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Landscape Design as a Tool to Meet Children's Needs in Residual Urban Spaces

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Abstract Residual spaces are defined as a category of open spaces that exist in our urban context but are rarely considered by urban designers. They have other terminologies, such as leftovers, loose spaces, lost spaces, neglected spaces, and neglected urban land. However, residual spaces can be used to serve in community problem-solving such as children's needs in outdoor spaces. Using landscape design as a tool, residual spaces in an urban context can be used to consider children's activities and their different needs. In this sense, this paper highlights the main aspects of the two main factors of the study, which are the landscape design elements and components of residual spaces and the different types of child needs. This research explores the relationship between these two main factors and their components to define the most suitable landscape design elements that can respond to the different children's needs in outdoor spaces. To achieve this goal, the research proposes a matrix based on a literature review and analysis of two case studies, one international and another local, that combine the two main factors of the study, which are the landscape design elements and components of residual spaces, and several types of child needs. It also proposes an inferred matrix that comes from the main matrix, which will provide a tool that helps the landscape designers evaluate the projects oriented to the child and contribute with the main matrix to design better and more responsive outdoor spaces for children in the future.

Keywords Residual Spaces, Children Needs, Landscape Design, Outdoor Spaces

1. Introduction

Children deserve more attention in urban planning than what they are getting nowadays. Children and toddlers are not likely to raise their voices against the demand and attention to their needs. It is important to support more initiatives to help children enjoy their outdoor environment by considering their needs (psychological, functional, social, and aesthetic) concerning urban planning. According to Enrique Peñalosa, Mayor of Bogotá, Columbia (1998–2001, 2016–present), a specialist in urban and transportation policy, "If we can build a successful city for children, we will have a successful city for all people." One of the most important rights concerning children is the participation rights that entitle freedom of expression and participation in decision-making. These rights support children in taking an active role in society [1] by involving them in the design and considering their needs in the outdoor environment and urban planning, especially the design of outdoor spaces generally and residual spaces specifically using landscape design. While residual space with no activity or attendance is the most undesirable in recent years, numerous cities have seen a progressive loss in open public places.

Authorities frequently fail to offer the necessary open spaces due to the need for fewer expenditure ventures and a lack of design in urban planning from the beginning [2].

While considering these residual spaces and redesigning them can help the city's modification processes and be a potential resource in developing urban planning, especially the outdoor spaces, which can trigger significant urban transformation processes, it can also support the outdoor spaces designed for children to serve their needs. Consequently, reconfiguring these spaces using landscape elements can satisfy the children by having outdoor spaces that serve their needs. The idea also meets the need to increase parks, gardens, and outdoor spaces for children.

Accordingly, this study investigates residual spaces as a type of outdoor open space in our urban areas and how to use them to upgrade the spaces designed for the child concerning his/her needs through landscape design elements. The reuse of these residual spaces can help to upgrade the urban space, taking into consideration its location and composition, urban characteristics, and finally, its importance and morphological classification, and how to find a tool and evaluate it to have a designed residual space for children that respects their needs.

This study aims to reach an assessment tool through which it is possible to evaluate and develop the residual spaces in residential areas to meet the child's needs as a target user. The research proposes a matrix that studies the relationship between the two main axes representing the two main factors of the study, the needs of the child in the open space and residual spaces, their impact on the landscape elements, and their allocated application.

The conclusion of this paper comes in the form of a matrix that provides a tool to help landscape designers to design better and more responsive outdoor spaces for children in the future.

2. Literature Review

The childhood stage has become the main concern at the institutional and societal levels. Accordingly, this study attempts to establish an understanding of the child's nature and needs in outdoor spaces, and his/her influential role in building society, as agreed upon in the Geneva Convention on the Child's Rights in 1989 (International Childhood Agreement). It also seeks to clarify how the residual spaces can act as outdoor spaces oriented to the children to serve their needs in outdoor spaces using landscape design elements.

There have been several previous studies about residual spaces in the urban context. These studies attempted to define the residual spaces, classify them, and suggest ways to utilize them. Some studies, for example, suggested turning them into viable open spaces [3]. Other studies suggest tactical urbanism as an approach to reusing residual spaces [4]. All of the previous studies addressed residual spaces to serve the community in general. However, they did not tackle residual spaces as an effective urbanization element and a potential solution for the lack of open spaces for children, to meet their needs.

The environment plays an important role in the lives of humans in general and children in particular, especially in the early childhood phase, as it affects their development and intelligence. Accordingly, outdoor play stimulates the growth of children more than indoor play [5]. A study by Moore (1986) further claims that children who experience nature as an open space for play have more positive feelings toward each other [6]. Moore's claim is supported by the revelations about the influence of nature on the emotional health of children. Contact with nature is equally important to contact with adults and the wider human community for children, as nature allows them solitude and a sense of wonder. Nature also develops the children's independence and autonomy by providing them with space in which they can gradually increase their distance from their caretakers. While indoor space could allow such separation to take place, the outdoor space enhances the children's independent experience and increases the trust of adults in the capabilities [6-8].

In addition to fostering their sense of wonder, the children's surrounding environment should meet certain aesthetic values that shall influence their psychological and physiological states. Thus, the success of a child-oriented space is achieved by considering psychological, aesthetic, functional, and social needs. A child-oriented space should also provide children with a sense of safety and security, which could be realized through the proper design of outdoor space [9] [10].

With the development of the urbanization process, some spaces emerge due to the lack of arrangement and orientation between the urban design process and location needs, which can be defined as residual spaces. Residual spaces are those that were not planned in urban planning. However, considering their conditions and transformation potential, they must be thoroughly examined because of the potential benefits to the city.

In the dictionary, the word "residual" implies a "leftover" or what remains after a part is taken. According to [11], residual spaces are also called "neglected spaces" and "liminal spaces", In Finding Lost Space, Roger Trancik states [12], "Generally speaking, lost spaces are unwanted urban places needing redesign—anti-spaces, offering no constructive contribution to the environment or users"[4]. They are ill-defined, have no discernible boundaries, and fail to engage in the urban aspects in a meaningful order. They are also characterized by being trashed, unmaintained, and prone to urban decay [3, 11, 13]. Ela Alanyali reveals in her definition of 'Leftover space'—a synonym of residual space, the reasons why they emerge, citing lack of control and maintenance as the main causes [14]. She also argues that leftover spaces spring from one of two scenarios:

- A space that was not designed by authorities and, accordingly, does not meet public needs.

- A space that was designed by authorities but has eventually deteriorated and lost its usefulness.

Alanyali's definition also reveals physical qualities through which leftover spaces could be identified and their occupation patterns. She cites the lack of boundaries and disorderly look as main features of a leftover space. She also claims that leftover spaces end up misused, underused, or appropriated, with the latter being the most recurring pattern [3, 14].

Residual spaces can also be defined as desolate, wasteful, non-functional urban realms that no longer conform to conventional, aesthetical, or commercial prospects. The interstices between distinct developed enclaves or transition zones inside such regions are the places through which people pass on designed paths or stumble on shortcuts. Unutilized plots may be reserved or identified as restricted zones while other spaces in historic city cores attract people of all ages for various activities. While others may be repulsed by the ugliness and threats they see in such regions, these leftover areas are commonly referred to as residual spaces in planning terminology [15]. In the light of the previous definitions and literature, it could be concluded that residual spaces are the marginal, unused spaces within an urban setting that could be utilized to upgrade the urban space. They can also be described as the 'urban patches' resulting from poorly studied urban planning and design.

