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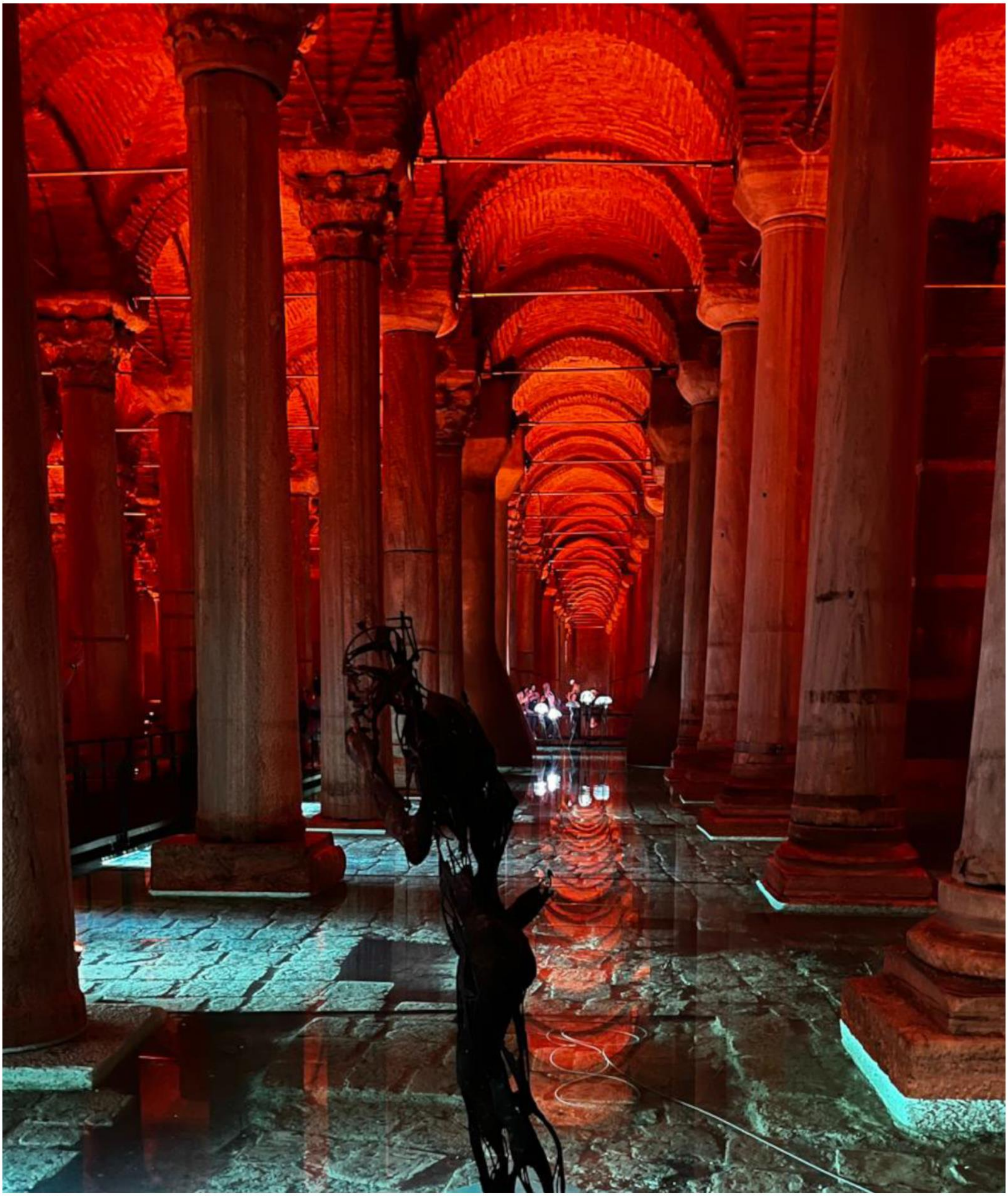

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Developing Dynamic and Flexible Façade Design with Fractal Geometry

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Abstract

The fact that built environments, which are necessary for people to survive by hosting organizations such as shelters, work, and service cannot meet the functional needs over time, creating a problem for investors, owners, and users. The way to deal with these problems is to have a flexible building design to suit the new conditions to change the capacity, function, and performance. The façade, which is highly affected by indoor and physical environmental conditions; should have a modular, similar, adaptable, and detachable system. In this study, façades with these systems are designed with fractal geometry features that mathematically define the complexity, self-similarity, and access to the macro scale from the micro scales. In conclusion, a façade system that can adapt to changes by making use of a fractal pattern and provide daylight and solar control in the interior with the electrical voltage applied to the glass surface has been proposed.

Keywords: *Fractal geometry, dynamic and flexible façade, electrochromic glass, façade design.*

Fraktal Geometri ile Dinamik ve Esnek Cephe Tasarımı Geliştirilmesi

Öz

Barınma, çalışma, servis gibi organizasyonları içinde barındıran ve insanların yaşamlarını sürdürebilmeleri için gerekli olan yapılı çevrelerin zaman içinde fonksiyonel ihtiyaçları karşılayamaması yatırımcılar, mal sahipleri ve kullanıcılar için sorun oluşturmaktadır. Bu sorunlarla başa çıkmanın yolu, kapasiteyi, işlevi ve performansı değiştirmek için yeni koşullara uygun esnek binalar tasarlanmasıdır. Binaların işlevi ile fiziki çevre koşullarından üst düzeyde etkilenen bina elemanı olan cephenin esnek tasarıma sahip olması için modüler, uyarlanabilir, benzer, sökülüp takılabilir özellikte olması gerekmektedir. Bu çalışmada, bu özelliklere sahip cepheler, karmaşıklığı, kendine benzerliği ve mikro ölçeklerden makro ölçeğe erişimi matematiksel olarak tanımlayan fraktal geometri özelliklerinden faydalanarak tasarlanmıştır. Sonuç olarak, cam yüzeye uygulanan elektrik voltajı ile iç mekanda gün ışığı ve güneş kontrolü sağlayan, fraktal desenden faydalanarak değişikliklere uyum sağlayabilen dinamik ve esnek bir cephe sistemi önerilmiştir.

Anahtar kelimeler: *Fraktal geometri, dinamik ve esnek cephe, elektrokromik cam, cephe tasarımı.*

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1. Introduction

The service life and potential obsolescence of buildings cause significant problems for investors, building owners, and users. The usefulness of the buildings weakens due to their inability to meet the needs in the process. The benefits to be obtained from the building, which reaches the end of its service life early, decrease, and economic problems arise due to the need for a new building. For this reason, it is an obstacle for designers to determine minimum performance levels for the life cycle of the building and solve problems arising from future environmental and functional needs. Rather than specifying minimum functional requirements for a particular functional use, it is necessary to set minimum levels of flexibility for buildings with long service life, providing a better way to cope with future changing demands.

For buildings with long service life, it is necessary to define and design the flexibility levels of elements such as structure, façade, service, circulation, and interior. The façade, which separates the exterior from the interior and is the source of the building's natural lighting and natural ventilation, is a critical building element for flexible design, as functional and comfort demands are highly affected. The façade has a long physical life but is only built according to current needs, is difficult to adapt to changes in the building use process. Similarly, façade systems unchangingly constructed with non-transparent and transparent surfaces cannot provide indoor comfort and efficiency against physical environmental conditions that change even during the day. In this direction, similar, addible, modular, and adaptable forms should be integrated with a dynamic system to change the transparent and non-transparent surfaces of the façade.

In a flexible façade, design features can be easily provided by developing an algorithm. Within the scope of the study, additive, modular and adaptive features are created with a dynamic and flexible façade design consisting of similar forms by benefiting from the elements of fractal geometry like similarity, incompleteness, and reaching from the micro scale to the macro scale. Also, a system that can be easily assembled and disassembled, be attached with similar forms, and switch from transparent to coloured for indoor solar control is developed.

The concept of the fractal comes from the Greek "fractus" and means fragment, fragmented, breaking, breaking, fraction, and irregularity. Fractals are defined as clusters with self-similarity between scales, formed by copying small-scale patterns from themselves. Introduced by Benoit Mandelbrot in the 1980s, fractal geometry is a link between the mathematical chaos of nature and Euclidean geometry. Euclidean geometry contains the concepts of certainty and solidity, while fractal geometry includes the concepts of uncertainty and disorder (Mandelbrot, 1982). Fractal geometry is used to define forms that are different from the forms of Euclidean geometry such as circles, squares, and rectangles, and cannot be defined by Euclidean geometry. Fractal geometry mathematically explains the complexity of an object in nature based on the order within that object (Yıldırım, 2018).

In studies that started with Benoit Mandelbrot and developed later, fractal geometry was classified as follows according to the degree of similarity and formation type (Mandelbrot, 1982; Mandelbrot, 1989; Vrdoljak & Miletić, 2019; Upadhayay & Maru, 2021):

Degree of self-similarity

1. Exactly self-similar fractals - Contains full-scale replicas of the entire fractal. Also known as geometric fractals

2. Semi-self-similar fractals - Contains several scaled copies of fractals and several unrelated copies of fractals. Also known as algebraic fractals.

3. Statically self-similar fractals - Do not contain copies of themselves, but some fractal properties remain the same.

Category of formation

1. Iterative fractals - These types of fractals are created after translation, rotation, copying, and replacing elements with duplicates. These fractals are self-similar.

2. Recursive fractals - These types of fractals are described from recursive mathematical formulas. These fractals are semi-self-similar.

3. Random fractals - This type of fractal includes partial properties of iterative fractal and recursive fractal. Clouds, snowflakes, etc. occurrences like these are the best example of random fractals.

The fractals' mathematical history began with the mathematician Karl Weierstrass in 1872, and Weierstrass introduced a "Weierstrass" function, that is perpetual everywhere but nowhere distinguishable. The Weierstrass function was studied by Helge von Koch in 1904. He improved the "Koch Snowflake" function (Figure 1a) that was more geometric description of the Weierstrass function (Lui, Croome & Viljanen, 2012). While Waclaw Sierpinski described self-similar patterns and the functions that produced them in 1915 (Figure 1b), Georg Cantor gave an example of a fractal self-similar (Milad, Akhmet & Fen, 2018). The fractals were further developed by Henri Poincare, Felix Klein, Pierre Fatou, and Gaston Julia in the 19th and early 20th centuries, after in 1975, Mandelbrot brought these studies together and introduced the concept of fractals (Lui et al., 2012).

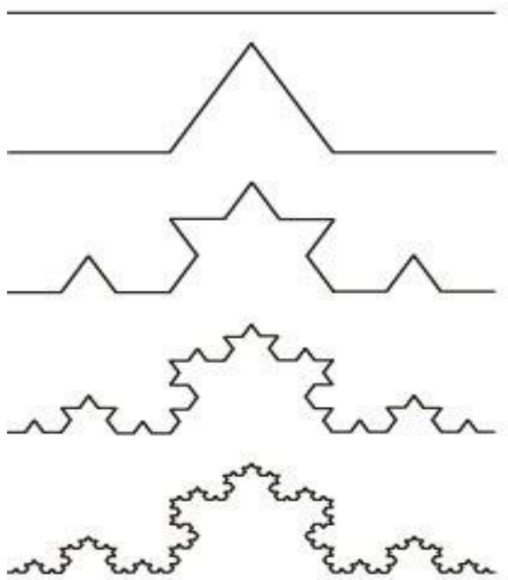


Figure 1a. Koch snowflake (Weisstein, 2022a)

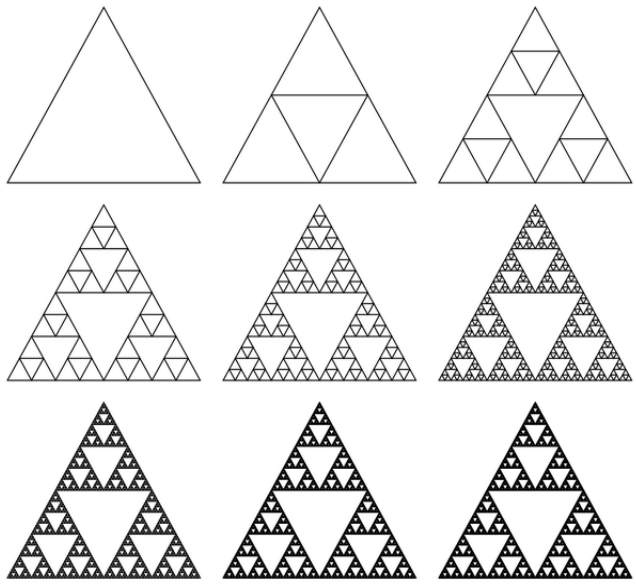


Figure 1b. Sierpinski triangle (Milad et al., 2018)

Benoit Mandelbrot stated that the metric measurement of the coastline is not sufficient in the studies on the measurement of the coastline, and it is wrong to reduce a beach with many shapes to one line. Mandelbrot introduced the concept of fractal by explaining that it is insufficient to represent some forms in nature such as mountains, clouds, and plants with Euclidean geometry (Bovill, 2000). In his studies on a fractal, Mandelbrot explained complex forms consisting of repetitions of similar forms with fractal geometry, based on the Koch Snowflake, which is formed by dividing a straight line into three equal parts, placing an equilateral triangle on the middle part, and the endless repetition of these operations (Ediz, 2003).

Ever-changing fractals have the advantage that they can create a wide variety of forms from a prespecified first structure. Fractals are models of dynamic systems that are improvable and modifiable. Fractal geometry relies on creating a whole from parts, as the emergence of the following step depends on the improvement of the previous one. The whole object is uniquely dissimilar from the first piece (Mayatskaya, Kashina, Gerlein & Yazyev, 2021).

2. Material and Method

Within the scope of the study, dynamic and flexible façade design with electrochromic glasses is proposed by the use of self-similarity as the degree of similarity and the iterative as the formation type of the fractal geometry. It is seen the literature that fractal geometry uses the features of self-similarity, repetition, imperfection, harmony, and the formation of macro forms from micro patterns in architectural design. Accordingly, first, fractal geometry and architectural design were analyzed, electrochromic glasses were detailed and finally, the study method was presented.

2.1. Fractals in Architectural Designs

The fractal dimensions seen in architecture include self-similarity, repetitions, and details that reach the macro scale from the micro-scale. Fractals are also seen in many details from urban design to the formation of a building mass, from building materials, and elements to the smallest elements in the interior. In the past, sub-concepts of fractal geometry were seen in many examples of different architectural processes. Reflection from fractal geometry in nature and repetition of certain forms or patterns were used in architectural designs in different periods, cultures, and geographies. Similar and repetitive patterns at different scales are seen in cathedral and church buildings in Gothic, Renaissance, and Baroque Architecture in Figure 2 (Jencks, 1997). In modern architecture, especially in Frank Lloyd Wright's buildings, in addition to the relationship between scales and inspiration from the forms in nature, complex forms were developed outside of the basic rules, and some structures had the same characteristics from small to whole (Figure 3) (Vaughan & Ostwald, 2011).

Figure 2. Notre Dame Cathedral repetitive rose windows and arches at different scales (Jencks, 1997)

Figure 3. The Robbie House building was designed by Wright: making a whole from identical parts (Vaughan & Ostwald, 2011)

When the existence of fractal geometry in today's architecture is analysed, examples are seen in the formation of holistic forms that come together from similar forms and modules in the design of the structure, shell, and interior elements (Figure 4, 5).

Figure 4. Moshe Safdie - Habitat ’67: Formation of holistic forms from similar forms (Gendall, 2017)

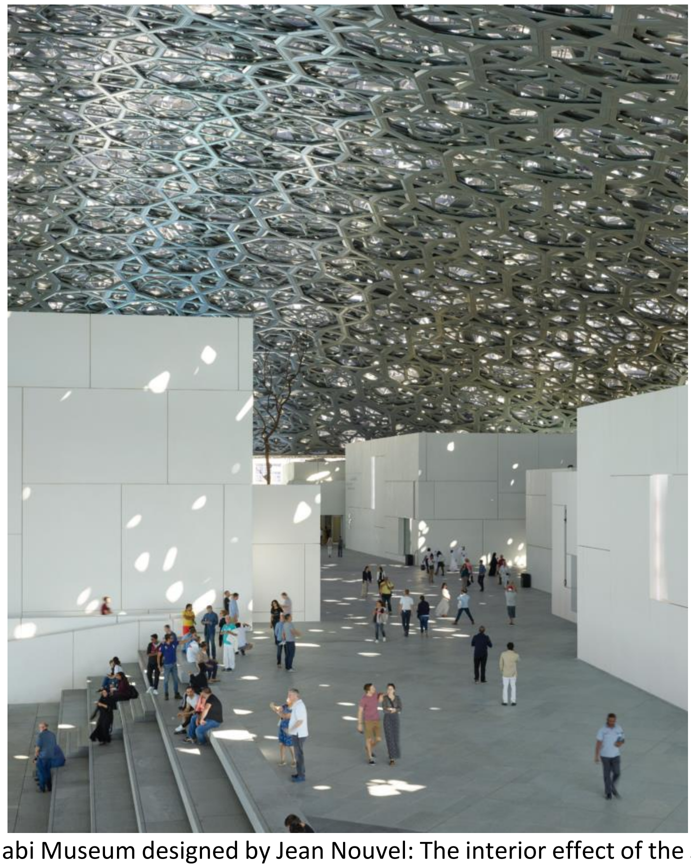


Figure 5. Louvre Abu Dhabi Museum designed by Jean Nouvel: The interior effect of the shell design (Mudhaffar, 2019)

Peter Eisenman designed the House XI project based on Mandelbrot's book “Fractals: Form, Probability, and Dimension” (Figure 6). The concepts of iterative, and self-similarity of fractal geometry were included in Eisenman's design. House XI was a composition formed because of the iterative of the letter "L" shape with rotation and vertical symmetry at different scales. Because, the letter L could scale efficiently many times and create a fractal architecture (Papasterevski & Cenovski, 2020).

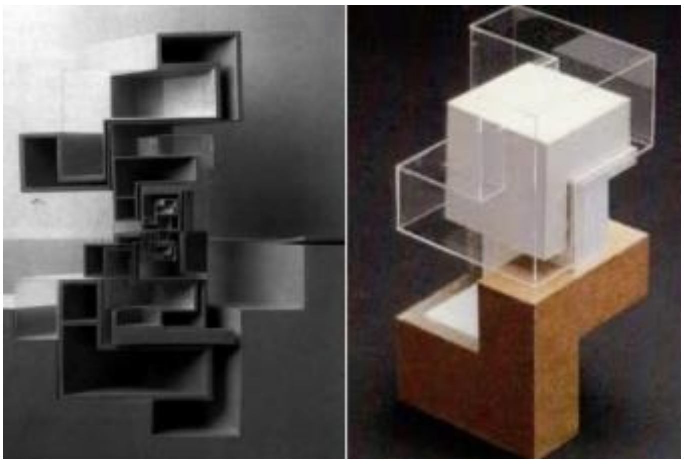


Figure 6. Peter Eisenman House XI: Holistic forms designed from similar parts of different scales (Papasterevski & Cenovski, 2020)

The dormitory building designed by Steven Holl is one of today's structures with fractal characteristics. The Menger Sponge described by Karl Menger was the inspiration for the building form. (Figure-7a). Accordingly, the form started with a cube; it was formed by dividing the cube into equal parts, first 9 and then 27. The hollow structure in the building, where there are gaps of different sizes in a hierarchical arrangement, continued as the scale gets smaller (Mutica, 2016) (Figure 7b).

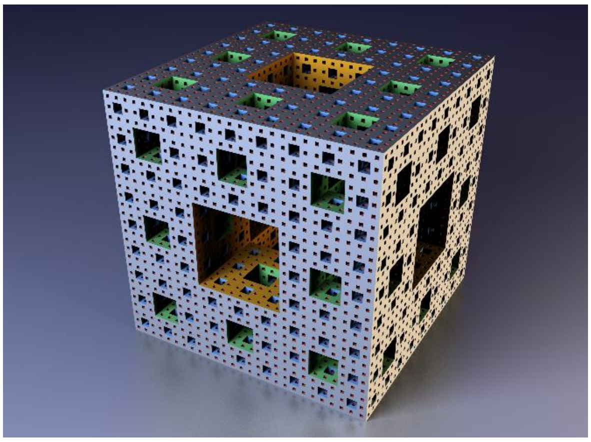


Figure 7a. Menger sponge (Weisstein, 2022b)

Figure 7b. Steven Holl MIT Building (Perez, 2010)

The Federation Square project with public buildings in Melbourne by Lab Architecture Studio; is an impressive example because of the use of fractal geometry in many areas such as interior, structure, and façade. Designers used fractal geometry to create geometric patterns consisting of simple components that allow repetition and differentiation. In the geometric patterns used in the shell structure of the atrium and amphitheater structures (Figure 8), in the facade cladding panels used in the buildings in the square, and in the ceiling coverings in the interior spaces, the smallest triangular form comes together to create holistic and similar forms (Figure 9,10) (Osama, Sherif & Ezzeldin, 2014).

The similar triangular patterns used in the facade panels, structures, and interiors of the Federation Square project designed by Lab Architecture Studio transformed into very different forms and produce solutions in many different areas such as facade, interior, and structure. For these reasons, triangular patterns were the reference for dynamic and flexible facade design from fractal geometry developed within the scope of that study.

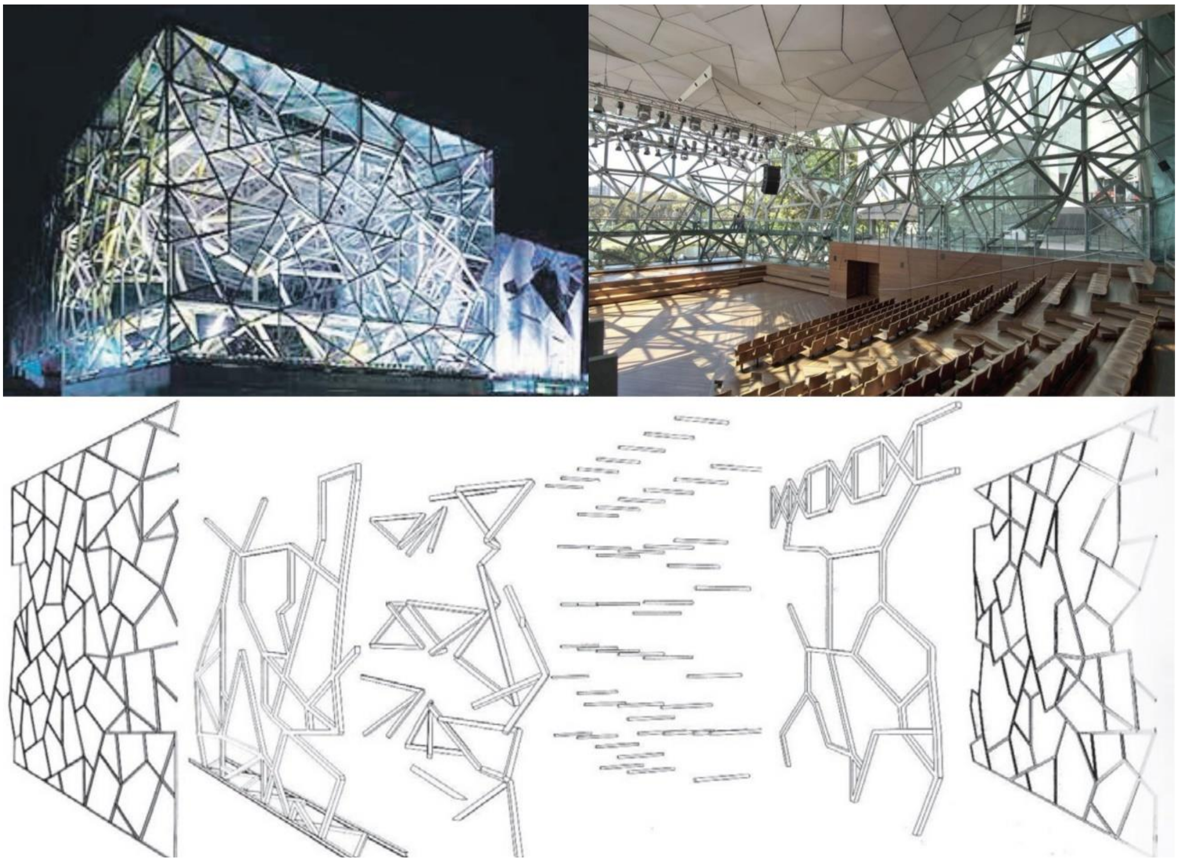


Figure 8. Fractal geometry in the Federation Square shell structure design (Osama et al., 2014)

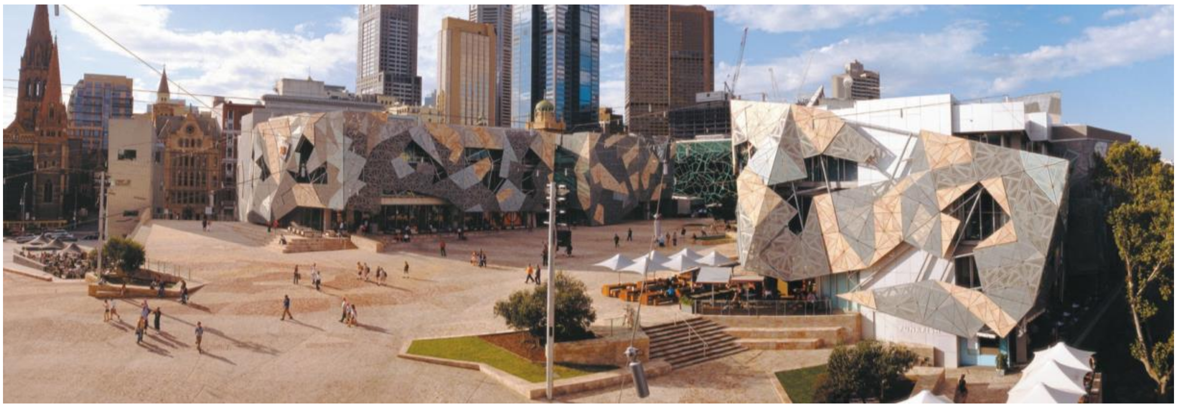


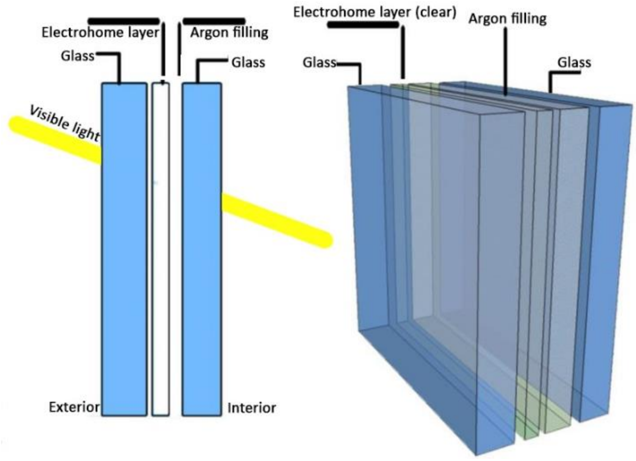
Figure 9. Fractal geometry in the Federation Square façade panel design (Osama et al., 2014)

Figure 10. Federation Square Buildings' interior fractal geometry effect (Osama et al., 2014)

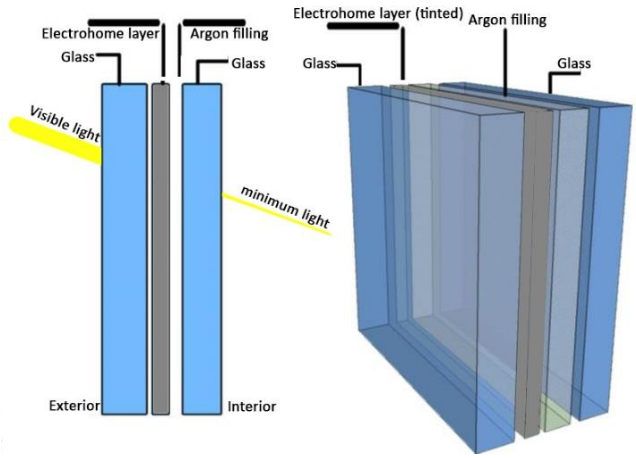
2.2. Electrochromic glasses

Electrochromic glasses are materials that change their colour and/or optical properties activated by the action of electric fields, ions (electric energy), or electrons (Ritter, 2007). Electrochromic glasses utilize a small electrical voltage to adjust the shading coefficient and visible light transmission. After turning off the power, they maintain the same degree of dimming. In this way, it is probable to control the façade' shading also the lighting and temperature of the inside (Savić et al., 2013).

Electrochromic glass takes advantage of the properties of some elements to change the transmission, reflection and absorption parameters of solar radiation according to electrical stimulation. The change of properties of these elements occurs through the addition or removal of mobile ions from the electrochromic layer. When the electric field is activated, the added ions form compounds that change the colour of the material and react with the compounds. The amount of energy required by the system to switch between different coloration states is minimal (1-2.5 Wp/m^2), and the amount of energy required to maintain is even less, thanks to the bistable configuration of electrochromic materials (Casini, 2015). An electrical voltage of 1-5 Volts is applied to the tungsten oxide film layer, which is applied to the glass surfaces as a multi-layer film with a thickness of about 1 micron, and the glass surface is transformed into different colours (Tavil, 2004) (Figure 11).



Transparent electrochromic layer without voltage applied



Coloured electrochromic layer with voltage applied

Figure 11. The method of benefiting from daylight with the energy applied to the electrochromic layer

2.3. Method

The features of fractal geometry that contain similar forms, allow additions and subtractions, be modular, and consist of systematic and harmonious patterns are compatible with dynamic and flexible facade designs. Accordingly, a façade design that can adapt to changing physical conditions and changes in the interior caused by user demands is proposed by developing an algorithm in which a similar whole is formed from the smallest piece with the repetition of similar patterns. The façade, created with fractal geometry and electrochromic glass, is a system that, thanks to its dynamic and flexible formation when any functional transformation is required or new spaces are organized with dimensional changes, protects against unwanted radiation levels, prevents glare, prevents unwanted heat gains on the condition of providing visual comfort inside.

The “1-2- √5” triangle, which is used to create texture areas of the facade and interior with panel elements, and steel structure designs in architectural designs with fractal fiction, is the recommended pattern for flexible and dynamic facade design. The right triangle “1-2-√5” to be used as a fractal facade pattern within the scope of this study is a special triangle, and the five triangles come together to form the larger “1-2-√5” triangle at the same rate. The patterns consisting of five “1-2-√5” triangles can come together to form a similarly larger triangle. These patterns can come together endlessly and turn into forms made up of similar patterns (Figure 12).

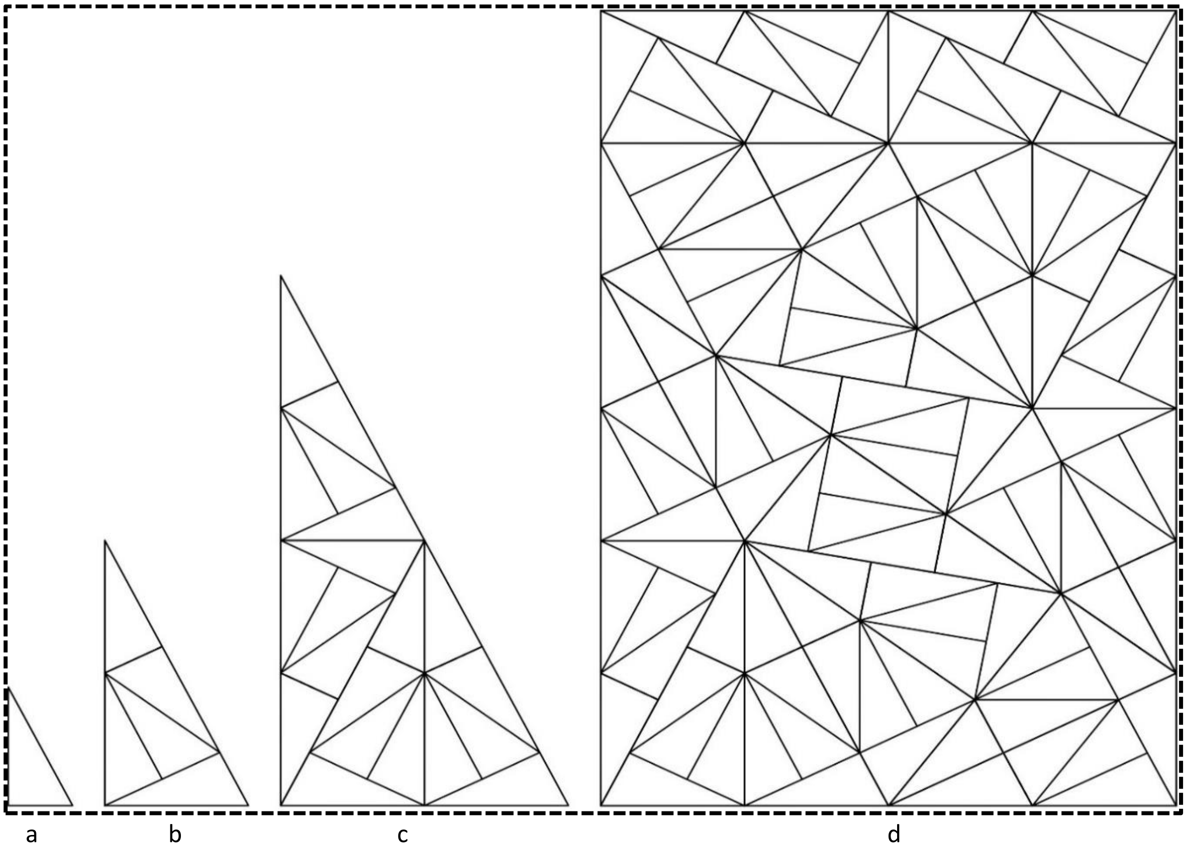


Figure 12. Example façade form created with a 1-2-√5 triangle (a-1-2-√5, b- five triangle, c- twenty triangle, d- example rectangle form)

The shading and visible light transmission on the glass are adjusted by electrochromic glasses utilizing a small electrical voltage. Thus, the glass surface is transformed into different colours. In this study, different voltages are applied to the electrochromic glass to create transparent and non-transparent glass surfaces according to the daylight requirement and solar control in the interior. That system allows changing a similar, modular, addable glass facade form in the interior by fractal geometric design and transforming transparent glasses to be coloured glasses by the electrical voltage.

3. Findings and Discussion

Fractals consisting of natural forms are used in different fields due to their harmony, aesthetic, and efficiency features, including architecture and urbanism. While fractals focus on urban planning and aesthetics in the architectural area, fractal designs are limited functionally and spatially. Since fractals are regular, modular, and can be articulated infinitely, they can also enable flexible design. The study also shows the suitability of fractal geometry for flexible architectural design. However, there are very few studies advocating a flexible design approach with fractal geometry, which allows adaptive and flexible design setup by responding to changing environments and enables to create of changing perspectives in the geometric framework (Belma, & Ayyıldız, 2016; Abdullah & Ismail, 2022; Nakib, 2010). In addition to academic studies, design applications related to fractal geometry in different ways were developed independently with flexibility and discussed under the title of "Fractals in Architectural Designs." In particular, the plan system and building envelope formed by the combination of amorphous and triangular shapes with a fractal pattern in the building designed by Lab Studio, and the building form formed by the repetition and coming together of cubes in the dormitory building designed by Steven Holl have taken their place in the literature (Osame et al., 2014; Mutica, 2016). They are crucial examples that contribute to that study.

Today, where energy conservation is of utmost importance, façade approaches defined as intelligent, kinetic, adaptable, and dynamic have been put forward to improve energy performance and indoor comfort levels (Bande, Hamad, Alqahtani, Alnahdi, Ghunaim, Fikry & Alkhatib, 2022). Dynamic and flexible/adaptable facades are classified as mechanical systems in which various mechanisms are adapted to the facade, hydraulic systems that provide movement on the facade with pistons placed in the cylinder, and pneumatic systems that can move by pumping air and gas under pressure (Harry, 2016; Yaman & Arpacıoğlu, 2021). In addition to these, facade systems are developed with material technologies. Smart glass systems dynamically manage daylight and solar gain by switching between transparent and reflecting modes to control the flow of natural light into buildings. These systems are frequently encountered material technologies and are transformed by an electric current named electrochromic or change under heat-light named photochromic (Jelle, 2013; Yaman & Arpacıoğlu, 2021).

In the study, a dynamic façade system is proposed based on the electrochromic glass that emerges due to flexible, developing material technologies with fractal geometry properties. The flexibility and dynamism advantages of this type of fractal facade:

- Easy formation and assembly due to repeating patterns,
- Changing transparent and non-transparent surfaces according to different needs due to the electrochromic glass,
- Allowing additions in new space requests due to modular, similar, and single materials,
- Transforming into different forms due to similar and iterative patterns,
- Energy efficiency due to reducing the need for cooling by providing solar control for hot climate regions,

can be listed as. The triangle patterns designed by making use of the self-similarity and iterative features of the fractal geometry will meet the adaptation, change, and transformation flexibility needs expected from the façade in the building. The fact that infinite patterns can be obtained by adding and subtracting congruent and similar triangles from triangles has led to the preference for the “1-2-√5” triangle. In the pattern shown in Figure 12, five of the “1-2-√5” triangles representing the smallest element on the façade, came together to form a larger triangle. The five triangle patterns come together to form larger patterns, and patterns consisting of “1-2-√5” triangles turn into a rectangular form.

In this direction, the dynamic and flexible façade design with fractal geometry developed within the scope of the study allows daylight and solar control in the interior, physical environment control, different uses of the spaces, and the change of non-transparent and transparent surfaces. In addition, the glass surfaces in the façade design have an electrochromic feature, and the transparency ratios are changed by applying different voltages to the electrochromic glasses. Thanks to the placement of electrochromic glasses on the façade with fractal design in Figure 13, transparent and non-transparent dynamic facades are presented by changing the colours of the glass surfaces.

