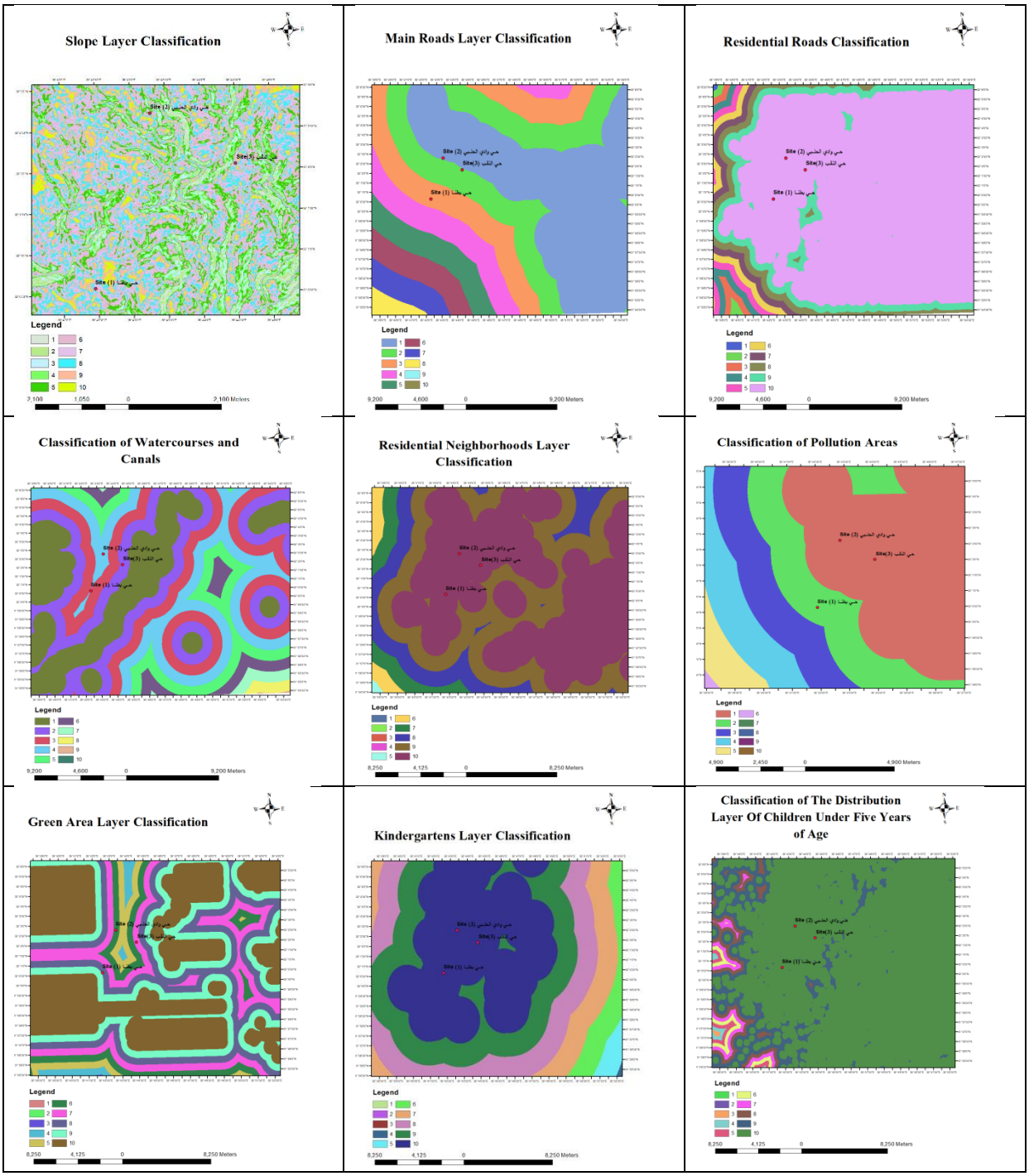

Fig. 3. Reclassification process results
Source: Own elaboration

– After reclassifying the slope layer, it became clear that the alternative with the least slope is the alternative of Batna neighborhood and Al-Naqab neighborhood, as they were ranked eighth in the slope degrees, which gives an equal degree of preference, while the alternative

with the highest slope value is the alternative of Wadi Al-Halabi neighborhood, which was ranked fifth in the classification.