The following sections of the research will proceed by first giving more details about the needs of children in the outdoor spaces. Then, they will move to the topic of landscape design elements in residual spaces. Afterward, the research method shall be revealed, followed by a review of international and local case studies. Finally, the research will conclude with the implementation of the methodology and the results.

3. Children's Needs

The child is one of the essential users of the outdoor environment, which directly impacts his or her personality, as shown in (Figure 1), following the global trend toward urban design for a child-friendly approach in urban planning to build successful inclusive cities [16]. Consequently, child-friendly urban spaces are treated as healthy, active, and motivating participatory approaches, where children are allowed freely to play, explore, and socialize in their neighborhoods. In addition, parents are included to feel comfortable because; children are free to walk outside without fear of being injured and constraints of safety levels are available in the playing area. This would occur if streets and the residual spaces allowed people of all backgrounds and ages to participate and communicate through various activities and functions [17]. Since then, the residual spaces have been used as child-oriented outdoor spaces to serve their needs. Thus, a child's needs in the outdoor environment must be considered. It is noteworthy that children use the environment to improve themselves, whereas adults use themselves to establish their surroundings. Paula Lillard has asserted that children do not only live in the surroundings but become a part of them [18, 19], as shown in (Figure 1) the child's interactions in the residual space and nature.

> *"Children use the environment to improve themselves; adults use themselves to improve the environment" also said that "The child does not just live in his environment; it becomes a part of him." – Paula Lillard [7, 8].*

Figure 1. Shows the child's interaction in the residual space and nature (Retrieved from www.handmadecharlotte.com)

There is a direct correlation relationship between the child and the surrounding environment. This relationship helps the child to gain life experiences and acquire values and principles through interactions with the environment [20], by considering their psychological, functional, social, and aesthetic needs [9, 21].

3.1. Psychological Needs

This is represented as a sense of vitality, belonging, and a distinct personality. Therefore, the physical environment must allow the children to contemplate and conclude reasoning within the space designated for them. This will be achieved through the availability of the discovery elements, the need for belonging, the need for love (kindness) and acceptance, the need for security, and the need for play [5].

3.2. Functional Needs

Functional needs provided that the surrounding environment encourages the formation of an ideal society and does not encourage isolation and introversion; consequently, this is accomplished through the availability of playing, sitting, exercising, walking, playing games, eating, drinking, and interacting in the child-friendly space. These spaces approach the functional needs by providing three elements: calmness, lighting, and the appropriate

climate for the child [22].

3.3. Social Needs

Social needs are confirmed through the availability of various social activities, where there are active social interactions in recreational and educational fields and team playing games. Certainly, the participatory approach indicates the involvement of space users through participation in design and implementation and the site's flexibility for development as per the user's need [23].

3.4. Aesthetic Needs

Aesthetic needs are available through the simplicity of forms, visual acceptance, sense of pleasure, and comfort. Besides, ease of space cognition through visual differentiation of colors, texture, and character of the void [10].

4. Landscape Design Elements in Residual Spaces

The following points highlight residual space definitions and the landscape design elements (hardscape, softscape, and water elements).

4.1. What are Residual Spaces?

Residual spaces are the in-between spaces mostly observed in crowded cities (Compact Urban Fabric) as it has a scarcity of voids and designated allocated open spaces. [13] In response to the latter, a call for action is needed to benefit from the remaining in-between spaces to meet the needs of the users and the children in particular [14].

The orientation toward dealing with these residual spaces will help provide innovative and practical solutions to overcome the lack and scarcity of open spaces in different shapes and merge them with the urban fabric. According to Lynch, residual spaces can form a network of interrelated small spaces well distributed within the urban space, more useful than large planned open spaces [24].

Some terminologies are related to residual spaces, classified according to practical use and size [25]. Thus, it can be used as play areas, celebrations, and meetings since the previously mentioned activities were restricted to the city's surrounding streets, central, vital squares, and parks. Therefore, dealing with the interspaces will help relieve pressure on these areas in re-activating these social activities [15].

On the other hand, other contradicting definitions of the residual spaces were defined as informal spaces that lie in inactive spaces and have lower levels of monitoring and controls. Subsequently, they were also called the "lost spaces," undesirable urban areas that need to be redesigned [12, 26]. Unfortunately, it is renamed "loose spaces," "liminal spaces," and "neglected spaces" [11, 27]. They were also defined as uninhabited, unproductive spaces alienated from the urban system, referred to as "Terrain vague" [3]. Other definitions of the remaining interstitial spaces are; "intermediate spaces," "no man's land," and "free zones"[28].

Additionally, it was also known as leftover space. This definition came after the reasons for their initial formation, in terms of the lack of control and maintenance. The same reasons were behind the transformation of some open spaces into remnants. As a result, two scenarios explain the reasons for its formation. First, a space has not gotten its share of the design from governance and authorities throughout urban planning phases; therefore, it does not serve the public. These spaces are usually characterized by disorganized, destructive, and haphazard appearances. Second, a space designed by the authorities has deteriorated and is no longer used or designed in a way that is inappropriate to the actual use and needs. This means the space can start in good condition and become residual over time [14]. The remaining residual spaces can be divided into three types, "spaces non-spaces," "leftover spaces," and "dual-use spaces" [29].

4.2. Elements of Landscape Design

The landscape for outdoor spaces plays an important and effective role for the child, so the design principles and standards for coordinating landscape design must be reviewed and applied to children to ensure the effectiveness of the design and its compatibility with the child. Landscaping can be either attractive or unappreciated due to the way its elements and components are used by a landscape designer; however, a skilled landscaper can easily consider the changes and growth stages of softscape elements and their relationship with the design of hardscape elements, to enhance the beauty of outdoor spaces [30].

One of the research scopes is the study of Landscape design definitions, site components, stages, and the extent to which the design process can be compatible with the nature of the child's needs. The study will present the child's needs as a user of the outdoor and residual spaces. Besides, it will define what child-friendly spaces are and what is represented for the child in terms of psychological aspects, cognitive aspects, and the extent of the child's relationship with the surrounding outdoor space as a user of it. The landscape is defined as the art of arranging and organizing of the elements of the outdoor environment, Softscape, and Hardscape elements to fit each other and with the external environment [31]. Landscape design has also been defined as a scientific and technical field that prepares and equips outdoor spaces, considering the behavior and needs of users. This study will focus on the child as a primary user of outdoor spaces where the child can interact in the outdoor residual open spaces because it

is more defined through the green borders and the landscape elements, as shown in (Figure 2). Landscape elements are classified into three main categories: Softscape elements, Hardscape elements, and water elements [32].

4.2.1. Softscape Elements

Softscape elements have morphological characteristics in terms of the element, whether it is a wooden element (i.e., trees, palms, shrubs, etc.) or herbal elements (i.e., creepers, ground covers, green lawns, etc.), and others such as cactuses, flowering bulbs, aquatic and semi-aquatic plants [33]. Each of them affects the interaction of the child with the element. For instance, herbal elements such as ground covers and green lawn areas are the best surfaces for children to play on, reducing the possibility of injury. The wooden elements can be used as boundaries for playing areas and climbing.

Figure 2. Shows the children's interaction in the outdoor spaces through both agriculture and the interaction with nature.

4.2.2. Hardscape Elements

Hardscape elements are the essential elements to form edges for the space. They include sidewalks, paving, fences, walls, pergolas, stairs, slopes, lighting elements, seating elements, signs, banners, umbrellas, trash cans, sculptural elements, gates and others [32]. They also include Streetscape elements, such as vegetation, surface materials, lighting, street furniture, and other elements, which are the same elements of street design [34]. Each has its properties that help better use the residual spaces.