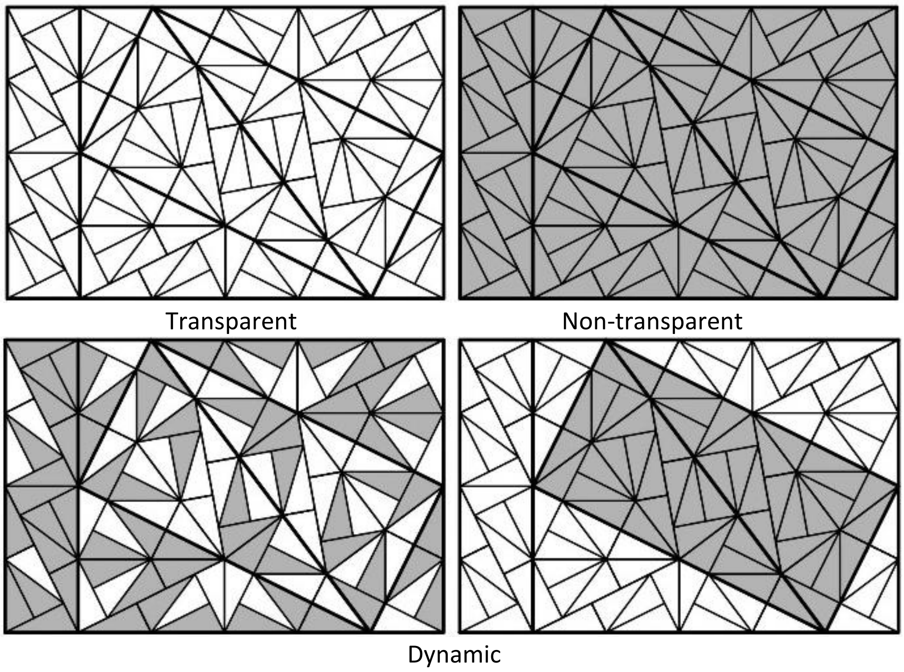


Figure 13. Dynamic façade design

When a voltage of zero is applied to the electrochromic glasses on the cube surfaces in Figure-14, where the glasses formed from similar patterns by taking the smallest scale of the triangle 1-2-√5 form the building envelope, all surfaces become transparent. With the increase in voltage, the permeability of the glass system decreases, and it becomes coloured. In addition, applying different voltages to each of the fractal patterns provides the desired transparent and non-transparent surfaces on the cube surface. As a result, thanks to the dynamic feature of the façade design with all glass surfaces, design flexibility has been achieved, whose transparent and solid surfaces can easily be changed according to the interior needs.

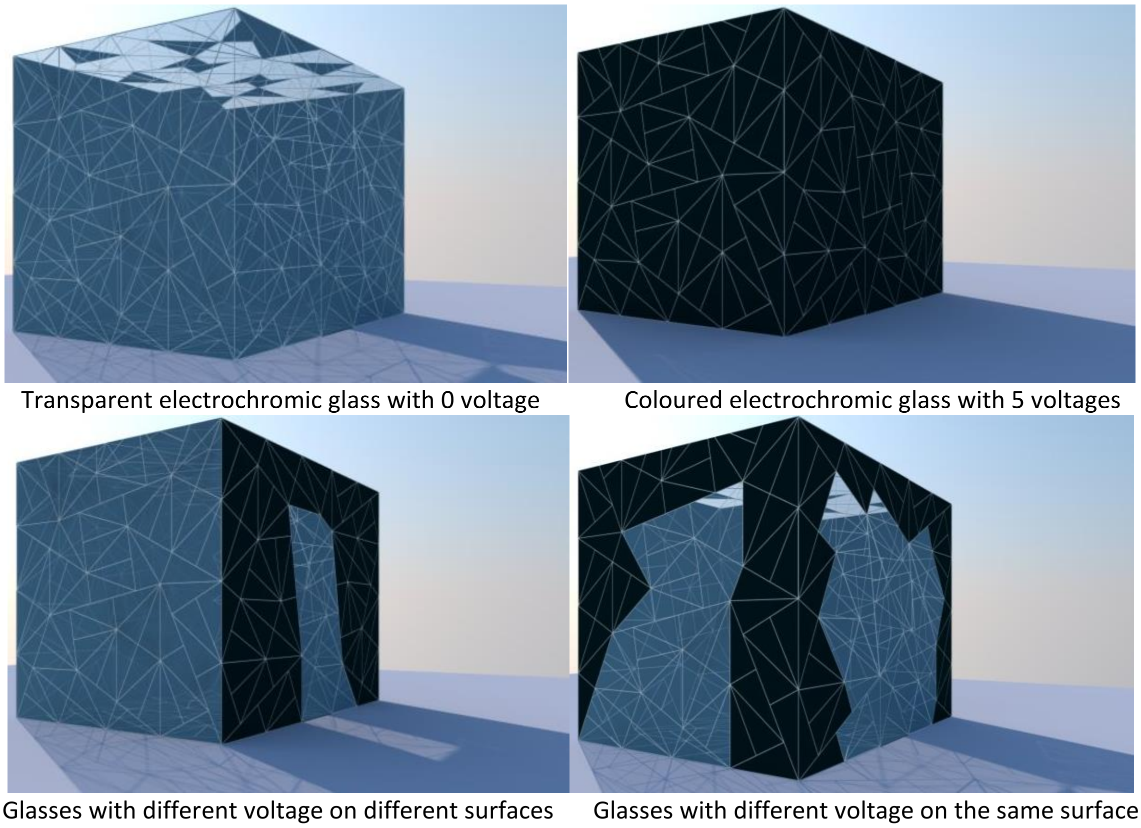


Figure 14. Solid and transparent surfaces were obtained by applying different voltages on cube surfaces with electrochromic glasses

4. Conclusion and Suggestions

The underlying of productive approaches is the understanding that the elements come together with order and rule to form a whole. In architectural design, rule, meaning, and context in the order of the final product from the architectural elements are similar to the productive approach processes. These similarities enable generative approaches to be included in architecture and offer designers new pursuits and solutions with the definition of the productive architectural design approach. Fractal geometry has been used to support a new approach in productive architectural design in recent years. In the process of designing forms and layouts that cannot be defined with Euclidean geometry, iterative algorithms based on fractal geometry provide solutions and conveniences. Although the form consisting of triangular patterns is a suggestion, the main aim study is to raise awareness among the stakeholders in the construction sector that flexible and dynamic designs can be achieved with façade systems created with fractal geometry.

Within the scope of the study, a facade model of flexible design that can easily adapt to environmental conditions and changing needs of users has been developed, based on the characteristics of fractal geometry, which offers new solutions in architecture, self-similarity, iterative, incompleteness, compatibility and the formation of similar large forms from small patterns. In the design developed by creating similar patterns from the 1-2-√5 triangle, a system that can be added with similar patterns can be adapted to different conformations and can be controlled indoors with the electrochromic glass system is proposed. That system prevents unwanted radiation levels, glare, and unwanted heat gains on facade for interior comfort. In conclusion, thanks to the flexible and dynamic facade design applied in buildings with long life cycle and where change is inevitable, built environments with continuous functional service life, economical, efficient, and environmentally effective will be designed.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to this manuscript. There is no conflict of interest.

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Using Fuzzy Logic Based Decision Support Systems for New Function Selection in Structures

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Abstract

These buildings, which function as important documents for the period in which they were built, and which have managed to preserve their original qualities, have been abandoned as a result of various some factors and have lose their functionality. It is very important to continue to use these original structures, which have since lost their functionality, with re-functioning as opposed to a passive conservation approach. Architectural decision support systems, used to create a solution mechanism can assist architects in deciding on the most appropriate function option for building by systematizing the relationship between spatial analysis of the existing building stock and functional expectations. Accordingly, the results were observed by using fuzzy logic method in order to determine the most suitable function option before the design and construction phases for reuse of the building were started.

Keywords: *Refunctioning, adaptation, decision support systems, fuzzy logic.*

Yapılarda Yeni İşlev Seçimi İçin Bulanık Mantık Tabanlı Karar Destek Sistemlerinin Kullanımı

Öz

Yapıldıkları döneme dair önemli bir belge niteliği taşıyan, özgün niteliklerini korumayı başarabilmiş yapılar, kimi faktörler neticesinde terkedilmekte ve işlevlerini yitirmektedir. İşlevini kaybetmiş özgün yapıların, pasif bir koruma anlayışı yerine, yeniden işlevlendirme ile kullanılmaya devam edilmesi oldukça önemlidir. Bu durum, yapıların sürdürülebilirliğinin sağlanmasının yanında ekonomik, ekolojik ve toplumsal faydaları da beraberinde getirmektedir. Yapı için uygun işlev seçeneğinin belirlenebilmesi adına, mevcut yapı stokunun mekânsal analizleri ile fonksiyona dair beklentiler arasındaki ilişkiyi sistematize eden ve tasarımcılara karar vermede yardımcı olan karar destek sistemlerinden faydalanılabilir. Bu sistemlerden, tasarım ve yapım aşamalarına geçilmeden önce, yapının yeniden kullanım amacına yönelik en uygun işlev seçeneğinin belirlenebilmesi için kantitatif bir değer şeklinde sistematik ve rasyonel bir yöntemle sonuç üretmesi beklenir. Bu sonuçların üretilmesi için çalışmada bulanık mantık yöntemi seçilerek sonuçlar gözlemlenmiştir.

Anahtar Kelimeler: *Yeniden işlevlendirme, adaptasyon, karar destek sistemleri, bulanık mantık.*

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1. Introduction

Historical environments refer to the ruins and settlements that have survived from past periods to the present day. These ruins and settlements, which take part in the transmission of such information in the historical process, are of vital importance in ensuring the continuity of culture. A lot of unwritten information about the past periods reaches the present day through structures. The structures in the historical rural settlements, on the other hand, are examples of architecture without architects. These structures are also important because they are a means of transmitting how sustainable architecture should be in terms of criteria, such as materials, construction techniques, plan diagrams, and adaptation to the topography, which have occurred as a result of the experience gained over the years. However, rural settlements are gradually losing population because the people of the region leave these settlements due to some reasons such as economic difficulties encountered in rural areas, security, education, and health; thus, the structures that make up the settlement tissue remain unclaimed over time. In order to maintain the existence of rural dwellings, which are one of the most important elements that constitute the rural fabric and which have become open to external influences because they remain derelict and dysfunctional and are facing the danger of extinction, different conservation approaches have been developed at different periods on the scale of settlement. Investigating the adaptive reuse of the settlement, and if possible reuse of it is one of these conservation approaches. In this context, four different options can be mentioned in order to reuse rural settlements: museumization, tourism, resettlement, and reforestation (Güler, 2016).

Following the identification of the appropriate revitalization and adaptive reuse option for the current settlement, it is inevitable that many of the structures shaped according to the time to which they belong will be loaded with a new function other than their original function. The fact that the structures maintain their economic life with their new function instead of a passive conservation understanding brings with it ecological and social benefits as well as cultural benefits. However, in order to ensure the sustainability of the structures in their original state as much as possible, the existing structure and the spatial requirements of the new function must be adaptable. In reuse, to be able to decide on the function option that will serve the revitalization option at the settlement scale, first of all, it is necessary to conduct spatial and environmental analyzes and, accordingly, the right choice of functions should be realized. A successful design and implementation can only be possible after this step. In the process of changing the function of single historical buildings, the intervention method can be determined by comprehensively analyzing the environmental and architectural features of the structure. But especially on a settlement basis, to be able to determine the adaptability capacity of the existing building stock and possible suitable functions, and to be able to provide decision support for the design and implementation stages, the selection of functions should be carried out systematically and rationally. At this point, support systems for decision makers can be developed for structure transformation by using multi-input models. It is thought that in this kind of multi-input design problem, a model that helps to make the right decision can support architects to decide on the most suitable function option for any structure by making spatial and environmental analyses of existing structures and systematizing the relationship between expectations about function. In particular, a decision support system based on fuzzy logic comes to the fore as a method that can be preferred in such models in cases where the most appropriate one among the adaptation options is evaluated instead of the exact results, such as determining the function.

Based on the above-mentioned considerations, this study, it was aimed to create a fuzzy logic-based decision support system by systematizing the relationship between existing capacity and new functional change demands and to produce decision support in this way.

2. Conceptual Context

In this section of the study, the concepts of “re-functionalization” and “fuzzy logic”, which constitute the subheadings of the research, are discussed in line with the limitations of the research, and general information about reuse and functional adaptation in structures is provided.

2.1. Re-functionalization

When it is aimed to protect an existing structure, various methods can be applied. *Re-functionalization* is one of these methods. It can be expressed as an intervention to extend the life of the structure by adapting it to a need that is different from its function at the first construction time (Yıldırım & Turan, 2012). Structures bearing the traces of the period in which they were built become unable to meet the requirements expected from them over time as a result of changes occurring in the structure and identity of society. Especially about the structures in settlements that have lost their population as a result of various factors, an overall dis-functionalization can be talked about. Structures that are out of function become structurally unusable over time by becoming vulnerable to the corrosive effects of external environmental conditions. Giving a new function to the civil architecture samples, which have the nature of historical documents, by preserving their structural features with certain principles ensures the transfer of memory and culture in addition to providing a significant amount of energy and resource conservation. When the sustainability of the existing structure is aimed at a new function, it is inevitable to experience a change and transformation in the existing space layout with a new program. In this process of change and transformation, which can be defined as adaptation in reuse, the adaptation of the structure in a way that can serve the new function and the preservation of its original identity should be considered in combination. Sustainable adaptation can only be possible in this way. The first step to be taken for this is to select the right function for the structure and perform a successful design and implementation (Aksoya & Aydın, 2015).

The sustainability and habitability of the structure depend on the adaptability of the existing structure to the requirements of the new function. The adaptation of the function to be given to the structure with the old space means that the context and spatial possibilities overlap (Büyükarslan & Güney, 2013; Arpacıoğlu, Çalışkan, Şahin, & Ödevci, 2020; Kutlu & Ergün, 2021,). Therefore, the spatial requirements of the new function should be questioned and its compliance with the structure should be well analyzed. For this, it is relatively easier to perform detailed analysis studies based on a singular structure. However, a preliminary decision support system will inevitably be needed to be able to make decisions for a large number of structures on a settlement basis.

2.2. Fuzzy Logic

Fuzzy logic is a concept that was put forward by the mathematician Zadeh in 1965. Fuzzy logic, which is a rule-based algorithm, also represents uncertainties in contrast to classical logic. This logic type was designed inspired by the human decision-making mechanism in changing environmental conditions. With this feature, it has been used for a long time in many decision-support models in the field of architecture (Baran Ergül, Varol Malkoçoğlu, & Acun Özgünler, 2022). In Fuzzy Logic, the main idea is to be able to generate other probabilities that fall between the values of 0 or 1. In classical logic, the result of a given proposition is either true or false. In fuzzy logic, on the other hand, intermediate values can be generated to represent uncertainties as an addition to the results of "0-1", "there is-there is not", and "yes-no" (Zadeh, 1965). The fuzzy logic system is based on the concept of a set and consists of three basic parts. These parts are as follows:

1. Fuzzification
2. Rule-based inference
3. Defuzzification

In fuzzification, the degrees of membership (membership value) corresponding to the value of the input variables are determined. These degrees help to determine how much an element belongs to that set or not. The function that shows the “degrees of belonging” of the set elements is called the membership function. The start and end values are included in this function. In the function (1) below, X represents the universal definition set, A represents the fuzzy set, x represents the cluster elements, and μ_A represents the membership degrees of the x cluster elements.

$$\mu_A(x): X \rightarrow [0,1] \quad \begin{cases} \mu_A(x) = 0; \text{ the element x is not included in the set A.} \\ \mu_A(x) = 1; \text{ the element x is fully included in the set A.} \\ 0 < \mu_A(x) < 1; \text{ the element x is a part of the set A.} \end{cases} \tag{1}$$

In rule-based inference, verbal rules are determined by experts using the degrees of membership coming from the fuzzification unit, and fuzzy results are obtained. That is, the result of the inference is a fuzzy set.

In defuzzification, in order for these fuzzy sets to make sense in the real world, the obtained fuzzy information is converted into information used in the real world. These operations can be performed through various mathematical operations, such as the center of gravity, weighted average, and center of area methods (Ödük, 2019).

With fuzzy logic, solutions can be produced for complex problems that classical logic cannot solve, and uncertainties that are also inherent in human nature can be represented. Thus, more objective results can be obtained by distinguishing between elements that are members of the same set.

2.3. Reuse and Functional Adaptation in Structures

The ability of unused structures to continue their service with their new function is primarily related to many issues, such as the compatibility of the function to be installed with the spatial layout of the structure (spatial adaptation) and its location in the settlement layout (environmental adaptation) (Aksoya & Aydın, 2015). In this context, it is possible to consider the adaptation of an old structure for the new function under two headings: “spatial functional adaptation" and “environmental functional adaptation”.

2.3.1. Spatial functional adaptation

In re-functionalized buildings, spatial functional adaptation is determined by identifying the spatial requirements and analyzing how the use and purpose of use are affected. Since identifying the spatial requirements related to the function and measuring the adaptation of the existing structure with these requirements will also shape the future of the structure to be re-functionalized, it is very important for the sustainability of its function.

The following criteria determine the functional performance of the space in the structures that are considered to be re-functionalized:

- *Spatial dimension* (the compliance of dimensional characteristics for the intended use of the new function and for users),
- *Circulation/circulation* (compliance of the existing circulation scheme of the structure with the functional relations of the new function),
- *Zoning/communication/workflow* (being able to meet some of the possibilities of the new function, such as service),
- *Flexibility / change* (adaptation of the current state of the structure to the needs of the new function, adaptation of the structure to the current situation, functional adaptation and flexibility of the reinforcement elements)
- Use / specialization (being a harmony between the original function of the structure and its reuse)”

2.3.2. Environmental functional adaptation

The re-functionalized structures continue to exist and are protected if they benefit the environment and the people of the region and if they can respond to environmental needs. Thanks to the re-functionalizing, it is possible to contribute to the environment by taking advantage of the existing structures, the sustainability of the settlement is supported, and it is ensured that future generations benefit from these resources (Dyllick & Hockerts, 2002; Aydın & Yaldız, 2010). In this context, the environmental performance of the place can be evaluated through creating a benchmark in the environment (emphasizing the cultural and historical value of the region, being a means of description in the environment in which it is located and accepting a new function in the city as a whole) and symbolic value (revealing the urban symbolic value, aesthetic value, document value of the building) (Yaldız, 2013). In addition, the location of the structure within the settlement, reachability as pedestrians and vehicles, accessibility for different users, or adaptability to the accessibility nature can be considered within the environmental functional adaptation criteria.

The reuse and functional adaptation table for the structures created in accordance with the specified performance criteria is shown in Figure 1. In the study, these adaptation criteria were analyzed, and in order to determine the ranges for all criteria, values were determined based on literature research.

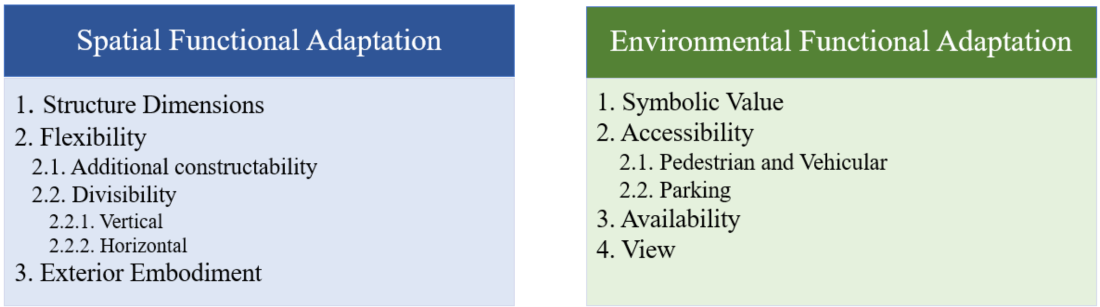

Figure 1. Reuse and functional adaptation table for structures (Baran Ergül, 2022)

3. Materials and Methods

Benefiting from decision support systems for re-functionalizing an existing building stock in a way that will serve the re-evaluation decision taken on a settlement basis will increase the efficiency of the design and implementation processes. Therefore, the study focused on the development of a fuzzy logic-based model for the selection of new functions in structures. The main reason for choosing a fuzzy logic algorithm in the model is that fuzzy logic can produce results that are not sharp and have high accuracy in uncertain ambient conditions. For this reason, it allows space for intuitiveness due to the nature of the design. Fuzzy logic can transform the design into a more subjective structure in a multi-layered decision process such as the selection of new functions in structures by ensuring that the designers' point of view and the variable environmental conditions in which the design is carried out are also included in the decision mechanism.

In this context, the fuzzy logic algorithm was used in the MATLAB environment for the purpose of creating a model for the selection of new functions in structures. The starting and ending ranges of the membership functions were determined in accordance with the expert opinion. The Mamdani controller was used. As shown in Figure 2, there are 9 inputs and 4 outputs in the model. Each input and output value consists of continuous sets with a certain range.

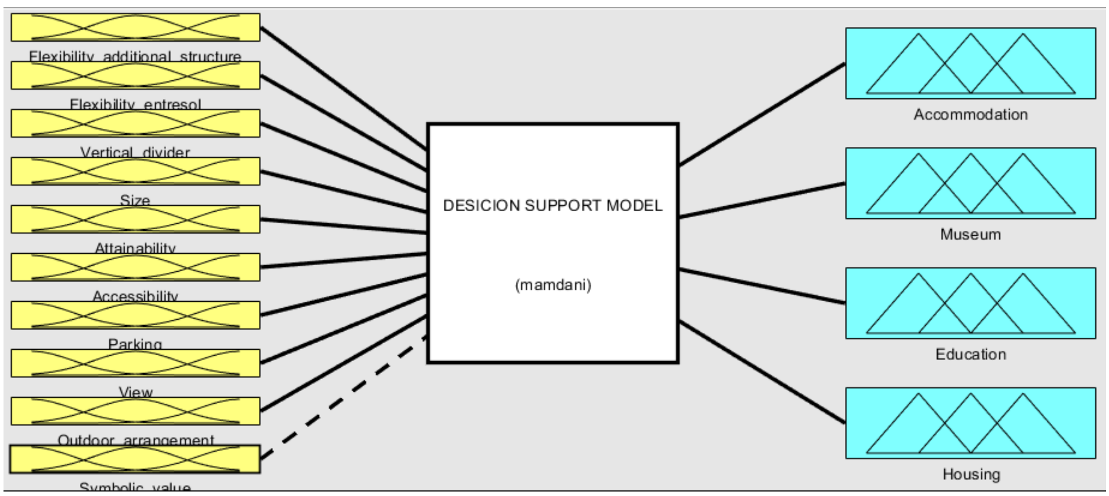

Figure 2. Fuzzy logic-based decision support model (Varol Malkoçoğlu, 2022)

The entry parameters were determined based on the spatial and environmental adaptation criteria. These criteria were concretized and evaluated in order to be included in the algorithm. For example, the horizontal divisibility criterion included in the flexibility criterion was evaluated based on the floor height. In addition, flexibility, which allows changes to the plan according to the new function, was included in the algorithm depending on the vertical divisibility axle range. The parking criteria included in the functional adaptation parameter in terms of environmental point of view were numbered taking into account whether there were enough parking lots in and around the structure, whether the structure had a relationship with the surrounding parking lots, or whether there is an urban place that can be considered as a parking lot. The target values related to all these criteria were obtained from the literature review and the opinions emerging in the focus group study. The range values determined for the mentioned properties are shown in Table 1 and Table 2.

Table 1. Membership functions belonging to each input property

Input Parameters	Degree of Membership		
	Name	**Parameters**	**Types**
Flexibility_additional_structure	None	[0 0 0]	trimf
	Small	[0 1 2]	trimf
	Medium	[1 2 3]	trimf
	Large	[2 3]	smf
Flexibilit _entresol	None	[2 3]	zmf
	Small	[2.5 3.25 4]	trimf
	Medium	[3.5 4.25 5]	trimf
	Large	[4.5 6]	smf
Vertical_divider	Small	[1 2.25 3.5]	trimf
	Medium	[2.75 4 5.25]	trimf
	Large	[4.5 6]	smf
Size	Small	[1 75 150]	trimf
	Medium	[120 235 350]	trimf
	Large	[300 500]	smf
Attainability	Small	[0 1 2]	trimf
	Medium	[1 2 3]	trimf
	Large	[2 4]	smf
Accessibility	None	[0 0 0]	trimf
	Small	[0 1 2]	trimf
	Medium	[1 2 3]	trimf
	Large	[2 3]	smf
Parking	None	[0 1]	zmf
	Small	[0.5 1 1.5]	trimf
	Medium	[1.5 2 2.5]	trimf
	Large	[2 3]	smf
View	Small	[1 2]	zmf
	Medium	[1.5 2 2.5]	trimf
	Large	[2 3]	smf
Outdoor_arrangment	None	[0 1]	zmf
	Small	[0.5 1 1.5]	trimf
	Medium	[1.5 2 2.5]	trimf
	Large	[2 3]	smf
Symbolic_value	None	[0 0 0]	trimf
	Small	[0 1 2]	trimf
	Medium	[1 2 3]	trimf
	Large	[2 4]	smf

Table 2. Membership functions belonging to each output property

Output Parameters	Degree of Membership		
	Name	**Parameters**	**Types**
Accommodation	Small	[0 0 40]	trimf
	Medium	[20 50 80]	trimf
	Large	[60 100 100]	trimf
Museum	Small	[0 0 40]	trimf
	Medium	[20 50 80]	trimf
	Large	[60 100 100]	trimf
Education	Small	[0 0 40]	trimf
	Medium	[20 50 80]	trimf
	Large	[60 100 100]	trimf
Housing	Small	[0 0 40]	trimf
	Medium	[20 50 80]	trimf
	Large	[60 100 100]	trimf

In the next step of the creation of the model, the structure types were determined. In the re-evaluation and selection of structures, the possibilities of new functions are quite numerous. However, in this study, re-evaluation alternatives were focused on for settlements of a rural nature, especially those that had been abandoned as a result of various factors, and the structure types that can serve options such as musealization, tourism, resettlement, and forestation were tried to be determined (Güler, 2016). In the study, the structure types were limited to four different types as accommodation service units, educational buildings, museums, and residences in a way that can serve all the options of musealization, tourism, and resettlement. Of course, in different studies, it is possible that different structure types that serve different main functions may also be included in the new function options.

At the stage after determining the types of structures, their interaction with the spatial and environmental adaptation parameters determined at the previous stage was carried out and they are shown in Table 3. The interaction values in this table were organized based on the data obtained from the literature review, and they indicate the importance of the criteria for the mentioned structure types that have four different functions. For example, structural dimensions are most important for accommodation service units in order to implement the correct plan design. Whereas reachability is an important criterion for accommodation service units, educational structures, and museum options in terms of the sustainability of the function, it is of less importance for the housing option. Whether the structure has a symbolic value or not is evaluated as an important criterion for choosing the museum function.

Table 3. Interaction with spatial and environmental adaptation parameters (Baran Ergül, 2022)

Accommodation		Education		Museum		Housing	
Structure Dimensions	high	Structure Dimensions	medium	Structure Dimensions	medium	Structure Dimensions	less
Flexibility/ Additional Constructability	high	Flexibility/ Additional Constructability	medium	Flexibility/ Additional Constructability	less	Flexibility/ Additional Constructability	none
Flexibility/ Divisibility/Vertical	medium	Flexibility/ Divisibility/Vertical	medium	Flexibility/ Divisibility/Vertical	less	Flexibility/ Divisibility/Vertical	none
Flexibility/ Divisibility/Horizontal	high	Flexibility/ Divisibility/Horizontal	medium	Flexibility/ Divisibility/Horizontal	medium	Flexibility/ Divisibility/Horizontal	less
Exterior Embodiment	medium	Exterior Embodiment	high	Exterior Embodiment	none	Exterior Embodiment	less
Symbolic Value	medium	Symbolic Value	medium	Symbolic Value	high	Symbolic Value	none
Accessibility/ Pedestrians and Vehicular	high	Accessibility/ Pedestrians and Vehicular	high	Accessibility/ Pedestrians and Vehicular	high	Accessibility/ Pedestrians and Vehicular	medium
Accessibility/Parking	high	Accessibility/Parking	medium	Accessibility/Parking	high	Accessibility/Parking	medium
Availability	high	Availability	high	Availability	high	Availability	less
View	high	View	medium	View	medium	View	less

In the model, after determining the possible structure types, the functional adaptation parameters that affect the selection of these structure types, and the interaction of these parameters with the structure types, rules were established based on these interaction states.

4. Findings and Discussion

In the fuzzy logic-based decision support system designed within the scope of the study, parameters, ranges of the parameters, and rules were determined by considering the literature review and the focus group. In order to test the resulting model, the results to be produced by the model were observed by taking the sample structure criteria. In this regard, the accuracy and likelihood of the results produced by the model were evaluated using a sample.

With the aim of testing the appropriateness of the decisions made by the fuzzy logic-based decision support system designed for the selection of new functions in structures, the examination of the Vasfi Süsoy House, which is located in the historical vicinity of Tokat and had been re-functionalized and transformed into a Tourism Development and Education center was carried out. The study in question was conducted based on the data obtained in the study titled "A Traditional House that has been Re-Functionalized; Tokat Vasfi Süsoy House" (Akin, Kalınbayrak Ercan, Mumcuoğlu & Yaprak Başaran, 2018). Vasfi Süsoy House was built in 1933 as a residential building in the Topçular Neighborhood of Tokat, which is now declared an urban protected area. The layout features, inward-facing layout, and plan and facade features of the traditional houses in Tokat and Anatolia are also seen in the Vasfi Süsoy House. The facade of the structure, which is in a garden and located on a plot of land that does not have a lot of slopes, is seen in a form leaning against the street. Considering the studies on the spatial performance of the building, and its harmony between the environment and users, the appropriateness of the Tourism Development and Education Center function for the building emerges. From the point of view of spatial and environmental functional adaptation criteria, it is seen that due to the fact that the structure is located in the garden, the outdoor arrangement value is high. The horizontal divisibility values of the structure are low due to additional constructability and floor height. However, especially due to the barn space that is present in its original structure, its vertical divisibility is possible. Although the building has a symbolic value due to the fact that it is located in the urban protected area, it is not a residential building that has taken place in the memory of the city. In addition, due to the fact that it is located within the urban protected area, the parking value was also determined as medium. As can be seen in Figure 3, when the values determined in accordance with the criteria were processed into the model, the model produced the result showing that the structure in question can be transformed into an educational structure by 87%. Based on this, it can be said that the model is able to produce correct decisions.

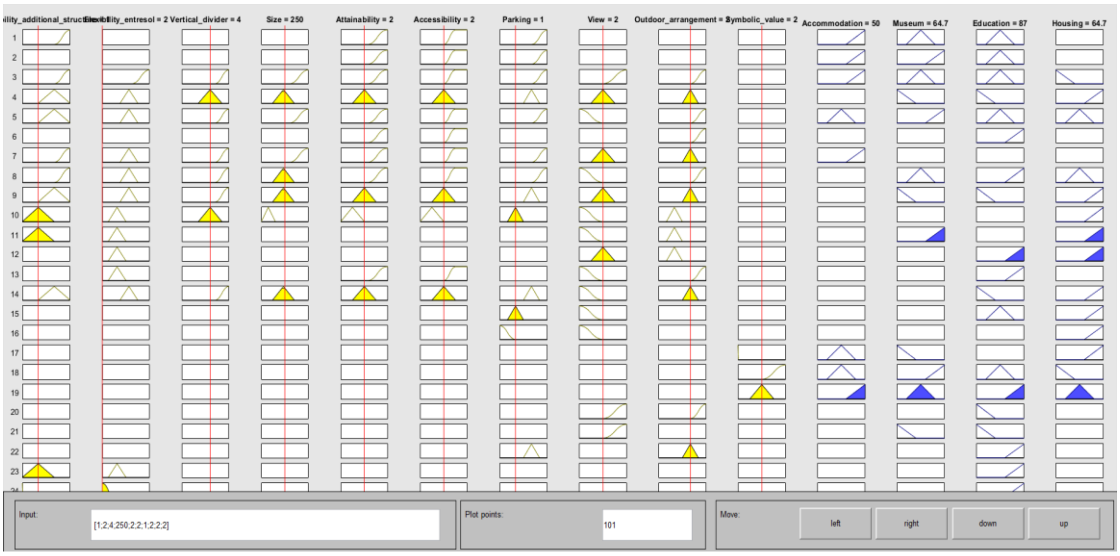

Figure 3. The example performed with the fuzzy logic-based decision support model (Varol Malkoçoğlu, 2022)

5. Conclusion

It is seen that the fuzzy logic-based decision support model, which will be used to decide on a function option that will serve the revitalization option at the settlement scale in reuse, works if the appropriate criteria related to the structures and the rules related to the structure types are determined correctly. But in order for the model to produce healthy decisions, in the documentation studies on the existing building stock, it is very important that spatial and environmental parameters related to the reuse of structures are included as data.

The model designed within the scope of the study has 9 different input features and gives results for 4 different structure types. The number of parameters belonging to the input and output characteristics used in the structure, the range of the parameters, parameter types, and the rules created thanks to these parameters were created as a result of a focus group method and literature review. It is possible to differentiate the number and nature of the determined input and output parameters in such a way as to serve the re-evaluation option, and to include different target-oriented structure types into the model as a result of this. In the decision support system developed for the selection of new functions in structures, more than 20 rules have been determined. It is thought that the number of rules should be increased to define more detailed results.

Finally, the determination of the interaction between the structure types and the functional adaptation parameters, which were determined in this study by literature review and the focus group method, is planned to be carried out by an artificial intelligence-based model in a future study.

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The article complies with national and international research and publication ethics. Ethics Committee approval was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

1st author %40, 2nd author %40 and 3rd author %20 contributed. There is no conflict of interest.

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Investigation of Methods and Studies for Determining the Material Selection Criteria with Low Environmental Impact in Hotel Buildings

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Abstract

Today, with the development of environmental sustainability awareness, measures have been taken in the construction sector to protect nature and human health. Building production with low environmental impact is possible with the use of building materials selected through various data and criteria. Studies have shown that many, and different building materials are used in hotels because hotels are trying to attract the attention of users. Materials taken from nature in their natural state and used by processed cause many environmental problems. In this study, the steps to be followed for the selection of finishing materials with low environmental impact to be used in hotel buildings are explained and evaluated within the scope of environmental sustainability through a literature review, and interviews with hotels. At the end of the study, it was determined that a systematic way should be followed especially in material selection during the design process.

Keywords: *Environmental sustainability, environmental effect, hotel building materials, material selection.*

Otel Yapılarında Çevresel Etkisi Düşük Malzeme Seçim Kriterlerinin Belirlenmesine Yönelik Yöntem ve Çalışmaların İncelenmesi

Öz

Günümüzde çevresel sürdürülebilirlik bilincinin gelişmesiyle birlikte, doğanın ve insan sağlığının korunması adına yapı sektöründe önlemler alınmaya başlanmıştır. Çevresel etkisi düşük yapı üretimi, çeşitli veri ve ölçütler yoluyla seçilen yapı malzemelerinin kullanılması ile mümkündür. Yapılan araştırmalar, otellerin kullanıcıların ilgisini çekmek adına farklı ve çok sayıda yapı malzemesi kullandığını göstermiştir. Doğadan alındıktan sonra işlenerek kullanılan malzemeler birçok çevresel probleme sebep olmaktadır. Bu çalışmada otel yapılarında kullanılacak olan çevresel etkisi düşük bitirme malzemelerinin seçimine yönelik izlenmesi gereken adımlar aktarılmış, kriterler; literatür taraması ve oteller ile yapılan görüşmeler aracılığı ile çevresel sürdürülebilirlik kapsamında değerlendirilmiştir. Çalışma sonunda otellerde malzeme seçimi konusunda sistematik bir yol izlenmesi gerektiği belirlenmiştir.

Anahtar Kelimeler: *Çevresel sürdürülebilirlik, çevresel etki, otel yapı malzemeleri, malzeme seçimi.*

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1. Introduction

In recent years, rapid urbanization and developments in the building industry have brought about a wide variety of building materials. The materials obtained naturally in the past and used in construction without much processing have become multifunctional, but of poor quality, with the increase in the performance criteria expected from the material today. This situation has brought with it the issue of mentioning the relationship with the environment in addition to the physical, chemical, mechanical, technological, economic, and availability properties of the material during the selection. In this sense, emerging environmental impact assessment approaches, decision-making and comparison methods, material databases and approaches to material selection, laws, regulations, and standards are very important (Khoshnava, Rostami, Mohamad Zin, Štreimikienė, Mardani and İsmail, 2020; Güner, 2017; Güleryüz, 2014). Solving the problems arising from material selection requires the people involved in the selection to act with awareness from the design stage. The environmental effects that will occur throughout the material's life cycle are preventable at this stage. The selection of materials with optimum properties for the building is defined as a complex process involving many different data and factors. For this process to be managed properly, a systematic method should be followed for the performance criteria expected from the material (Rahim, Musa, Ramesh, and Lim, 2020).

The most used area in hotels is known as the bedrooms. For this reason, the people involved in the design process try to use so many different finishing materials to attract the attention of the users, and to keep up with the times, they make renovations from time to time before the material service life expires. The bedrooms' wall, floor, and ceiling finishing materials are chosen by their price, availability, color, and texture properties without considering the environmental effects. There are many decision-making methods to reduce the environmental effects in the selection of these finishing materials (Gültekin, 2006; Alptekin, 2014; Koyaz, 2016; Bayır, 2020). However, the decision-making process becomes difficult as there are many different criteria, data, and impact classes. The inadequacy of the methods for the selection of materials used in hotel buildings and the difficulties experienced in the decision-making process necessitates the creation of an environmental impact assessment model that compares different material alternatives. In this study, the problems with the environmental effects and the importance of the material selection of hotel buildings are discussed. Then, the most used materials in hotel bedrooms in Türkiye were determined. Renovation behaviors and performance requirements of the finishing materials are examined. Important regulations, notifications, standards, certificates, and award programs are defined.