- After reclassifying the main roads layer, it became clear that the alternative that is farthest from the main roads with the best value is the alternative of Batna neighborhood, as it was ranked third in the classification, while the alternative of Al-Naqab neighborhood is ranked second, and the alternative of Wadi Al-Halabi neighborhood is ranked last.
- After classifying the roads layer within the residential neighborhoods, it became clear that all alternatives are surrounded by residential roads, which facilitates access to them, and makes them all have the same value of preference, as all alternatives were ranked tenth, which represents the highest value.
- After the classification process for the waterways and canals layer, it was found that the Wadi Al-Halabi neighborhood alternative and the Batna neighborhood alternative were equal in seventh place in terms of distance from waterways and canals, while the Al- Naqab neighborhood alternative was in sixth place.
- It was found that all alternatives are located within residential neighborhoods, which indicates that they are close to residential areas, which gives an equal value preference to all proposed alternatives, as all alternatives were in tenth place, which means that the surrounding residential areas can reach them, and they can all serve the surrounding community.
- It was found that the Batna neighborhood alternative, which obtained second place in the classification, is the farthest from polluted areas, and the other two alternatives are equal in the same place represented by the first.
- It was found that the Batna neighborhood alternative obtained the highest value in terms of the presence of green areas surrounding it within eighth place in the classification, and the Al-Naqab neighborhood alternative was in seventh place, the second best alternative, while the Wadi Al-Halabi neighborhood alternative was in sixth place, which means that it is in last place.
- It was noted that all the proposed alternatives have existing kindergartens in their vicinity, which gives all alternatives equal preference value, meaning that they compete with other kindergartens.
- It was found that all the proposed alternatives have a high percentage of children under the age of five in their vicinity, which indicates that there is an actual need for the population to establish kindergarten facilities, and gives equal preference value to all the proposed alternatives, as they all ranked eighth in the classification.

2. The result of the optimal site for kindergarten:

After carrying out all the operations related to the criteria and giving them the appropriate relative weight, the result of applying the spatial suitability method in choosing the optimal site for educational facility projects and arranging the alternatives from the most suitable to the least is obtained. We find that the alternative to the Batna neighborhood was ranked eighth in the classifications, while the alternative to the Negev neighborhood constitutes the seventh rank in the classifications, while the alternative to the Wadi al-Halabi neighborhood is ranked sixth in the classifications as listed in Fig. 4.

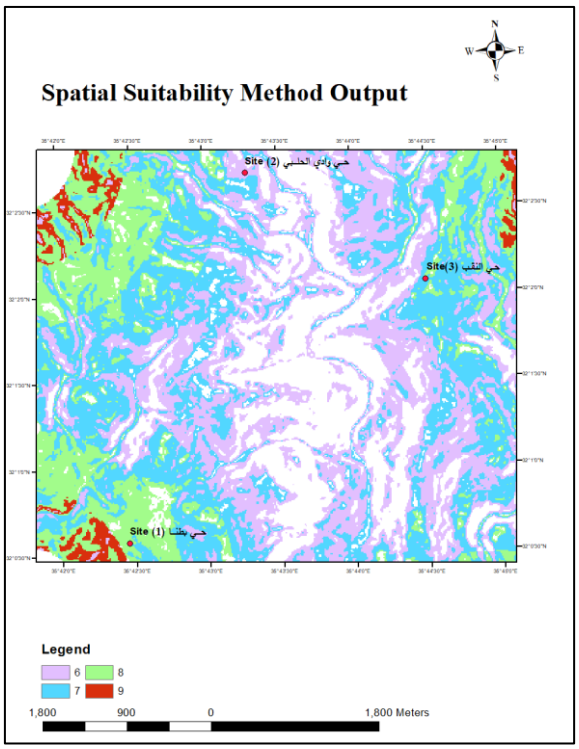

Fig. 4. Results of the spatial suitability method
Source: Own elaboration

The study concluded with a set of results, summarized as listed below:

- The optimal alternative is the Batna neighborhood, due to its high spatial suitability for most important criteria such as slope, distance from main roads, distance from polluted areas, and proximity to green areas, where it ranked eighth in the classification. It is followed by the third alternative, the Negev, with its good features as well, which ranked seventh in the classification, while the second alternative, Wadi Al-Halabi, remains acceptable but does not outperform the other alternatives in a comprehensive manner, due to it being the least suitable alternative among the other alternatives, which ranked sixth in the classification.
- The criteria that received a high relative importance were the criterion of distance from main roads, which is one of the sub-criteria of the safety and security criterion, as well as the criterion of proximity to secondary roads within residential areas, which is one of the sub-criteria of the ease of access criterion, as the two criteria received a relative importance of (18%), and this result is attributed to the fact that these criteria improve the quality of the site and raise the percentage of its spatial suitability. This is consistent with the study (Utomo et al., 2020). Followed of the criteria of distance from waterways and water channels, which is one of the sub-criteria of the safety and security standards, and distance from polluted areas, which is one of the sub-criteria of the environmental factors standards, where the two criteria obtained a relative importance (14%), then the criterion of the presence of a distance between competing projects, which is a sub-criteria of the competitiveness standard, with a percentage of (13%), followed by the criterion of proximity to residential neighborhoods, which is a sub-criteria of the ease of access

standards, , with a percentage of (8%), then the criterion of the actual need of the population for kindergartens, which is one of sub-criteria of the population density standard, with a percentage of (7%), then the criterion of proximity areas, which is one of the sub-criteria of the environmental factors standards, with a percentage of (5%), and finally the criterion that obtained the least relative importance, with a percentage of (3%), is the slope of the site, which is a sub-criteria of the site topography standard , and the variation in the relative importance of the criteria is attributed to the difference in their impact on making the decision on the optimal site for kindergartens.

- The effectiveness of Geographic Information Systems (GIS) and the spatial suitability method in achieving the optimal site selection for educational facility projects, such as kindergartens in the city of As-Salt. This is consistent with the study (Zuqoni et al., 2022; Mohieldeen et al., 2021). This result is attributed to the fact that these technologies allow for a comprehensive and accurate assessment of multiple criteria, spatial integration and data analysis, improvement in the decision-making process, and future applications that ensure project sustainability. Thus, GIS technology and spatial suitability contribute to providing a safe and healthy educational environment that meets the needs of children and families, and supports sustainable development in society.

Recommendations

Based on the above results, the study recommends the following:

- The necessity of establishing a kindergarten project in the Batna neighborhood in the city of As-Salt, as it achieves the highest percentage of suitability among the proposed alternatives for the specified criteria.
- The necessity of strict adherence to the criteria specified in the study when selecting the site of kindergarten projects, in order to ensure that all environmental, health, and geographical factors that have been analyzed are taken into account, to ensure the provision of a safe and healthy educational environment for children.
- Work on developing unified and approved main standards in Jordan to select suitable sites for establishing educational facilities projects, taking into account the balance between environmental, economic and social development, to ensure the continuity of these projects and achieve maximum benefit for local communities.
- Promote the use of GIS technology in the planning and implementation processes of other educational facilities projects. GIS technology contributes to accurately analyzing spatial data and providing a clear vision of potential sites, which helps in making informed decisions supported by evidence.
- Conduct further future studies to evaluate and improve the process of selecting the optimal sites for educational facilities projects using GIS technology and the spatial suitability method. Studies should include an analysis of the impact of new and emerging variables and standards, such as climate change and urban expansion, to ensure the continued achievement of the best results in planning and implementing educational facilities projects.

Conclusions

The project site is an important framework for the project activities, and it is the dynamic environment that affects how businesses are formed and developed, which makes site study very important, including educational facility project sites. When this type of project is established in a manner that meets the standards, this means that it has the ability to keep pace with the development in the increasing demand for the services it provides, and that it provides its services efficiently and without obstacles. Therefore, it is necessary to follow the foundations and standards when choosing the sites of educational facilities and avoid randomness in their distribution. Since the optimal site for educational facilities in general, and kindergartens in particular, is of primary concern to potential students and their parents, this prompts the need to apply planning standards and principles when choosing the sites of kindergarten facilities. GIS technology works to determine the optimal sites for projects and produce relevant maps efficiently, as the optimal sites are determined based on various carefully selected criteria, then reclassified, and the relative weight is given to each of these criteria according to their importance. These maps classify the study area into ranges according to the degree of spatial suitability for establishing projects on them. This paper presents an application for selecting the appropriate site for a kindergarten project in the city of As- Salt, Jordan. Using the spatial suitability method and GIS technology based on many criteria used to compare between the proposed alternatives. The results of this study provide information of great importance to city planners and those responsible for following up and evaluating educational facility projects, as they can be used in establishing kindergarten projects. They play an important role in reducing educational gaps and enhancing efforts to improve educational infrastructure in needy communities.

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