4.2.3. Water Elements

Water elements are considered one of the necessary complementary elements in coordinating the in-between spaces and open spaces for children, whether they are natural elements or artificial elements such as fountains, lakes, waterfalls, etc. Both must be employed and used in a manner that serves the proposed design for the child. Additionally, both elements can link and separate elements between the various activities within the open space. Therefore, the child can interact with it, and accordingly, the water element must be studied from a design and functional point of view to know whether it is fixed, movable, enclosed, or not enclosed [35]. The water element can control the environmental aspects in terms of climate control, adjusting the temperature and reducing the intensity of acoustic pollution. In terms of safety, if the children are in direct contact with the water element, safe access must be applied by controlling the water element's depth to avoid drowning or slipping inside.

5. Research Method

After identifying the children's needs in outdoor spaces and residual spaces and knowing the different definitions of residual spaces and the elements of landscape through previous literature reviews, there is a proposed methodology to have an evaluation matrix, as shown in (Figure 3), which can be proposed to be used as an evaluation tool for the projects designed for the children, especially in residual spaces. This matrix will help understand the child's needs in designing residual spaces by identifying the relationships between each need concerning each landscape element and each component of residual spaces. The latter relationships are concluded from the literature reviews and the observations, documentation, and analysis of one international case study and another one local of the child-oriented residual spaces. Therefore, urban designers and landscapes can use the results to upgrade the urban space.

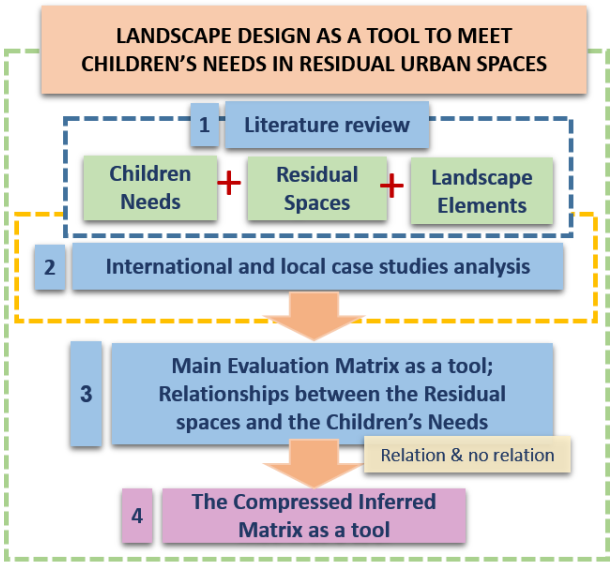


Figure 3. Shows the proposed methodology to have the evaluation matrix

6. Case Studies

Two case studies were selected: an international case study and a local case study, provided that each case study is child-oriented and meets the criteria for designing the residual space. Certainly, the requirements and needs of the child within the open space are carefully considered in general and the residual space specifically. Thus, the child will be satisfied with functional, aesthetic, psychological, and social needs. Consequently, both case studies have

diverse activities within child-oriented residual space. In addition, the space has diversity in forms and flexibility, which assists in distributing activities at the design stage. The chosen residual spaces in case studies must be within the area and scale suitable for the child; from this, the study will be analyzed through the observational and documentation of the residual spaces using the concluded criteria of analysis from the matrix review in terms of the residual spaces' components and the nature of their urban formation. Besides, the study analysis of the user needs to conclude and monitor the resulting interactions' pros and cons in the residual spaces.

The analysis represents design guidelines for the residual spaces in the residential areas that can be developed to meet the needs of the child as a user. Later, this helps identify the nature and components of the residual spaces and the requirements to be considered when dealing with or designing a residual space with the help of the landscape design elements.

6.1. International Case Study: La Forte Ville Toddler Playground

French urban planning and architecture firm Espace Libre has designed a multi-functional residual space, which is located between buildings (i.e., residual space) as shown in (Figure 4), which is designed to be a toddler's playground. It is 7.6 kilometers from Paris's center, completed in 2014, covering 2,500 square meters. The playground was designed to reuse the residual spaces and be a child-oriented space to interact and experiment with the environment through his senses. Besides, it includes features that encourage exploration in which toddlers can develop their creativity and fine motor skills.

It was divided into three parts, as shown in (Figure 5), a raised area for adults, a central space for children, and a plot area. The site's topography was designed on several levels (distinctive stairs in red, slopes, voids, etc.).

This was done using multiple color indication elements, such as red, yellowish-white, blue, yellow, and green, as well as various textures such as soft, medium, and rough. Also, spaces were interconnected using softscape elements, such as trees, shrubs, groundcovers, and climbers... Thus, the latter will allow the child to integrate and interact through a stimulating and appropriate environment.

Figure 4. Site layout of Forte Ville Toddler Playground, France

Figure 5. The playground is divided into three parts.

6.1.1. Functional Needs

The Seating areas and their relationship with the outdoor space show simplicity in form and comfort in dealing with the landscape elements (Figure 6). Additionally, it allows the parent to censor and monitor their children easily. Besides, safety and recreational factors are realized through red rubber materials, since hot colors such as red indicate the slopes and ramps, inclinations, and main walkways to attract the child's attention and ease of cognition to provide safety for them (Figure 7).

Figure 6. The seating areas and their relationship with the outdoor space

Figure 7. The use of rubber materials for safety and borders

6.1.2. Psychological Needs

The tangible human space has a free form, which clarifies its function, in addition to the use of color and diversity in materials. The design also facilitates playing in groups and interaction with the outdoor space (Figure 8). Additionally, there is a balance between green areas and other activities zones, as shown in (Figure 9).

Figure 8. Playing in groups and interaction with the outdoor spaces.

Figure 9. The balance between green areas and other activities zones

6.1.3. Aesthetical Needs

The distinctive distribution of spaces and a sense of recreational character were free forms. The proportions of the form of the garden are appropriate to the scale of the child. Also, visual cues for the elements of the landscape and the presence of green areas around the playing areas provide a sense of recreation through the element of color, either through a green color, which refers to plants, or through the paths of movement and the simplicity of free form, as shown in (Figure 10). Additionally, it provides visual correspondences between the elements of the landscape and its relationship with the child and the degree of his interaction with it, concerning the usage of hot colors (i.e., red) to attract the child's attention.

Figure 10. Freeform design by using distinct colors and green areas around the playing areas

6.1.4. Social Needs

Creative activity fields are available, where drawing is done through the help of landscape elements; the walkway texture changes to a black chalkboard to allow drawing and coloring activities (Figure 11).

In order to provide recreational areas and group playing areas within the space, the efficient use of materials and colors suitable for a child's cognition was essential in this case study, and the form of space with clear edges and tangible scale (Figure 12). Besides, the flexibility factor of the site for the development and facilitation of redistributing activities and games was applied through participatory approach.

Figure 11. Using a chalkboard in the landscape enhances social interaction in group activities and elevates children's drawing skills.