2. Material and Method

Within the scope of the study, first of all, a literature review was carried out for the environmental effects of hotel buildings and the importance of material selection in the hotel buildings' life cycle process. Secondly, hotels are classified according to national and international sources by literature review and selected by the classification of Regulation on the Qualifications of Tourism Facilities for the study. According to the selection, the most used finishing materials have been analyzed. Due to the low number of 1, 2, and 3-star chain hotels, a total of 31 hotels, including only 15 5-star chain hotels and 16 4-star chain hotels, were included in the study. The hotels are selected by the geographical prevalence with the help of TS 825 Degree Day Regions by Province. (TS 825, 2013). In terms of suitability for data collection, the lowest-priced double bedroom was selected in each hotel. Furnitures and the bathrooms are not included in the study. Later on, renovation behaviors were analyzed by interviewing the hotels, and the findings are shown in the section 'Renovation Behaviours of the Materials'. Performance requirements of the materials have been defined according to International Organization for Standardization, (2016). Important standards, regulations, awards, and programs were found according to the literature review. Within the scope of this study, national regulations, notifications, national and international standards regarding tourism structures were investigated through; the Turkish Presidency Regulatory Information System, Turkish Standards Institution (TSE), International Organization for Standardization (ISO), European Standard (EN), British Standards Institution (BSI), American Society for Testing and Materials (ASTM), The American National Standards Institute (ANSI).

3. Findings and Discussion

Although studies are carried out at the national and international levels for the impact of building materials, it is seen that hotels in Türkiye have a passive role and fail to preserve their values in their geographical location by not giving importance to the use of renewable resources and energy, raw material, and water, destroying natural areas for large-scale projects, not paying attention to the recycling of wastes, changing migration routes of animals, reducing the biodiversity of wastes dumped into the sea. The lack of necessary legal regulations is one of the biggest reasons for all these problems. Considering that sustainable architecture requires a holistic and strategic approach to the building, it is imperative that people take precautions during the design phase of the building. According to the studies, the most important environmental effects of the materials in Türkiye are; global warming, depletion of the ozone layer, acidification, eutrophication, photochemical smog formation, indoor air quality, fossil fuel consumption, mineral resource consumption, water consumption, waste, and land use (Karaman Öztaş, 2014). It has been found that the subject has not been adequately addressed and hotels have to take precautions as a result of the research. It has been determined that the material selection is made regardless of the location of the hotels, there is no general method for the renewal of the materials, and the performance criteria are not taken into account, there is no standard or regulation for the selection of sustainable materials in the hotels, the certificate and award programs preferred by the hotels are based on environmental sustainability.

3.1. Environmental Effects of Hotel Buildings

Building materials play one of the biggest roles in lowering the environmental impact of hotel buildings (Vatan & Poyraz, 2016). Increase in waste production, consumption of raw materials, energy, and water, air pollution, decrease in biodiversity, occupation of agricultural land, seawater pollution, depletion of the ozone layer, and global warming are just a few of these impacts (Kuo & Chen, 2009; Chen & Hsieh, 2011). When the environmental policies of the hotels are examined, it is seen that lowering the effects of building materials has not been adequately addressed. Hotels attach importance to the concept of eco-label to reduce the environmental impact of the materials used and to provide other sustainability criteria. Green Flag Award, Biohotels, Sustainable Tourism Eco-Certification Program, Energy Star, and Enviro-Mark are some of the environmental management system certificates that hotels receive. In Türkiye, the hotels use environmental management system certificates such as GTBS (Green Tourism Business Scheme), Blue Flag, GreenGlobe, Green Key, White Star, Greening Hotels, Green Star and LEED, ISO 14000, Travelife (Nakhla & Mossad, 2022; Ertaş, Can, Yeşilyurt & Koçak, 2018). In addition, the "Environmentally Friendly Accommodation Facility Certificate" was given to the hotels that attach importance to environmental issues by the Ministry of Culture and Tourism; it has been observed that non-governmental organizations and environmental organizations also carry out studies on the subject. Reducing the environmental impact of the materials used in hotel buildings is not possible only with the use of environmental management system certificates and environmental labels. It is necessary to use Life Cycle Impact Assessment models such as BEES, BEPAS, and BELES, which evaluate the environmental effects of products, notification services such as GreenFormat, GreenSpec, EPD, product labels such as EC Eco-labelling scheme, Blue Angel, Eco mark, which discuss materials in detail and specify the system limit in the life cycle process (Karaman Oztas, Tanacan & Oğuz, 2017). Life cycle impact assessment models should also be compatible with Turkish conditions. In this sense, although there are studies (Tuna Taygun, 2005; Karaman Öztaş, 2014; Gültekin, 2006; Türkmen Bayraktar, 2010; Alptekin, 2014) that have been carried out, a general method has not been accepted. Reducing the environmental effects of the materials used in hotels is only possible if they are traceable and measurable. For this reason, it is necessary to establish a systematic method that facilitates material selection during the design process.

3.2. The Importance of Material Selection in the Hotel Buildings Design Process

The first building materials consisted of stone, wood, and earth which people found without getting too far from their location. Over time, the increase in population, the increase in human knowledge, and the advancement in technology caused a wide variety of material alternatives with higher performance requirements (Gökçe, Aytekin, Kuşan & Zorluer, 2017; Tufan & Özel, 2018). Accordingly, selecting the best materials at the design stage became hard, which showed the necessity of following a systematic way. One of the biggest reasons for this is the increase in environmental effects caused by building materials (Çizmecioğlu, 2020). The materials used in the buildings cause global warming, depletion of raw materials, water, and energy resources, and great damage to human health (Kaya, 2013; Çiftçi, 2021). At this point, selecting materials by evaluating their life cycle and environmental impact performance is important. When the environmental effects of building materials in touristic buildings are examined, it is seen that hotels are in the first place (EkoYapı, 2013). Especially after the 1960s, the increasing number of hotel buildings started to use different kinds of building materials to keep the attention of the masses alive (Horne, 2009). As a result, hotels' "environmental sustainability" awareness has started to develop with the emergence of environmental effects. With this awareness, building materials with low environmental impact have become a feature; preferred by the building industry, and designers.

3.3. The Most Used Materials in Hotel Bedrooms

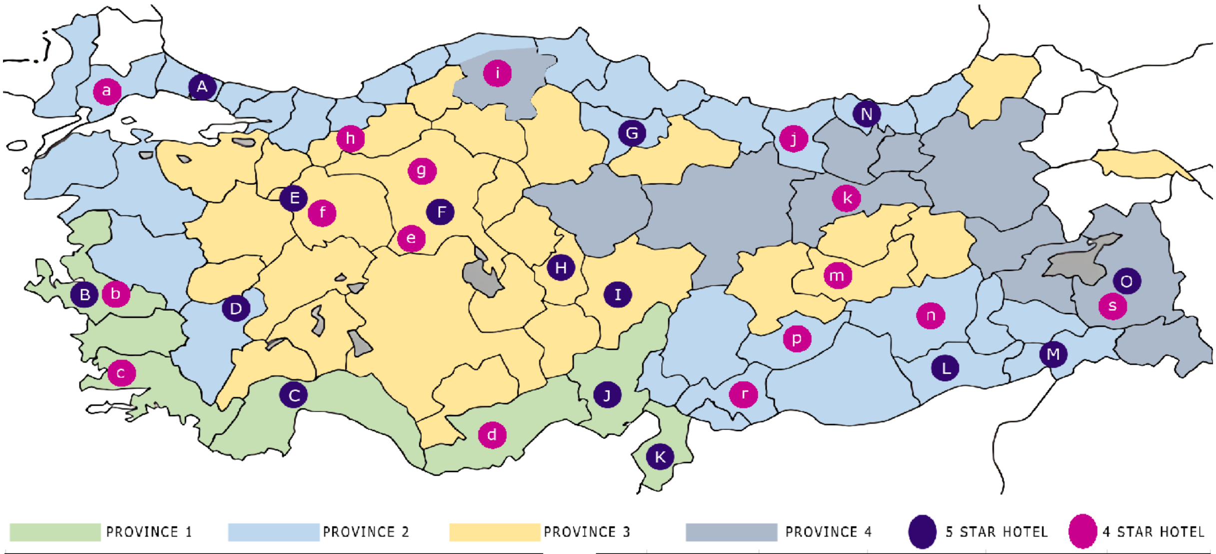
According to national sources; hotels are classified according to the purpose of accommodation, duration of the activity, legal characteristics, and size. The purpose of accommodation hotels is classified as; central hotels (city hotels), coastal hotels, mountain and sports hotels, spa-cure hotels, and congress hotels. In terms of the duration of the activity, hotels are classified as; permanent hotels and seasonal hotels. In terms of legal characteristics, hotels are classified as; municipality licensed hotel businesses and hotel managements with tourism operation certificates. In terms of size, hotels are classified as; very small hotels with 25 rooms or less, small hotels with 25 - 100 rooms, medium-sized hotels with 100 - 299 rooms, and large hotel complexes of 300 or more rooms (Mevzuat Bilgi Sistemi, 2005; Elmas, 2008). According to international sources, hotels are classified by; the star classification system, American Automobile Association Classification System, Forbes (Mobile) Classification System, and Michelin Classification System (Minazzi, 2010; World Tourism Organization, 2015).

In this study, in terms of accommodation purpose; city hotels, in terms of activity period; permanent hotels, in terms of legal features; hotels with tourism operation certificate, in terms of property; private hotel businesses, in terms of size; hotels with 25- 100 and 100- 299 rooms, in terms of star classification; 5-star and 4-star hotels were selected (Figure 1) (Aydoğdu, 2017).

Bedrooms are the most used spaces in hotels that need regular renewal. Many building products used in hotels are discarded before the end of their service life as a result of renewal. It is seen that as the number of stars in hotels increases, their ecological footprint also increases. To analyze the most used finishing materials in hotel bedrooms, 5 chain hotels (2 national, 3 international) which are among the top 10 hotels in Türkiye have been selected (Table 1).

Table 1. Selected chain hotels for the study (T.C. Kültür ve Turizm Bakanlığı Belgeli Konaklama Tesisleri, 2021)

No	National	Hotel number	Web page
1	Anemon	21	https://www.anemonhotels.com/
2	Dedeman	18	https://www.dedeman.com.tr/
3	Divan	17	https://www.divan.com.tr/
No	**International**	**Hotel number**	**Web page**
4	Wyndham	8900	https://www.wyndhamhotels.com/tr-tr
5	Hilton	3897	https://www.hilton.com.tr/



5 STAR CHAIN HOTEL					
	HILTON	**WYNDHAM**	**ANEMON**	**DEDEMAN**	**DIVAN**
P1	Antalya (C)	İzmir (B)	Hatay (K)		Adana (J)
P2	Trabzon (N)	Mardin (L)	Denizli (D)	İstanbul (A)	Şırnak (M)
P3	Ankara (F)	Nevşehir (H)	Eskişehir (E)	Tokat (G)	
P4	Van (O)	Kayseri (I)			

4 STAR CHAIN HOTEL					
	HILTON	**WYNDHAM**	**ANEMON**	**DEDEMAN**	**DIVAN**
P1	Bodrum (c)	Mersin (d)	İzmir (b)		
P2	Adıyaman (p)	Giresun (j)	Diyarbakır (n)	Gaziantep (r)	Tekirdağ (a)
P3	Bolu (h)	Eskişehir (f)	Ankara (e)	Elazığ (m)	Ankara (g)
P4	Erzincan (k)	Van (s)		Kastamonu (i)	

Figure 1. Geographical prevalence of selected hotels (T.C. Kültür ve Turizm Bakanlığı Belgeli Konaklama Tesisleri, n.d.)

To carry out the analysis, the wall-floor-ceiling finishing materials used in the selected chain hotels' selected rooms were examined through a literature review and field studies. First, a legend is created for the determination of the materials as a result of the examination (Toydemir, Gürdal & Tanaçan, 2000). According to this legend, the most used finishing materials in bedrooms are shown in Figure 2.

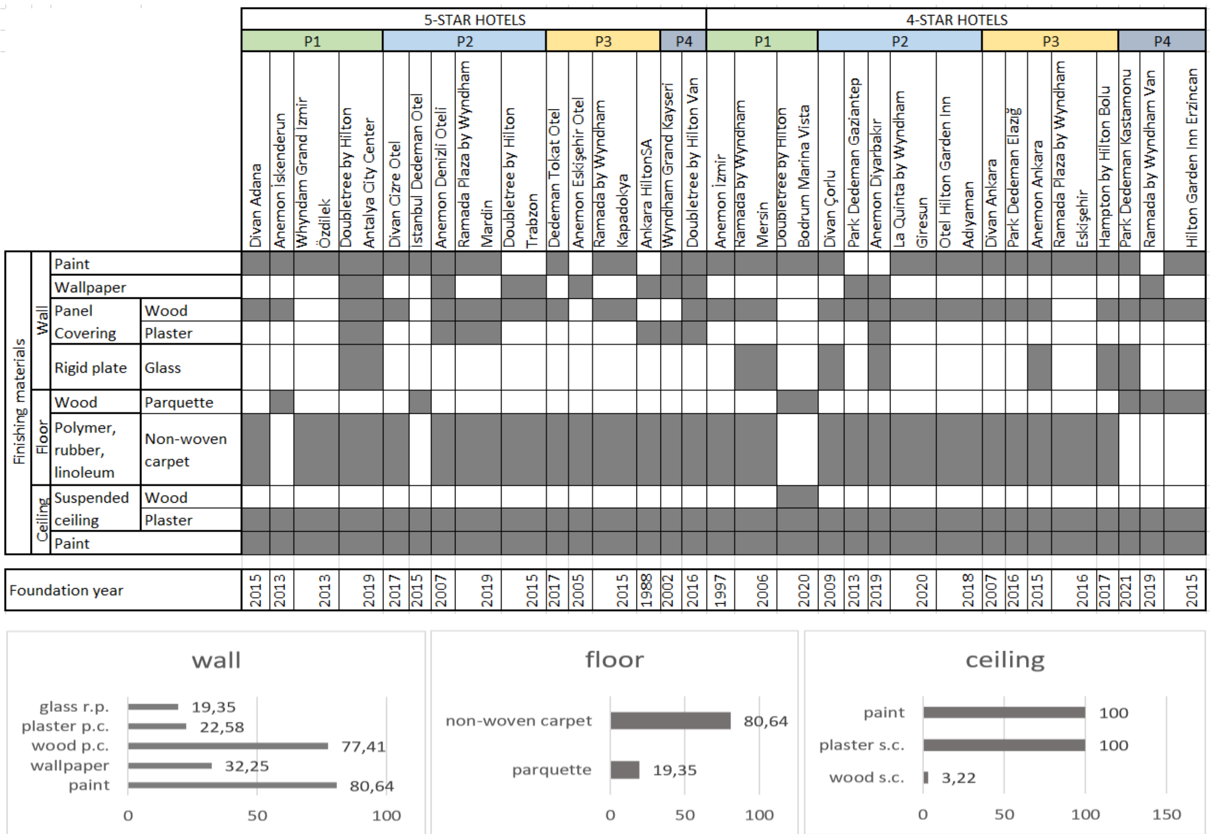


Figure 2. The most used finishing materials in bedrooms (Divan, 2022; Anemon Hotels, 2022, Wyndham Hotels and Resorts, 2022, Dedeman Hotels and Resorts, 2022; Hotels by Hilton, 2022)

As shown in the analyses, the most used wall finishing materials in the chain hotel bedrooms are; paint, wood panel covering, wallpaper, plaster panel covering, and glass rigid plate, the most used floor finishing materials in the chain hotel bedrooms are; non-woven carpet and wood parquette, the most used ceiling finishing materials in the chain hotel bedrooms are plaster suspended ceiling, paint and wood suspended ceiling from most to least. It is seen that the bedroom finishing material selection criteria of chain hotels do not differ geographically, and the same type of materials are used in the building without changing to maintain the chain hotel perception. Considering that each geographical region has different climatic characteristics, local materials, and site properties, the materials used in these regions should also change as they will have different performance requirements. It is known that during the design of chain hotels, pre-prepared design sheets are used to maintain the user's perception of trust and to ensure continuity. Unfortunately, these design sheets do not differ by region, they only help the designer during material selection. Today, the biggest problems such as global warming, deterioration of human health, regional air pollution, and climate change occur due to mistakes made in material selection during the design phase (Mahmoudkelaye, Taghizade Azari, Pourvaziri & Asadian, 2018). Materials should be chosen not only considering their physical, chemical, mechanical, technological, aesthetic, and economic properties, but also their environmental impact which will lower the high ecological footprint of chain hotels.

3.4. Renovation Behaviours of the Materials

The renovation behavior of hotels has a great contribution to the environmental problems caused by the materials. Interviews have been made with each selected hotel about the subject. The resulting information is as follows:

- There are two approaches to hotel renovation. In the first approach, the hotel is completely closed and renovated. A complete renovation is possible if the hotel is very old or has changed hands.

- In the second approach, the hotel is kept under regular surveillance. If, for example, there is a problem with the parquet in the bedroom, the parquet can be repaired/replaced. It is not possible to change every material at the same time. At this point, depreciation is taken into account. This increases as a result of the sales and use of the rooms. For example, curtains change on smoking floors may be more frequent than on non-smoking floors. Since the hotel changes frequently and in different regions, the hotel renewal date cannot be given.

- Hotels generally carry out renovation work during the winter months (October-November). However, if there is a very urgent problem, the room can be closed and intervened. In these months, wall-floor-ceiling finishing materials are renewed sequentially, not at the same time.

- Because it is not needed, there are no serious renovations for the first 5 years after the hotels are opened.

- It also has been stated that after the hotels change/renew the materials, the old materials end their life as a waste.

Interviews with hotels have shown that the biggest problem in the renovation behavior of hotels is the disposal of materials as waste before their end of life which is an important issue in creating environmental problems. Materials salvaged and reused as a result of construction practices can be overhauled and reused, or if they are not suitable for reuse, they can be recycled. It can also be used as a raw material in the production of other products. These recycled building materials not only add ecological value to the building they are used in but also provide economic benefits and affect environmental and structural sustainability (İpekçi, Coşkun & Karadayı, 2017).

3.5. Performance Requirements of the Materials

The performance requirements of finishing materials in hotels can be determined by using International Organization for Standardization, (2016). In this standard, 4 levels are proposed to determine the performance of a building or a part of a building (Figure 3).

A detailed explanation of specifying performance is given below:

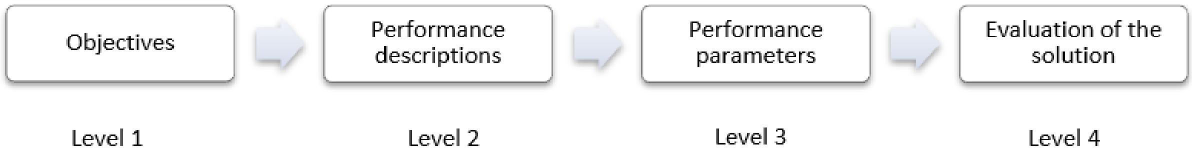


Figure 2. Proposed levels for the performance (ISO 19208, 2016)

- Objectives: It includes the expectations regarding the properties expected from the material. Some commonly expected objective categories described in the standard are; stability, fire safety, safety in use, tightness, air purity, durability, accessibility, contributions to sustainable development.

- Performance descriptions: It defines the agents, factors affecting human behavior, and changes in performance over time. Agents are classified as; mechanical, electromagnetic, thermal, and chemical agents; factors affecting human behavior are classified as; physical abilities, sensory abilities, and mental abilities. Changes over time describe the characteristics, reason, and variation over time of the performance requirement expected from the material.

- Performance parameters: These sets the qualitative requirements for the behavior of the material. It may vary depending on the type and nature of the performance. For example, the performance of the material affecting society can be determined through simulated CO_2 emissions.

- Evaluation of the solution: It constitutes the stage of evaluating the results of the performance statements and bringing solution proposals. For example, evaluation of a whole building can be obtained through; a) experiments on a full-scale building, b) integration of performance of elements through calculation, etc. (Experimental results of elements), and c) logical reasoning of performance from materials or products, through elements to a whole building (ISO 19208, 2016)

Considering the environmental problems of today's world, examining all the materials in the design and production processes with the realization of the act of architecture; it is important to select performance-oriented materials. The performance requirements expected from the finishing materials used in the wall, floor, and ceiling in hotel bedrooms differ from each other. Research conducted in selected hotels has shown that the biggest factor in material selection is visual appearance and economy. The performance properties of the material such as fire, safety, durability, and acoustic properties have been ignored and the user has been left vulnerable to various agents. After selecting the materials suitable for all these criteria in hotels, the long-term performance of the materials should be analyzed. However, no such practice has been found in the selected hotels. It is important for everyone involved in the design of the building to act knowing this, and to reduce the contribution of the material to the environmental impact by working with the best performance and the best life.

3.6. Standards, Regulations, Awards and Programs

Within the scope of this study, national regulations and notifications (Table 2), national and international standards regarding tourism structures (Table 3) were investigated. There are several certificate and award programs to reduce the role of hotels in environmental destruction. There are many eco-friendly hotel labels around the world today. These differ in areas such as geographical scale, sub-sectors of tourism, and certification methods. The most well-known national and international certificate and award programs are summarized in Table 4.

When the regulations, notifications, and standards related to hotel buildings are examined, it is seen that there is information about the design strategies such as the usage of the textiles or lighting of the building or the places, but the selection of the materials, specifications, performance requirements and environmental solutions is missing. Although there isn’t a detailed explanation about this subject, the marked areas in Table 2 and Table 3 can contribute information about both material properties and environmental effects but they are not in detail. The number of hotels that receive certificates and award programs for their environmentally friendly practices is increasing day by day as can be seen in Table 4.

Table 2. National regulations and notifications of hotel buildings (Mevzuat Bilgi Sistemi, 2022)

Regulations	Regulation on the Qualifications of Tourism Facilities
	Fire Protection Code of Buildings
	Regulation on Planning and Implementation In Culture and Tourism Conservation, Development Zones, and Tourism Centers
	Planned Areas Zoning Regulation
	Istanbul Zoning Regulation
	Bursa Metropolitan Municipality Zoning Regulation
	Ankara Metropolitan Municipality Zoning Regulation
	Gaziantep Metropolitan Municipality Zoning Regulation
	Regulation on the Protection of Buildings Against Noise
	Regulation on Evaluation and Management of Environmental Noise
	Regulation on Facilities to be Built and Opened Near Highways
Notification	Communiqué on the Implementation of the Regulation on the Qualifications of Tourism Facilities
	Communiqué on Preparation and Application of Evaluation Forms Regarding Classification Studies
	Communiqué on Issuing an Environmentally Friendly Accommodation Facility Certificate
	Communiqué on Giving Bicycle Friendly Accommodation Facility Certificates to Accommodation Facilities with Tourism Operation Certificate

Table 3. National and international standards for hotel buildings (Türk Standartları Enstitüsü, 2022; International Organization for Standardization, 2022; European Standard, 2022; British Standards Institution, 2022; American Society for Testing and Materials, 2022; American National Standards Institute, 2022)

Standards	TS 10082 Workplaces- Accommodation Facilities- Hotels Of Tourism Certificated- Classification- General And Private Rules
	TS EN ISO 18513 Tourism Services — Hotels And Other Types Of Tourism Accommodation — Vocabulary
	TS ISO 8100-32 Lifts For The Transportation Of Persons And Goods — Part 32: Planning And Selection Of Passenger Lifts To Be Installed In Office, Hotel And Residential Buildings
	TS ISO 22483 Tourism And Related Services — Hotels — Service Requirements
	TS ISO 21401 Tourism And Related Services — Sustainability Management System For Accommodation Establishments — Requirements
	ISO/TS 13811 Tourism And Related Services — Guidelines On Developing Environmental Specifications For Accommodation Establishments
	TS 6915 Workplaces- Accommodation Facilities- General Rules
	ISO 9000 Quality Management System
	ISO 14001 Environmental Management
	ISO/DIS 23405 Tourism and Related Services — Sustainable Tourism — Principles, Terminology, and Model
	ISO 21902:2021 Tourism and Related Services — Accessible Tourism For All — Requirements and Recommendations
	ISO 21621 Tourism And Related Services — Traditional Restaurants — Visual Aspects, Decoration, And Services
	ISO/DIS 21620: Tourism And Related Services — Heritage Hotels — Equipment And Service Requirements
	BS ISO 17679:2016 Tourism And Related Services — Wellness Spa — Service Requirements
	BS ISO 17680:2015 Tourism And Related Services— Thalassotherapy — Service Requirements
	BS ISO 21426:2018 Tourism And Related Services — Medical Spas — Service Requirements
	ISO/PAS 5643 Tourism And Related Services — Requirements And Guidelines To Reduce The Spread Of Covid-19 In The Tourism Industry
	IES DG-25-12 Design Guide for Hotel Lighting
	GB/T 14308-2010 Classification And Accreditation For Star-Rated Tourist Hotels
	GB/T 21084-2007 Green Hotels
	GB/T 22800-2009 Textiles For Star-Tourist Hotels
	GB/T 24453-2009 Plastic Products Used In Guestroom Of Hotel
	GB/T 26357-2010 Construction Standards Of Management Information System For Tourist Hotel
	GB/T 39634-2020 Management Specification For Water-Saving Of Hotels

Table 4. The most well-known national and international certificate and award programs (Ovalı, Çakır, & Atık, 2020; Ertaş et.al., 2018)

Certificate and award programs	Green Star	Green Key	TUI Umwelt Champion&Eco Resort
	White Star	Viabono	Green Globe
	Blue Flag	EU Ecolabel	Green Seal
	Greening Hotels	Nordic Swan Ecolabel	Green Leaf
	Green Key	EU Flower	Ecotel
	Environmental Impact Assessment Report	EHC	Green Tourism Business Scheme (GTBS)
	Eco-Management and Audit Scheme (EMAS)	Blaue Schwalbe	Travelife
	Leadership in Energy and Environmental Design (LEED)	Bio Hotels	Naturidyll Hotels
	Building Research Establishment Environmental Assessment Method (BREEAM)	Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB)	Japan Environmentally Sustainable Accommodations International Standard (ESAIS)

While awards and certificates are the most frequently mentioned environmental factors on the websites of environmentally friendly accommodation establishments, the most emphasized issues are environmental policy, waste evaluation, personnel and guest training, and energy saving. In addition to political and legal pressures, these businesses give importance to environmentally friendly practices due to reasons such as the increase in tourists' interest in environmental issues, the increase in environmental regulations, the desire to provide more consumer satisfaction and to solve problems related to physical appearance (Auzair, 2011). When the websites of the selected chain hotels (Table 1) are examined, it has been observed that the international hotels clearly share their environmental policies compared to national hotels. Especially in city hotels where users spend a short time, the scarcity of awards and programs mentioned in the table above draws attention. It will be an important step in terms of environmental awareness that environmentally sensitive accommodation establishments discuss this issue in detail and share it with the public. In addition, it is seen in this study that the features expected from the material differ according to the certificate and award program. Establishing a common certification system and award program for a more effective result is important for the joint development of environmental awareness.

4. Conclusion and Suggestions

Hotel buildings are structures with high environmental impact due to the materials used. Considering environmental factors in the selection of finishing materials in hotels may cause additional costs for businesses in the short run, but in the long run, it will be effective in reducing the costs of the businesses and increasing their profits. This will contribute to the economy and help increase social welfare. In addition, it will increase the prestige of hotel businesses if they show the environmental effects of the materials in a clear, and accessible way through sustainability reports. Finishing materials in hotel buildings are selected by the features such as functionality, durability, ease of maintenance, cost, and aesthetics. Reducing the environmental impact of hotel buildings is only possible with the use of sustainable building materials (Başyiğit, Hanifi Alkayış & Kartlı, 2021). Even though most of the studies on hotel designs have defined the concept of a sustainable hotel and mostly focused on the social, economic, and environmental impacts of the operation process superficially, it is seen with this study that hotels should consider many factors for environmental impact evaluation. In this sense, it is important to prefer materials that are renewable or reusable, cause the least damage to the environment and human health, require less maintenance, energy, raw materials, and water throughout their life cycle by everyone involved in the design process of the building (Gamal Sahlol, Elbeltagi, Elzoughiby and Abd Elrahman, 2021). The awareness of hotel designers and decision-makers in this field, especially architectural design teams, and material preferences and incentives with low environmental impact will also encourage material manufacturers to publish environmental product declarations for their products and make improvements in their usage processes. This study is important in terms of thinking about the quality of life of future generations and acting on this issue. It is emphasized that the choice of sustainable materials in the building is not in line with human desires, but is necessary for the realization of human needs. For the selection of materials used in hotels, it is necessary to establish common and detailed laws, regulations, and standards, to determine the performance requirements expected from the material, to give importance to recycling during the material renewal behavior, to select the materials specific to the geographical region and to establish a common method for material selection. In this sense, both the state and designers must work together. Thus, a better environment can be left for future generations by ensuring the use of sustainable materials in the building.

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The article complies with national and international research and publication ethics. Ethics committee permission was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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Building from Scrap: Computational Design and Robotic Fabrication Strategies for Spatial Reciprocal Structures from Plate-shaped Wooden Production Waste

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Abstract

This paper describes an innovative methodology allowing upcycling production waste into legitimate construction material for spatial structures, with minimal change to elements` shape. The system is based on interlocking joints between the boards. The plates are organized around nodes, creating a three-dimensional reciprocal system guaranteeing the stability of the entire structure, without any fasteners. We use an inversed, data-driven design process, in which unique components are defining the form of the structure. The design-to-production workflow consists of measuring and labeling of the elements, creating a data file, data-driven generation of the structure with a custom form-finding algorithm, structural optimization of the form, robotic processing of the scraps and manual assembly. The proposed methodology was tested in public spaces as a temporary pavilion and three wood-clay composite sitting elements, thus practically demonstrating the feasibility of our approach.

Keywords: *Circular economy in construction, data-driven design, design based on availability, robotic fabrication, spatial reciprocal structures.*

Atık Kullanarak İnşa Etmek: Levha Şeklindeki Ahşap Üretim Atıklarından Üretilmiş Uzaysal Mütekabil Strüktürler İçin Hesaplamalı Tasarım ve Robotik İmalat Stratejileri

Öz

Bu makale, üretim atıklarının, minimum biçim değişikliği ile mekansal yapılar için meşru inşaat malzemesine dönüştürülmesine izin veren yenilikçi bir metodolojiyi açıklamaktadır. Sistem, levhalar arasındaki geçme bağlantılara dayanmaktadır. Plakalar, herhangi bir bağlantı elemanı olmadan tüm yapının stabilitesini garanti eden üç boyutlu bir karşılıklı sistem oluşturarak düğümler etrafında düzenlenmiştir. Benzersiz bileşenlerin yapının biçimini tanımladığı tersine çevrilmiş, veriye dayalı bir tasarım süreci kullanılmıştır. Tasarımdan üretime iş akışı, öğelerin ölçülmesi ve etiketlenmesi, bir veri dosyası oluşturulması, özel bir form bulma algoritmasıyla yapının veriye dayalı olarak oluşturulması, formun yapısal optimizasyonu, hurdaların robotik işlenmesi ve manuel montajdan oluşmaktadır. Önerilen metodoloji, kamusal alanlarda geçici pavyon ve üç ahşap-kil kompozit oturma elemanı olarak test edilmiştir, böylece yaklaşımımızın uygulanabilirliği pratik olarak gösterilmiştir.

Anahtar Kelimeler: *İnşaatta döngüsel ekonomi, veri odaklı tasarım, mevcudiyete dayalı tasarım, robotik imalat, mekânsal karşılıklı yapılar.*

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1. Introduction

Ecology and circular economy are becoming major topics in the architectural discourse. This comes as no surprise, as a significant part of the environmental impact of human activities arises from construction (Hughes, 2019). The climatic crisis and new globally applied environmental strategies are forcing construction to change its approach towards more suitable solutions. Such strategies can involve the reuse of existing buildings by refurbishing them, as was outlined by Pehlivan (2018). Other approaches include the use environmentally friendly raw materials like earth (Özgünler, 2017), or wood, which is also generally considered a sustainable building material. To the authors' knowledge, however, the use of waste streams emerging from construction has not yet been sufficiently investigated in the literature. This paper presents a novel methodology for using wooden production scrap as a legitimate building material.

Timber construction companies order wood in standardized dimensions and cut it to final shapes defined by the current design practice. The remaining cut-offs, irregular in size and properties, cannot be used in standard buildings and are usually downcycled or burned, which causes significant losses for the manufacturer and environment. Although the problem concerns roughly 10% of ordered material, it is mostly neglected, as it is difficult to tackle with available traditional techniques and approaches. Poor digitization of the construction sector is one of the factors hindering better exploitation of production waste and opportunities in circular economies (Durmisevic et al., 2021). To this end, new digital working methods have been defined, in which available materials are considered as a source of ideas, following the principle: reuse, re-invent and give life again.

Building with heterogeneous elements requires a paradigm change in architectural aesthetics, design, manufacturing, structural optimization, and assembly. We believe that one of the greatest potentials of growing digitalization is shifting the construction industry towards more circular solutions. Data-driven design strategies and robotic fabrication can help in repurposing production waste into form-found functional structural shapes and lead to smarter and more sustainable cities.

This paper describes working methods to design and fabricate spatial structures out of irregular production scraps. This includes the following: a description of structural principle of a spatial reciprocal system consisting of non-uniform rectangular boards, data-driven design, robotic fabrication and sequencing and assembly of complex structures. Finally, it shows the implementation of this process in two constructed demonstrators: a temporary pavilion for ArchitekturWoche Basel (Figure 1a) and 3 wood-clay sitting elements constructed for the TouchWood exhibition in Museum ZAZ Bellerive in Zurich (Figure 1b).

a) b)

Figure 1. Constructed pavilions: a) a temporary pavilion for ArchitekturWoche in Basel, b) wood-clay sitting elements at TouchWood exhibition in Museum ZAZ Bellerive in Zurich (Photos courtesy of ARCHIBATCH)

1.1 State of the Art

1.1.1. Circular strategies for working with wood waste

Wood is a renewable resource, but not an infinite one. Across Europe, the construction sector accumulates 70.5 million tons of wood waste annually, of which only a third is currently recycled (WoodCircus, 2019). A significant amount is incinerated, which means the stored CO_2 is re-emitted into the atmosphere (Rüter & Diederichs, 2012). In this context, several European research projects have emerged with the prerequisite of establishing a circular economy setting to extend the service life of wood (WoodCircus (2019) and CaReWood (Risse & Richter, 2018)). One solution is cascading of wood (Hughes, 2019), meaning that the material goes through usage cycles through consecutive downcycling to maximize the duration of its availability in construction. An alternative approach is reusing material, which can further reduce the environmental impact of a building, as less energy is used for reprocessing (Kromoser et al., 2022). Designing within the constraints of non-standard components, however, requires changing conventional design and manufacturing processes (Moussavi et al., 2022), as explored by various research projects (Malé-Alemany et al., 2022, Circulating Matters, 2022). Most projects that deal with the circular economy in construction focus on working with elements reclaimed from demolished buildings. The problem of manufacturing waste, although significant, is not adequately addressed. These scraps are either downcycled (as biomass, panel board or animal bedding) or burned. This calls for developing new strategies to return the production waste to the construction cycle.

1.1.2. Data-driven approaches in architectural planning

In the face of growing complexity in the building industry (Kolarevic, 2009) and its low efficiency (McKinsey, 2016), new data-driven design approaches have recently been introduced, replacing the traditional, linear, and sequential project workflow (Alvarez et al., 2019). As stated by Brown and Mueller (2017), despite the widespread belief that architecture depends on human intuition, reasoning and creativity, data can complement or enhance human activities, for example, by helping to make informed decisions and to solve complex problems (Wei, Yuan & Liu, 2020). This method is used in multi-objective design processes, where an architect is guided by simulations that describe several aspects of building performance (Brown & Mueller, 2017). This data can be either used as guidelines in the next design decisions, without a direct impact on the generation of the geometry (Deutsch, 2015) or, as shown in the recent studies (Brown & Mueller, 2017, Bianconi & Filippucci ,2019), can be connected to the form-finding algorithms. In this case, data-driven design can effectively support the designer in problem-solving by comparing different generated design solutions. However, it requires constant human feedback and is still marked by computer performance problems.

Data-driven computational strategies have been also applied in production-aware design practice (Wei, Yuan & Liu, 2020, Figliola & Battisti, 2019). In these projects, data collected during manufacturing guide the architects in optimizing the design to improve the adaptability of products to the manufacturing environment. This approach is particularly beneficial when working with irregular materials (such as non-engineered wood) and when combined with structural goals, as shown in the Wood Chip Barn project (Mollica & Self, 2016). Here, the data-driven design, along with advanced computation fabrication techniques led to the construction of a stable truss with minimal processing of the original wooden trunks.

Only a few projects have attempted to generate building form by analyzing the shape of the available material (Monier, Bignon & Duchanois, 2013). One example is `Mine the scrap` by Nolte et al., (2016). The authors developed an algorithmic tool that scans scrap elements from demolished buildings and rearranges them into new architectural envelopes using pattern recognition, classification and machine learning. These forms defined by non-uniform stocks of material are characterized by a new architectural vocabulary. The challenge in these constructions remains, however, assembly and structural performance.

2. Materials and Methods

The proposed methodology enables the flexible design of structures from components with predefined dimensions and properties and facilitates their production and assembly. It is based on the concept of digital craftsmanship (Augustynowicz et al., 2021), manifesting itself in application of custom digital design tools and hybrid manufacturing system that intelligently combines automated and manual production to achieve economic feasibility and high aesthetic quality. The process consists of several prototypical digital and manual processes, which were developed independently and can be used in various configurations depending on the design task (Figure 2). All computational tools were written in the Grasshopper plugin for Rhinoceros with custom Python components. The robotic fabrication tool additionally uses KUKA|Prc plugin for planning of robotic paths.