Figure 12. Easy to play in groups

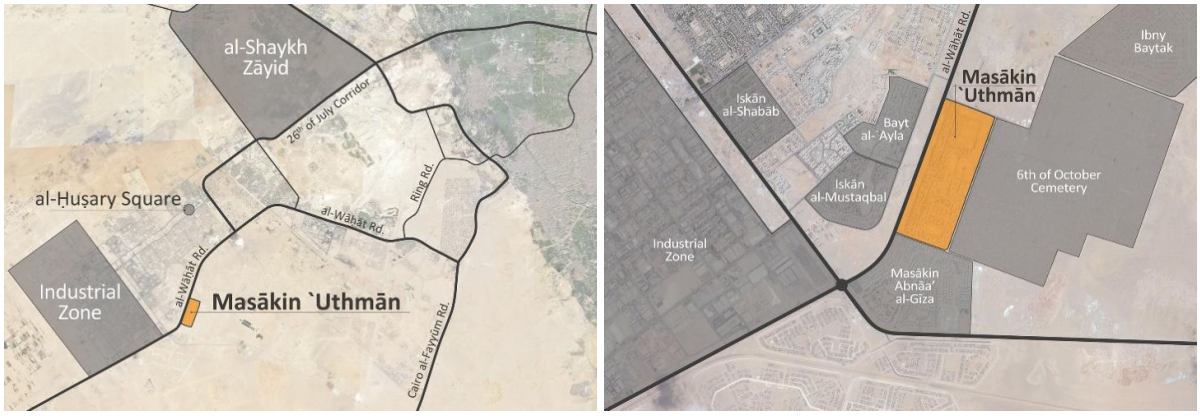


Figure 13. The site location of El Geneina project.

6.2. Local Case Study: Geneina Project in Masaken Osman (Takween Integration)

El Geneina Project is a residual space for children to gather and play in Masaken Othman, 6th of October City, Egypt (Figure 13), El Geneina, in partnership with the Training/Solidarity Office. It is a central public area for play and gathering, designed for children and residents in Masaken Othman, 6th of October City. The project was funded by the United Nations High Commissioner for Refugees UNHCR and partnered with the Sixth of October City administration.

El Geneina project aims to contribute to social cohesion and integration among region residents and children with diverse backgrounds. It supports social acceptance between Egyptian families from diverse backgrounds and Syrian and Sudanese refugees. This should be through the participation of users, including children and families, in the planning, design, and implementation of the El Geneina project in the residual spaces. The set goal of the project was to fulfill the needs of the child and assist in building an inclusive development process to create an accessible public space for all residents. The project responds to one of the important needs identified by the United Nations High Commissioner for Refugees (UNHCR) in Masaken Othman, where there is a need for safety and friendly public residual open spaces for children. In addition, it should be suitable for the child's needs and requirements of play in different age stages. Thus, it includes basic recreational activities and allows mothers and young girls to gather and socialize.

El Geneina creates a safe and friendly public open space within Othman Residence by providing benches, paving, plants, and playing elements in an empty, unoccupied plot in the public service center. The project's participatory approach will allow users to contribute and participate in discussing the project's idea. The concept was how to make a design that meets the user's needs, as this was done by making some recreational shows directed to children to help them indirectly imagine and understand the distinct cultures through the work of Puppet Theater and performance.

6.2.1. Functional Needs

The space was divided to support various activities, such as sitting, playing, running, and artistic performances through an open theater (Figure 14). In addition, the gathering places and paved borders were made to provide an element of safety and ease of movement (Figure 15).

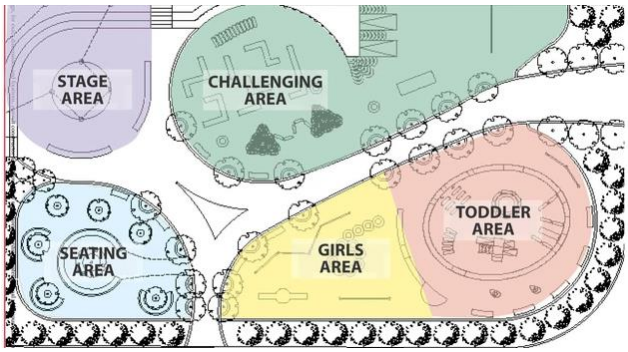


Figure 14. Conceptual zoning showing the free form of El Geneina.

Figure 15. Sharing the idea with the users and their families in the outdoor seating

6.2.2. Psychological Needs

A sense of safety is available where the space is surrounded and defined (Figure 16). Also, the residual space is designed to have various places for play and gatherings through the organic design and the free form (Figure 17).

Figure 16. Show borders of the residual space and a design with an organic and free form

Figure 17. Spaces of Play, gathering areas, and reuse of tires.

6.2.3. Social Needs

The possibility of playing in groups through the free form design of the residual space is shown in (Figure 14). Flexible design in which tires were reused for the Children to play in groups are shown in (Figure 18).The children and the residents participated in the design phase through a participatory design, using a small model to explain and imagine. Fortunately, this was done by conducting workshops, meetings, and seminars with the users (Figure 19), where the project was divided into four areas. These areas are stated as follows: a space for girls and young boys, a play area for challenge and energy directed to older children, a covered theater, and a seating area away from the disturbance area for parents to censor their children.

Figure 18. Playing in groups and reusing tires.

Figure 19. Workshops stages and model results

6.2.4. Aesthetical Needs

The simplicity of the free form of the residual space (El-Geneina) is appropriate to the nature of the child, and the target user is using distinct colors (Figure 20). The principle of using recycling materials, tires, and coloring them was also used to help enhance the aesthetical factor of the residual space and sharing the ideas with the children using models (Figure 21) as well as it creates diversity in forms and activity types to define the residual space.

Figure 20. Define the residual space using distinct colors.

Figure 21. Reuse tires and other recycling materials to make different activities and share ideas with children using models.

7. Evaluation Matrix as a tool: Relationships between Residual Spaces and Children's Needs

According to the literature review and case study analysis, an evaluation matrix is proposed for defining the relationships between the two axes of the matrix, including the existence of a relationship and the absence of a relationship where the overlaps and relationships between the residual space and the child as a user of this residual space are extracted. Thus, it is used as a tool to help in evaluating the quality of projects and the residual spaces which are designed for the children, and how its success in providing the child's needs in them, which helps the designer in deciding on the process of landscape design for residual spaces which are oriented to the children. The matrix includes, on the horizontal axis needs of the child in the residual spaces (functional needs, social needs, psychological and aesthetic needs) and the characteristics of each of them. In contrast, the vertical axis reviews the coordination of the landscape elements of the residual spaces and their components, which are classified into (the dynamics of the space, the importance of the space, the morphological classification of spaces, the urban characteristics, the location and composition of the space, the components of the space), and the characteristics of each of them as shown in (Figure 22).

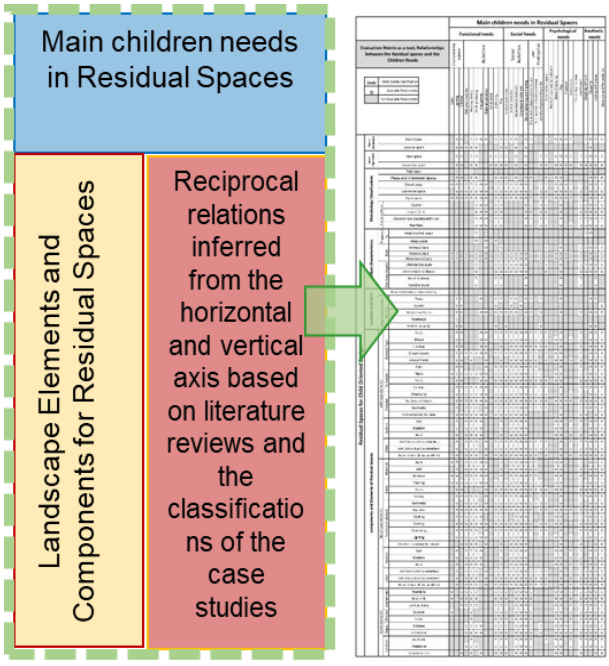


Figure 22. Vertical and Horizontal axes of the evaluation matrix

7.1. Vertical Axis

According to the literature review, the elements of the vertical axis of the study of the residual space can be classified in terms of the dynamics of the space (i.e., static and dynamic), the importance of the space (i.e., major and secondary), the morphological classification of the spaces (i.e., walkways, in-between spaces, enclosed spaces, interconnected space, open space, and the geometrical form of the space), the urban characteristics of the space (i.e., ratios, the scale of the space, and the degree of space

containment), the location and composition of the space (i.e., natural space surrounding the city or urban space within the city) (Table 1), and space components (i.e., softscape elements, hardscape elements, and water elements), as shown in (Table 2).