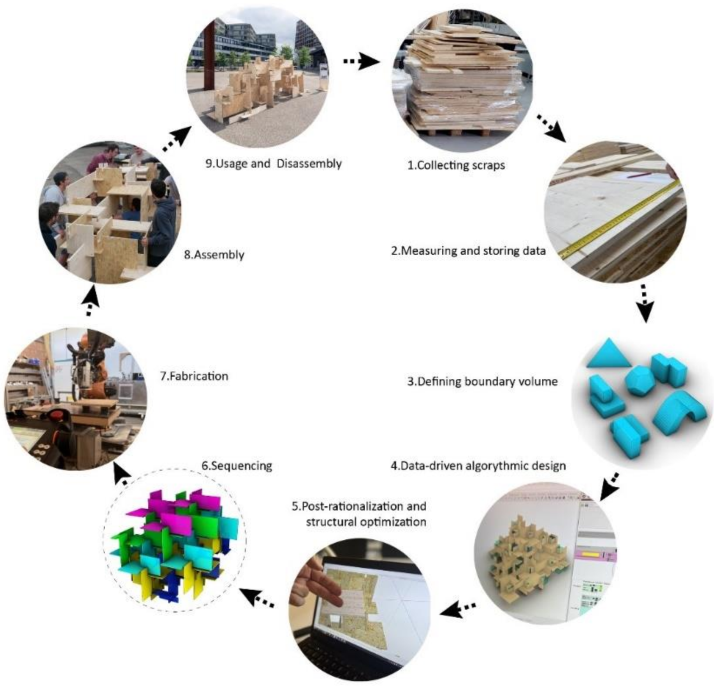

Figure 2. Proposed design, fabrication and assembly process in steps

2.1. Structural Principle

The main objective for developing the structural concept was to ensure the overall stability of the system, built out of irregular plates. The authors wanted to avoid generating more waste by cutting the scraps to specific dimensions. It was also crucial that the components return to the construction cycle after the project's lifespan by avoiding the use of additional adhesives or metal fasteners. An interlocking plate-based spatial reciprocal system was chosen as the best answer to these prerequisites.

Reciprocal Frame Structures (RF) are spatial configurations consisting of load-bearing elements, where each one supports, and in turn is supported by, all the others (Larsen 2014), with no clear structural hierarchy (Pugnale et al., 2011). The advantage of RF lies in the fact that they can cover large spans with small and lightweight components (Araullo & Haeusler, 2017) so that the assembly can be performed by people with little construction expertise and without the need for sophisticated machinery. Although most research focuses on exploring surface-based linear RF (Larsen, 2014, Thönnissen, 2014), planar components can also be arranged in a reciprocal arrangement, which has been applied in furniture design (Baverel & Pugnale, 2013) and has been explored recently in various projects (Araullo & Haeusler, 2017, Plate Pavilion, 2014). There are several approaches to working with planar RF (Baverel & Pugnale, 2013). The design principle chosen for this project is based on the solution developed for the Kodama Pavilion (Kuma et al., 2019). In this project the solid larch slabs of uniform size were organized in an interlocking manner around nodes (Figure 3a).

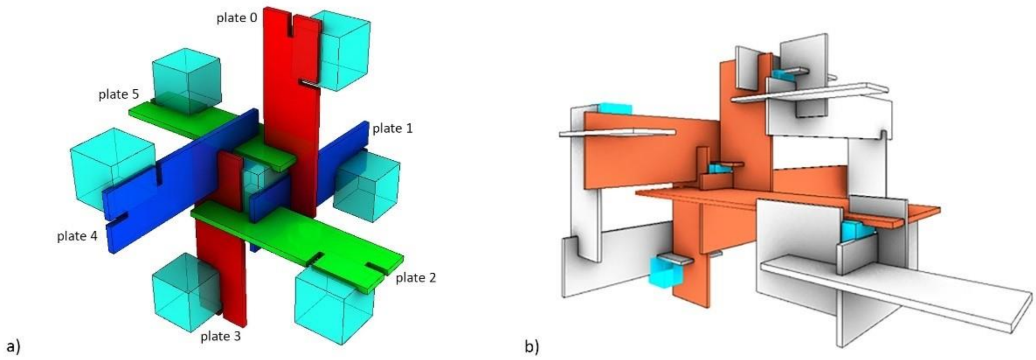

Figure 3. Connection principle. Each node is built out of 6 interlocking plates in 6 directions. a) a single node with uniform interlocking plates (Kodama pavilion). Cyan blocks symbolize the nodes around which the plates are organized. b) the second generation of structure with irregular plates

Every plate has two nodes in diagonal corners, where each is a starting point for the subsequent aggregation. To ensure stability, every member must have at least two and optimally four connections to neighbouring elements through a system of notches. In the project described here, the individual components were of a non-repetitive size, which posed a challenge in providing each board with sufficient intersections while avoiding unwanted overlaps (Figure 3b). Therefore, an advanced data-driven algorithmic approach for aggregation of plates has been developed.

2.2. Material

During the project, the authors collaborated with a local wood construction company, which provided waste panels from its production accumulated over a month: 1.5 tons of heterogeneous cut-offs both in dimensions (length:50-100cm, width:20-70cm, depth:1.8-4.2cm) and properties (OSB and layered panels) (Figure 4).

Figure 4. Material used in the project: 1.5 tons of cut-offs irregular in dimensions and properties, received from a local wood construction company, ERNE AG Holzbau

Roughly half of the available plates were measured manually and logged in a CSV file. Out of the 350 measured plates, over 90% were OSB and the remaining plates were three-layer panels. A statistical overview of the material dimensions is provided in Figure 5. The available material resources were very heterogeneous. Plates with a width of around 250-300 mm were particularly common, while the lengths were relatively evenly distributed between 300 and 1000 mm. The distribution of thickness reflects plate types commonly used in construction. It is noteworthy that the authors were dealing with aspect ratios that were from close to square up to long strips that were almost four times as long as they were wide.

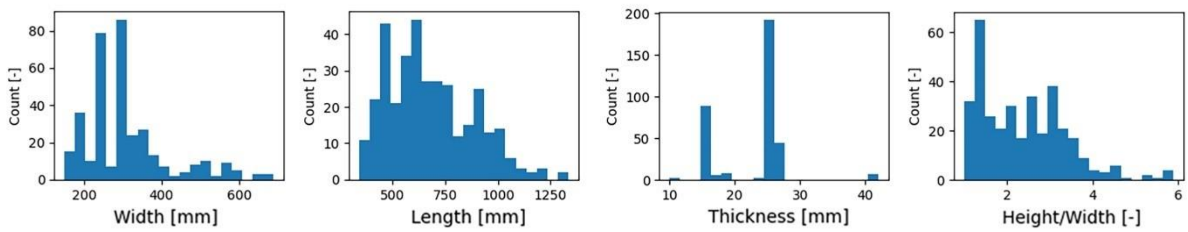

Figure 5. Distributions of the dimensions and aspect ratios of the material used in the project

2.3. Data-driven design approach

This data collected from board measurements was then fed into an algorithm, which organized the scraps into user-defined boundary volumes according to the structural principle described earlier (Figure 6).

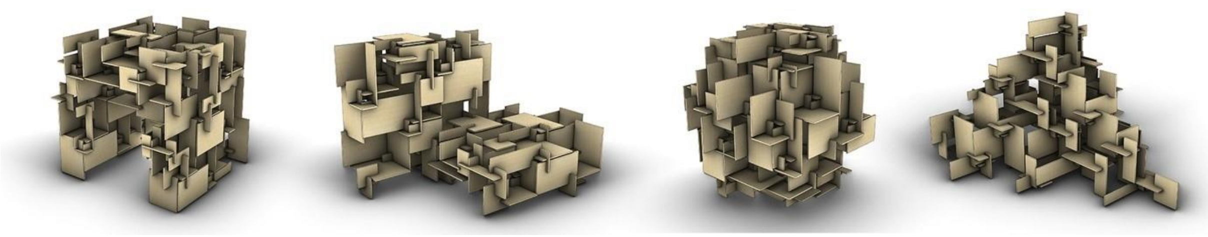

Figure 6. Results of the plate aggregation algorithm for different, user-defined, boundary volumes

Users can indirectly influence the placement of plates in the volume by parametrically adjusting the weights assigned to their width, length, or depth, which define the order of elements in the database and prioritize their selection in subsequent iterations of the program. The proportion of employed elements and the porosity of the structure are controlled by several numerical parameters: the node size, the distances between plates and the depth of the notches. The optimum node size should allow for sufficient intersection length between plates and correlate with the dimensions of available material (Figure 7).

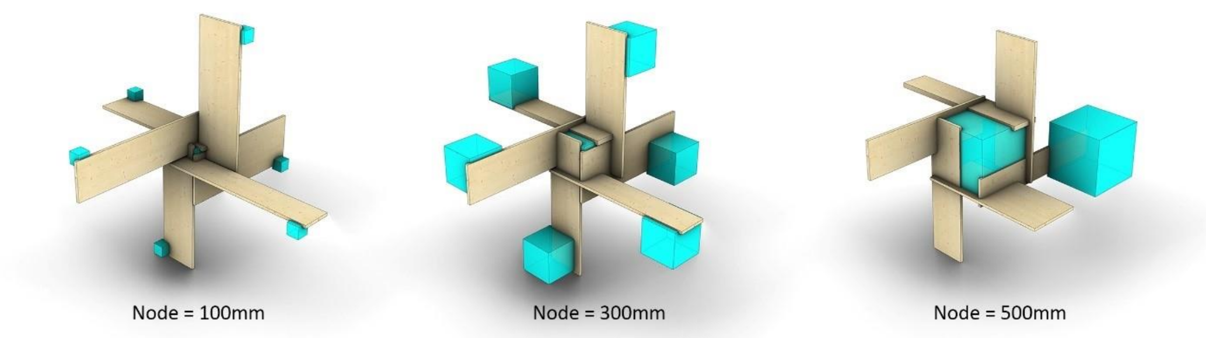

Figure 7. Influence of the node size on the interconnection between the plates. The size of the nodes should be adjusted to the dimensions of the available plates in the set. In the depicted example node = 100mm would not ensure enough of intersection surface, whereas node = 500mm is too big for the given set and would stop the aggregation in the second iteration

A Python-based custom algorithm carried out the distribution of plates and initial optimization of the structure. It stores data tree for nodes, a nested list containing six items for each plate orientation relative to a given node, and another one with meshes defining a collision-free zone for each element. The aggregation process is iterative, where the number of iterations influences the density of the structure. In each loop, the algorithm distributes plates around the available nodes from the data tree in such a way as to allow intersections with already placed elements at the neighboring nodes and simultaneously reach the limits of the boundary volume. Each added plate introduces another node into the data set, located at its opposite end. The optimal number of iterations enables sufficient intersections between the scraps while keeping the number of elements within a reasonable range (Figure 8).

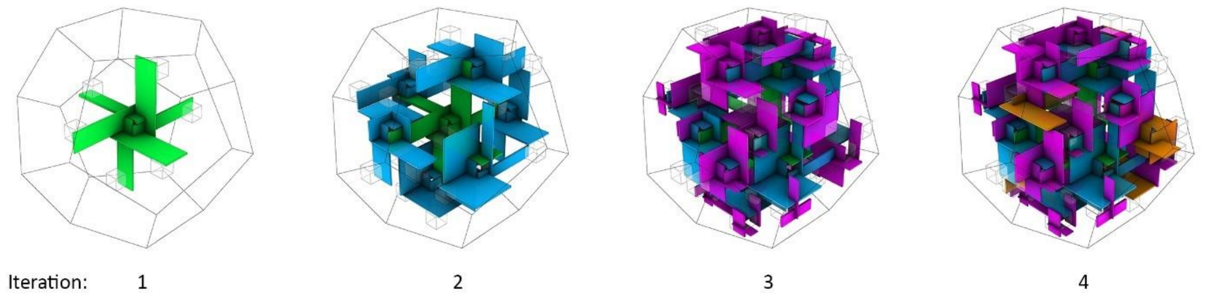

Figure 8. The iterative process of generation of the plates within the predefined boundary volume. The nodes mark the position of the next iteration

However, as the dimensions of elements are diverse, the program's biggest challenge is providing each board with at least two connection points while avoiding joints impossible to assemble. Several means have been introduced to address this issue. After each iteration, the script performs self-checking and automatically removes those boards with insufficient support points. In addition, the geometry is post-rationalized after it is generated when the user manually removes those elements that overlap or adds additional supports to ensure sufficient connections to the base. For this purpose, another script was written to find the best-fitting item in a given location from the data file, excluding already used elements.

Notches between the plates are automatically generated based on their respective geometries and assumed tolerances for fabrication and assembly.

The current implementation of the generating algorithm does not perform any checks regarding the integrity and static properties of the finished structure. Therefore, the design was exported to RFEM software for finite element analysis (FEA). Material properties and joint stiffnesses were approximated, thus no quantitative results on stresses and deformations were obtained. However, this analysis allowed us to identify areas of concern, which were then supported with additional plates from the material catalogue (Figure 9). Based on this analysis, 4 plates were added to stiffen the structure.

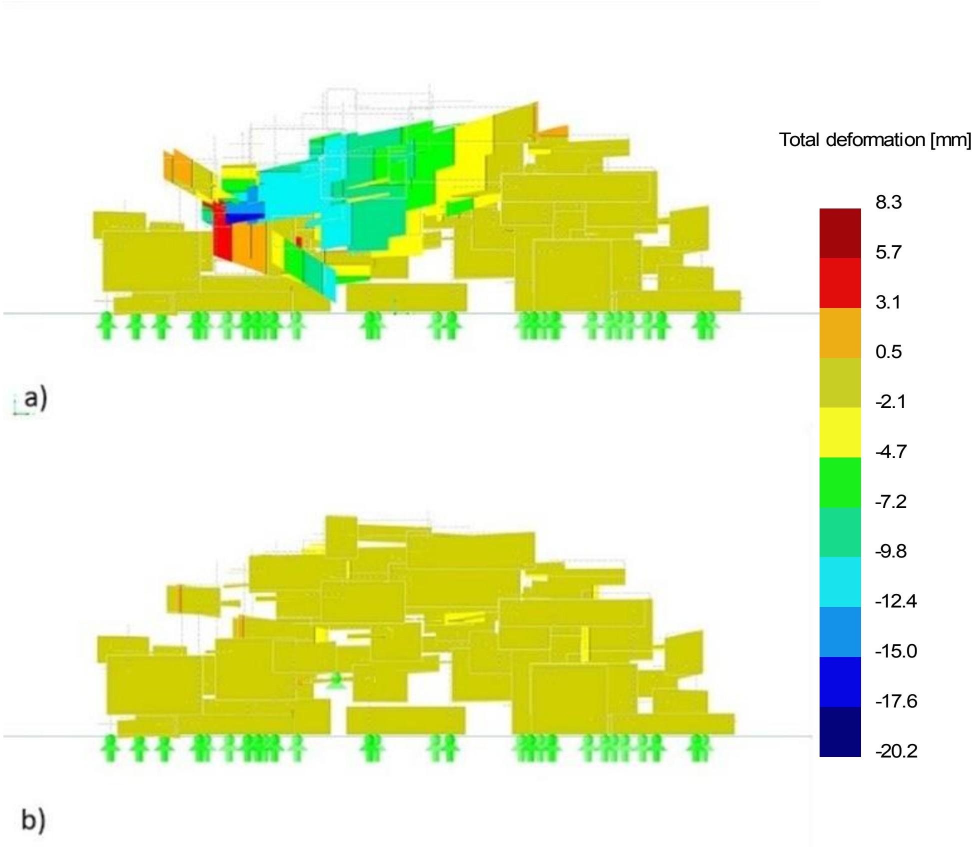

Figure 9. Finite Element Analysis of the structure: a) deformation of the structure in the original form, large deflections can be seen in the centre left of the structure. b) reduced overall deformation after adding additional support

2.4. Fabrication

In order to compare a manual and an automated process, roughly half of the plates were processed using conventional hand tools (Figure 10a). The other half was milled on an industrial robot (KUKA KR 60 HA, Figure 10b) equipped with an HSD E919 spindle. All milling was performed with an 8 mm 2 flute roughing carbide endmill. Plates thinner than 25 mm were milled in a single pass, while thicker plates were milled in two passes. We used a feed rate of 100 mm/s at 24000 RPM. For work holding, we used the Schmalz Innospan vacuum clamping system on a 1200 x 800 mm raster table. The vacuum cups had to be repositioned for almost every board – this process was facilitated by printing 2D plans of every workpiece. The boards were positioned by aligning two edges with a laser cross projected on the raster table.

Robotic path planning was performed directly in Rhino/Grasshopper using the KUKA|PRC plugin. This custom script translated a Brep geometry of the plates to fabrication data. The fabrication relevant attributes are bit size, location of the notches and thickness of the plates, which define the number of milling steps. The generated KRL code was exported and transferred to the robot controller, where the appropriate program for each board was executed.


a) b)

Figure 10. Manual cutting (a) versus robotic milling (b) of the notches.

2.5. Sequencing and assembly

The complex nature of the structure required the development of an algorithm to categorize the plates according to their assembly sequences. The basic logic is as follows - since the notches between the plates are always orthogonal (X, Y or Z), the structure is divided into layers in which all elements are connected horizontally (X and Y). Thus, the connection between consecutive layers has only one vertical direction. This is necessary for simultaneous connecting multiple plates in sliding motion (Figure 11). However, due to the irregular geometry of the components, the order of assembly had to be further adjusted by hand in more complex layouts.

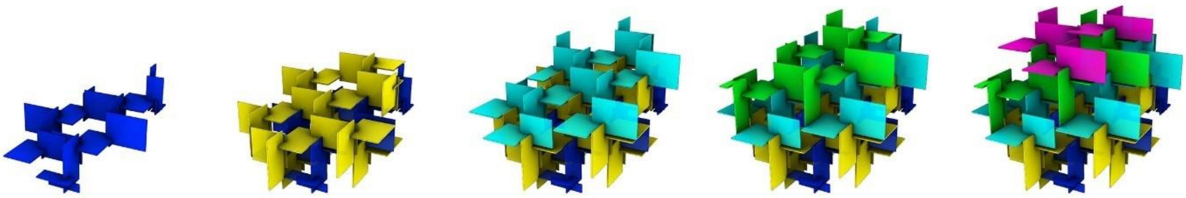

Figure 11. Clustering of a structure into construction layers. To ensure that the design can be assembled, all panels within a layer are joined together horizontally (in X or Y direction). The segments must then be connected vertically

Both constructed demonstrators were manually assembled by students with carpentry backgrounds on-site in a collaborative effort. As far as a digital model with tags and separated construction sequences proved essential to the process, the need to look at the screen to place the individual members in the correct location was suboptimal (Figure 12a). To address that problem, during the workshops, the students tested a Microsoft HoloLens system with software provided by Tecslot. It was concluded, however, that the technology failed in the case of multi-agent collaboration, where immediate communication and feedback are necessary (Figure 12b).

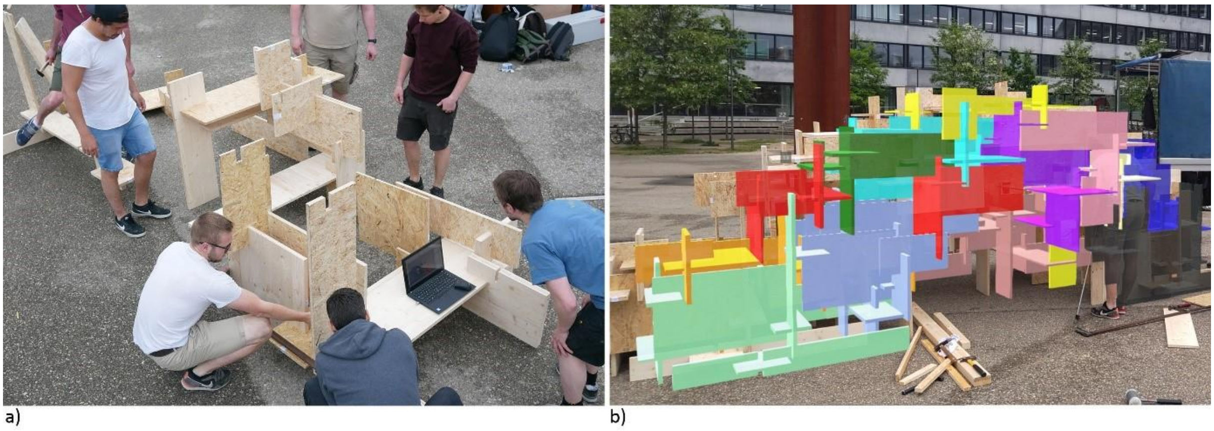

Figure 12. Manual assembly of the structure. a) collaboration between multiple builders, during which the position of the plates was checked on a monitor screen. b) Unsuccessful test of using Microsoft HoloLens during assembly

3. Findings and Discussion

3.1. `Structure from Scraps`: temporary pavilion for the ArchitekturWoche Basel, 2022

The first application of the described methods was a temporary pavilion designed and constructed by 13 bachelor students from Bern University of Applied Science within a 1-week long workshop for the ArchitekturWoche in Basel. The workshop task was to construct the possibly largest structure with a maximum of 150 plates. The final pavilion had a form of a quarter of an ellipsoid of dimensions 5.7mx2.4mx2m, with a spherical void in the centre and consisted of 142 plates (Figure 13).

Figure 13. Temporary pavilion constructed during week-long workshops with bachelor students from BFH for Architektur Woche Basel. (Photos courtesy of ARCHIBATCH)

This design resulted in a very porous space, where most of the components had only 2 points of support. The structure was divided into 13 construction segments, consisting of 5 to 20 elements (Figure 14), which were partially preassembled before the transportation to the final location. On-site the structure was assembled within just 2 hours. The efficiency achieved during the workshop in design, fabrication and assembly exceeded the authors' expectations.

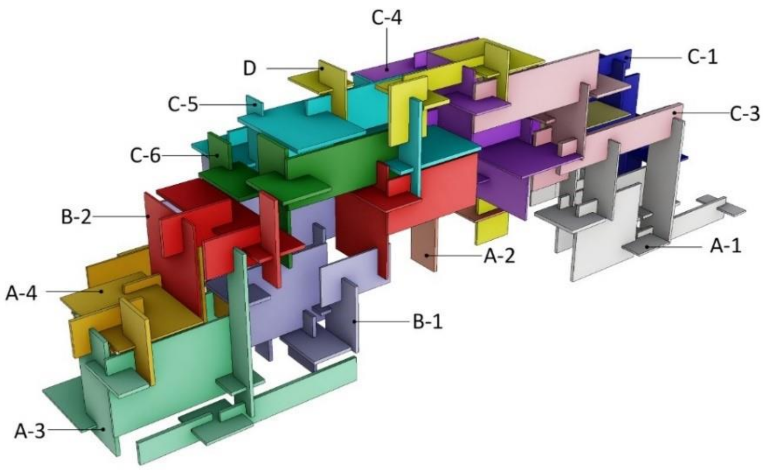

Figure 14. Division into 13 construction segments of pavilion in Basel, each consisting of 5 to 20 individual elements

3.2. Three wood-clay sitting elements for Touch Wood Exhibition, Zurich, 2022

The second demonstrator was three wood-clay sitting elements, produced in June 2022 in collaboration with ERNE AG Holzbau for the TouchWood Exhibition in Museum ZAZ Bellerive in Zurich (Figure 15). This project focused on exploring the potential of hybrid material, where both components stem from a renewable origin, with digital design and fabrication tools. The clay plinths were construction waste from the production of the new office building of ERNE AG Holzbau. They were fabricated robotically at the newly established facility of the company (Figure 16a). Each of these massive blocks measured 2.26mx0.35mx0.85m, weighed around 900kg, and was transported on-site with a crane. Due to the delicate nature of the material and uneven ground, the top surface of the blocks had to be manually levelled after positioning them in the final location (Figure 16b).

Figure 15. Wood-clay sitting elements for the Touch Wood exhibition in museum ZAZ Bellerive in Zurich

a) b)

Figure 16. a) Robotic production of clay blocks at ERNE AG Holzbau; b) manual levelling of the top surface of the clay plinths before the assembly of the wood plates

The 68 pieces of 3-layered boards of uniform depth (27mm) and varied width (0.2m-0.9m) and length (0.3m-1.65m) were arranged around the blocks in such a manner that they protected their top surfaces from rain while the clay plinths provided support for the wooden plates. The design process required increased manual control, so each node was generated separately in just one, maximum of two iterations. Due to the structural requirements, each plate had, on average, four points of support, which resulted in a much denser structure and complicated sequencing. The wooden elements were assembled on-site within seven hours by three workers. Although the plates did not need any foundations, their bottom had to be adjusted to the correct height to compensate for the sloping, uneven terrain during assembly.

3.3. Discussion

The built demonstrators represent a successful validation of the proposed methodology for building from manufacturing waste of irregular size and properties. Both structures were received very positively by the visitors at these events. Its irregular shape encouraged people of all ages to playful spatial explorations (Figure 17). The algorithmic design organized the heterogeneous components in an optimal manner but required significant manual adjustments to guarantee stability and assembly of the structure. While the reuse of waste materials for construction has been explored in literature (e. g. Bolden et al., 2013, Purchase et al., 2022) and shown to be ecologically and economically viable, mostly the reprocessing of bulk materials has been investigated so far. This approach often involves significant processing to produce materials for the use with technologies like large scale 3D printing (Dey et al., 2022, Patti et al., 2022). Our approach is new in that it attempts to make use of the materials' shape with minimal changes.

A comparison of automated and manual notch fabrication favored the robotic approach. Although it took significant time to prepare, it outperformed the manual process in terms of processing speed and, more importantly, precision. The manual assembly of the structures was very efficient, partially due to the workers' high level of carpentry knowledge. The current process requires coordination between installers and validation of each component's position in the 3D model, which leaves room for improvement. The tested AR assembly with Microsoft HoloLens was too slow and inaccurate. Since the students only worked with one device, group collaboration was impossible, which was of great importance in the case of the pavilion. We thus faced some of the issues as outlined by Daling & Schlittmeier (2022), we do, however, expect the technology to advance in the future to become more viable for our purposes.

Figure 17. Usage of the project demonstrators. This type of structure enhances people of all ages to explore them in various playful ways. Left: Temporary pavilion in Basel, right: Wood-Clay sitting element in Zurich

4. Conclusion and Suggestions

The project is the first step in a longer study focusing on data-driven design, manufacturing and assembly strategies for reusing wood waste. The study found that the challenges of working with non-standard building elements create complexity not yet encountered. This requires more integral planning from the early stages of the project and more advanced design and fabrication strategies to deal with the induced complexity. It is interesting to note, however, that while the design approach heavily relies on digital tools, fabrication and assembly can also be performed manually. Therefore, it is concluded that this approach has an exceptionally high potential for use in lower-income areas without access to expensive machinery and new resources.

Future research steps will test assisted assembly strategies that allow for greater collaboration between builders, automated, image-based techniques for measuring the elements and hybrid material systems. Another potential improvement will be advancing the algorithmic design process to create more interactive and structurally informed assemblies without requiring manual adjustments. There are plans to publish the software as open source, opening up the potential of using it in areas where such an approach would enable construction of functional structures. In terms of design, an additional investigation must ensure the structure's safety and durability for long-term public usage.

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Author Contribution and Conflict of Interest Declaration Information

Author's contribution: 1st author: 75%, 2nd author: 25%. There is no conflict of interest.

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Concept of Co-Living and its Application: The Case Study of Padova

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Abstract

Today, factors such as rapid and unplanned urbanization and high living costs shape the concept of housing. The concepts of co-housing and co-living emerged with the desire to reduce the living costs of individuals in the city and to have a social life by becoming a part of a small community, which are offered as potential solutions to high living costs in densely populated areas. The co-housing model aims to provide a minimum standard of living for singles, students or professionals. In this study, adequacy analyzes were carried out in terms of the user requirements of a residential flat in the city of Padova, Italy, where 6 individuals aged between 20-25 years lived between 2021-2022. The study is aimed to identify the deficient aspects of housing in terms of user needs and to guide the professionals who will design this type of housing in the future. As a result of the study, it was determined that co-living is ideal for young singles in terms of their user requirements, especially for short-term accommodation in their abroad experience.

Keywords: *Padova, co-housing, co-living, co-living, user requirements.*

Birlikte Barınma Kavramı ve Uygulaması: Padova Örneği

Öz

Günümüzde hızlı ve plansız kentleşme, yüksek yaşam maliyetleri gibi faktörler barınma kavramını şekillendirmektedir. Ortak konut (co-housing) ve birlikte barınma (co-living) kavramları yoğun nüfuslu bölgelerde yüksek yaşam maliyetlerine potansiyel birer çözüm önerileri olarak sunulan, bireylerin kent içerisindeki yaşam maliyetlerini azaltmak ve küçük bir topluluğun parçası haline gelerek sosyal bir yaşama kavuşma isteğiyle ortaya çıkmıştır. Birlikte barınma modeli bekârlar, öğrenciler veya profesyoneller için asgari bir yaşam standardı sağlamayı amaçlamaktadır. Bu çalışmada İtalya'nın Padova şehrinde birlikte barınma özelliğine sahip, 2021-2022 yılları arasında yaşları 20-25 yaş aralığında 6 bireyin yaşadığı konut tipindeki bir dairenin kullanıcı gereksinimleri bakımından yeterlilik analizleri yapılmıştır. Çalışma ile birlikte barınmanın kullanıcı gereksinimleri açısından eksik olan yönlerinin tespit edilip ileride bu tip konutları tasarlayacak meslek insanlarına yol göstermesi hedeflenmiştir. Çalışma sonucunda birlikte barınma (co-living) kavramı, genç bekarların özellikle yurt dışı deneyimlerinde kısa süreli barınmaları için kullanıcı gereksinimleri açısından ideal olduğu tespit edilmiştir.

Anahtar kelimeler: *Padova, birlikte barınma, ortak konut, kullanıcı gereksinimleri.*

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1. Introduction

The challenge of shelter has begun with the emergence of humanity on earth. Throughout history, the qualities of the shelters/housings he used and built to meet his needs have changed. But what has not changed is the need for him a "Place to lay his head" (Önver, 2016). Housing is not only defined area within the physical environment, but also a cultural product (Kan Ülkü, 2018). The fact that people spend most of their time outside their homes and the loss of time in transportation in crowded cities has encouraged users to calculate their basic needs at home with minimum dimensions (Tavşan & Bektaş, 2022).

Housing, which has been one of the common concepts for human beings from the past to the present and has various meanings, expresses more than just the structure that brings together stone, brick and other materials that undertake the function of shelter. The type of building that forms the interface between private spaces belonging to individuals and society is defined as housing (Acar, 1999). Housing is the first type of building that has emerged since the day human beings existed on earth. The housing concept began in the tree and rock hollows, developed in the process, and reached today with the modern housing. The process of change and evolution within houses has never ceased and continues to evolve today (Salihoğlu, 2001).

The terms “Co-living” and “Co-housing” are two interrelated concepts presented as potential solutions to high living costs in densely populated areas (Ehrenberg & Keinanen, 2021). McCamant and Durrett (1989) defined the term “Bofællesskab”, which means living community in Danish, as co-housing in their published communal housing book (Beck, 2019). Szypulski (2016) defines the concept of shared housing as inclusive housing for all people with and without disabilities. Therefore, describes shared housing projects as predominantly community based. In this lifestyle, users share a social life based on community activities, mutual aid and a reliable neighborhood phenomenon. Osborne (2018) defines communal living (co-living) as a form of rental housing that aims to create community among users by providing features such as community managers, paired with large communal spaces and typologically small and furnished private spaces. Moreover, it has been determined that the lack of sufficient research on the common living typology causes the designers not to adhere to a certain principle while designing the common living spaces and to make different applications.

Co-housing structures is a residential project planned for the first time outside of Copenhagen, Denmark in 1972 by 27 families who wanted to experience a greater sense of community alongside the possibilities offered by suburban subdivisions or apartment complexes (McCamant & Durrett, 2011). Co-living first appeared in newspaper advertisements in 2011 and 2012, when the housing need of technology workers arose during the rise of Silicon Valley, but it has been heavily taking part in people's lives since 2016 (Steding, 2019). There is a graph of the searches on the concepts in the Google search engine since 2010 (Figure 1). In accordance with the data, it was seen that the concept of co-living decreased during the pandemic period and increased again in the last two years.

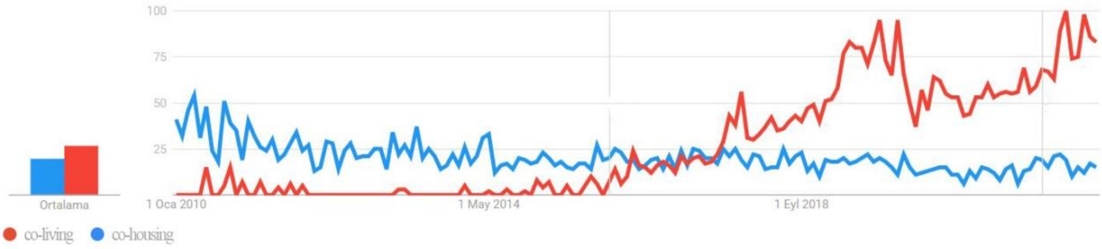

Figure 1. Google trend analysis of the words Co-living and Co-housing after 2010 (Google Trends, 2022)

Another difference between the concepts of co-housing structures and co-living is the ideological motivation. While the definitions of co-housing are often based on feminist discourses such as cleaning services, maintenance of common areas, and equality of labor in these fields, co-living is a market solution created by companies or landlords that can offer similar services as specified. Co-living aims to provide a minimum standard of living for singles, students or professionals (Ehrenberg

& Keinonen, 2021). Co-living is associated with individuals having better life opportunities in smaller spaces and increasing their level of well-being. The community in a residence should not be more than 8 to 12 people to establish and maintain these values, because individuals in small communities can get to know each other in a shorter time establish friendships and have a sense of belonging to the place (Steding, 2019). In other words, co-living is a leaseable place where a group of people live under the same roof but each person in the residence has a contract independent of the other. Residences rented in this group usually have single rooms with private or shared bathrooms and have common areas (laundry, library, gym, etc.) where people can eat and interact. University students, professionals working in precarious jobs, the need for a dynamic and flexible lifestyle, low income, and increasing housing rents have given birth to this new lifestyle (DoveVivo, 2022a). The concept of co-housing structures was brought up for discussion at the international conference on co-housing structures held in Stockholm in 2010 (Vestbro, 2010). The concept of co-living was not fully expressed in those years but was expressed under the heading of co-housing structures until 2011. To measure the suitability of co-living, the spaces in the residence must meet the basic requirements for the people living in that place (Steding, 2019; Ehrenberg & Keinonen, 2021).

Throughout history, individuals have needed settlements to survive, ensure their security and meet one of their basic needs, which is shelter. These basic needs are expressed in a pyramid form within the scope of Maslow's hierarchy of needs. Maslow addresses the basic needs in a certain order, stating that the only way for individuals to move to the upper level is to meet the needs at the lowest level (Çoban, 2021). To date, researchers have determined different classifications for user requirements. Buğday (1991) and Gül (1993) classified user needs under two main headings as physical and psycho-social needs. Then, they divided the physical user needs into 4 sub-headings as spatial, health, physical environment and security. Psycho-social user needs are grouped under 4 subheadings: privacy, behavioral, aesthetic and social (Korur, Sayın, Oğuzalp & Korkmaz, 2006). Spatial requirements are primarily to respond to the dimensions where individuals can perform their actions (individually or collectively) in accordance with the variability of the number of users. Furthermore, it should have features such as dimensional ratio, color, and lighting suitable for the number of users that will provide psychological comfort to the users in the space (İmal, 2009). Health requirements are the whole of the measures taken to prevent all the negative factors that will affect the health of the users in the space. At the beginning of these factors is the proper discharge of sewage, garbage and other wastes, and then ensuring the air quality in the space, and the supply of clean water (Korur, Sayın, Oğuzalp & Korkmaz, 2006). Physical environmental requirements are to create a visual and acoustic comfort area in the space and to provide appropriate temperature control and humidity balance in accordance with the number of users. On the other hand, the safety requirements consist of measures to be taken against basic risks such as the strength of the structure of the apartment against fire and other disasters that may occur there (Bekar & Koç Altuntaş, 2021).

Psychosocial requirements are the minimum conditions required for users to be able to perform their actions in space without experiencing any negativity and without feeling uncomfortable. The privacy requirements are providing the users with visual, auditory and social privacy conditions both within the space and with the immediate surroundings it is in. The concept of social privacy tried to be explained here is that the user can protect the social privacy (secrecy) between him/her and other individuals in the space he/she is in (Bekar & Koç Altuntaş, 2021). For aesthetic requirements, first of all, the minimum conditions of all basic physical requirements for individuals must be met within space. Aesthetic requirements are creating values related to visual effects such as color and texture in spaces, designed with aesthetic concern to ensure that the users are psychologically satisfied in spaces that meet these conditions at a minimum (Korur, Sayın, Oğuzalp & Korkmaz, 2006). Behavioral requirements are subjective judgments that can vary depending on the wishes and psychology of the users. This type of requirement consists of subjective phenomena such as the thoughts of the users when they enter the space (such as the space being large, having high ceilings or having too many windows), and the expectations of the individuals from the space. Social requirements are the reflection of the relations of the users with each other in space (Bekar & Koç Altuntaş, 2021).

Special standards have been established by calculating the physical space requirements of the users for new buildings to be built in European countries and for buildings to be renovated. As stated by Yunitsyna (2014), the average of the mandatory standards for living spaces in the housing standards of 31 European countries and 7 regions was taken and the minimum dimensions that the most common user spaces should provide were determined (Figure 2).

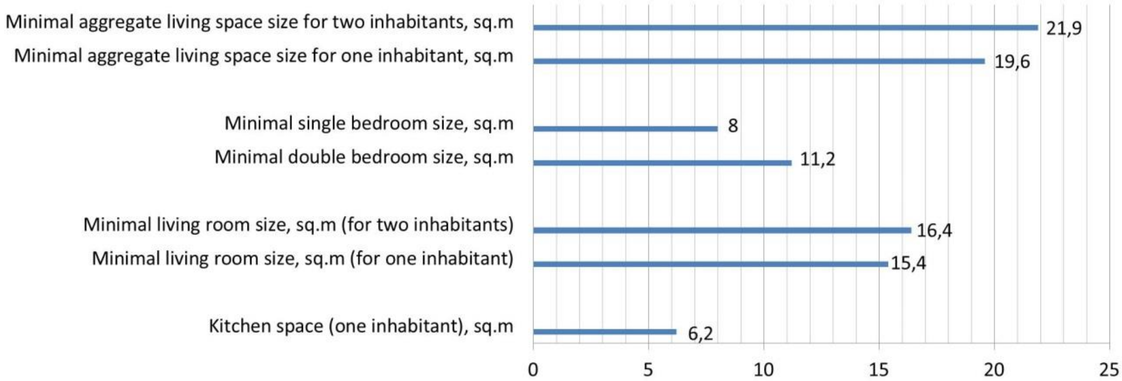

Figure 2. Minimum living spaces according to European housing standards (Yunitsyna, 2014)

As a result of Yunitsyna's (2014) study, he classified the size of the space according to the function numbers it contains in European House Standards. Accordingly, these standards,

- If it is between 15.4 m^2 and 16.4 m^2, that place is universal,
- If it is between 11.2 m^2 and 15.4 m^2, it can have 3 functions,
- If it is between 8 m^2 and 11 m^2, it can have 2 functions,
- If the area of the place is less than 8 m^2, that place is specialized it can only exist within 1 function.

This study aims to determine the suitability of the co-living concept in terms of the basic requirements of the residential users by examining the floor plan of the apartment for six people located on the second floor of the Ospedale Civile building of DoveVivo Company in the Veneto Region of Italy (Figure 3).

Figure 3. Map of Europe, Italy and Padova (Turismoitalia, 2022)

2. Material and Method

2.1. Material

As the material of the study, a 6-person apartment on the second floor of the Ospedale Civile building owned by DoveVivo Company in Padova, Italy, was chosen (Figure 4).

Figure 4. Ospedale Civile Building, Furnished Plan for 6 Person

There are several factors in choosing this apartment. This communal lifestyle, which mostly appeals to young professionals and students, further highlights the location of the building. The fact that the building is located in the historical city center of Padova and close to the hospital and school districts (Figure 5) is one of the important factors in choosing the apartment.

Figure 5. Workspace enviromental analysis (adapted from Google Maps, 2022)

Another reason for choosing the apartment is that a historic building was recycled and reintroduced to the city. This building (Figure 6), which used to be a religious boarding school, was transformed into a structure consisting of all shared apartments by DoveVivo company in 2021 by preserving its exterior and renovating its interior and plumbing systems.

Figure 6. Ospedale Civile Building, old view (Google Earth, 2022)

There are 12 shared apartments in total in the renovated building. The number of users of the apartments in the building may vary. Apartments are designed for 4 to 7 people. At the rear of the building, apart from the bicycle and parking areas (Figure 7), there is another single-storey building independent of the main building. There are three shared apartments in this independent building (Moranduzzo, 2021).

Figure 7. Ospedale civile building, current view (DoveVivo, 2022b)

In Italy, there are sanitation provisions as a factor in determining that buildings are habitable by governments. The selected building is deemed suitable according to the living space sanitation provisions of the Italian Government.

Sanitation is the definition given to the whole of the work done to protect the health of individuals and to ensure hygiene in societies. Sanitation provisions include the basic principles to be applied for protecting and improving the user's health, and in the case of loss of health, in the recovery (Şimşek, 2014). There are different sanitation provisions according to the conditions of each country. While there is the provision of "TS13811 Hygiene and Sanitation Management System" in Türkiye, the "Main Sanitation of Living Spaces" legislation of the Ministry of Health with the 5 July 1975 date is applied in Italy (Anonymous, 2022).

The last factor is that DoveVivo is Europe's largest co-living company in terms of room and revenue (3 Countries, with 10,000 rooms in 15 cities) (DoveVivo, 2022c). The mission of the company coincides with the concept of co-living. Within this context, the company expresses its main purpose as follows; "*We aim to create a platform where individuals can connect with a local and international community as long as they want, by making use of personalized services in an all-inclusive life module. Whether users have moved to a new country for professional reasons such as education, work, or for personal reasons, the company's aim here is to provide individuals with a good living experience while they are getting to know a new country*" (DoveVivo, 2022c).

2.2. Method

This study consists of five stages. In the first stage of the study, one of the authors between the years 2021-2022 first experienced the lifestyle in the apartment, as the study material. In the second stage of the study, the suitability of five clauses related to accommodation, which is one of the living space sanitation provisions put into effect by the Italian Government in 1975, for the apartment as the material of the study was examined (Table 1).

In the third stage of the study, separate building surveys of the common and individual spaces of a shared apartment were taken and the layout plans were drawn in the AutoCAD software. Each place has been examined according to the functions consisting of 6 parameters in accordance with the information obtained from the literature (Table 2). The functions of the spaces are defined within the context of these 6 headings provided. These functions are respectively working, sitting, sanitation, social environment, sleeping and eating.

In the last stage of the study (Table 3), in the light of the information obtained from the literature, two basic principles of user requirements, the physical and the psycho-social requirements and the adequacy status of the spaces were evaluated within the scope of the sub-parameters of this principle. Physical user requirements were examined in four sub-parameters: spatial, health, physical environmental conditions and safety. Psycho-social user needs are discussed under four headings: privacy, behavioral, aesthetic and social. The tables in the second and third stages of the study were created as a result of the observations and analyzes that were personally experienced between the years 2021-2022 in the apartment, which is the material of the study, and the method flow diagram of the study is provided in Figure 8.

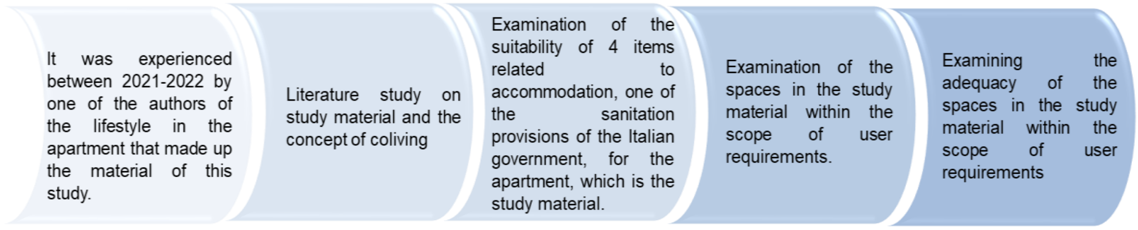

Figure 8. Method flow chart

3. Findings and Discussion

In the study, firstly the suitability of 5 clauses related to accommodation, which is one of the living space sanitation provisions put into effect by the Italian Government in 1975, was examined in terms of the floor plan of the apartment as the material of the study (Table 1). It has been determined that the apartment is in accordance with 4 clauses.

Table 1. The living space sanitation provisions issued by the Italian Government in 1975, 5 articles related to accommodation (Anonymous, 2022)

Article No	The Content Of The Substance	Suitability of the apartment
2.1	For each user, a minimum living area of 14 m², for the first 4 users and no less than 10 m² for each subsequent user must be provided.	Suitable
2.2	The bedrooms should be at least 9 m² for single people and a minimum of 14 m² for two people.	Suitable
2.3	Each accommodation must have a living room of at least 14 m².	Unsuitable
2.4	Bedrooms, living room and kitchen should have a pop-up window.	Suitable
5.1	All rooms of the accommodation unit, except for rooms reserved for toilets, corridors, stairs and storage areas, must have natural lighting suitable for the purpose of use and direct lighting.	Suitable

In Table 2, the concept of co-living was examined within the scope of their functions. Because of the examination of the apartment within the scope of their functions, it has been concluded that the spaces contain more than one function, regardless of whether they are for individual or shared use. The kitchen and balcony direct the users to activities that enable them to act collectively with other individuals (working, eating, etc.) and at the same time turn into social spaces where individuals spend time together. Shared bathrooms 2 and 3 can no longer be spaces where users only see sanitation, such as washing, but can also turn into spaces where female users can socialize by dyeing each other's hair. Since they are common spaces, the cleaning of the bathrooms is carried out by the users in the order they determine or jointly. If we take the functions of individual spaces into account, it is possible to say that they mostly have the same functions. Apart from working, sitting and sleeping functions, also different functions are seen for room 1. Since Room-1 has a bathroom that is only used by its user, sanitation processes are also included in the room. It has been determined that all the spaces in the examined apartment have been renewed in accordance with the articles 2.1, 2.2, 2.4 and 5.1 of the living space sanitation provisions put into effect by the Italian Government in 1975 regarding accommodation provided in Table 1 and it does only not fulfill the obligation in the article 2.3 of the same provisions. In the examined flat, there is no requirement to have a living room of at least 14 m² in each flat specified in article 2.3. In the examination, it was seen that the individuals met their living room needs from the kitchen and balcony. Moreover, Yunitsha (2014) determined that the kitchen area should be at least 6.2 m^2 per person and accordingly, the kitchen should be 37.2 m^2 for an apartment used by 6 people. The existing kitchen of the flat is 18 m^2, which is insufficient by European standards. According to European standards, a single bedroom should be at least 8 m^2 (Yunitsha, 2014). Each room within the scope of the study meets this criteria, but the provision in the same study indicating that if the width of a room is between 8 and 11 m^2, it only accommodates two functions, does not meet the standard (Room 2-6). The residents of the Rooms in Room 2, Room 3, Room 4, Room 5 and Room 6 perform their functions of sleeping, working and sitting. Regarding Room 1, which is 14 m^2, was again indicated to have three functions according to the average of the European standards, but it was experienced that the Room 1 was used for sleeping, working, sitting and sanitation functions.

Table 2. Inspection of the apartment in the scope of their functions

		PLAN	m^2	FUNCTIONS
COMMON SPACES	Kitchen		18 m^2	• Working • Sitting • Social environment • Eating
	Corridor		11.2 m^2	• Social environment
	Balcony		10.3 m^2	• Working • Sitting • Social environment • Sitting
	Bathroom - 2		3.8 m^2	• Sanitation processes • Social environment
	Bathroom - 3		4.9 m^2	• Sanitation processes • Social environment

INDIVIDUAL SPACES	Room - 1		14 m²	• Working • Sitting • Sanitation processes • Sleeping
	Room - 2		11 m²	• Working • Sitting • Sleeping
	Room - 3		9 m²	• Working • Social environment • Sitting
	Room - 4		9 m²	• Working • Sitting • Sleeping
	Room - 5		10 m²	• Working • Sitting • Sleeping
	Room - 6		11 m²	• Working • Sitting • Sleeping

If we analyze the adequacy status within the scope of the user requirements of the apartment, it is observed that the individual spaces are more adequate than the common spaces (Table 3). If we consider user requirements under two main headings physical and psycho-social needs, physical needs are examined according to whether the physical conditions in the space are sufficient for the user and whether they can meet the physical requirements of individuals.

When we conducted a spatial adequacy analysis by considering all the requirements in common spaces (balcony, corridor, kitchen, bathroom 3 and bathroom 2), it was observed that the adequate space was the corridor, and the insufficient space was the bathroom-2 (Table 3). The corridor was found to be adequate for most of the physical and psychosocial requirements. The balcony was found to be insufficient for six users in spatial requirements, and it was sufficient in behavioral requirements. When we compare the shared bathrooms with each other, bathroom-3 seems insufficient under the spatial heading of physical requirements compared to bathroom-2. The increase in the number of users using the space is directly proportional to the increase in spatial requirements. For this reason, bathroom 3, which was considered inadequate, was also deemed insufficient in terms of privacy and social requirements due to the high number of users. The number of users using bathroom-2 is 2 (rooms 2 and 5), and the number of users using bathroom-3 (rooms 3, 4 and 6) is 3. The kitchen, which contains many functions, was found to be sufficient except for the spatial and privacy requirements. When the kitchen is considered within the scope of spatial requirements, it has been determined that it is difficult for six users to use and actively evaluate the space at the same time. This situation negatively affects the privacy requirements of individuals and makes their personal spaces inadequate.

When the adequacy status of the individual spaces (Rooms 1-6) is examined according to the user requirements, it is seen that rooms 1, 2, 4 and 5 are sufficient and room 6 is insufficient. Rooms 1, 2, 4 and 5 were adequate for all requirements except spatial requirements. This state of adequacy is a concept that can vary depending on the experience of the users in terms of psychosocial requirements. Room 3 was found to be inadequate in terms of privacy and spatial requirements. This is because the kitchen, balcony and Room 3 share the same circulation axis. Users who spend time in the kitchen late at night should be quiet or head to another area because of the user in room 3. Likewise, the user in room 3 may experience sleep problems due to the noise made by the users in the kitchen. Room 6 was found to be inadequate in terms of safety, spatial and privacy requirements. The main problem here, as in room 3, is that bathroom 3 and room 6 use the same circulation axis.

Table 3. Adequacy analysis of the apartments user requirements

		USER REQUIREMENTS							
		PHYSICAL REQUIREMENTS				PSYCHOSOCIAL REQUIREMENTS			
		Space	Health	Physical environment	Security	Privacy	Aesthetic	Behavioral	Social
COMMON	Kitchen	-	+	+	±	-	+	±	+
	Corridor	+	+	±	±	+	+	±	+
	Balcony	-	±	+	+	+	+	±	+
	Bathroom- 2	±	-	-	±	-	-	±	-
	Bathroom- 3	-	+	+	±	-	+	±	-
INDIVIDUAL SPACES	Room - 1	-	+	+	+	+	+	+	+
	Room - 2	-	+	+	+	+	+	+	+
	Room - 3	-	+	+	+	-	+	+	±
	Room - 4	-	+	+	+	+	+	+	+
	Room - 5	-	+	+	+	+	+	+	+
	Room - 6	-	+	+	-	-	+	+	±

- Inadequate, ± Partially Adequate, + Adequate

4. Conclusion and Suggestions

The co-living model aims to provide a minimum standard of living for singles, students or professionals. These living standards vary according to the specific laws of each country. For the co-living model, which is still a new concept in the world and in Turkiye, to function correctly, it is necessary to determine the minimum standards and the minimum and maximum dimensions required for the design, in accordance with the laws. While creating these standards, physical and psychosocial user requirements, which are among the basic requirements that Maslow created in 1943, must be taken into consideration.

Co-living is a special and highly unusual arrangement that reflects a particular way of life. First of all, this way of life should be handled and analyzed by scientists from different disciplines. This study has been addressed in terms of interior architecture by the author, who has experienced the co-living. As a result, it has been determined that this lifestyle is ideal for short-term accommodation abroad experiences, and people living together at home help each other and socialize a lot.

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The article complies with national and international research and publication ethics. Ethics committee approval was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article.

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Social Sustainability and Re-functioning of Cultural Heritage: Seljuk Bath and Ali Aydın House

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Abstract

It is important for preserving our cultural heritage to ensure the social and cultural sustainability of historical buildings and hand down them to the next generations. Functioning historical buildings by protecting them also increases circulation to those structures and ensures that they are handed down to the future. In this study, the social sustainability of the Seljuk Bath and Ali Aydın House, located in the ancient city of Stratonikeia, were examined. The tracing method, which is a qualitative research method, was used in the study. While ensuring the sustainability of the buildings, the issue was also considered together with the historical environment they are in and a performance evaluation was conducted within the context of the historical environment. Since the bath and residential structures are both in the ancient city and both have become original structures, this study contributes to the literature on holistic conservation and sustainability of historical buildings.

Keywords: *Historical building, sustainability, re-functioning, conservation, Seljuk Bath, Ali Aydın House.*

Kültürel Mirasın Sosyal Sürdürülebilirliği ve Yeniden İşlevlendirilmesi: Selçuk Hamamı ve Ali Aydın Evi

Öz

Tarihi yapıların sosyal ve kültürel sürdürülebilirliğinin sağlanması ve gelecek nesillere aktarılması kültürel mirasımızı korumada önem taşımaktadır. Tarihi yapıların korunarak işlev kazandırılması o yapılara olan sirkülasyonu arttırarak geleceğe aktarımını da sağlamaktadır. Bu çalışmada Stratonikeia antik kenti içerisinde bulunan Selçuk Hamamı ve Ali Aydın Evinin yeniden işlevlendirilerek sosyal sürdürülebilirliğinin sağlanması incelenmiştir. Çalışmada nitel araştırma metodu olan iz sürme yöntemi kullanılmıştır. Yapıların sürdürülebilirliği sağlanırken içerisinde bulunduğu tarihi çevre ile birlikte de ele alınmış ve tarihi çevre bağlamında performans değerlendirmesi yapılmıştır. Hamam ve konut yapısı hem antik kent içerisinde bulunması hem de özgün yapı haline gelmesi nedeni ile literatüre bütüncül koruma ve tarihi yapıların sürdürülebilirliği hakkında katkı sağlamaktadır.

Anahtar kelimeler: *Tarihi yapı, sürdürülebilirlik, yeniden işlevlendirme, koruma, Selçuk Hamamı, Ali Aydın Evi.*

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1. Introduction

Within the frame of the principle of sustainability, conservation in the historical environment requires the active use of the old texture and planning the changes in the environment in a way that will respond to the needs of today's life (Kuban, 2000). For the cultural heritage to be preserved and sustainable, the management plan should proceed with the aim of keeping it alive, that is, incorporating it into our daily lives, adding an economic dimension and handing down these phenomena to future generations (Kuşçuoglu & Taş, 2017). Accordingly, the historical environment and cultural heritage should be taken into account as valuable resources and considered as development incentives (Gražulevičiūtė, 2006).

"Although the sustainability of cultural heritage plays an important role in the heritage of human civilization and history, the evaluations related to these areas remain limited" (Jiang, Cai, Chen, Zhang, Wang, Xie & Yu, 2022, p. 1). Although these studies are limited in number, the conservation and continuity of cultural heritage also play a critical role in the sustainability of societies. It is accepted that these cultural resources are very important for sustaining the social, economic and cultural development of communities. For this reason, the physical texture where it is located must also be protected (Gražulevičiūtė, 2006). The conservation of cultural heritage assets that ensure handing down of cultural values and meanings across generations is considered by UNESCO (2013) to be of critical importance for cultural sustainability to become possible.

Considering that one of the aims of sustainability is continuous improvement, the improvement and reuse of historical buildings are one of the means to achieve this (Bullen, 2007). Therefore, the adaptive reuse of historical buildings and passing the wasteful processes of demolition and reconstruction play a major role in the development of sustainability (Department of Environment & Heritage, 2004). Charter on the Built Vernacular Heritage ratified by the ICOMOS 12th general assembly, in Mexico, October 1999 (ICOMOS, 1999). Its strongly emphasizes that the reuse of historical buildings should be a harmonious use with minimal interference. For this purpose, compatibility evaluations should be carried out by questioning the new function of the structure and the performance of its new users (Yaldız & Asatekin, 2016). In this context, it is important for sustainability in terms of the expectation that the buildings that have lost their functional properties due to the change in the lifestyle, will be re-functionalized today, and that the building should be protected to meet the needs in the future (Tanrısever, Saraç & Aydoğdu, 2016).

Likewise, various societies have lived in archaeological areas for centuries and these areas have been stratified over time and hosted different civilizations. The management of archaeological sites is closely related to the sustainability of cultural heritage. Cultural heritage management can be defined as the legal processes and practices for the detailed research, conservation, use, presentation, operation and planning of archaeological resources (Kerber, 1994). Cultural assets should be considered as a whole with their environment and their sustainability should be ensured by evaluating them according to the archaeological sites they are in.

In this study, the ancient city of Stratonikeia, which is an archaeological site, is taken into account. While, since the ancient city is quite large and contains many buildings, the study area was narrowed down and the Seljuk Bath, which is considered a cultural heritage, and the Ali Aydın House, which is a combined structure with this bath, were examined.

As a result of the restoration and re-functioning of these structures, their social and cultural sustainability has been evaluated by dividing them into time intervals since the date they were built. Based on the fact that they are located in the historical environment and ancient city, the study was concluded by evaluating the performance of the bath and residential building in terms of the historical environment. Questioning the decisions and reports taken during the restitution and restoration processes of the cultural heritage structures examined were excluded from the scope of the study.

2. Cultural Heritage and Sustainability in Area Management of Ancient Cities

Archaeological sites reflect the unity of humans and nature that emerged as a result of centuries of harmony developed by human beings according to the positive and negative conditions of the environment in which they live (Takaoğlu, 2004; Yakar, 2000; Naycı, 2014).

Natural and cultural environmental values should be taken into consideration as a whole for managing cultural assets within the scope of archaeological site management, the participation of the society living in the area should be ensured to establish a spiritual bond with the areas, and approaches that will allow these studies to be established with economically sustainable tools and methods should be introduced (Naycı, 2014). It is very important to apply a holistic approach to preserving archaeological sites to hand them down to the future (Bahçeci, 2004). According to Naycı (2014, p. 192), sustainability goals in archaeological sites should be two-way; "Sustainability should be ensured in archaeological site management studies" and "the information value of archaeological sites should contribute to sustainable development" (Figure 1).

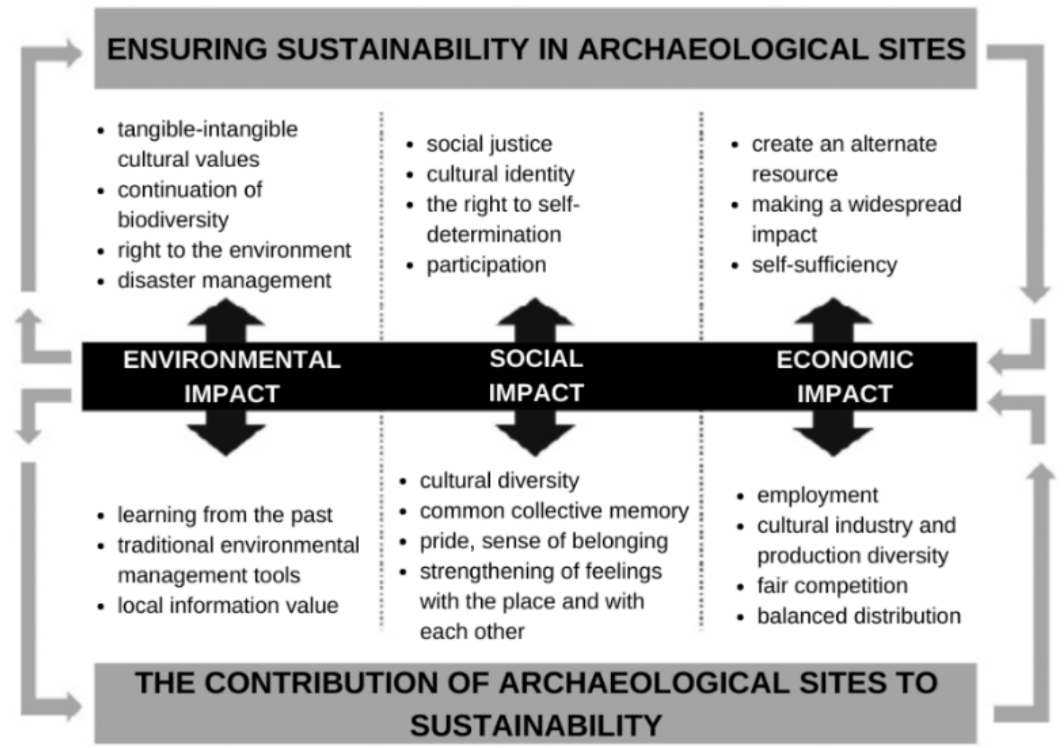


Figure 1. Sustainable development goals in archaeological site management (Naycı, 2014, p. 192)

It is also important to ensure the sustainability of the cultural heritage it contains while providing archaeological site management. Cultural heritage management has been going through a process of change that focuses on the cultural significance of tangible and intangible values and qualities (Pereira da Silva & Pereira Roders, 2012). According to Kuşçuoğlu & Taş (2017), cultural heritage is the richness that has meaning for all humanity in a way that can be intangible and concrete, describing the common past and historical accumulation of people in the same society. At the same time, Madandola & Boussaa (2023) defined cultural heritage as creative and symbolic resources that have been handed down to humanity through generations. The sustainability of cultural heritage is important not only for the present but also for continuing this heritage in the next generations. Therefore, it is necessary to increase social awareness by considering it with a holistic approach to make the cultural heritage sustainable (Kuşçuoğlu & Taş, 2017).

In a declaration published by UNESCO, it is mentioned that cultural heritage should be protected in all its forms and that a real bond should be established between cultures by handing down it to future generations and promoting it in all its varieties (UNESCO, 2001).

2.1. Preserving and Refunctioning of Cultural Heritage

The concept of conservation can be defined as a chain of studies to ensure that cultural heritage is handed down to the present and the future due to its artistic, historical and functional characteristics. This chain also includes stages such as maintenance, repair and restoration (Emre, 2017). It can be ensured that a structure is sustainable as a result of making it usable by assigning a different function to the structure that has become unusable and has lost its function over time through the conservation of historical buildings, which are accepted as cultural heritage. Architectural structures located at important points of the city and embedded in the memory of the city are of great importance. The structures that gain value with the concept of conservation come to the fore with the accumulations carried from past to present (Temur & Kurak Açıcı, 2022). The concept of reuse is the renewal of a building for adapting it to a new use. This concept is a common way of preserving our cultural heritage by making abandoned, underutilized or unused historical buildings suitable for reuse. “The loss of vernacular forms is not only a cultural loss, but can also have a negative effect on the way of life of the society concerned” (Arpacıoğlu, 2016). The alternative to demolishing old buildings is to arrange them as new and contemporary areas of use (Bacon, 2001).

The issue of the conservation of cultural heritage has started to be studied at the international level by organizations such as UNESCO within the United Nations. In these studies, it has been accepted that the concept of cultural heritage is an important value not only for the society where it is located but also for all people. Within this context, the “Venice Charter” was adopted in 1964, where the rules applicable everywhere in interventions to historical buildings were determined (Kuşçuoğlu & Taş, 2017). ICOMOS was established in 1965, following the Venice Charter. The purpose of ICOMOS (International Council on Monuments and Sites), an international organization, is "to develop principles, techniques and policies for the conservation and evaluation of historical monuments and sites, and support and guide any relevant researches and studies (ICOMOS, 2018). The charter of ICOMOS, which was published on May 22, 1978, has taken its final form in that issue and continues to be applicable today. The Law 1710 Numbered on Antiquities with 25.04.1973 date, which is the first conservation law of the Republic of Turkiye, was also enacted during this period (Dağıstan Özdemir, 2005). With this law, monuments, complexes, sites, historical sites, archaeological sites, ruins and natural sites were defined and accepted as ancient works, and it was emphasized that they should be evaluated and protected completely (T.C. Cumhurbaşkanlığı Resmî Gazete, 1973).

In the following years, 2863 numbered and 5223 numbered laws, came into force in 1983, and the Law on the Conservation of Cultural and Natural Property clearly set forth the conservation rules. In accordance with these rules, it is every individual in society's duty to protect and keep cultural assets alive (Emre, 2017). Article Number 61 of the Law on the Conservation of Cultural and Natural Heritage with 21.07.1983 date has the clause indicating that “Public institutions and organizations, municipalities and real and legal persons must comply with the decisions of the High Council of Conservation and the Regional Councils of Conservation.” (T.C. Cumhurbaşkanlığı Mevzuat Bilgi Sistemi, 2022). All kinds of practices and evaluations regarding “cultural assets” and “protected areas”, which are deemed worthy to be registered within the scope of this phrase, are carried out primarily in line with the resolutions of the Supreme Council for the Conservation of Cultural and Natural Assets and in particular the decisions of the Regional Conservation Boards (Aygün, 2011).

It can be said that cultural heritage is a value that every individual in the society should protect, and after the conservation of these values, it is extremely important to re-function them by considering the environmental conditions and the period where they are located and to use them in accordance with that function. For this reason, while preserving our cultural heritage and handing down it to future generations, it is necessary to establish the balance between conservation and use to ensure social and cultural sustainability.

Historical buildings are structures that describe the values and culture of the society in which they are located (Kavut & Selçuk, 2022). The transformation of historical buildings into abandoned spaces due to natural disasters, migration or neglect may adversely affect cultural sustainability. Restoring these historical buildings, which have become cultural heritage, in a way that they can adapt to today's conditions and provide a new function and continuing their use becomes an important factor both for preserving historical accumulation and ensuring social and cultural sustainability. “Although it is thought that the preservation of historical buildings made with traditional system is more costly; it is a more economical solution compared to the fact that these structures are kept alive with the protection practices to be carried out regularly” (Kahraman & Arpacıoğlu, 2019). Considering that every redesigned building harms the environment, it can be said that environmental, social and cultural benefits are provided by restoring and using existing structures instead of demolishing and rebuilding the buildings (Aydın & Okuyucu, 2009). Reuse of a structure is only a tool for the active conservation of the building, and its new function while maintaining its historical, cultural, environmental and economic sustainability (Yaldız & Asatekin, 2016). Reuse acts as a bridge between the past and the present through the traces it carries, the cultural values, lifestyle and socio-economic levels of the period in which the historical buildings are located. These cultural assets also contribute to creating the character and identity of the place they belong to. For this reason, it is necessary to protect and ensure the sustainability of historical buildings.

3. Material and Method

3.1. Material

Bath structures have been built in various civilizations since ancient times. Especially Turks gave importance to these structures and ensured they became widespread. The element of water, which has a great place in Muslim societies, caused the increase in mosques and baths in these periods. Due to the personal and social cleaning culture of the Turkish people, especially in the Principalities and Ottoman Periods, the number of Turkish baths built increased accordingly (Ertuğrul, 2009).

The main material of the study is the Seljuk Bath and Ali Aydın House, located in the ancient city of Stratonikeia in the Yatagan District of Mugla. As there is no document about the construction date of the bath, the exact date of construction is not known, but it is known that it has 14th and 15th-century characteristics in terms of architecture and findings and it was built during the Menteseoglu Principality (Söğüt, 2019). Ali Aydın House, a registered house built in 1951, is located in the undressing section of the bath. Ali Aydın House was built later and became a building together with the bath during the restoration phase (Figure 2).

Eskihisar Village, located in the Yatagan District of Mugla, is a well-known settlement area with an ancient city since the Mentese Principality Period. The typological characteristics of the residential buildings in the South Aegean Region can also be observed in Eskihisar Village. Generally, 1 or 2-storey houses on large parcels are seen in the construction of this region. In addition to large mansions, houses are generally built for single-family use and can be found inside the garden or adjacent to the garden wall.

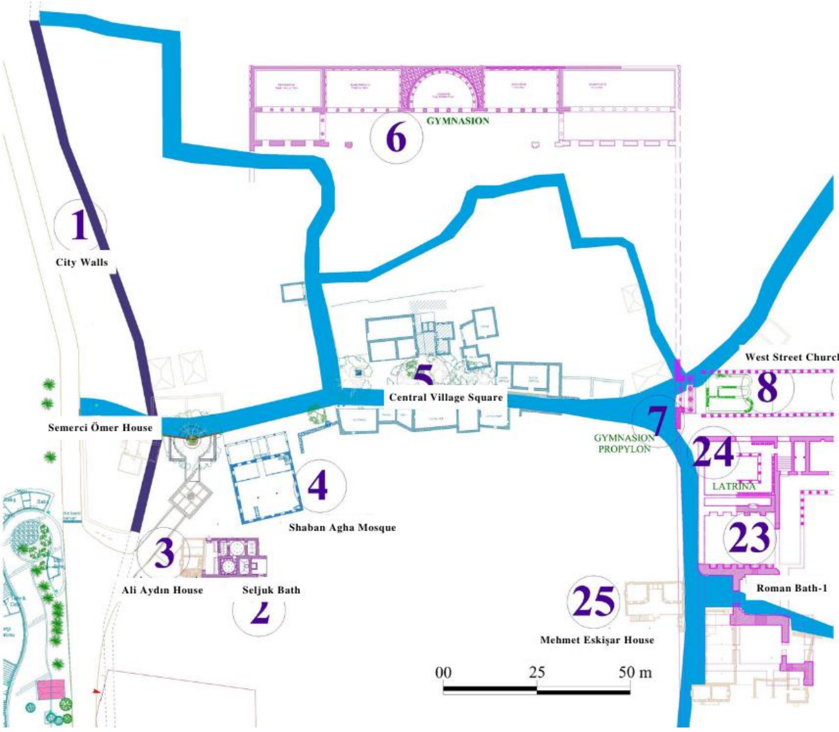


Figure 2. Seljuk Bath and Ali Aydın House in Stratonikeia Ancient City (Söğüt, 2019)

These two structures were registered as Immovable Cultural Heritage to be Protected in 2002 with the 26.06.2002 dated and 1458 numbered decision of Mugla Cultural and Natural Heritage Conservation Board. Since the house and bath structures are considered together, restoration works and projects were also applied together and restoration works were carried out in 2017. The combination of the bath and the residential structure in this way and the conservation of it in an ancient city is one of the most important characteristics for keeping the structures original.

3.1.1. Historical Development of Eskihisar Village

Eskihisar Village, which was called Stratonikeia in the ancient period, started to take shape during the Mentese Principality Period and showed a settlement together with the ancient city. The most important factor for choosing this place in the ancient city was that a three-orifice water source comes out of this place. According to the obtained information, it is known that the 19th century and the first half of the 20th century were among the good times of the village (Söğüt, 2019). In this period, the village hosted many social places such as a mosque, Turkish bath, village room, shop, barber, bakery, butcher, and coffee house, together with approximately 400 households. Among the main reasons for the increasing development of Eskihisar Village and becoming a focus of attention is the public bazaars in the village square, which continue for two days. Due to being a commercial center for every period, the physical texture of the village has changed and its borders have expanded (Yurdugüzel, 2005).

Eskihisar Village, which has maintained its rich structure for a long time, has experienced many events in the historical process, including earthquakes and migration. Earthquakes had a great impact on the development of the settlement and the construction of new buildings. Apart from the frequently seen small earthquakes, some of them were found to have a magnitude of 7.5 in historical periods. The most important recent earthquake in the history of the settlement was experienced in 1957 (AFAD, 2022). Because after this earthquake, the people living in the village migrated to other areas. In this period, a new settlement area was created in the north of the existing village and it was provided that the ones who wanted to move there moved there. During the period, some families did not leave their homes in the ancient city and continued to live in the same area (Söğüt, 2015).

Later, with the start of coal excavations in the second settlement area, the villagers were relocated and moved to the third settlement, which was established approximately 1 km west of the ancient city of Stratonikeia. Thanks to these new settlements, new structures could not be added to the village settlement in the ancient city and the old settlement pattern was preserved (Söğüt, 2020). The ancient city of Stratonikeia (Figure 3) is located in the region that the locals call "Eskiköy".

Figure 3. Stratonikeia ancient city (Google Earth, 2023)

Although Eskihisar village has experienced immigration many times, the area called "Eskiköy" has never been empty. Today, there are families still living in the old settlement located in the ancient city of Stratonikeia (Söğüt, 2019).

3.2. Method

The study aims to examine the cultural sustainability of Seljuk Bath and Ali Aydın House and the re-functioning of these structures. The tracing method, which is a qualitative research method, is used in the study. The tracing method or process monitoring method is a qualitative research method that examines a single case or a small number of cases and examines the causal mechanisms in general (Bekler, Soyluk & Ayçam, 2021). This method, which ensures that both data collection and sampling studies are reliable, results in the identification of the organizational processes of the relevant research topics in a given time frame. Criteria are created by sampling the special cases of the process that is the subject of the study (Bennett & Elman, 2006; Bekler, Soyluk & Ayçam, 2021).

The buildings selected within the scope of the study are divided into four groups according to the events and changes they have undergone. These periods are the 14th century – 1951, 1951 – 1991, 1991 – 2016, and 2016 – 2023. The main reason for choosing the specified periods is that the structures studied have undergone structural or functional changes during these periods. The periods when the buildings were built, annexed attachments, and excavations were carried out and restored were used as a criterion for selecting these year intervals. Within this context, by examining the data obtained from the changes in the determined periods, the study was concluded by evaluating the performance of the bath and residential building in terms of the historical environment in the context of international conservation criteria within the context of the Venice Charter (ICOMOS, 2023a) and Washington Charter (ICOMOS, 2023b) to be able to talk about the sustainability of its new function in the archaeological area.

4. Findings

Seljuk Bath and Ali Aydın House are divided into periodic groups according to the events they have undergone in the historical process and the changes they have gone through. Structural and functional changes were revealed by examining these groups with graphics and tables. These periodic groups are determined as follows (Figure 4);

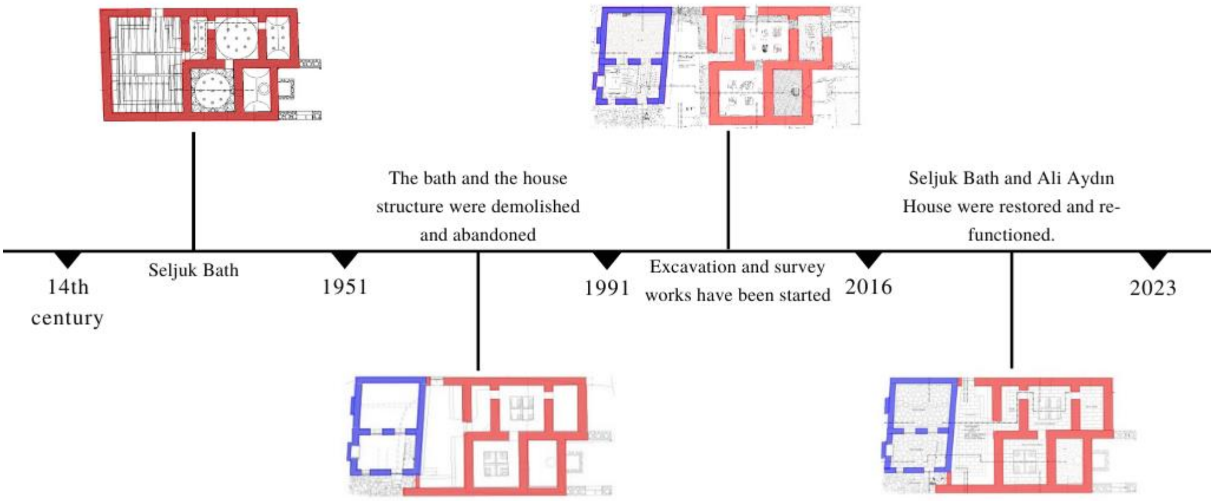


Figure 4. Seljuk Bath and Ali Aydın house sustainability scheme from the 14th Century to the Present

- 14th century – 1951: It covers the period between the construction date of the Seljuk Bath and the construction date of the Ali Aydın House.
- 1951 – 1991: It covers the construction date of the Ali Aydın House and the excavations carried out during the 1982 excavation period of the Seljuk Bath.
- 1991 – 2016: It covers the survey and restitution period up to the year when these two buildings were restored.
- 2016 – 2023: It covers the period from the beginning of the restoration works and the preparation of the survey, restitution and restoration projects of the bath and the house to the present day.