7.2. Horizontal Axis

Based on the literature review, the horizontal axis reviews the children's needs within the residual space of the following categories: functional needs (i.e., Needs for the appropriate environment and activities), social needs (i.e., social activities and user participation), psychological needs and aesthetic needs and identifying the requirements of each need separately, as shown in (Table 1 & Table 2).

Table 1. The evaluation matrix as a tool; shows relations availability between children's needs and Landscape elements and components in Residual spaces (part 1).

Code	Relationship classification
O	Available Relationship
	Non-Available Relationship

Landscape Elements and components for residual spaces			Main children needs in Residual Spaces: Functional needs: Environmental aspects: Calm	Lighting	Climate
Space Dynamics	Static Space			O	O
	Dynamic Space			O	O
Space Importance	Main space			O	O
	Secondary space			O	O
Morphology Classification	Path ways			O	O
	Plazas and In-Between Spaces			O	O
	Closed space		O	O	O
	Connected space			O	O
	Open space		O	O	O
	Geometric Form	Square			
		organic form			
		Geometrical Combined Forms			
		free form			
Urban Characteristics	Proportions	longitutudinal space			
		Deep space			
	Scale	Intimate Scale			
		Humane Scale	O	O	O
		Monumental Scale	O	O	O
	Enclosure degree	Ultimate Enclosure			
		Intermediate Enclosure			
		Weak Enclosure			
		Non-Enclosure			
Location and Form	Urban Extension arround the city				
	Urban Space within the City	Plazas		O	O
		squares		O	O
		Recretional Parks		O	O
		Roadways		O	
		Pedestrian walks		O	O

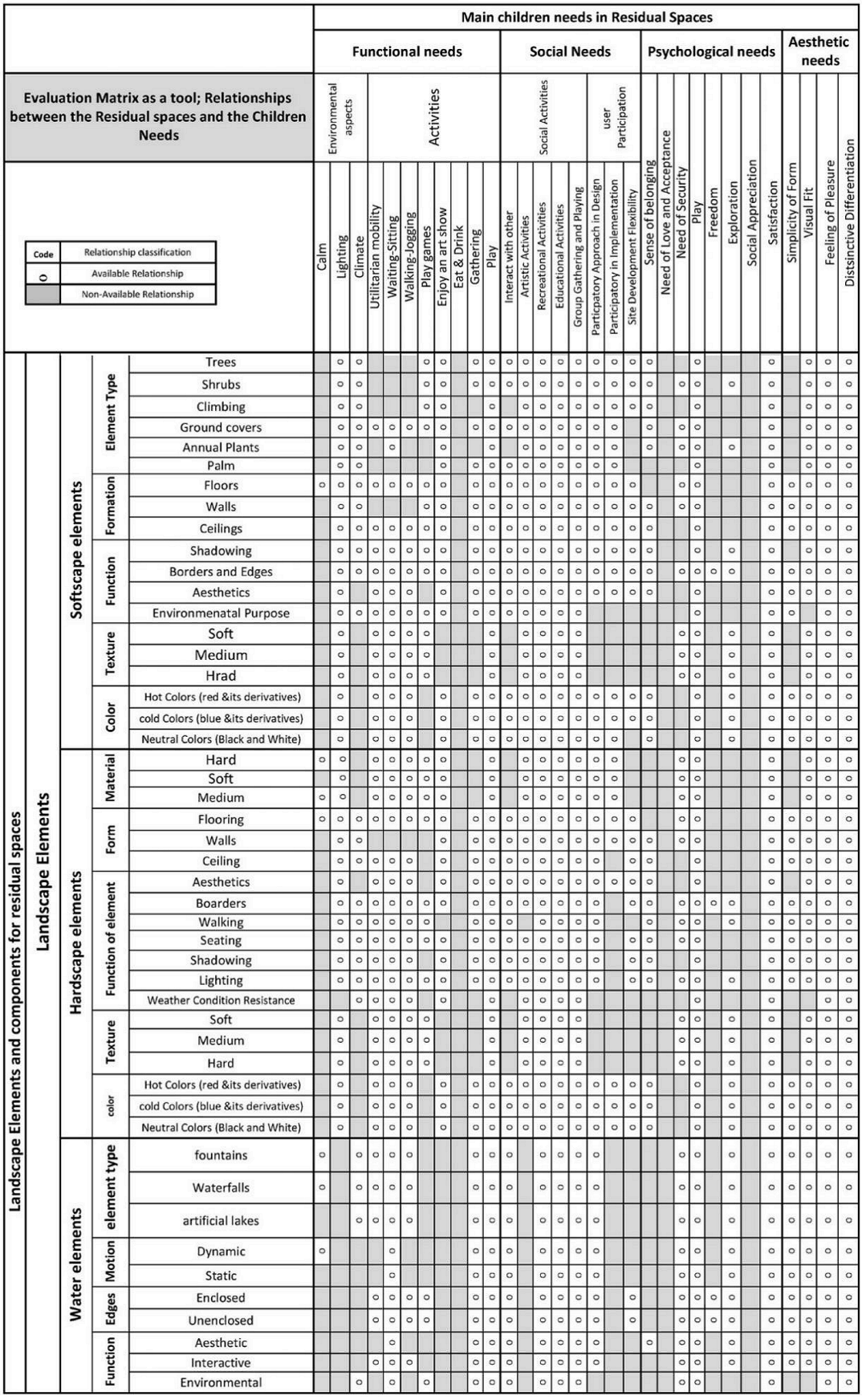
Main children needs in Residual Spaces: Functional needs: Activities	Utilitarian mobility	Waiting-Sitting	Walking-Jogging	Play games	Enjoy an art show	Eat & Drink	Gathering	Play
Static Space		O	O	O	O		O	O
Dynamic Space	O	O	O					
Main space		O	O			O	O	O
Secondary space		O	O			O	O	O
Path ways	O	O						
Plazas and In-Between Spaces		O	O				O	O
Closed space	O	O	O	O	O		O	O
Connected space		O	O	O	O		O	O
Open space	O	O	O	O	O		O	O
Square			O	O	O		O	O
organic form			O	O	O		O	O
Geometrical Combined Forms			O	O	O		O	O
free form			O	O	O		O	O
longitutudinal space			O					
Deep space			O		O		O	
Intimate Scale					O			O
Humane Scale	O		O		O		O	O
Monumental Scale	O		O		O		O	O
Ultimate Enclosure			O				O	O
Intermediate Enclosure			O				O	O
Weak Enclosure			O				O	O
Non-Enclosure			O				O	O
Plazas				O			O	O
squares							O	
Recretional Parks				O	O		O	O
Roadways								
Pedestrian walks							O	O