There have been many cultural and social changes between the years mentioned above. As a result of these changes, the buildings became unusable and abandoned. With the restoration works carried out, the baths and house structures were preserved and re-functioned, and structural integrity was ensured. In this way, while providing cultural sustainability, the buildings were re-functionalized and handed down to future generations.

The first period covers the years between the 14th century and 1951. During this period, the bath was used as a single structure. With the construction of a house on the cold section of the bath in 1951, both these structures became a unified structure. However, the bath is not in use during this period.

The second period covers the years between 1951 and 1991. During this period, the house was built and afterwards many different events and migrations were experienced. After the earthquake in 1957, migration started from here, although the house was not destroyed in the earthquake, it was also abandoned. Later, during the 1982 excavation period, cleaning and drilling works were carried out around the Seljuk Bath (Figure 5).

a) b)

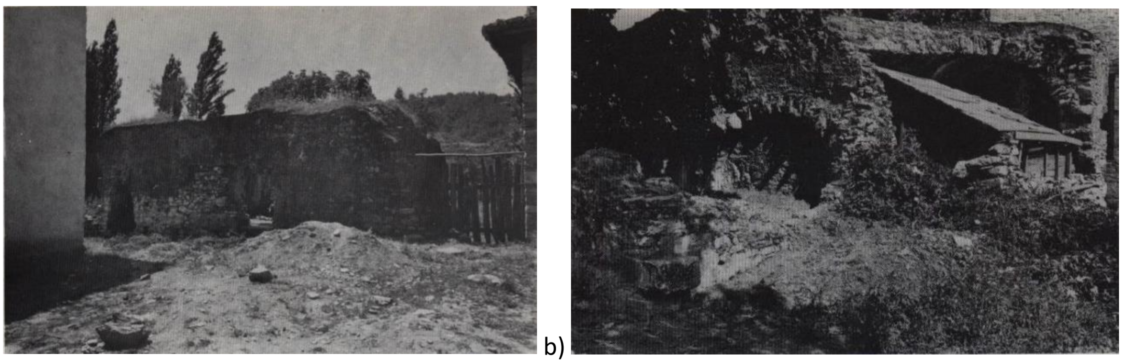


Figure 5. a) Northwest view of Seljuk Bath; **b)** Southeastern view of Seljuk Bath (Baş, 1991)

The third period covers the years between 1991 and 2016. In this period, the buildings lost their former use and became abandoned buildings over time. With the registration of Seljuk Bath and Ali Aydın House in 2002, the structures were expropriated and more detailed excavations and surveys were carried out between 2009 and 2011 (Figure 6).

a)  b) 

Figure 6. a) Ali Aydın house; **b)** Seljuk Bath (Stratonikeia &Lagina Excavation Archive, 2016)

The fourth period covers the years between 2016 and 2022. In this period, survey, restitution and restoration projects were prepared between the years of 2016-2017, and with the financial support of the Southern Aegean Development Agency of the Republic of Turkiye and Pamukkale University, and the work of the excavation team. Within the scope of the projects, Seljuk Bath and Ali Aydın House were restored and ensured to reach our time by re-functioning (Figure 7).

a)  b) 

Figure 7. a) Seljuk Bath; **b)** Ali Aydın House (Stratonikeia & Lagina Excavation Archive, 2022a)

With the excavations completed in 2011, the ground plan of the bath was revealed. With the studies, it was concluded that the building occupies a rectangular area. Half of the undressing section one of the parts determined within the bath is now under the house. The walls of the undressing section were mostly destroyed, and the south wall continued under the foundation of the house. On the other hand, Ali Aydın House has a plan with two floors, one room and an outer sofa. The lower floor of the house was used as a barn and a sofa when it was built. The main living area is on the first floor and consists of an outer sofa and a room. The house is covered with Turkish-style tiles on a hipped roof (Figure 8).

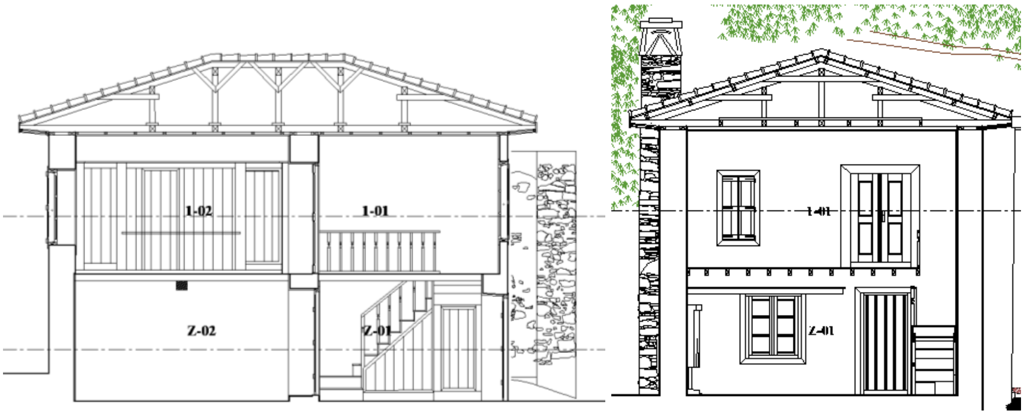


Figure 8. Ali Aydın House restitution sections (Stratonikeia & Lagina Excavation Archive, 2011)

The conservation part of the bath and house structure, with their restoration, was completed in 2017 and was carried out and handed down to the next generations. These structures were later re-functioned to ensure their social and cultural sustainability. The historical structure of the Seljuk Bath has been preserved, and it has been converted into an exhibition area to both see the texture of the bath at that time and understand its interaction with its surroundings (Figure 9). While visiting the bath, which is still used as an exhibition area, the historical texture can be felt and information about other structures in the ancient city can be obtained at the same time.

Figure 9. Seljuk Bath Interior Photos (Stratonikeia & Lagina Excavation Archive, 2021)

Ali Aydın House has also been re-functioned and turned into a place that the excavation team and committee members can use when necessary. In this way, the house was made sustainable by ensuring the continuity of use (Figure 10).

Figure 10. Ali Aydın House Interior Photos (Stratonikeia & Lagina Excavation Archive, 2022b)

These structures can be visited 12 months of the year, depending on the application made by the visitors to the city. In the bath, people can sit and read the Turkish and English advertisement boards about all the structures of the city. This application provides convenience, especially for individuals who cannot travel the whole city. By organizing exhibitions in the bath, an area suitable for activities to increase awareness of the structures was obtained.

4.1. Performance Evaluation in terms of Historic Environment

Since the Seljuk Bath and Ali Aydın House are structures which are re-functioned according to the historical environment they are in, social and cultural sustainability is ensured, and an environmental performance assessment has been conducted (Figure 11).

Figure 11. Seljuk Bath, Ali Aydın House and Landscaping (Stratonikeia & Lagina Excavation Archive, 2023)

While evaluating the environmental performance, literature reviews, the building's survey, restitution and restoration reports and building visuals were taken as a basis, according to international conservation criteria and articles related to the study (Kutlu & Ergün, 2021). According to this direction, within the context of international conservation criteria, a performance evaluation has been conducted by addressing articles no. 4, 5, 6, 7, 12 and 14 of the Venice Charter (1964) and articles no. 4, 8, 9, 11, 12, 13 and 15 of the Washington Charter (1987) (Table 1).

Table 1. Performance Evaluation of Seljuk Bath and Ali Aydın House in terms of Historical Environment

Periods		Seljuk Bath		Ali Aydın House	
		Performance Enhancing Features	Performance Reducing Features	Performance Enhancing Features	Performance Reducing Features
	14th century - 1951	• The bath was used in its original function.			
	1951-1991	• With the start of the excavation and conservation works of the historical structure, it was brought to the environment in which it is located,	• Landscaping has progressed more slowly as the priority is in the historic and proprietary structure.	• With the start of the excavation and conservation works of the house structure, it was brought to the environment in which it is located.	• It progressed more slowly due to the fact that the works were carried out together with the bath structure.
	1991-2016	• In order to ensure the sustainability of the structure, excavations for survey and restitution works have begun.		• In order to ensure the sustainability of the structure, excavations for survey and restitution works have started and interest in the structure has increased.	
	2016-2023	• Restitution and restoration projects have been prepared for the continuation of the excavations of the bath structure and the restoration works. Later, its restoration was started and it was restored in accordance with the historical environment in which it was located. • While the restoration works of the building were carried out, conservation works were carried out in accordance with the period in which it was located. • In addition to the restoration works of the building, environmental arrangement was also made and its sustainability was contributed. • After the structure is preserved, a suitable function is gained and the circulation to the structure and its surroundings is increased. • In order to facilitate access to the structure, road and parking arrangements have also been made and made a frequented point for visitors.	Due to the fact that the bath structure is located in the ancient city, landscaping has been realized within certain limits.	• Survey, restitution and restoration projects have been prepared for the continuation of the excavations of the residential structure and the restoration works. Then, its restoration was started and it was restored in accordance with the historical environment in which it was located. • While the restoration works of the building were carried out, conservation works were carried out in accordance with the period in which it was found. • In addition to the restoration works of the building, environmental arrangement was also made and its sustainability was contributed. • After the structure is preserved, a suitable function is given to be in parallel with the house structure. As a result, the circulation to the structure and its surroundings is increased. • In order to facilitate access to the structure, road and parking arrangements have also been made and made a frequented point for visitors.	Due to the fact that the house structure is located in the ancient city, landscaping has taken place within certain limits.

The performance evaluation of the bath and residential building was conducted by considering the articles in the Venice Charter (1964) and the Washington Charter (1987).

- According to the 4th article and the 5th article of the Venice Charter (1964), the aforementioned monuments should be permanent and their continuity should be ensured while they are protected. Furthermore, while the monuments are protected, they should be used for useful purposes for society and the building should be re-functioned without changing the plan. In accordance with these articles, it has been revealed that the proposed function to ensure the sustainability of the bath and house increases the performance of the building.
- According to the 6th article, the conservation of monuments should include care for their surroundings. In accordance with this article, it has been determined that landscaping must be done within certain limits since the bath and the house are located in the ancient city. Therefore, landscaping is included in the table as a performance-reducing feature.
- According to the 7th article, 12th article and 14th article, monuments are an integral part of the environment they are in and the integrity of this cultural property should be protected and should not be moved to another place. In addition to these, while complementing the deficiencies, they should be in harmony with the whole, should not reflect the history incorrectly, should be distinguishable from its essence and should be presented in a livable way. Due to the fact that the baths and house structures were completely preserved during the completion of the deficiencies, they were included in the performance-enhancing features.
- According to the 8th article and 9th article of the Washington Charter (1987), re-functioning should be compatible with the city area and the historical city. However, the improvement of housing should be one of the main objectives of conservation. Due to the relationship between the bath and the residential structure and the archaeological site, the conformity of the building's conservation approach to these items was determined and it was chosen as a performance-enhancing feature.
- According to the 4th article, the 11th article and the 15th article, it is necessary to have a prudent, systematic approach and discipline while protecting the city area. In addition to this, archaeological research on the history of the city and the historical area should be developed and a program that informs the citizens should be prepared to ensure the participation of the public. Due to the fact that historical buildings are handled in accordance with these items, they have been chosen as performance-enhancing features.
- According to the 12th article and the 13th article, the traffic in the historical city and urban area should be controlled, and the parking areas should be in such a way as not to damage the historical texture. Moreover, transportation to the city should be facilitated without introducing new highways to the historical city and urban area. In accordance with these articles, the suitability of transportation and roads to historical buildings and the city has been determined and has been selected as a performance-enhancing feature.

As a result of these evaluations, the articles in the Venice Charter (1964) and the Washington Charter (1987) were evaluated by considering the Seljuk Bath and Ali Aydın House in separate historical processes. As a result of the evaluation, performance-enhancing and performance-reducing features were included in the table and a performance evaluation was conducted in terms of the historical environment.

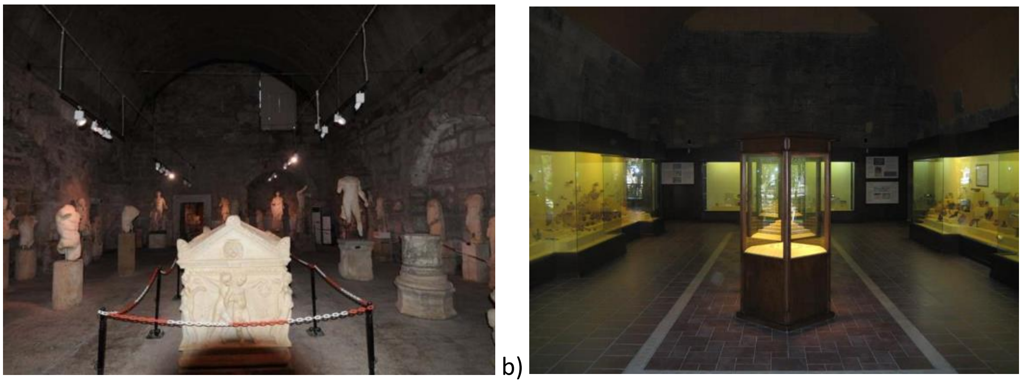
5. Discussion and Conclusion

Archaeological sites are one of the most important cultural heritages that provide us with information about the societies that lived in the past and the architectural structures that were built. These areas can turn into places that have been destroyed and abandoned as a result of some natural disasters or migration over time. These structures need to be re-functioned and brought back to society to protect our cultural heritage and hand down it to future generations. Re-functioning historical buildings are also extremely important for understanding and learning the cultural values of the period they were built.

It enables every archaeological site and structure brought to society to become culturally and socially sustainable at the same time. The transformation of historical buildings into navigable and usable areas can only be achieved by preserving and restoring them. According to Yaldız & Asatekin (2016), carrying these structures to the present due to their traces and cultural values serves as an important bridge between the past and the present. According to Söğüt (2019), these restorations of the areas in ancient cities are among the practices that not only protect the building, but also show vital continuity and add value in transforming ancient cities into living historical areas, and are also places where conservation awareness is best provided to all visitors.

Göküz (2022) emphasized that archaeological assets should be exhibited by protecting them from all kinds of factors and the public should be informed about this heritage. Furthermore, he mentioned that including archaeological assets in city life will enable the public to become conscious of protecting these cultural assets. This will also contribute to cultural tourism, which will be an element that enriches the city life of those living in an archaeological city.

Examples of reuse are the Side Agora Bath and the large bath at Hierapolis (Figure 12). Side Agora Bath was converted into a museum in 1962 and the findings from the excavations are exhibited in it (Ahunbay, 2010).



a) b)

Figure 12. a) Side Museum inside (Antalya Governorship official website 2023); **b)** Pamukkale Hierapolis Archaeological Museum (Ministry of Culture and Tourism official website, 2023)

According to Bacon (2001), re-functioning is the sustainability of the cultural heritage, and re-use is the renewal of the structure in accordance with its new use. Therefore, it is necessary to make the function of historical buildings open for reuse properly and to adapt to their surroundings. Seljuk Bath and Ali Aydın House, as the examined structures, have been restored and re-functioned in this direction, and it is ensured that they are handed down to future generations.

Since the bath and house structures, which are registered structures, are located in the ancient city of Stratonikeia, it is extremely important for them to re-function. Because the structures in the ancient city are structures where local and foreign tourists can interact and circulation can be provided continuously. Seljuk Bath was first restored and opened to use as an exhibition area with panels describing the ancient city and other structures in it. Moreover, this allows the heating system of the principalities period, which is under the bath with its glass floor, to be seen. In this way, while visiting the interior of the bathhouse, the visitors can both see the systems and walls from their period and get information about the city where it is located.

As a result of the proper re-functioning, the continuity of the circulation in the Seljuk Bath was ensured and it is ensured that it is handed down to the next generations. Likewise, Ali Aydın House was restored and its residential structure was preserved. It has become a structure where the members of the committee or scientists working in the ancient city can be accommodated by making the interior arrangement.

As Söğüt (2015) emphasized, the sustainability of this house and handing down it to future generations were realized by adding a usage function to its conservation function. In addition to this, the performance evaluation of these two buildings in terms of their historical environment has been examined in accordance with the Articles of the Venice Charter (1964) and Washington Charter (1987).

As a result of the examination, it has been concluded that the residence and bath are in harmony with the historical environment where they are located, together with the conservation and re-functioning of the historical environment.

The structures are very original since the Seljuk Bath has been preserved from the 14th century to the present day and has been restored by becoming a building together with the Ali Aydın House. This is a good example of social and cultural sustainability both in the world and in Turkiye.

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The article complies with national and international research and publication ethics. Ethics Committee approval was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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Wood-Based Hybrid Construction Technology

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Abstract

Although the use of different building materials in a single construction system is a well-known technology and the design principles of hybridization are similar from the past to the present, they are explained with different concepts in literature, and there is no single comprehensive systematic classification. This study, which is open to development in this respect, classifies hybrid structures whose main material is wood according to hybridization levels and the parts they are used in the building, and each category is evaluated in detail. In determining the measures, parameters affecting the building's performance were taken into account. In the research, secondary data gathered with quantitative approaches were evaluated using a qualitative method. The study aims to create a comprehensive technical guide on wood-based systems and to achieve linguistic unity in the related literature. In this context, the difference between the uses of a single building material and a hybrid system is evaluated with their strengths and weaknesses in the context of factors such as heat, humidity, acoustics, and fire. The hybrid systems presented in the study are modern systems that are frequently applied today and are open to diversification through development.

Keywords: *Wood-based construction, hybrid construction technology, timber structure.*

Ahşap Esaslı Hibrit Yapı Teknolojisi

Öz

Yapı malzemelerinin tek bir yapım sistemi bütününde bir arada kullanılması yeni bir teknoloji olmamasıyla beraber ve geçmişten günümüze hibritleşme tasarım prensipleri benzer olsa da, literatürde farklı kavramlar ile açıklanmakta ve kapsayıcı bir sistemli sınıflandırması bulunmamaktadır. Gelişime bu yönüyle açık olan bu çalışmada ana yapı malzemesi ahşap olan hibrit sistemler, yapıda bulundukları bölümlere ve hibritleşme seviyelerine göre sınıflandırılmış ve her bir kategori detaylı olarak değerlendirilmiştir. Değerlendirme ölçütlerinin belirlenmesinde yapının performansını etkileyen parametreler dikkate alınmıştır. Araştırmada, nicel yaklaşımlarla toplanan ikincil veriler nitel bir yöntem kullanılarak değerlendirilmiştir. Çalışmanın amacı ahşap esaslı sistemler konusunda kapsamlı bir teknik kılavuz oluşturmak ve literatürde bu konuyla alakalı bir dil birliği yaratmaktır. Bu bağlamda tek çeşit yapı malzemesi kullanılması ve hibrit bir sistem kullanılması arasındaki fark, güçlü ve zayıf yönleri, ısı, nem, akustik ve yangın gibi etkenler bağlamında değerlendirilmiştir. Çalışmada ortaya konan hibrit sistemler günümüzde uygulanmakta olan modern sistemlerdir ve geliştirilerek çeşitlendirilmeye açıktır.

Anahtar Kelimeler: *Ahşap esaslı konstrüksiyon, hibrit yapı teknolojisi, ahşap yapı.*

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1. Introduction

A structure is built of the systematic differentiation of all the parts it includes, as well as the construction of these parts while keeping this distinction in mind. This differentiation results in evaluating each section separately and obtaining more systematic data. These sections can be counted as system, building, unit, part, component, and ingredient. This study aims to gather the weakness and strengths of wood hybrid constructions compared to other modern systems. While defining them, their hybridization levels were classified according to the way they come together in different levels such as building-level hybridization, system-level hybridization, and component-level hybridization to become a full-fledged construction. In this article, hybrid wood construction systems are elaborated on by classifying them and taking into account the most suitable parts of the construction, which are the building, system, and components.

As a traditional and well-known construction material, wood has been used with not only conventional methods but also advanced technological methods for decades in many regions all over the world. Given that wood has the potential that can be placed in both the tensile and compression zones of the component, it performs high durability despite its lightness. Therefore, wood can be used in any section considering the sustainability and aesthetic purposes to meet the rigidity and other mechanical performance requirements when it comes to hybrid constructions.

The main purpose of hybridization is to provide and gather the most effective properties of every material in one system. As a result of this process, the system is expected to be more possible to prefabricate, construct/deconstruct, and afford with comparatively higher quality of mechanical properties than using a single material (Schober &Tannert, 2016).

Compared to construction systems consisting of only steel material, it has been understood that a wood-steel hybrid system will perform better, especially in fire, when similar precautions are taken. Compared to the building systems consisting of only reinforced concrete, it has been determined that wood-reinforced concrete hybrid systems perform particularly well in acoustic and thermal insulation, and in most cases, they are more efficient models in terms of reducing the dead load of the structure and increasing the tensile strength of the system, when similar precautions are taken. Compared to only timber structures, with similar precautions, wood-based hybrid systems can perform better or similarly in some respects (for instance, wood-reinforced concrete slabs have the same acoustic performance as wood slabs with less thickness, or similar loads can be carried with thinner column-beam measures in steel-reinforced wood hybrid systems).

2. Material and Method

The study used a qualitative method to assess secondary data gathered through quantitative approaches. A new categorization for wood-based hybrid constructions was proposed after conducting a review of the literature and using content analysis. This study which consists of three stages is a summary of a M.Sc. thesis in which wood hybrid construction technologies are presented and supported by application examples.

In the first stage of the study, a comprehensive review of the literature was conducted to identify applied or wood-based hybrid construction technologies that were suggested based on laboratory tests. These data were used to define the hybridization levels in the second part, and by identifying the relevant evaluation criteria, an evaluation model that contains the necessary design data for each construction system was created. In the third stage, the findings were examined and the strengths and weaknesses of wood-based hybrid construction systems were compared with systems using one-type material (wood or steel, or reinforced concrete). The second and third parts of the study contain a strong base potential for future studies and are open to development.

3. Literature Review

A hybrid is an alliance between two things with different origins. In structural engineering, the term "hybrid" refers to a component, system, or building that combines two different materials or systems to maximize certain characteristics of each and produce a whole that is better than the sum of its parts (Fast, 2014). In literature and application examples, the terms hybrid and composite have both been used to describe this combination method. However, as the term hybrid is relatively new, it is more often used for new technologies.

Moreover, Foster, Reynolds, and Ramage (2016) identified different terms to refer to this technology, such as mixed and composite structures. They created a hybrid category by considering the placement of various materials along the height of the building. If two or more materials are utilized together along the height of the building, it is considered a composite structure. If one material goes through just a few stories and the other stories are built with different materials, it is named a mixed structure.

Alternatively, Salvadori (2021) made a hybridization classification mainly dividing buildings into post and beam systems or panelized systems, taking into account subsystems of the structure such as podium and core. As a result, there are now 32 building categories for mid-rise wood-based construction.

The first attempt to combine concrete and wood was made in 1939 by Otto Schaub, who developed a wood-concrete composite floor system using H and Z-shaped connectors (Ali et al., 2017).

Bella and Mitrovic (2020) researched the acoustic characteristics of cross-laminated timber (CLT) systems. Their study found that in masonry structures, the presence of a CLT-paneled exterior increased strength by 40% and ductility by 100%. Furthermore, when CLT panels were applied in a building that was severely damaged in an earthquake, the system's rigidity can be rephrased to an almost undamaged, pre-earthquake state. When CLT panels were hybridized with reinforced concrete structures via anchored dowel connections, the system showed good performance.

Selle et al. (2010) studied different approaches for hybrid concrete-wood floors. As the adhesion between timber and concrete is critical, the researchers analyzed this parameter by taking into account the connector types and the moisture effects on the timber surface. The results showed that fresh concrete does not pose a danger of moisture damage to wood.

Winter et al. (2016) examined timber-steel hybrid beams and proposed 26 different beam types, which were tested. Simple flanges made from folded steel were found to be easy to produce, transport, and assemble. Additionally, cold-formed flanges were relatively lighter and cheaper than welded beams. In the context of timber-steel combination, reinforcement of the timber with steel is generally applied. To compare the mechanical performance of 5x15 cm timber beams reinforced with steel bars by making 1x1 cm grooves, Soriano, Pellis & Mascia (2016) conducted tests. The bearing capacity of reinforced beams increased from 51.1% to 79.2% compared to wooden beams.

Chang (2015) conducted an experimental test to observe the behavior of two different types of tensioned and joined timber walls related to the technique of strengthening wooden shear walls using the pre-tensioning technique. A U-shaped bent plate (UFP- U-Shaped Flexural Plate) was used to connect the shear walls. The combined shear walls are expected to successfully distribute and absorb energy uniformly.

Schänzlin et al. (2018) studied a timber-concrete hybrid system based on a frictional connection system developed by a Swiss engineering office. It is often called the "Plus-Minus-system" which consists of doweled wooden elements with varying widths of the planks. Lehmann (2004) (Weimar University) conducted some research on increasing the resistance by increasing the friction surface area between wood and concrete plates. He applied bending tests on three different fastening systems.

Dickof (2007) examined the Kanazawa M building, a combination of wood, concrete, and steel at both the structural and component level. The first floor is a reinforced concrete shear wall, the second and fifth floors are steel and wood hybrid frame supported, and the columns and braces of the structure consist of wooden elements reinforced with steel bars in the center. The wood in the beams stiffens and strengthens the beam in bending under gravity loads and prevents buckling under lateral loads and lateral rotational torsion under gravity loads. In the columns, the wood around the steel element prevents buckling and serves as a cover to safeguard the steel from fire. The design is made in the direction of the wood to take the axial load while the steel is deformed.

A new wood-concrete hybrid system (HWC box system) including a combination of solid wood and reinforced concrete for high-rise buildings has been proposed by Tongji University and UBC, taking into account the Chinese fire code limiting wooden buildings to three floors. This system is built on the principle of the main system + subsystem, which is a common structural concept for buildings in China. According to this concept, a reinforced concrete core and frame supported by shear walls on every three floors constitute the main system, while modules formed with a light wood frame system constitute the subsystem. The connections between the main and subsystem are critical units as they hold the system together and transfer shear and axial forces between the concrete and wood members. With the bolted joint, the connection of the modules with the reinforced concrete core is ensured. In this system, the connections (bolts) form the third line of defense of the system in case of an earthquake and are designed to not bend before the shear walls and reinforced concrete elements, but to keep the two systems completely connected (Kaushik, 2017).

Loss et al. (2016) studied connections for steel-timber hybrid buildings. According to this study, as the first joint typology in a wood-steel hybrid structure, there are “fully dry” mechanical joints (A-type), connections using epoxy-based resins (B-type), and mixed mechanical joints combining the resistance properties of the resin with steel elements (type C). With these several types of modular connection solutions, it is provided not only the lightness, easy repair, and reuse possibility of components but also the reduction of costs and time. Kinder & Kingsley (2021) presented some steel-wood and wood-concrete connection solutions in their study. Okutu (2019) included the results of the research in which Blass and Schlager tested the performance of different types of fasteners between reinforced concrete slabs and wooden beams.

Hein (2014) researched hybrid timber construction in terms of sustainability in tall buildings. Various connections between wood beams and reinforced concrete slabs or precast concrete slabs are presented in this study.

Margani et al. (2020) presented a sustainable design model for the seismic retrofitting of reinforced concrete structures. The model involves the addition of cross-laminated timber (CLT) facade panels to the structure to resist lateral loads. A connection detail is also included in the model to act as an energy-absorbing damper between floors, which enhances the earthquake resistance of the structure.

4. Findings and Discussion

4.1. Hybridization Parameters

The strength of the structural system of a building is as important as its ability to resist external factors and offer a comfortable space during use. Wood tends to naturally meet sound and heat insulation requirements due to its structure, but it requires specific design regulations for fire safety as it is a combustible material. Additionally, it is essential to limit the entry of water and moisture into the building and prevent them from getting trapped in the elements. Similarly, when reinforced concrete and steel materials are evaluated, their performance characteristics differ. For instance, steel is a noncombustible material, but it loses its strength by undergoing plastic deformation in the event of a fire. This factor should be taken into account when combining it with wood.

4.1.1. Fire design

Fire safety requirements necessitate that structures be built taking into account the conditions that must be met in case of a fire. These conditions include protection of the load-carrying capacity for a certain period of time, limiting the formation and spread of fire and smoke, restricting the spread of fire to neighboring structures, creating evacuation routes for the building occupants, and ensuring the safety of rescue teams. Wooden structures are generally limited to eight stories due to practical and economic constraints, but this limit can be increased in the case of hybrid wooden structures (Östman et al., 2013).

Structures must undergo fire resistance tests to prevent collapse. The fire resistance of structural elements can be obtained by supporting the design load for the entire duration required by the fire test. However, standard fire tests apply only to individual elements such as floors/ceilings, walls, beams, and columns, and do not cover connections. Under fire conditions, bolted and dowelled joints experience a negative effect on their fire resistance, as the heat transmitted into the wood from the more heat-exposed area of the fasteners leads to a localized reduction in the strength and rigidity of the wooden member (Létourneau-Gagnon et al., 2021).

The timber structure is classified as a combustible structure in IBC (International Building Code) and concrete and steel construction is classified as a noncombustible structure. In IBC, timber structures can be used in Type III, IV, and V structures. Type III, IV, and V structures are limited to low and medium-rise buildings with limited construction area: Type III allows combustible construction for internal load-bearing and non-load-bearing elements. There can be external wall mounts. Fire-resistant wood provided meet a 2-hour fire resistance rating (FRR) or has non-combustible exterior walls. Type IV (Heavy wood) is a construction method based on wood elements with minimal measures, providing a natural FRR (Barber, 2018).

Fire can reduce the cross-section, rigidity, and strength of the timber element on the burning surface, and rapid thermal degradation of wood can occur at temperatures of around 200 °C. The front surface of the charred portion is at a temperature of around 300 °C, and the pyrolysis area could be between 200 and 300 °C (Erchinger et al., 2009).

Despite having a zero fire rating for the structure, low-rise structures up to three floors high can nonetheless sustain considerable damage from a fire. For fire-resistant structures; larger or higher is permitted if it contains fire-segregated compartments, is separated from adjacent structures, or where an automatic sprinkler system is applied. Mid-rise buildings with a roof height of less than 25.91 m (85 ft) are supposed to have a 1-hour FRR (Fire Resistance Rating). Multi-story buildings (75 ft (22.86 m) or more to the highest occupied floor) are supposed to have a 2-hour FRR of primary structure, sprinkler protection, and many additional fire protection features. For buildings higher than 128 m (420 ft), fire ratings of 3 hours for load-bearing structures and 2 hours for floors are required (Barber, 2018).

When steel plates are protected from heat by surrounding elements, connections with slotted steel plates can provide high fire resistance. The rate of heat conduction in the joint zone depends on the relative exposure of wood and steel elements. The low temperature behind the charred layer also prevents the wood from decreasing in strength as it heats up (Létourneau-Gagnon et al., 2021).

During ASTM E 119 fire resistance tests, it was estimated that protected surfaces of plywood sheathed uprights delayed the onset of carbonization by 6 minutes, while surfaces insulated with mineral wool insulation delayed it by 19 minutes (American Wood Council, 2021).

There are various design solutions available for solid wood structures that are suitable for fire design. These can be broadly categorized into three types: fully exposed, partially protected, and encapsulated. In a fully exposed design, structural elements are visible from the start of the fire. In a partially protected design, the structural elements are behind a protective covering, although this coating does not prevent pyrolysis (thermal decomposition of the material) for the entire duration of the fire. In encapsulated design, adequate protection is provided to the underlying structure or substrate to reduce the onset of pyrolysis until combustion.

In both exposure and partial protection, it must be assumed that the structure will become a fuel source at some point during a fire. The implementation of these methods requires demonstrating, by a competent fire engineer with relevant experience, that the likelihood of the structure recovering from combustion is reasonable, taking into account the effect of the burning structure on fire development, the structure's self-extinguishing ability, and the structure's ability to support the loads applied during and after the fire event. Regardless of the solution offered, the residual structural members must be capable of supporting the load for either the duration of the fire resistance or the entire duration of a fire (Hopkin et al., 2020).

4.1.2. Acoustic performance

The greatest blocking of sound coming from the source of sound to the people in a place is referred to as sound insulation. If the sound source and the listeners share the same space, acoustic comfort is provided by sound absorption methods, and if they share different spaces, acoustic comfort is provided by insulation methods. If the noise associated with the insulation primarily affects the air, it's called air sound; impact sound if the sound affects a structural element; and if walking affects parts of the building such as flooring, footsteps occur (Neufert, 2014).

Wood, which is a highly absorbent material, is utilized indoors for acoustic purposes. When arranged in pieces with holes, it can absorb the proper medium or high-frequency noises (Avlar, 1995). The installation of a floating screed layer or a soft fiber covering material (such as wood) on a jointless insulating layer, which can be used for all flooring types, is a proven method of reducing the effect of footsteps that directly vibrate floors (Neufert, 2014).

Achieving sound insulation efficacy heavily depends on the many ways that CLT panels are connected, even if they have the same mechanical properties as the joint. The potential to use appropriate fastening methods to lessen vibrations that are conveyed through joints allows the transmissions to be controlled and, consequently, prevents significant acoustic insulation losses (Bella & Mitrovic, 2020).

Pitts (2000) conducted a research project aimed at identifying solutions to improve the acoustic performance of timber frame structures. The test results showed that standard wooden beam floors met the minimum Building Code standards. The addition of a drywall layer to the floor reduced airborne sound by 1-2 dB and impact sound by 3-4 dB. Wooden I-beams and metal mesh/wood flanged beams with the same other layers exhibited the same performance as solid wood beams in airborne sound insulation but performed 2 dB better in impact sound insulation.

Martins et al., (2015) tested the acoustic performance of wood flooring and wood-concrete hybrid flooring using five different samples. The study revealed that the acoustic performance of hybrid flooring solutions was better than that of wood flooring. In terms of airborne sound insulation, the difference between reinforced concrete and wood solutions without ceiling covering was 13 dB and 12 dB for the same samples with suspended ceilings. Regarding impact sound insulation, when comparing solutions with and without ceiling cladding, a 27 dB gain for wood flooring and a 21 dB gain for hybrid flooring was achieved. The study also found that simple solutions without ceiling coverings did not meet the air and impact sound insulation requirements in 24 European countries, whereas the criteria for airborne sound insulation in five European nations were achieved by wood flooring with ceiling cladding. Hybrid floors with ceiling coverings were shown to provide air and impact sound insulation in almost all countries.

4.1.3. Thermal comfort

Natural wood has a porous structure, which generally categorizes it as an impermeable building material in terms of heat conduction. However, this property may change depending on the type of wood (lighter woods conduct heat less) and the direction of the fibers (heat conductivity is relatively higher in the direction parallel to the fibers). The calculation does not account for the shrinkage and swelling of wood caused by temperature changes (Erkoç, 2004).

The thermal conductivity of wood depends on factors such as density, moisture content, fiber orientation, and knots. The thermal conductivity in the radial and tangential directions is almost the same, while the conductivity parallel to the grain is higher than the conductivity perpendicular to the grain (Glass & Zelinka, 2010).

The thermal conductivity of a building material alone cannot determine environmental comfort during the summer months. In this case, the building components' ability to absorb and release heat as a whole plays a crucial role. Therefore, it is necessary to evaluate quantities such as specific heat, periodic thermal permeability, and phase shift. A low-mass building usually has more thermal emissions than a high-mass building, meaning that there will be higher maximum temperatures inside the building during the summer months. However, wooden walls and insulation layers can improve this situation (Bella & Mitrovic, 2020).

Wood has six times more thermal insulation properties than brick, 15 times more than concrete of equal cross-section, and 400 times more than steel due to its nature. Therefore, heating/cooling costs may be high in structures built only from steel or concrete. The use of wood, which reduces the amount of energy consumed for heat management in buildings, can also prevent moisture condensation from occurring on cold surfaces (Tokyay, 2017).

Different properties of materials that may be involved in hybrid structures should be carefully examined during design. For example, for wood-steel hybrid structures at the component level, design gaps can be left between wood and steel to prevent uneven load distribution due to hygroscopic and temperature mismatches between the two materials.

4.1.4. Moisture management

Moisture poses no threat to wood or wood-based structures as long as the detailing of the buildings is done carefully. Moisture management solutions are necessary for hybrid structures, especially in the junction area details.

It was stated by Aklan (2021) that humidity management was successfully completed in the Pyramidenkogel observation tower, which was built in 2012 by Rubner Holzbau in Tyrol, Austria. Moisture management is required for the hybrid attachment points of the structure, which consists of Glulam bar members, CLT panels, and steel cross and support beams, and for areas of wood exposure to precipitation. For example, at the top ends of the columns, there are metal caps fixed to the column at intervals (to allow the wood to breathe inside) (Figure 1a). Droppers have been added to prevent water from entering the screw gaps at the wood-steel connection points (Figure 1b). The same insulation solution is found on the upper surfaces of the tower frames of the Mjøstårnet structure (Figure 2).

Figure 1. a; metal caps for columns, b; dropper detail (Aklan, 2021)

Figure 2. Metal caps for the top frame (CTBUH, 2021) (Photo: Moelven)

Indoor air contains moisture that varies with temperature. In cases where detailing is not successful, humidity in the air may cause condensation on the surface of building elements. It is crucial to prevent condensation-induced water from damaging the building elements, particularly in hybrid wooden structures where there is a risk of metal connection corrosion, weakening of wooden elements due to excessive moisture absorption, and separation of finishing layers from supporting layers.

To prevent such damages, thermal insulation must be successfully applied. The moisture barrier layer should also be positioned correctly, and designs that prevent thermal bridges should be selected (Neufert, 2014).

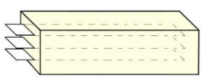
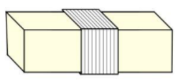
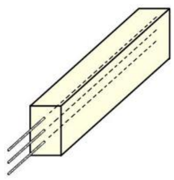
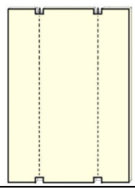
4.2. Hybridization Levels

It is possible to examine hybridization at different levels within a building. For example, this can include analyzing a component that contains two materials, a system that contains various components made of different materials, or a building that contains diverse elements made of various materials in different parts of the structure (Schneider, 2015).

4.2.1. Hybridization at the component level

Hybridization at the component level involves using two or more materials to create a single component that maximizes the benefits of each material. Examples include wood hybrid columns, hybrid beams, and hybrid wall panels. For instance, in the wood-steel hybrid system, steel is used for its tensile strength, while wood is utilized for its compressive strength. In contrast, in the wood-reinforced concrete hybrid arrangement, wood provides tensile performance, while concrete provides compressive performance. Table 1 outlines four different types of hybridization at the component level.

Table 1. Hybridization at the component level (Barış, 2022)

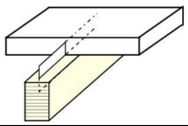
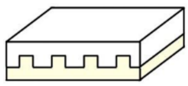
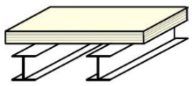
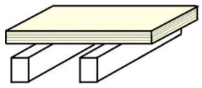
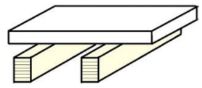
	Flitch Beam Steel plate beams are assembled inside the wooden element. Available in sheet, box, and H profile	**Belted timber** It is applied as a belt to existing wooden elements to increase the rigidity of the element	**Post-tensioned timber beam** The bars placed in the gaps in the wooden element are tensioned without being attached to the element	**Post-tensioned timber curtain wall** After being fixed in place, the rods are tensioned in the prefabricated panels where the rod positions were previously designated
				
Fire	The steel pieces are protected from fire when the wooden section proportions around the steel plate are intended for fire	The steel belt cannot fulfill its function by flowing during the fire since the element is bare	A fire design should be created to guarantee that the wood is damaged before the steel	Steel tension rods in the gaps of wooden panel components should not be left exposed and fire insulation should be made
Acoustic	Like wood-beam floors, this system provides minimum standards, and better performance can be achieved with an additional layer of drywall	It does not require an additional acoustic arrangement as it is usually applied to the individual elements in the building	The performance of the acoustics is unaffected by the steel volume's thinness	The hollow spaces where the tension rods are should also have insulation continuity
Thermal Comfort	The fact that the system consists mainly of wood requires precautions to be taken into account in wood elements	It does not require an additional thermal arrangement as it is usually applied to the individual elements in the building	The fact that the system consists mainly of wood requires precautions to be taken into account in wood elements	Massive timber panels offer adequate thermal insulation, while additional insulation in the tension holes might be necessary

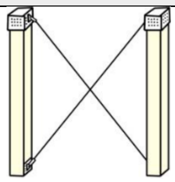
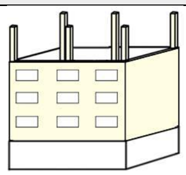
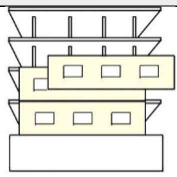
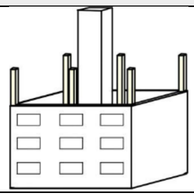
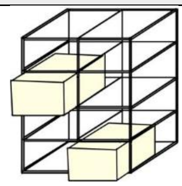
Moisture	The wooden components that surround the steel must be joined in such a way that water vapor cannot contact the steel	When employed indoors, the location's moisture insulation must be successfully applied	Especially in the case of steel, detailing in the joint regions of the elements should be planned to prevent moisture absorption into the gaps	The panels must have a permeable covering, and moisture must not accumulate where the panels attach to the tension rods

4.2.2. Hybridization at the system level

Hybridization at the system level involves integrating several components made of different materials to improve a system's effectiveness, economy, and efficiency. This approach can be used for various systems in a building, including floors, roofs, facades, cores, frames, and main/subsystems. For instance, hybrid wood bridges use this approach. Another common application is building the structure, other than the core structure, with timber and the core structure with incombustible material such as concrete due to building code restrictions for fire in some regions. Table 2 outlines ten types of hybrid construction technologies categorized at the system level.

Table 2. Hybridization at the system level (Barış, 2022)

	Timber-Concrete Ribbed Floor	**Timber-Concrete Floor Plate**	**Steel Frame with Timber Floor**	**Concrete Frame with Timber Panel**	**Timber Frame with Precast Concrete**
	It is constructed by paving fresh concrete with mesh reinforcement over wooden beams with notched screws or metal plates (HBV)	Mesh reinforcement and fresh concrete are applied on eccentric located laminated wood elements, nails as connectors between concrete and timber	Wooden panels are placed on steel beams or can be internally and externally suspended from steel H profiles	Wooden panels are positioned in these locations after the prefabricated reinforced concrete frame (or reinforced concrete precast) details of the junction points with the wood are completed	Precast reinforced concrete slabs that have joints that have been modified are fastened to the beams at the predetermined locations
					
Fire	In non-insulated solutions, wooden beam sections should be designed in measures to allow the carbonization layer/ribs can be closed with fireproof plasterboard	Fire retardant materials can be applied to the wooden part of the section measures can be designed according to the fire	The suspended ceiling or the connection details with the wooden panels can be built to leave the least amount of steel exposed, preventing direct exposure of the steel elements to the fire	The cross-sectional measures of wood flooring are significant and may have additional layers of insulation, but a reinforced concrete frame does not require any precautions	No additional insulation is needed for the concrete part since the cross-sectional measures of the exposed wood frame members are built with the carbonization layer in consideration

Acoustic	Reinforced concrete slab, insulation between ribs, and cladding board (OSB) provide good sound insulation. The concrete cross-section can be increased on uninsulated floors	This system, which exhibits better acoustic performance than solid concrete slabs, exhibits higher performance by increasing its cross-section	A timber saddle can be placed between the wooden panel system located on the metal to absorb the vibration / insulating tape can be used to separate the floor system from the walls	It shows a better acoustic performance than solid reinforced concrete floors and in insulated solutions, the acoustic layer should be continued in the wall-floor junction areas	The continuity of the sound insulation between the wooden elements should be ensured along the gaps and joints
Thermal Comfort	A thermal insulation layer can be added between the wooden ribs by supporting it with a wooden panel from below	It doesn't need an additional thermal insulation layer because of its thermal insulation property, but concrete can still receive an additional layer if necessary	The thermal insulation layer can be added between the H profiles or on the wooden floor panel; an additional insulation layer may not be necessary if the wood cross-section is thick.	The thermal insulation layer can be hidden in the suspended ceiling or applied over the wooden flooring. Thermal insulation measures are applied in reinforced concrete structures for external walls.	For both walls and flooring, an insulation layer comes between the linear wooden elements, for floors, the insulation remains inside the suspended ceiling
Moisture	There should be a film between the wood and concrete that prevents moisture in the fresh concrete from penetrating the wood section	Wood prevents moisture condensation from occurring on cold surfaces due to its high thermal insulation feature	Moisture insulation is applied between the wooden floor and the floor covering in wet areas and with a vapor barrier in the roof system	Moisture insulation is applied between the wooden floor and the floor covering in wet areas and with a vapor barrier in the roof system	There is no risk of moisture transfer from concrete to wood as it is installed with dry joints on site. Normal waterproofing is applied for wet areas
	Steel Braced Timber Frame Wooden elements and steel braces with metal caps are fixed with bolts, screws, metal connectors, or screws in timber frame systems	**Podium Structure** The system includes a podium whose first floor(s) is constructed of reinforced concrete or steel, connectors for the connection line are created simultaneously with the construction of the podium	**Facade System** They are buildings with varied materials and production processes used to create the building's structure and facade system. The carrier system is built initially, followed by the facade system	**Core Structure** The construction of the core system and the construction of the wooden construction can continue simultaneously	**Modular System** Dry jointing is used to secure the prefabricated timber modules to the field-installed steel/reinforced concrete frame structure. Except for module production, the assembly order may differ depending on how complex the system is
					

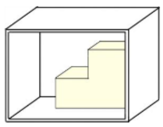
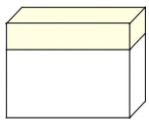
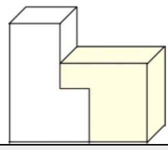
Fire	One of the methods applied to protect steel from fire is to cover the braces with a wooden sheath, fire-retardant paint can be applied to wooden and steel elements	Each material has separate fire regulations. For the hybrid system, the same regulations apply for the connections on the podium and wooden connection line as for the fire regulation required for wood	The wooden facade system doesn't exhibit a destructible feature in a fire in situations when the façade is not load-bearing. Pay close attention to the cross-sectional measurements and consider using fire retardant paints	The construction of fire-escape stairs from non-combustible materials provides an escape route during a fire without the need for additional precautions.	The frame supporting the modules must allow 120 minutes of fire escape during the fire; however, because the wooden modules do not serve as carriers, the fire has no destructive effects
Acoustic	Acoustic layers are applied to the façade, floor, and wall systems because they are typically created as a part of the exterior wall, building envelope, or lattice frame system in timber-framed structures	Insulation should be continued in the connection line between the podium and the wooden structure	It is applied in combination with the acoustic insulation facade system. The acoustic insulation layer should be continued in the junction areas of the facade panel modules	Additional layers should be applied uninterruptedly for the insulation of vibration-induced (machine, elevator, etc.) sounds between the core system and other sections	When modules are placed side by side on internal walls, the acoustic performance improves as the massiveness of the double wall increases. For exterior walls, the acoustic insulation is removed from the module walls or additional insulation is added to the facade
Thermal Comfort	The floor, wall, and facade system to be combined into the system must contain thermal insulation layers	Wood-concrete; The insulation is located between the wooden elements, an extra layer of insulation can be added for the exterior walls and continued along the reinforced concrete podium	Thermal insulation is applied in combination with the facade system. For wood-filled facades, an extra insulation system may not be required when the insulation layer is wood composite panels with insulation, such as SIPs	The wooden construction system is designed to subject to thermal insulation regulations in the relevant building code	For exterior walls, the thermal insulation is dissolved between the studs inside the module walls or constructed with self-insulating composite panels. An additional insulation layer may come under the cladding on the facade

Moisture	Protective caps, droppers, etc., must be kept intact if the construction is situated in an area subject to environmental conditions	For wood-concrete systems, there must be a separator layer (timber saddle, moisture barrier, etc.) to prevent moisture transfer at the podium junction line	In timber facade systems, there should be a layer that provides moisture control between the plywood and the cladding / when the wood is applied as a filler on the facade, sealing should be provided at the junction points with the structure	To prevent moisture transfer from reinforced concrete walls to wooden elements (if there are no additional measures), the dry joint is recommended	If the wood becomes wet, there needs to be adequate room between the modules so that it can dry out. Additionally, the structure and connections of the modules shouldn't be left exposed, and the facade might acquire an additional layer of insulation

4.2.3. Hybridization at the building level

Hybridization at the building level typically involves adding to the building while reusing historical structures to enhance adaptability. While wood is a common choice for added structures due to its lightness, the existing structure can also be made of wood. Table 3 outlines three types of hybrid construction technologies categorized at the building level.

Table 3. Hybridization at the building level (Barış, 2022)

	Add-on module into the structure	**Additional storey**	**Add-on module from outside**
	Benefiting from the advantage of easy workability and assembly, the wooden attachment is formed as semi-pre-production or fully supported in place or mobile	The existing structure is generally made of a more rigid material (concrete, brick, etc.). For wooden additional floors, in some cases, the attic floor is demolished and additional floors are added to the load-bearing system with a support system	In most cases, the existing structure and the add-on act as two different structures, so the connections are not rigid
			
Fire	Fire retardant liquid can be applied and sprinkler systems can be integrated for wooden attachments, which are usually bare for aesthetic reasons	They are built according to the height limitations of the fire regulations, they do not pose a destructive risk in fire, as they do not form the carrier system of the whole building, and they may require an additional fire escape route	Fire safety designs of existing and add-on parts are handled separately. Care should be taken to ensure that the dilatation space between the two structures is not airtight
Acoustic	Impact sound insulation is not needed, precautions should be taken at the connections for airborne sound insulation	A floating screed or a soft fiber coating can be applied on the insulation layer, especially in the first layer of flooring added	Acoustic solutions dissolve in themselves and do not affect each other, since the existing and add-on often act as two separate structures with dilatation

Thermal Comfort	Because the extensions are located indoors and the heat insulation feature of the wood, it performs well and does not require additional insulation	Since the mass of the structure to absorb the heat is increased, the thermal oscillation of the wood used should be calculated according to a hybrid whole by paying attention to the properties such as thermal permeability, density, and phase shift	Since some of the façades of the existing building that absorb and release the heat are covered by the add-on part, the thermal release of the new building is recalculated
Moisture	Indoor ventilation must be done well to prevent condensation on wooden surfaces	The connection line between the existing and new module must not be exposed and must have a vapor barrier layer under the facade cladding and a minimum gap	The connection line between the existing and new module must not be exposed and must have a vapor barrier layer under the facade cladding and a minimum gap

5. Conclusion and Suggestions

The systems discussed in this study include construction technologies that have been applied in the context of modern wood hybrid construction or have been tested in laboratory environments and put forward by scientific studies as suggested systems. Each presented system also includes inputs from new wood construction technology. The findings and results of the study, which has the potential to contribute to the development of hybrid wood construction systems, are as follows:

The efficient design of a wood-based hybrid system requires attention to the design of connection and joint details, which play a critical role in the construction.

A wood-steel hybrid system, when similar precautions are taken, performs better than construction systems consisting solely of steel material, particularly against fire. Wood-reinforced concrete hybrid systems, when similar precautions are taken, perform well in acoustic and thermal insulation and are more efficient in reducing the dead load of the building and increasing tensile strength in earthquake design, compared to building systems consisting solely of reinforced concrete material. When similar precautions are taken, wooden hybrid systems can perform better or similarly in some respects compared to only wooden structures. For example, wood-reinforced concrete slabs have the same acoustic performance as wood slabs with less cross-sectional thickness, or similar loads can be carried with fewer column-beam measures in steel-reinforced wood hybrid systems.

Hybridization at the component level involves using wood as a sheath for the steel element to increase the fire resistance of the system. It provides the same level of performance as wooden construction systems in terms of acoustic and thermal insulation and requires similar regulations. Water and moisture management are important considerations, and care must be taken to prevent water from entering the structure from the end points of the hybrid elements.

When it comes to hybridization at the system level, design principles should be applied by evaluating the suitability of each material for fire resistance, and metal connections should be designed in such a way that they do not yield before any of the hybrid elements. It is also essential to ensure the continuity of the insulation layers in the junction lines to ensure acoustic comfort. Water and humidity management are critical, especially at connection points, which should be designed with hidden joints to prevent water exposure.

It has been determined that the movement of the building as a whole is important in hybridizations at the building level, and in some cases, articulated joints may be the most efficient way to connect two separate volumes. Each module must be properly designed for fire resistance, heat, humidity, and acoustic performance, and must meet individual regulatory standards. In the context of the data obtained as a result of the research, it is possible to conclude that wood-based hybrid structures built with modern technologies offer more efficient and economical construction models in the long run than traditional building technologies in most cases.

This study facilitates the understanding of wood hybrid construction technology and provides a basis for future research. In the future, the study can be improved by expanding the classified systems.

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The article complies with national and international research and publication ethics, and ethics committee approval is not required for the study.

Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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Wood Damages and Improvement in Rural Mosques: Ordu Mosque

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Abstract

This study discusses the damage to wooden materials, which is among the most common problems in the protection of wooden mosques and conveys this issue through examples of mosques in the region. In the case of Ordu mosque, the problems and interventions in wooden materials were analyzed. The condition of the wooden material in the building and the protection approach was examined through the protection and art report of the mosque, the relief and restoration drawings, and photographs. Problems have been identified in wood due to regional conditions, time, transportation, and lack of maintenance and repair. The approach of conserving the original parts was adopted, and the material was renewed at the point where there was deterioration, loss or decrease in strength. It has been revealed that the research in the field should be increased and new strategies for protection should be developed by evaluating the data holistically.

Keywords: *Rural architecture, wooden mosques, protection, wooden material, wood material damages.*

Kırsal Camilerde Ahşap Malzeme Hasarları ve İyileştirilmesi: Ordu Camii

Öz

Çalışmada ahşap camilerin korunmasında en sık karşılaşılan sorunlar arasında yer alan ahşap malzemedeki hasarlar konu edinilmiştir ve konu bölgedeki cami örnekleri üzerinden aktarılmıştır. Ordu ahşap camii örneği özelinde ahşap malzemedeki sorunlar ve müdahale şekilleri analiz edilmiştir. Camiye ait koruma ve sanat raporu, röleve ve restorasyon çizimleri, eski ve yeni fotoğrafları üzerinden ahşap malzemenin yapıdaki durumu ve koruma yaklaşımı çözümlenmiştir. Ahşapta bölge koşulları, zaman, taşınma, bakım ve onarım eksikliğinden kaynaklı sorunlar tespit edilmiştir. Temel koruma yaklaşımı olarak özgün parçaların korunması, çürüme, kayıp veya mukavemeti azalan malzemede ise yenilemeye gidilmiştir. Alan ile ilgili araştırmaların artırılması, verilerin bütüncül olarak değerlendirilerek korumaya yönelik yeni stratejilerin geliştirilmesi gerektiği ortaya konulmuştur.

Anahtar kelimeler: *Kırsal mimari, ahşap camiler, koruma, ahşap malzeme, ahşap malzeme hasarları.*

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1. Introduction

The historical wooden mosques in the rural area of the Black Sea Region are belief structures built from the late 15th century to the beginning of the 20th century. Although the first wooden mosque examples have not survived to the present day, the existing wooden mosques are accepted as the late examples of the first mosques. These examples represent the Turkish wooden mosque style (Küçük, 2017). The buildings, in which wood is the basic material, are part of the traditional architectural identity with the construction techniques and craftsmanship specific to the region. The buildings, examples of which we still see in the Black Sea rural area, have remained idle over time with the acceleration of migration from rural areas to the cities and the decrease in population, and have been neglected in terms of maintenance and repairs. On the other hand, while the new mosques in the area were built using up-to-date technology and materials, the existing architectural heritage became unusable and faced the danger of extinction due to inadequate laws and regulations and wrong policies.

The change and transformation experienced in rural areas around the world have revealed the problem of protection of the existing architectural heritage. In order to transfer the values of the works to future generations, a process that starts with the evaluation of the assets in the rural areas as cultural heritage has been put forward. This process first came to the fore with the Venice Charter (ICOMOS) in 1964, and the "rural" area was also included in the historical environment in the definition of the monument. In the next period, the protection of rural areas has been the agenda topic in various international statutes and regulations (Eres, 2020). In Turkey, the Venice Charter was accepted in 1967. The Convention for the Protection of the Architectural Heritage of Europe, confirmed on October 3, 1985, was ratified by Law No. 3534 of April 13, 1989. International conventions and approaches to protection have been generally adopted in Turkey (Eres, 2013). On the other hand, with regard to wooden structures, a wood committee for the protection of wooden structures was established within ICOMOS in 1972. In 1999, at the 12th General Assembly of ICOMOS, "Principles for the Protection of Historic Wooden Buildings" were accepted. The charter outlines the main principles and recommendations for the protection and restoration of historic wooden structures (ICOMOS, 1999). While conducting studies for the protection of architectural heritage in rural areas at the international and national level, it is important to determine what the problems in the field are and how the protection activities are carried out, and to convert them into usable information through analysis. Starting from this point, wooden mosques located in the Black Sea rural area and facing the danger of extinction are discussed in this study. In addition to representing the socio-cultural and economic life of the period in which they were built, the architectural heritage also carries the art of building construction, technology, information about materials and construction techniques of the period (Çakır & Sağıroğlu Demirci, 2021). For this reason, the deformation observed in the building and the factors causing this deterioration and the modes of intervention were analyzed and evaluated by putting forward an approach in the field.

1.1. The Role of Wood Material in Rural Architecture in the Black Sea Region

Figure 1. Examples of buildings with different functions using wooden materials in rural areas (Yalçınkaya, 2016; Serander, 2016; Buzlupınar Bridge, n.d.)

The Black Sea rural area has a rich building architecture as a region where wood is used as the basic building material and unique construction techniques are developed. Different techniques have been used in different construction elements and components of the wooden building with which different functions such as serander, mosques and bridges, especially residences (Yalçınkaya & Sancar, 2010) (Figure 1).

The fact that wood is easily accessible and workable in the rural architecture of the Eastern Black Sea has made it one of the oldest materials used in the region for centuries. The tree species found in the region has different characteristics. The choice of the tree type to be used in the building and the place of use in the building comes from the tradition gained over the years (Eruzun, 1977). The most common type of wood used in buildings in the area is chestnut. It is followed by oak, valonia oak, pine, beech, fir, spruce and elm. The rich tree species found in the region have enriched the use of wood in the structures built (Biber & Kurak Açıcı, 2021). Due to the rainy and humid climate of the region, the stone material is used to separate the main spaces of the building from the high-humidity ground. Wood material, which is less resistant to humidity but is abundant in the region, is widely used in sections above floor level (Vural, 2005; Pınar, 2018). Wood also plays an active role in the construction techniques which is specific to the region and gives the building a characteristic feature. In particular, the main element that gives the buildings a characteristic feature is the external wall construction. In the wooden frame system, "eye stuffing" (göz dolması) and "amulet stuffing" (muskalı dolma), in the wooden stacking system, "wolf throat" (kurt boğazı), "ring throat" (çalma boğaz) can be seen (Özgüner,1970) (Figure 2).

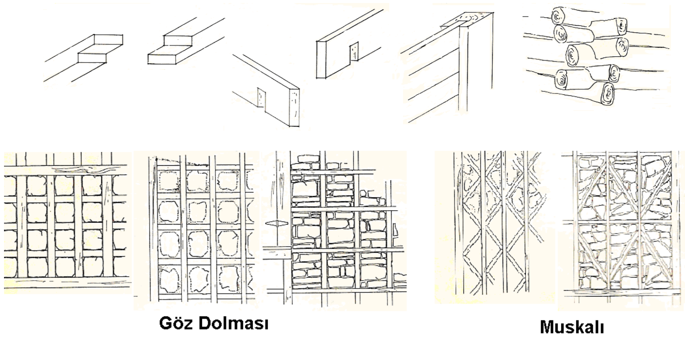

Figure 2. Local construction technique (eye stuffing, amulet stuffing and throat) (Özgüner, 1970)

1.2. Deformation of Wood Material in Rural Mosques in the Region

When the subject is evaluated in terms of rural mosques, wooden materials are used in many parts of the building in mosques. It is possible to come across the use of wood from the load-bearing system to the roof, from the minaret to the stairs (Figure 3). The environmental conditions of the tree from which the wood used in mosques is obtained can strengthen or weaken its features. Environmental conditions create anatomical defects within the tree and adversely affect the resistance and strength of the wood material. These environmental conditions continue to be effective on the tree, which turns into a building material in the process. Problems arising from both the physical environment and the user in the structures in the region cause problems such as deformation of section-surface in wooden materials, fragmentation in wooden materials, deviation (deviation from horizontal and vertical), deterioration, cracks and surface pollution, and loss of value in the original element.

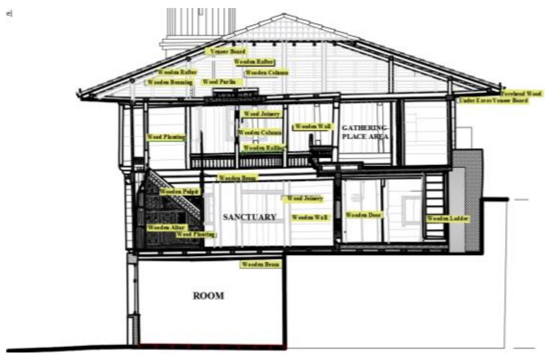

Figure 3. The use of wooden materials in mosques in rural areas

Environmental degradation: Regardless of which part of the building it is used, it is essential that the wood be dry. The Black Sea Region is a region with abundant precipitation, high cloudiness and high humidity. The physical, biological and chemical conditions caused by this situation can adversely affect the wood material. The intense humidity in the region causes irreversible damage to the wood material over time. For example, while moisture on the material causes swelling, an increase in humidity can lead to deterioration. Again, the humidity in the area causes the wood to deteriorate and the loss of parts. Humidity and heat change cause contraction and expansion in the material originating from the hygroscopic structure of the wood and affect the strength of the wood material. Too many repetitions of this situation cause cracks and split in the wood (Peker, 2010).

Atmospheric conditions such as rain, snow, temperature changes, UV rays, and wind in the region have more negative effects on the wood used especially in areas exposed to external atmospheric effects. Depending on the temperature, excessive dryness of the wood can lead to cracks, and if the temperature increases, it can lead to splitting (Perker & Akıncıtürk, 2006). The color change is common in wooden mosques due to water contact with the chestnut tree. The most deteriorated area in mosques is the floorboards of the roof and portico, which are exposed to external weather conditions (Uzun, 2016).

Another situation that causes damage to wood is the chemical interaction between the metal and the material. In mosques, the effect of wooden material on items such as locks, hinges, doorknobs, and door and window elements can be seen. Although the joints technique was used in the wood joints at the beginning, materials such as nails and screws have been used in the structure over time. Over time, there is an interaction between wood and metal, and the wood is damaged by the effect of corrosion.

Another factor that causes damage to wood is bacteria and fungus in the environment. Bacteria, fungi and insects can be physically and biologically effective on wood material. They commonly cause increased water permeability of the material, decreased strength, and damage such as odour, deterioration, cracking, discoloration and staining. Insects also cause damage such as flying holes, insect galleries and dusting on wood (Peker, 2010; Tunca, 2019) (Figure 4) (Figure 5).

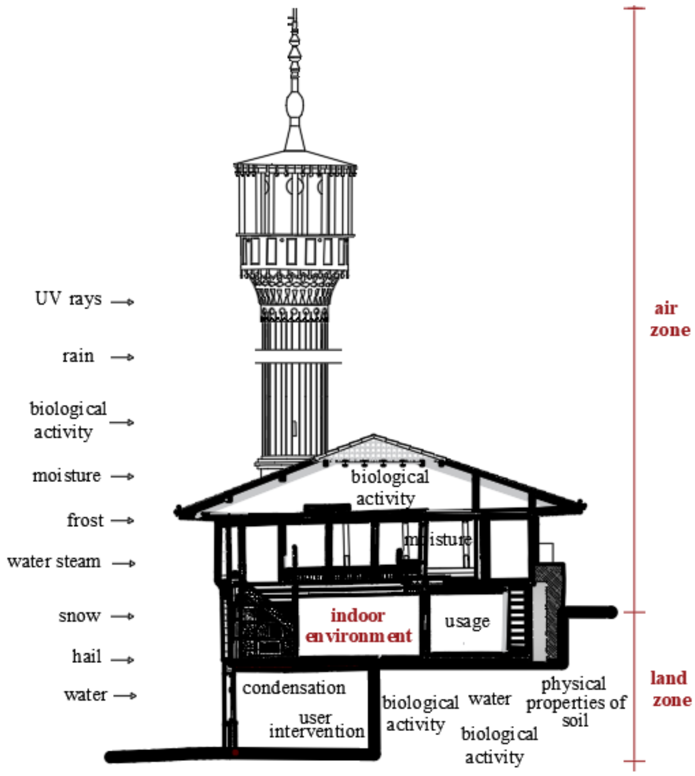

Figure 4. Factors causing deterioration of wood material

Figure 5. Examples of deformation in wood material originating from the environment in Wooden Mosques

Deformations Due to Human Causes: One of the main reasons for the deterioration of the wooden mosques in the region is the factors caused by lack of care and abandonment. Migration from rural areas to the city and the decrease in the population, the fact that reinforced concrete mosques are being built instead of repairing and maintaining existing mosques cause these buildings to be abandoned. The wooden mosques that still exist in the region today are matched with the last ones built 50 years ago. The lack of periodic maintenance and repairs of the wooden material used in the mosques, the material being exposed to water and the surrounding vegetation, the loss of parts in the original building element or the equipment due to reasons such as wear and tear due to use, and the collapse of the building in case the problems experienced spread over time. In some cases, there is a process leading to destruction.

There is a need for heating and lighting in order to provide comfortable conditions in mosques. For this purpose, the installation system added to the space requires intervention in the wooden material from place to place. This unqualified intervention damages the building. In order to increase the level of illumination in the interior, there are examples of expanding existing windows or opening new spaces (Küçük, 2017; Uzun, 2016).

Depending on the needs that emerged over time in mosques, interventions were made to the original plan. The space can be divided or the gathering-place floor can be enlarged. This floor is made of wooden material, and the material may be damaged at the junction points of the new addition and the existing wooden elements. On the other hand, it is possible to come across examples in the region where deformations on wooden wall surfaces are used instead of maintenance and repair. The construction technique gives wooden mosques the ability to be dismantled and rebuilt. In this process, reasons such as changing the order of the wooden boards and loss of parts cause damage to the building in case of transport (Figure 6).

Taşkıran Mosque

Plumbing system attachment
Kondu Mosque

additional space, use of unqualified materials
Günebakan Mosque

Figure 6. Examples of human-induced deformation of wooden materials in wooden mosques

2. Material and Method

In the research, the problems and interventions in wooden materials are analyzed through the example of a rural wooden mosque. This analysis provides data to reveal the protection approach in the region and to ensure the sustainability of wooden mosques in the region. In the research, the analysis of the wooden mosque of Ordu village, which bears traces of the traditional building culture in the rural area, is included. Restitution, relief and restoration project reports, drawings and photographs of the building were used to designate the determination. Answers were sought to questions such as in which parts of the mosque in the rural area, what problems were encountered and what interventions were made as a solution to these problems.

Ordu Mosque, chosen as the study area, is located in Ordu village within the borders of Çarşamba district of Samsun province (Figure 7). The first place of the mosque was dismantled and moved to its current location due to the periodical overflow of the creek next to it, and the construction of this mosque is dated to the beginning of the 15th century.

The masonry bag (yığma çantı) technique was used in the building, which was built entirely with wooden materials. The mosque, which consisted of only the existing sanctuary section in the first period, has survived until today with the addition of the narthex and the portico section in both directions. Today, it consists of three places, the last congregation place, the main place of worship and the women's gathering place. The porched section, which surrounds the main space and is the second-period annex, is designed as a continuation of the narthex. The mosque, which had a flat housetop at the beginning, was closed from the outside with a hipped roof as an annex of the second period. Looking at the life cycle of the building, it is known that its location has been changed and that it has undergone some additions and renovations in the process. This situation caused different periodic effects to be seen in the building (Eravşar, 2015; Zan Mimarlık, 2015a) (Figure 8).

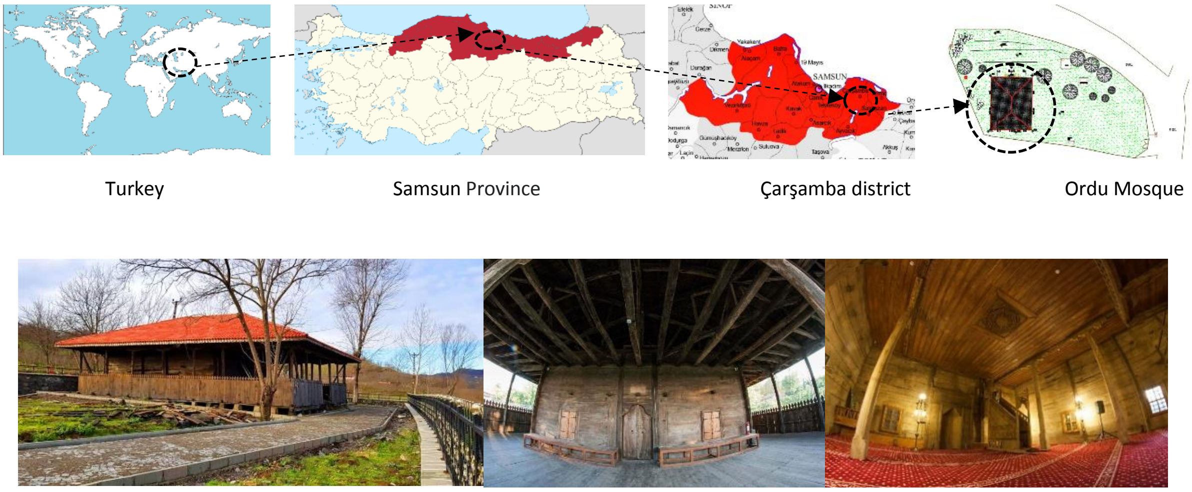

Figure 7. Location and general view of Ordu village mosque (Ordu Mosque, n.d; Zambak, 2019)

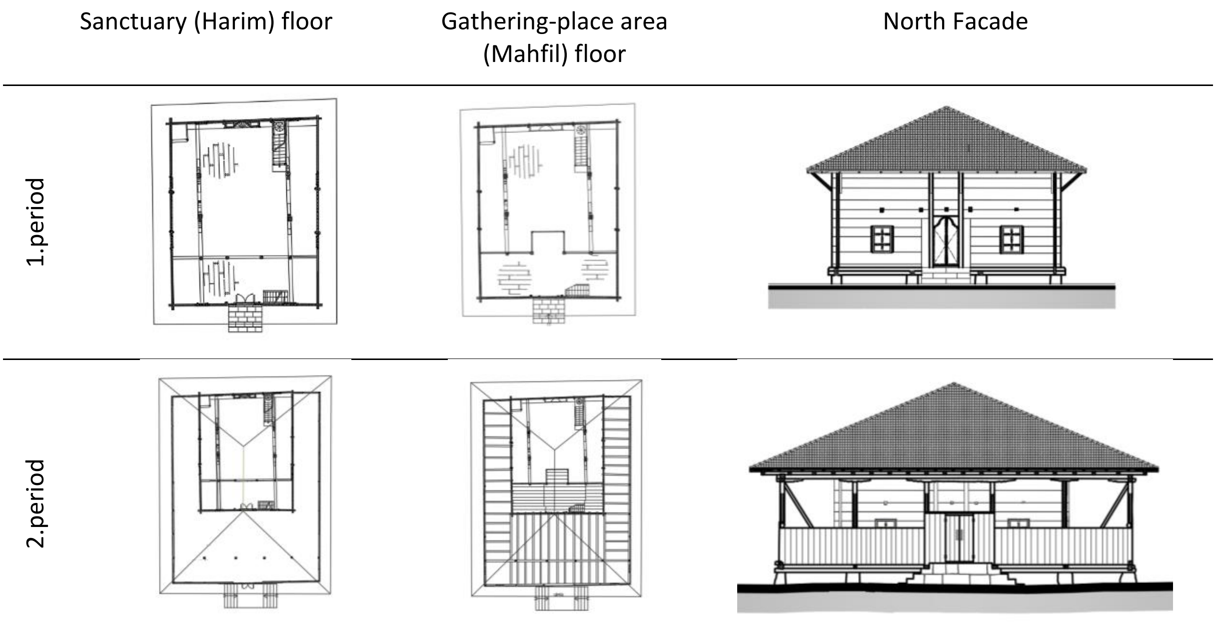

Figure 8. Plan, section and facade of the 1st and 2nd Period of Ordu Village Mosque (Zan Architecture, 2015a)

3. Findings and Discussion

When the condition of the wooden material in Ordu Mosque is evaluated, the location change in the life cycle of the building, the physical environmental conditions, and the additions and renewals made over time have caused different types of deformation in the wooden material. For the continuity of the building, it is aimed to protect its original character with the least intervention. The general approach for this is to eliminate the factors that cause physical deformation and repair the damaged points. In the study, the places of these deformations and the repair/renewal decisions are conveyed through the plan, section and view drawings and their photographs are included. Damages and interventions seen throughout the building are conveyed with the help of a model.

The condition of the wooden material in the building is discussed under two headings indoor and outdoor. When the deformation of the wooden material in the roof, narthex, portico and façade areas exposed to the outdoor conditions and the intervention made are evaluated (Figure 9);

Figure 9. Deformations and interventions in wooden material in Ordu village mosque; roof, narthex, portico and façade

- The fact that the columns, railings and beams in the narthex and portico section are open to atmospheric factors caused the formation of holes, cracks and crevices in the material. Again, physical damage such as deterioration, wear and tear were observed in the exterior wall coverings and flooring in this section (Zan Mimarlık, 2015b). In the areas that were problematic in the protection process, the surface was cleaned, and holes, cracks and crevices were filled and strengthened in the wooden material in the first step. The areas with high deformation were renewed in line with the original.
- The wooden balustrades around the narthex and portico sections of the building were deformed due to atmospheric factors. The damaged wooden balustrades were rebuilt with hardwood in line with the original (Zan Mimarlık, 2015b). Again in this section, the openings covered with metal gauze were restored by removing the metal.
- On the south façade of the mosque, the southeastern and southwestern parts of the portico were covered with unqualified wood. The woods in this area were removed and the portico area was completed with wooden railings and supported with wooden studs.
- Various reductions and deformations have occurred on the window door in the building with the effect of time. The damaged, missing and broken wooden parts on the windows have been renewed. The south façade of the mosque has two window openings to the right and left of the mihrab. These two unqualified windows have been removed and their gaps closed. At the entrance to the sanctuary, the surface was cleaned, and the damaged and rotten parts were taken care of; holes, cracks, and crevices were filled and strengthened (Zan Architecture, 2015b).
- Widespread deformation was observed on the roof. As a general approach, the solid elements were preserved in the wooden roof, and the damaged ones were renewed.