Main children needs in Residual Spaces: Social Needs: Social Activities	Interact with other	Artistic Activities	Recreational Activities	Educational Activities	Group Gathering and Playing	user Participation	Participatory Approach in Design	Participatory in Implementation	Site Development Flexibility
Static Space	O		O		O		O		
Dynamic Space	O		O		O				
Main space	O		O		O				O
Secondary space	O		O		O				O
Path ways									
Plazas and In-Between Spaces	O				O		O		
Closed space	O	O	O	O	O		O		O
Connected space	O	O	O	O	O		O		O
Open space	O	O	O	O	O		O		O
Square					O		O		O
organic form					O		O		O
Geometrical Combined Forms					O		O		O
free form					O		O		O
longitutudinal space									
Deep space									
Intimate Scale									
Humane Scale	O	O	O	O	O		O		O
Monumental Scale	O	O	O	O	O		O		O
Ultimate Enclosure	O	O	O	O	O				
Intermediate Enclosure	O	O	O	O	O				
Weak Enclosure					O				
Non-Enclosure					O				
Plazas		O	O		O		O		O
squares		O		O					
Recretional Parks	O	O	O		O		O		O
Roadways									
Pedestrian walks	O								O

Main children needs in Residual Spaces: Psychological needs	Sense of belonging	Need of Love and Acceptance	Need of Security	Play	Freedom	Exploration	Social Appreciation	Satisfaction
Static Space	O		O	O	O	O		
Dynamic Space								
Main space	O		O	O	O	O		O
Secondary space	O		O	O	O	O		O
Path ways					O			
Plazas and In-Between Spaces	O		O	O				
Closed space	O		O	O	O	O		O
Connected space	O		O	O	O	O		O
Open space	O		O	O	O	O		O
Square	O			O				O
organic form	O			O				O
Geometrical Combined Forms	O			O				O
free form	O			O		O		O
longitutudinal space								
Deep space								
Intimate Scale	O			O				O
Humane Scale	O		O	O	O	O		O
Monumental Scale	O		O	O	O	O		O
Ultimate Enclosure	O			O				O
Intermediate Enclosure	O			O				O
Weak Enclosure				O				O
Non-Enclosure				O				O
Plazas				O				
squares								
Recretional Parks				O				O
Roadways								
Pedestrian walks								

Main children needs in Residual Spaces: Aesthetic needs	Simplicity of Form	Visual Fit	Feeling of Pleasure	Distsinctive Differentiation
Static Space	O	O	O	O
Dynamic Space		O		
Main space	O	O	O	O
Secondary space	O	O	O	O
Path ways		O		
Plazas and In-Between Spaces		O	O	O
Closed space		O	O	O
Connected space		O	O	O
Open space		O	O	O
Square	O	O	O	O
organic form	O	O	O	O
Geometrical Combined Forms	O	O	O	O
free form	O	O	O	O
longitutudinal space	O	O		
Deep space				
Intimate Scale	O	O	O	O
Humane Scale		O	O	O
Monumental Scale		O		O
Ultimate Enclosure	O	O	O	O
Intermediate Enclosure	O	O	O	O
Weak Enclosure			O	
Non-Enclosure			O	
Plazas		O	O	
squares				O
Recretional Parks		O	O	O
Roadways				
Pedestrian walks		O	O	

Table 2. The evaluation matrix as a tool; shows relations availability between children's needs and Landscape elements and components in Residual spaces (part 2).



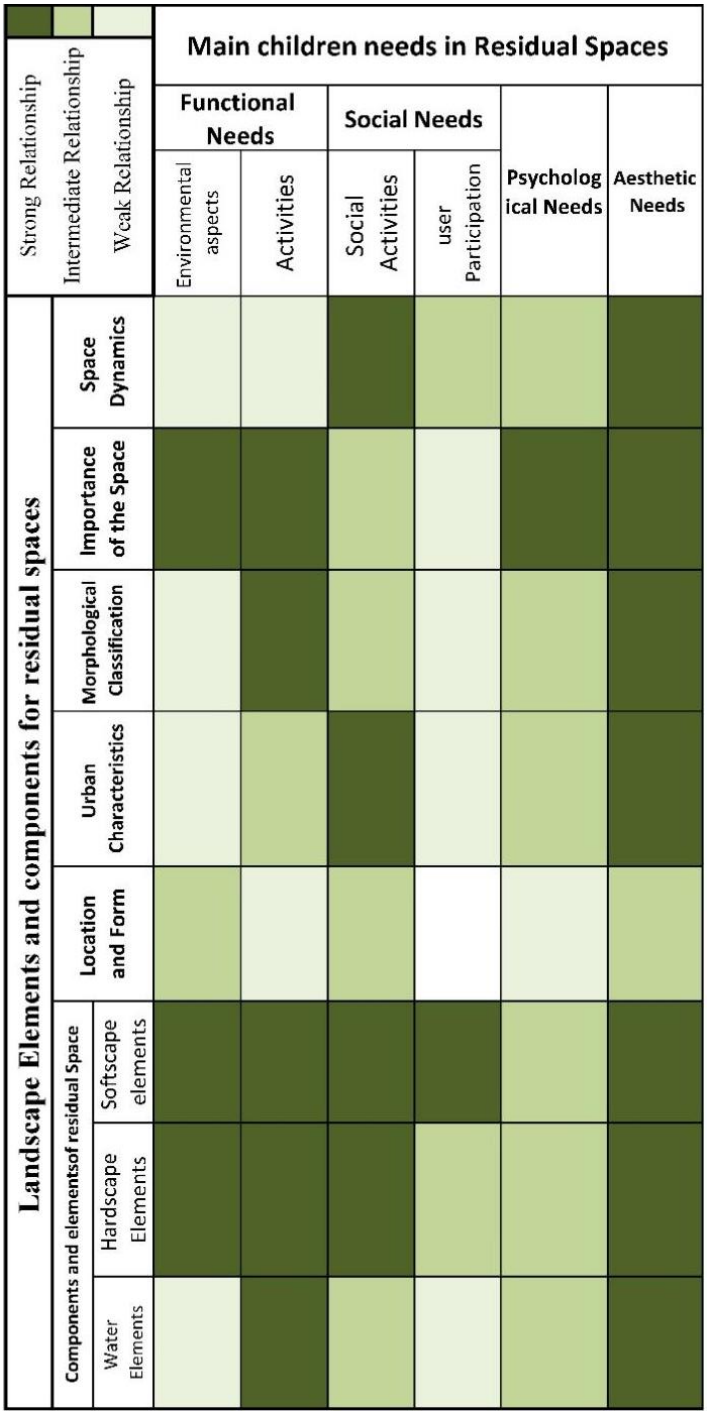
7.3. Inferred Interrelationships

Finding the interrelationships between the vertical and horizontal axes and identifying the existence of a relationship from the absence of a relationship, is achieved by identifying each of the elements present in the horizontal and vertical axes, and through previous readings and studies (literature reviews) and exposure to analysis of international and local projects for children, as shown in (Table 1 & Table 2).

8. Results (Summary of the Matrix)

The matrix will introduce the most important relationships, in general, that must be available in successful projects, and the strength of the interrelationships is shown in the following colors: dark green (shows the important and necessary relationships), the medium green (shows medium relationships), and light green (shows weak relationships) as shown in (Table 3).

Table 3. The matrix is inferred from the main matrix as an evaluation tool.



8.1. Matrix Application for the International Case Study

Through the case study analysis, the relationship between the elements on the horizontal axis and alternate vertical axis is discussed in terms of the relationship strength of each comparison element. Findings refer to a strong relationship between the special needs of the child and some elements in the residual spaces. The analysis was resolute that there is a medium relationship closer to a weak one, and there is no relationship, as shown in (Table 4).

Findings indicate that softscape elements from trees and natural elements would help achieve the main purpose of recreational gardens and meet child's needs, where the children can interact to develop their perception and senses. In addition, there is a need to add hardscape elements, such as shading elements, as they help in achieving functional needs, aesthetic needs, and psychological needs of the child.

There is a weak relationship between the location and composition of the residual space on the vertical axis with the functional needs on the horizontal one. The reliance on the use of the color element in differentiating between the spaces and activities, while the weakness of providing safety between the places of play, walking, and sitting. Besides that, there is a strong relationship between the aesthetic needs of simplicity formation, visual cues, distinction, and a sense of recreation.

Table 4. Conclusion of the international case study

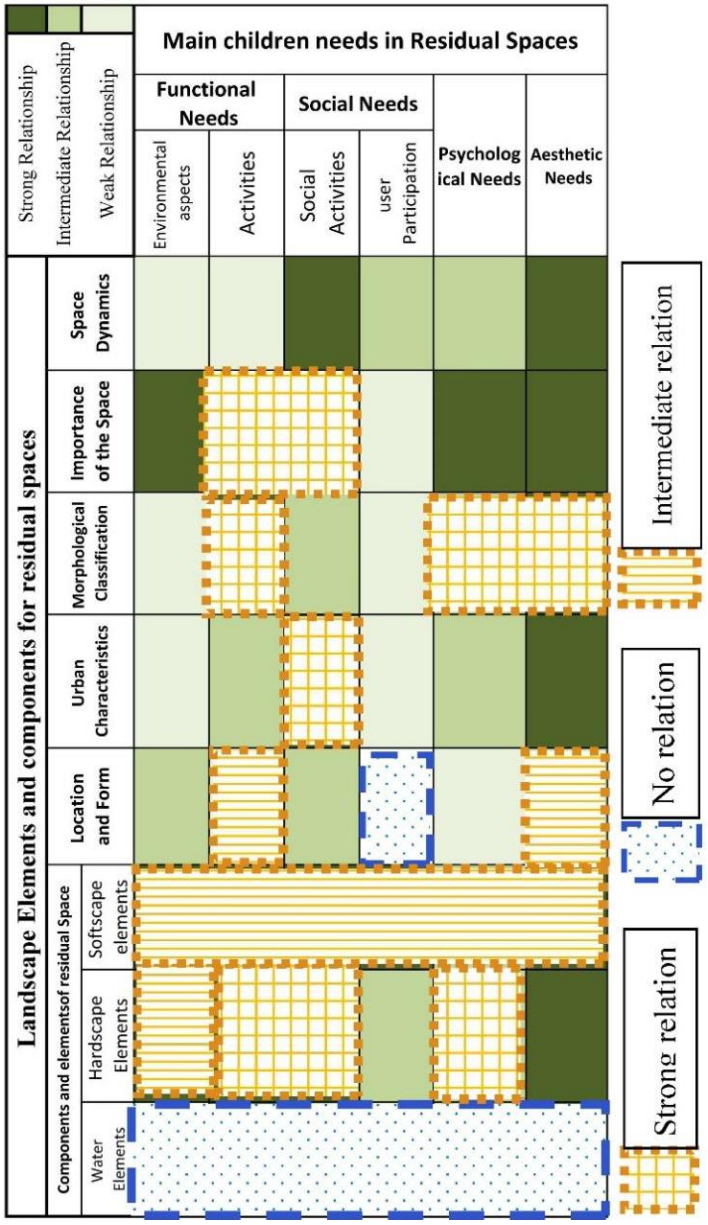
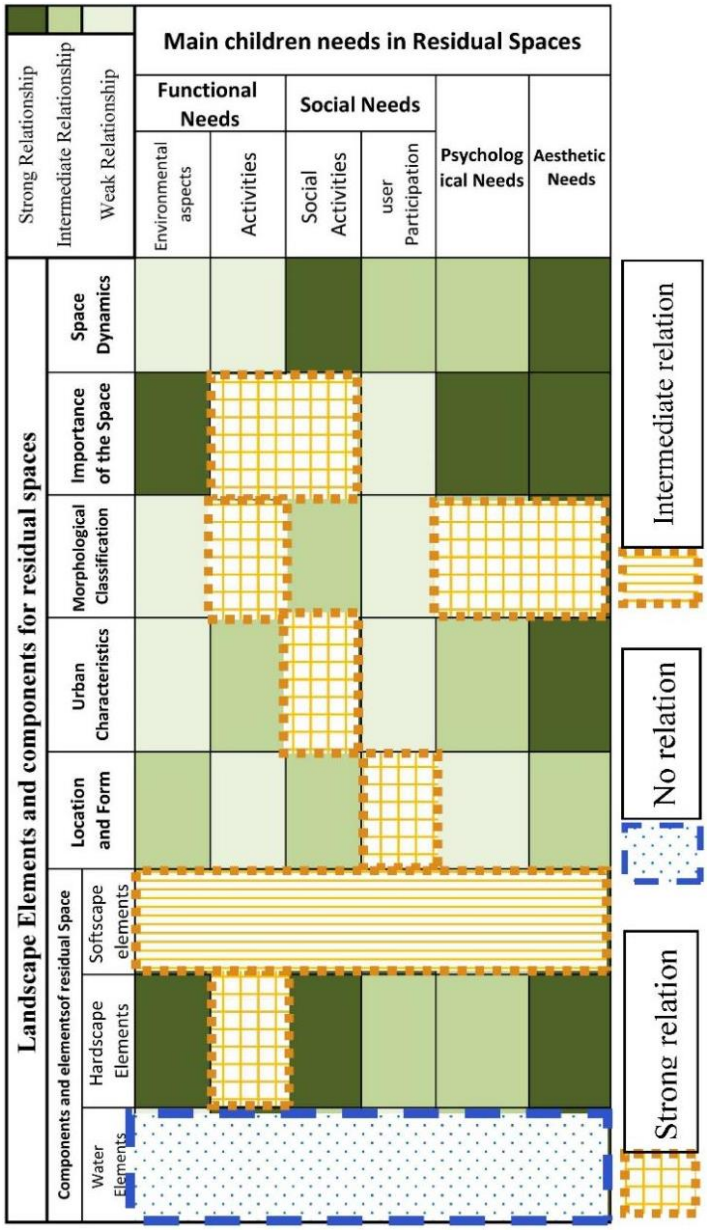


Table 5. Conclusion of the local case study



8.2. Matrix Application for the Local Case Study

Through the previous case study analysis, the relationship between the elements on the horizontal axis and the vertical axis is discussed in terms of the extent to which the element is achieved in the child-oriented design. Thus, findings refer to a strong relationship between the special needs of the child and some special elements in the residual space. Besides, there is a medium relationship closer to a weak one, and there is no relationship, as shown in (Table 5).

Recommendations are directed toward the natural elements from trees and plants to help achieve and provide for the child's psychological, functional, aesthetic, and social needs.

9. Discussion

Based on the analysis of the literature review, the site's landscape was found to have two roles. Firstly, it supports the privacy of the child as a user. Secondly, it assists in meeting children's functional, social, psychological, and aesthetic needs in the residual spaces. The case studies agreed on both roles by compatibility with the functional, social, psychological, and aesthetic needs. At the same time, the case studies differed in the fulfillment degree of the needs. Certainly, the latter needs are related to many factors, the dynamics of space, the importance of the space, the morphological classification, the urban characteristics of the space, the location and composition of the space, and the components. The study presents an evaluation matrix in response to the children's needs and the design guidelines

of the landscape elements in child-oriented residual spaces that link the theoretical literature review, case studies, and the analytical output of interrelated factors. After deducing the matrix of relationships between the children's needs in the residual space and landscape elements and components of residual spaces in (Table 1 & Table 2), it was found that there are important relationships, relationships of medium importance, and weak relationships, as clarified by (Table 3) in the concluding evaluation matrix. The evaluation matrix provided is considered an assessment tool for the child-oriented residual space, which specifies the child's needs to be considered when designing a directed residual open space. It identifies the essential landscape design elements to use in the residual space and convert it into a child-oriented space.

In the light of what has been observed in the evaluation matrix (Table 3), which was concluded from the main matrix (Table 1 and Table 2) and through the color code, signifying the levels of importance of the relationships between landscape components of residual spaces and children needs, a variety of relationships were found. First, in terms of functional needs, both the 'environmental aspects' and 'activities' were found to have a strong relationship with 'importance of space' and the softscape and hardscape elements, while 'activities' alone showed a strong relationship with 'morphological classification' and the water elements. Second, in terms of social needs, social activities were found to have a strong relationship with 'space dynamics', 'urban characteristics, as well as softscape and hardscape elements, while user participation only showed a strong relationship with the softscape elements, which engage the senses of the children with their varied colors and through interactive activities like gardening. Third, psychological needs were found to have a strong relationship with 'importance of space'. Finally, aesthetic needs exhibited a strong relationship with all the landscape components included in the matrix except for 'location and form' with which they have a relationship of medium importance. Otherwise, all the resultant relationships between the landscape components and the children needs vary between medium and weak, with the majority being medium. All of the previous points emphasize the significant role played by landscape elements and components in meeting the needs of children in residual spaces.

10. Conclusions

This study was conducted to investigate residual spaces as a type of outdoor open space in urban areas and how to use them to upgrade the spaces designed for the child concerning his/her needs through landscape design elements, which can be used to serve the community and counter the lack of child-oriented open space. The study provided and identified the children's needs in outdoor spaces generally and residual spaces particularly. Thoroughly, the needs of the child (i.e., natural, social, psychological needs, and aesthetic) are related to each other by logistical and causal interrelationships in positive or negative reflectance. Also, the study contributes with a tool (matrix) that can help to evaluate and develop the residual spaces in residential areas to meet the child's needs as a target user. Also, this tool will help landscape designers to design better and more responsive outdoor spaces for children in the future.

Certainly, the study is proposing a solution using the landscape elements. The study will influence the child's personality and formation in early growth stages in response to the latter. As this study covered the psychological, social, aesthetic, and functional needs of children, future studies could tackle the cognition, behavior, and importance of play for children in order to establish a comprehensive matrix that relates most of the children's related aspects to the landscape elements of open spaces in general. The development of such a matrix would considerably help with the upgrade and improvement of open spaces and residual spaces that address the child.

REFERENCES

[1] Aerts, J., Shaping urbanization for children: A handbook on child-responsive urban planning. 2018: Unicef.

[2] Madanipour, A.J.W.P.S.I.C.S.i.U.D. and Development, Whose public space. 2010. 237.

[3] Khalil, M.H. and D.M. Eissa. Reclaiming Residual Spaces for the Public: a Case Study from the City of Cairo. in Proceedings of the International Conference on cities, people and places-Colombo. 2013.

[4] El Messeidy, R.J.J.o.E.R., Tactical Urbanism as an approach to reuse residual spaces. 2019. 3(December): p. 41-47.

[5] Acar, H.J.P.-S. and B. Sciences, Learning environments for children in outdoor spaces. 2014. 141: p. 846-853.

[6] Azlina, W., A.J.P.-S. Zulkiflee, and B. Sciences, A pilot study: The impact of outdoor play spaces on kindergarten children. 2012. 38: p. 275-283.

[7] Bartlett, S.J.U.a., Putney, VT, Access to outdoor play and its implications for healthy attachments. 1996.

[8] White, R. and V.J.E.C.N. Stoecklin, Children's outdoor play & learning environments: Returning to nature. 1998. 10(2): p. 24-30.

[9] McAndrew, F.T.J.E.S.i.I.C., The psychology, geography, and architecture of horror: How places creep us out. 2020. 4(2): p. 47-62.

[10] Pringle, M.K., The needs of children. 2013: Routledge.

[11] Carmona, M.J.J.o.u.d., Contemporary public space: Critique and classification, part one: Critique. 2010. 15(1): p. 123-148.

[12] Trancik, R., Finding lost space: theories of urban design. 1986: John Wiley & Sons.

[13] Eissa, D., et al., From appropriation to formal intervention: An analytical framework for understanding the appropriation process in residual spaces of Cairo. 2019. 8(2): p. 201-214.

[14] Alanyali, E., Redefining Leftover Space: Value and Potentiality for the City. 2009, VDM Publishing, 3639144953, 9783639144956.

[15] Shukla, D. and R.G.J.C.U. Deshmukh, Need for Conscious Planning: Residual Spaces–A Consequence of the Current Planning Process. 2021. 1(1): p. 23-29.

[16] Nolas, S.M.J.C. and Society, Children's participation, childhood publics and social change: a review. 2015. 29(2): p. 157-167.

[17] AHMED, M.M., et al., Responsive Open Spaces for Children in Residential Communities in Cairo: A Child Participatory Approach.

[18] Day, C. and A. Midbjer, Environment and children. 2007: Routledge.

[19] Kraftl, P., Environment for children: passive lessons from the everyday environment. 2008, Taylor & Francis.

[20] Eames-Sheavly, M., Designing Outdoor Environments for Children: Landscaping Schoolyards, Gardens, and Playgrounds. 2008, JSTOR.

[21] Pol, E.J.M.a.y.c.h., Blueprints for a history of environmental psychology (I): From first birth to American transition. 2006. 7(2): p. 95-113.

[22] Acar, H., Landscape design for children and their environments in urban context. 2013: IntechOpen.

[23] Koohsari, M.J., et al., Public open space, physical activity, urban design and public health: Concepts, methods and research agenda. 2015. 33: p. 75-82.

[24] Lynch, K., City sense and city design: writings and projects of Kevin Lynch. 1995: MIT press.

[25] Armstrong, H. Time, dereliction and beauty: An argument for 'Landscapes of Contempt'. in The Landscape Architect, IFLA Conference Papers. 2006. Citeseer.

[26] Weththasinghe, A. and J.J.C.P.P.A.I.J.o.U.E. Wijesundara, Reclaiming Traffic Influenced Urban Residual Spaces for the Public in Colombo, Sri Lanka. 2017. 2(1).

[27] Franck, K. and Q. Stevens, Loose space: possibility and diversity in urban life. 2006: Routledge.

[28] Groth, J. and E.J.U.s. Corijn, Reclaiming urbanity: Indeterminate spaces, informal actors and urban agenda setting. 2005. 42(3): p. 503-526.

[29] Winterbottom, D.J.P., Residual Space Re-evaluated [Portfolio]. 2000. 13(3).

[30] Farooq, S. and M.A. Kamal, Analysis of Landscape Design and Facilities in National Bank Park at Lahore, Pakistan. 2021.

[31] VanDerZanden, A.M. and S.N. Rodie, Landscape design: theory and application. 2008: Delmar Learning.

[32] Booth, N., Foundations of landscape architecture: integrating form and space using the language of site design. 2011: John Wiley & Sons.

[33] Clouston, B., Landscape design with plants. 2013: Newnes.

[34] Felix, M. and M. Elhefnawi, Landscape design elements as a defensive tool for building security, in Urban and transit planning. 2020, Springer. p. 227-238.

[35] Bahamón, A., Landscape architecture: water features. Vol. 10. 2006: Rockport Publishers.