Ordu mosque has a sanctuary and a gathering-place area as an interior environment. Items such as the pulpit, mihrab and lectern in this area are made of wood. When the deformation of the wood material in the indoor environment and the intervention made are evaluated (Figure 10);

- Deformations and deterioration were observed on wooden walls, wooden columns and beams in the sanctuary and gathering place. Common contamination, loss-deformation and discoloration were observed on wooden surfaces indoors. The surface has been cleaned in the problematic areas, and holes, cracks and crevices have been filled and strengthened.
- Deformation and missing were observed in the wooden material in the core of the wooden ceiling. The damaged parts are refurbished from hardwood.
- Wood deterioration was common in the flooring in the sanctuary and gathering place. Corrosion was also found on the wooden staircase connecting the sanctuary and the gathering place. Problem areas on the floor and stairs were renewed with hardwood in line with the original.
- Physical destructions such as deterioration, wear and tear have occurred in elements such as the pulpit, mihrab and gathering-place kiosk, and lectern (Zan Mimarlık, 2015b). These items have been strengthened by cleaning the surface and filling holes, cracks and crevices.
- Missing and damaged sections were found on the railings on the gathering-place floor (Zan Mimarlık, 2015b). The railings were scraped and their damaged and missing parts were renewed.

Figure 10. Deformation and interventions in wooden material in Ordu village mosque; sanctuary, gathering place and wooden items

When the problems and interventions in wooden material in Ordu mosque are evaluated on the basis of the construction element and its element (Figure 11);

- 6 different types of wood damage were found on the wall element of the mosque. These are missing/deformation, contamination, addition, vegetation and deterioration in wooden elements. These problems were intervened in the form of strengthening the original wood, removing surface dirt and insect disinfection (spraying) and removing unqualified addition.
- Missing / deformation and deterioration were observed in the wooden elements of the flooring. For this, strengthening the original wood material, insect disinfection and reconstruction in accordance with the original were preferred.
- In the single bearing, contamination and deformation were observed in the wooden element. Here, the cleaning of surface dirt and painted surfaces and the strengthening of the original wood material were followed.
- Deterioration was observed in the beams and throughout the ceiling, as missing and deformation of the wood in the ceiling core. Filling of splits and cracks, strengthening of original wood, cleaning of surface dirt and insect disinfection were carried out.
- Deterioration in the stairs, door windows and railings, loss of deformation and vegetation in additions and materials were seen. On the roof, on the other hand, problems of losing strength have emerged. In these four areas, it has been tried to be reconstructed in accordance with the original.
- Filling the splits and cracks, cleaning the surface dirt and insect disinfection for the addition and contamination seen in the lectern, pulpit and mihrab in the building.

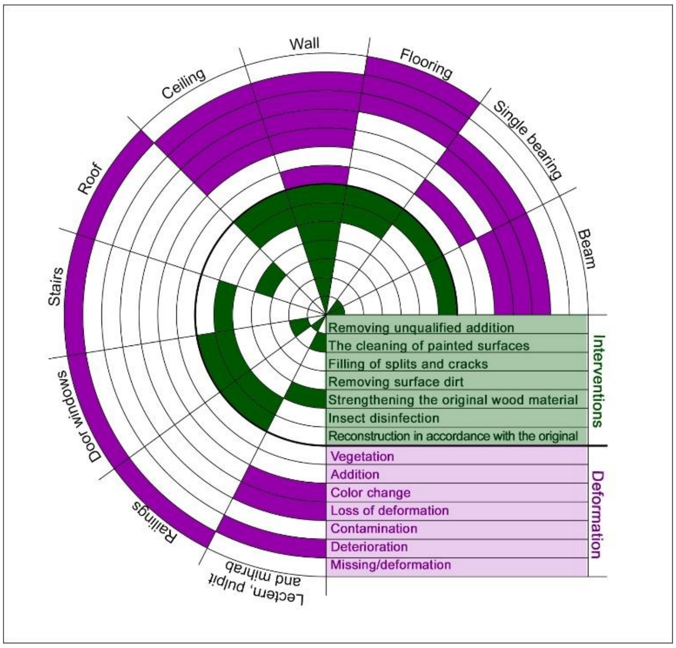

Figure 11. Deformation and interventions in wooden material in Ordu Mosque

Missing/deformation and deterioration of wooden material in the building are seen in points throughout the building and in larger areas in flooring. It is seen that the repair is based on the building in general, and the building element has been changed with the reconstruction in accordance with the original on the stairs, floor and roof.

4. Conclusion

The subject discussed in the example of the Ordu Mosque in the study, in fact, provides data for the analysis of the problems seen in the wooden mosques in the region and the approach to their restoration, and the development of a strategy for the sustainability of the wooden mosques in the region.

Although the wooden material in Ordu Mosque is in good condition in general, factors such as the wearing effect of time, climatic conditions and infestation have caused deterioration. Physical destruction such as size change, color change, deterioration, wear, breakage and corrosion has been observed in the wooden material in the structure, more intensely in the elements exposed to external weather conditions and acting as carriers. In the protection studies in the region, it has been found that in order to eliminate the problems in the wooden mosque and to ensure its continuity by protecting its originality, the approach is completely avoided, the traces and remains in the structure are preserved, and the traces of it are made to be read in possible interventions. Within the framework of this approach, it was determined that the factors causing physical deterioration in Ordu Mosque were removed and the damaged parts were repaired.

In rural mosques in the region, wooden material was used in many parts of the building, especially the load-bearing system. The lack of maintenance and repair of the wooden material in the building makes it more difficult to protect the building group with each passing day. It is seen that the problems caused by the factors that cause deterioration in the wood material in the regions are similar in general terms. The life of the material should be extended by increasing the number of research on this subject and analyzing the material in the buildings. A holistic protection strategy for buildings in rural areas should be adopted and the sustainability of the existing building stock should be ensured through regular maintenance and repairs. Thus, the richness of the rural architecture of the region and the country can be passed on for generations by keeping these architectural works, which are representative of the local construction tradition and reflect the social-cultural structure of the period in which they were built.

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Ethics Committee approval was not required for the study. The drawings and reports of Ordu Mosque were prepared by Zan Architecture. Used in the study with the permission of the company.

Author Contribution and Conflict of Interest Declaration Information

The article has a single author and there is no conflict of interest.

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Determining the Climate Future Projection of Erzurum City with the UrbClim Model

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Abstract

The negativities brought by climate change, which is among the crisis agendas today, directly affect the cities. According to the UN, the rate of urbanization in the world is increasing rapidly. It is estimated that it will reach 6.4 billion in 2050. The UrbClim model is also used to project future climate in cities. For the province of Erzurum, where the climate negatively affects living things, the climate data of the city for the first 10 days of July 2016, 2017, and 2018 were analyzed using the UrbClim model. This study, it is aimed to analyze the exemplary cities with cold climates in the world, which will set an example in the determination of climate change and support sustainable and livable urbanization, use energy efficiently, and to produce climate adaptation strategies at the point related to landscape.

Keywords: *Future climate change, UrbClim, planting design, global climate model, Erzurum.*

UrbClim Modeli ile Erzurum Kentinin İklim Gelecek Projeksiyonunun Belirlenmesi

Öz

Günümüzde kriz gündemleri arasında yer alan iklim değişikliğinin getirdiği olumsuzluklar doğrudan şehirleri etkilemektedir. UN'e göre dünyada kentleşme hızı hızla artmaktadır. 2050 yılında 6,4 milyara ulaşacağı tahmin edilmektedir. UrbClim modeli şehirlerdeki iklim tahminleri için de kullanılmaktadır. İklimin canlıları olumsuz etkilediği Erzurum ili için 2016, 2017 ve 2018 Temmuz aylarının ilk 10 gününe ait kentin iklim verileri UrbClim modeli kullanılarak analiz edilmiştir. Bu çalışma ile dünyada soğuk iklime sahip örnek şehirlerin iklim değişikliğinin belirlenmesinde örnek teşkil edecek, sürdürülebilir ve yaşanabilir kentleşmeyi destekleyecek analiz edilerek enerjinin verimli kullanılması ve peyzaj ile ilgili noktada iklim uyum stratejilerinin üretilmesi amaçlanmaktadır.

Anahtar kelimeler: *Gelecek iklim değişikliği, UrbClim, bitkisel tasarım, iklim modeli, Erzurum.*

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1. Introduction

The IPCC stated in 2007 that climate change associated with global warming is a reality. He demonstrated with 90% reliability the existence of the temperature increases experienced by the effect of this change, that is, the human being in the leading role of the increasing temperature. This situation and the human impact on global climate change were also confirmed by the IPCC, and it was confirmed that the 30-year period between 1983 and 2012 was the hottest in the last 1400 years (IPCC Synthesis Report, 2014).

According to the evaluation report "Climate Change 2021: The Physical Science Basis" published by the IPCC in August 2021, it is certain that scientists do not have any doubts about the warming of the world and that the changing parameters are human-induced actions. According to all the scenarios studied, it is predicted that the world temperature increase will be above 1.5 °C. It is stated that since 1970, global surface temperatures have risen faster than 50-year periods in the last 2000-year timeframe (IPCC, 2021).

Understanding the urban climate is crucial due to the unique climate conditions found in urban areas, such as higher levels of heat stress during heat waves. To gain a better understanding of the urban climate, Caluwaerts et al. (2020) emphasize the importance of obtaining detailed insights into urban environments. In this regard, Hooyberghs et al. (2016) have used the UrbClim model to generate temperature maps for London, providing an evaluation of the current climate as well as future projections for the period 2081-2100. Analyses have been conducted using the UrbClim model in Colombo, Sri Lanka.

The greening simulations show that increasing green space by up to 30% in urban areas can decrease the average air temperature by 0.1 °C (Maheng et al., 2019).

Reducing urban heat island effects helps to mitigate the harmful effects of climate change. In England, a temperature increase of 3.0 °C is expected until 2080. As an adaptation strategy, different types of green areas have been created in local areas of the city, and their relationship with energy demand has been investigated to reduce the effects of urban heat islands. According to simulations conducted, energy savings of up to 4.8% have been achieved (Skelhorn et al., 2016). In a study conducted for Ankara, the urban heat island changes were identified between 1985-2002. Based on these findings, measures have been proposed to reduce the urban heat island effect under the headings of wind, sunshine, and vegetation at both the micro and macro scales (Yüksel & Yılmaz, 2008; Nazarian & Lee, 2021).

Climate change through urbanization is accepted as an important indicator of human pressure on the environment. Urban centers and cities are often several degrees warmer than the surrounding areas and rural areas, making them vulnerable to changing climatic conditions (Figure 1). Thermal comfort in urbanization is associated with high surface and air temperature, often referred to as an urban heat island. The low albedo (reflection) of building roofs, asphalt roads, wide squares, and dense hard ground surfaces in cities, the trapping of radiation in the urban canopy, the heat storage of urban components, and the decrease in evapotranspiration due to impermeable surfaces cause heat island formation in cities. In addition, the intensive use of urban infrastructure components such as transportation and energy at small spatial scales leads to intense anthropogenic heat releases that can increase up to 1.0°C in urban heat islands. Due to the urban heat island (UHI) increase, cities are particularly vulnerable to heat waves (Oke, 1978; Ohashi et al., 2007; Gabriel & Endlicher, 2011; Tremeac et al., 2012; Uzun & Gül, 2021).

In this paper, the UrbClim numerical model is used to simulate urban heat accurately at a fast rate and high spatial resolution for the cities of Johannesburg and Ekurhuleni, South Africa (Souverijns et al., 2022).

A decade-long measurement dataset has been created in Milan, Italy. These data were used to obtain thermal areas with medium to high resolution close to the surface using grid cells. In this study, the UrbClim and ERA5 models, which are used to determine future temperature, were compared. During the winter and summer segments, a comparison was conducted between different datasets with overlapping periods of available data. The findings show a general agreement in both cases, but there is a consistent underestimation of the impact of BSI on Milan. On average, the bias can be measured at -2.0 °C, but in certain sections considered, this underestimation range could exceed 10.0 °C (Frustaci et al., 2022).

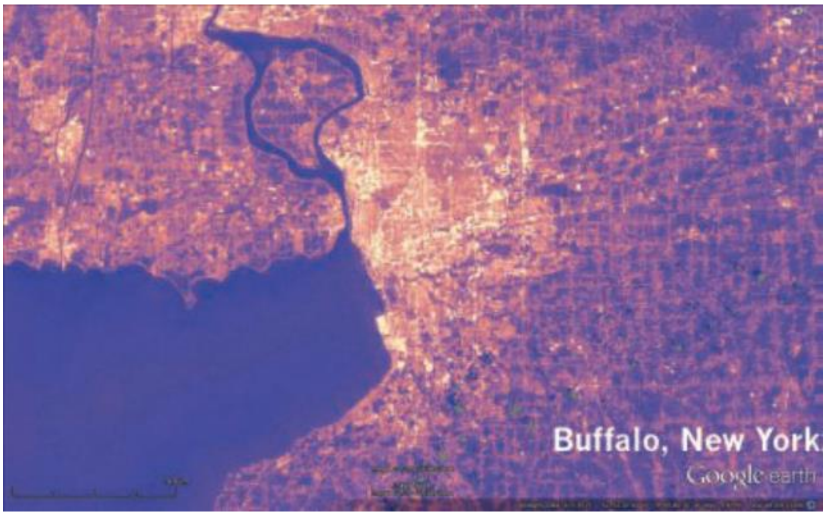

Figure 1. Urban heat islands measured by NASA satellites in Buffalo, New York (Rosenzweig et al., 2018)

To evaluate common artificial urban boundaries and related climate hazards such as high temperatures in built environments, an urban analysis is necessary at various spatial scales, including meso, local, and micro scales. This approach can be applied in different urban planning phases, from zoning areas to designing urban canyons, and it can provide urban design recommendations at various levels. However, due to the high computational cost of numerical models used in this approach, it also has limitations. Improvements in the accuracy of numerical modeling capabilities at different scales can make multi-model coupling more feasible. In this regard, it is becoming increasingly common to impose boundary conditions on microclimate models (Lobaccaro et al., 2021),

There are academic studies on effective and functional urban uses for reducing the Urban Heat Island (UHI) effect that occurs in global areas. Urban parks that have the feature of reducing the UHI effect (Arellano et al., 2020; Jamali et al., 2021; Yilmaz et al., 2022; Menteş et al., 2023), plants (Irmak et al., 2018; Yilmaz et al., 2023), water surfaces (Wang et al., 2018; Qiu and Jia, 2019), street orientation (Mutlu et al., 2018; Yilmaz et al., 2021), and eco-friendly materials in ground-building surface coverings (Irmak et al., 2017; Ranagalage et al., 2017) is known to be effective measures in terms of energy and economic efficiency (Arnfield, 2003; Taleghani, 2018; Santamouris, 2020; Kim et al., 2021).

The city's social services sectors, such as energy and health, are easily affected by the UHI effect. A study of a small city in western Greece found that the city center needs more/less cooling/heating in summer/winter than in the surrounding countryside (Vardoulakis et al., 2013). In Shanghai, China, a study on the heat island found increased heat-related deaths in urban areas with the negative effects of high temperatures on health (Tan et al., 2010). Considering the combined effects of increased heat waves due to climate change and research on the UHI effect, it poses serious health risks for the urban population (Li & Bou-zeid, 2013).

A comprehensive understanding of the urban climate system is the starting point for the climate risk assessment process. Critical to this is the need for long-term, quality-controlled, observed climate data. Without long-term historical records, the role of climate variability cannot be adequately defined and climate change projections cannot be supported by a strong historical basis. Even where a long-term record is available, there is often content to expand urban climate monitoring networks to better understand urban changes and raise awareness of climate risks. (Blake et al., 2011; Rosenzweig et al., 2018).

2. Material and Method

This study will be carried out in Erzurum, which has extreme climate characteristics in Turkey. Erzurum is known as the only large settlement in the Eastern Anatolia Region, located at an altitude of 1959 meters (Figure 2). The settlements, located in the southwestern part of a high plateau, are located on a plain reaching up to 2000 meters. There are the Dumlu Mountains in the north of the city and the Palandöken Mountains in the south. Its area is 25,355 km^2, and Erzurum 2020 population is known to be 758,279. Erzurum is connected to every part of the country by land, air, and railway transportation network (Anonymous, 2021a; Anonymous, 2021b).

UrbClim is the first and current urban climate model with enough capacity to cover a long period for creating urban climate projections. It has been confirmed to comply with international scientific standards. The model was first tested for a short period in Toulouse and Ghent cities (De Ridder et al., 2015a; Hooyberghs et al., 2016).

The UrbClim numerical model is designed for high-resolution and precise meteorological output, including temperature, humidity, heat fluxes, and soil parameters, over an extended period at the city level. It comprises a detailed land surface scheme with simplified urban physics and a 3-D atmospheric boundary layer model. This makes the model ideal for long-term integrations, especially for urban climate projections. Studies have shown the model to be effective for this purpose (Souverijns et al., 2022; Hooyberghs et al., 2016).

Understanding the urban climate system is accepted as the beginning of the climate risk assessment process. Critical, therefore, is the need for long-term, quality-controlled, observed climate data. Without long-term historical records, the role of climate variability cannot be adequately defined, and climate change projections cannot be supported by a strong historical basis (Blake et al., 2011; Rosenzweig et al., 2018).

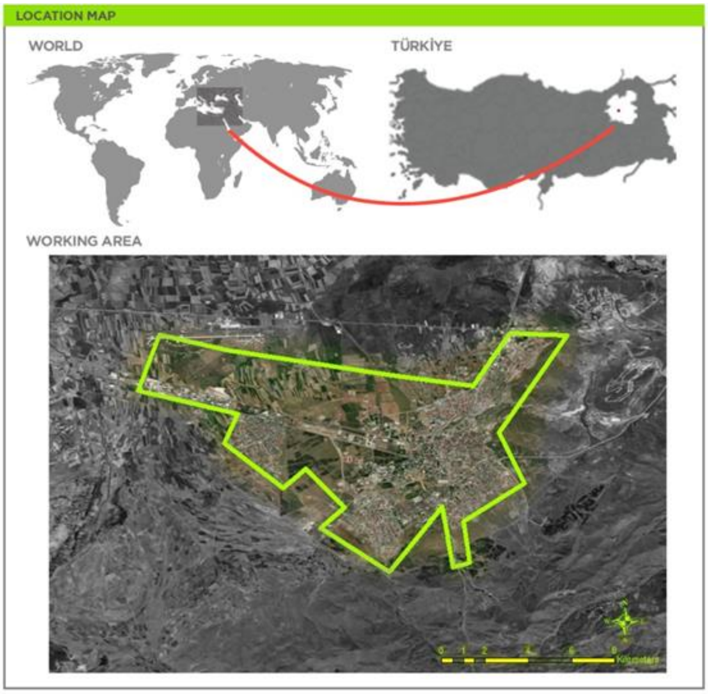

Figure 2. Erzurum location map, working area

The UrbClim model, which will be used in the city of Erzurum, which is a cold climate city, for a comprehensive understanding of the urban climate system and the initiation of the climate risk assessment process and forecasting for the future; It is designed to simulate temperature and heat stress on a city scale. The UrbClim model, which was designed in 2013 to determine the effect of temperature change and sustainable urbanization on an urban scale, is implemented in many European cities. This model is a combination of a three-dimensional atmospheric boundary layer and simplified urban physics. UrbClim generates very high-resolution spatial local climate data by dividing information about urban building components (vegetation, soil isolation, typology, land use and land cover) into forward-looking 100 m grids, combining a physics approach to urban scales. Each grid cell has its energy balance and corresponding thermal behavior (De Ridder & Schayes, 1997; De Ridder et al., 2015a; García-Díez et al., 2016; Martinez et al., 2017; Lauwaet et al., 2017; Verdonck et al., 2018; Ingole et al., 2020) (Figure 3).

The structure of the model includes a comprehensive scheme for the land surface that incorporates simplified urban physics, as well as a 3-D atmospheric boundary layer model. The land surface scheme is based on De Ridder & Schayes' (1997) soil-vegetation-atmosphere scheme, which has been adapted for urban physics by integrating the inverse Stanton number. For further information on the UrbClim numerical model, including its efficiency compared to full mesoscale models, please refer to (De Ridder et al., 2015a; García-Díez et al., 2016; Souverijns et al., 2022).

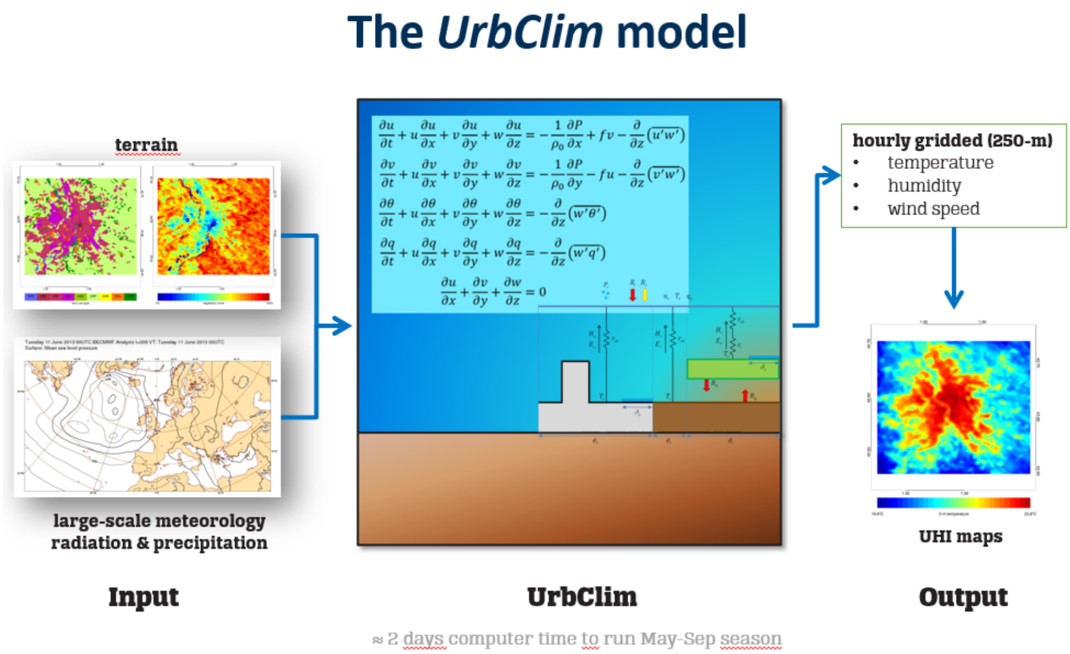

Figure 3. Working principle of UrbClim Model (De Ridder et al., 2015b)

The model has been validated by studies in the cities of Barcelona (Spain), Toulouse (France), Brussels, and Ghent (Belgium).

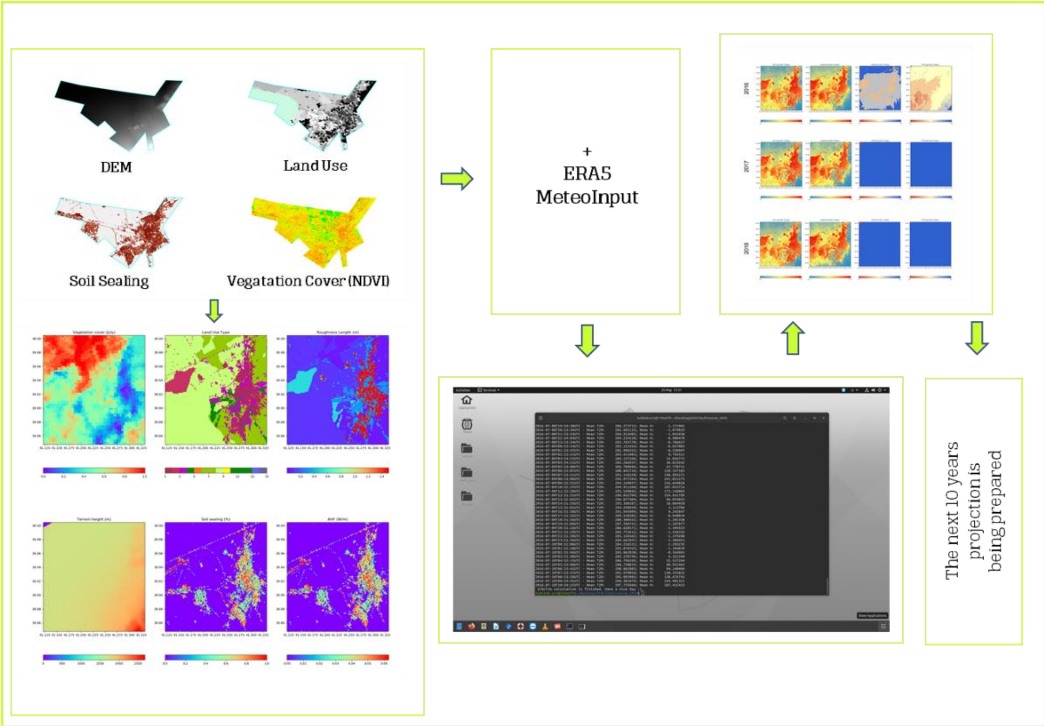

Figure 4. UrbClim model steps in the workspace

In this study, first, maps of the study area were created. DEM map was created from the USGS database. A Land Use Map was created from the Urban Atlas Database. The vegetation cover map was created from MODIS NDVI Landsat 8 database. A soil sealing map was created from the Copernicus database. These maps were run with the scripts provided by the UrbClim model manufacturer VITO company and a total of 6 surface maps were created: Vegetation Cover, Land Use, Roughness Lengths, Terrain Height, Soil Sealing, and AHF maps (Figure 4).

Secondly, meteorological data for the first 10 days of July 2016, 2017, and 2018 were collected from the ERA5 database.

According to the working principles of the UrbClim model, the data entries were completed and the analysis was started.

3. Findings and Discussion

Finally, images of UHI, tMean, HWD, HTD maps were produced using new scripts as a result of the analysis (Figure 5). The findings of 2016 were different compared to other years. This is because, according to the UrbClim model standards in 2017 and 2018, the threshold for hot days is 35.0 °C; the up threshold for heat wave day is 35.0 °C; the bottom threshold for heat wave day is 25.0 °C parameters are used. But in 2016, when Erzurum was a cold climate city, its parameters were threshold for hot days 25.0 °C; up the threshold for heat wave day 25.0 °C; 15.0 °C bottom threshold for heat wave day parameters taken. For this reason, as seen in Figure 5, the maps for 2016 yielded different results compared to other years. Regardless of the climate model used, UHI exists and is increasingly affecting living organisms (Frustaci et al., 2022). Various climate models simulate future scenarios (Ren et al., 2017).

The UrbClim model is presented as an urban climate model designed to study the urban heat island effect at a spatial resolution of several hundred meters. UrbClim is known to be both simpler and at the same level of accuracy when compared to complex and sophisticated models. It also works much faster than high-resolution medium-sized climate models. Therefore, the model is well suited for long-term integrations, especially for applications in urban climate projections (Hooyberghs et al., 2016).

As in this study, the UrbClim model was used in Barcelona. The comparison between heat exposure index maps detailed directly from the temperature outputs produced by the UrbClim model and those produced from the LCZ cartography is well suited for simulating heat exposure index maps for scenarios corresponding to temperature percentages between 50% and 90% (Gilabert et al., 2021).

Urban areas absorb higher amounts of thermal energy during the day and release slowly in the evening (Oke et al., 2017). The predicted results obtained in UrbClim were also observed in the UHI study for Belgium and the city of Bilbao. The correlation coefficient between simulated and observed data was recorded as 0.95 and 0.90, respectively (De Ridder et al., 2015a).

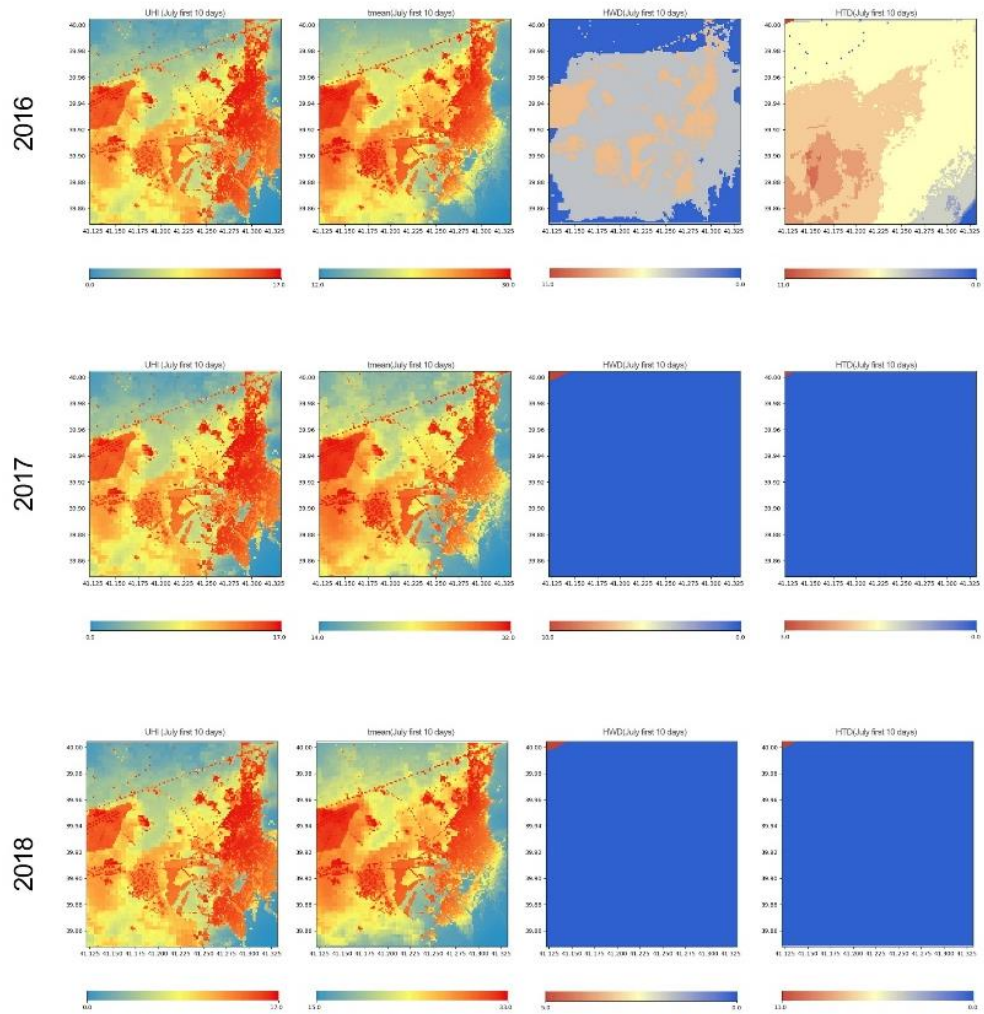

Figure 5. Map findings created from the data of the first 10 days of July in 2016-2017-2018

4. Conclusion and Suggestions

Hot stress is experienced more intensely in urban areas compared to rural settlements, and projections indicate that the effects of climate change on human health will increase. In this study, the UrbClim numerical model was applied to enable a high level of detailed analysis of urban climate over long periods at limited computational costs.

With this research, considering the changing climate parameters, it is necessary to reveal the necessity of climate projection to reduce the physical and psychological stress of the dense population formed in Erzurum and cold cities with similar extreme climate parameters and to make sustainable and ecological plans. In addition, the necessity of reducing the negative effects of urban density on human life and increasing the quality of life is adopted. Manufacturers design and effectively implement plans and projects in the current climate change situation, which is a very complex issue in cities. In future studies, the implementation of urban planning projects in the model enables the quantitative evaluation of the impact of spatial changes on heat stress. This will be an important step towards a thorough and detailed knowledge of the urban climate to address climate change resilience. When the natural data of the planned area are taken into consideration in the design, it may have a positive effect on outdoor thermal comfort.

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The paper complies with national and international research and publication ethics. Ethics committee approval was not required for this manuscript.

Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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Indoor Environmental Quality in Residential Care Facilities: A Scoping Review with Design Focus

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Abstract

Elderly adults experience physical and cognitive deterioration, which makes them more dependent on others for their daily needs. It is not always possible to provide adequate care in their own homes, emphasizing the crucial need for qualified residential care facilities (RCFs). Given that elderly spend most of their time indoors, it's crucial to provide a good indoor environment quality (IEQ) at RCF. Using the PRISMA scoping review approach, this study seeks to review the body of knowledge about IEQ elements of RCFs. A keyword search yielded 1044 possible papers; however, after removing irrelevant articles and duplications, only 94 papers remained to be reviewed. A snowball search was used to add 32 papers, and finally 126 papers were included in this paper.

Keywords: *Design for elderly, elderly care, indoor environmental comfort, indoor environmental quality, residential care facility.*

Kurumsal Yaşlı Bakım Alanlarında İç Mekân Çevre Kalitesi: Tasarım Odaklı Araştırma Makalesi

Öz

Yaşlı bireylerin fiziksel ve bilişsel işlevlerinin azalması, yaşamlarını başkalarına bağımlı olarak sürdürmeye neden olmaktadır. Bireylerin evlerinde sürekli bakım sağlamaya uygun koşullar bulunmadığında yaşlı kurumsal bakım alanların acil ihtiyacı karşılamaktadır. Yaşlı bireyler zamanlarının çoğunu iç mekanlarda geçirdikleri için, tesislerin yeterli iç ortam kalitesini sağlaması hayati önem taşır. Bu makalede, tesislerin iç mekân çevre kalitesi ile ilgili var olan literatürün incelenmesi amaçlanmaktadır. Makalede PRISMA kapsam belirleme yaklaşımı benimsenmiştir. Belirlenen anahtar kelimeler ile yapılan arama sonucunda 1044 potansiyel makale tespit edilmiştir, ancak kapsam dışı makaleler ve tekrarlar elendikten sonra geriye analiz edilecek 94 makale kalmıştır. Kartopu yöntemi ile 32 adet makale eklenmiş olup, toplamda 126 adet makale araştırmaya dahil edilmiştir. Elde edilen sonuclara göre; gürültü kontrolü için izolasyon uygulanması ve bölgeleme yapılmasının, günışığı kullanımını arttırırken, kamaşmaya karşı kolay kullanımlı kontrol seçeneklerinin tercih edilmesinin, doğal havalandırmanın etkin şekilde kullanımına ek olarak kullanıcıların kolay kontrol edebileceği HVAC sistemlerinin kullanımının kurumsal yaşlı bakım alanlarında iç mekân çevre kalitesinin iyileştirilmesine katkıda bulunduğunu göstermektedir.

Anahtar Kelimeler: *Yaşlılar için tasarım, yaşlı bakım, iç mekân çevre konforu, iç mekân çevre kalitesi, yaşlı kurumsal bakım alanları.*

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1. Introduction

Associated with aging, elderly adults undergo physical and cognitive functioning declines that result in increased frailty, sensory loss, and mental competence deterioration (Hegde & Rhodes, 2010). Thus, as people age, they become more environmentally gentle and live a passive lifestyle (Wang, 2020). Unsuitable or inaccessible spatial arrangements endanger the elderly and make their lives even more passive. Though aging in place—living in their homes—for as long as possible is the preferred lifestyle both for the elderly and government policies (Darton et al., 2011; Victoria Maria et al., 2018), it is generally very difficult to supply proper care and services in their homes.

As the elderly population arises and their needs vary, a corresponding need for residential care facilities that support special care and supporting services (such as healthcare, recreational activities, transportation, eating, bathing, and memory care) develops (Wang, 2020a; Yuan et al., 2019). This need is not regional but global, and in the grand scheme of things, many different names are given to these facilities that provide these elderly care services (such as residential care facility, senior living facilities, assisted living facilities, nursing homes, homes for the aged, elderly house, attention homes, retirement homes, skilled nursing facilities, long-term care facilities, intermediate care facilities, geriatric rehabilitation centers, etc.). As their names change, so do the types of care they give (such as rehabilitation, professional eldercare, high-quality medical care, nursing care, etc.) also vary. All those different names and their differences in terms of service are not that clear due to the need for a flexible level of care (Yuan et al., 2019). In this study, all forms of eldercare institutions are referred to as "residential care facilities (RCF)" for the sake of simplicity.

Indoor environmental conditions that satisfy its occupants' comfort requirements have a direct impact on their health, performance, and wellbeing(Šujanová et al., 2019; Tao et al., 2020; Wong et al., 2014). The findings identified the general effects of noise, lighting, thermal conditions, and air quality as the most important factors of the interior environment. Generally, these factors are named "Indoor Environmental Quality" (IEQ), which includes acoustics, lighting, thermal environment, and indoor air quality (Nimlyat et al., 2015; Wong et al., 2014). When IEQ is insufficient, it can negatively influence elderly people's wellbeing and quality of life because they spend 17 hours indoors on average (Pinto et al., 2019; Tao et al., 2020). However, studies on IEQ do not adequately address or incorporate elderly profiles into international standards (Wu et al., 2019). The existing theoretical and empirical literature on RCFs focused on several aspects, including physical health (Mei et al., 2013; M et al., 2020; Pérez-Ros et al., 2019; Robinovitch et al., 2013; Toraman & Yıldırım, 2010), mental health (Hallit et al., 2020; Lapp et al., 2019; Tseng et al., 2020; Zhang et al., 2019), and social support (Carlson & Bengtsson, 2014; Cheng et al., 2011; Drageset et al., 2011; Tao et al., 2018). However, less attention has been directed toward the design of IEQ aspects in RCFs that are significantly effective in improving the elderly's life quality (Pinto et al., 2019; Tao et al., 2020). In this paper, a scoping review of the literature on indoor environmental design aspects for RCFs is reported. The primary goal is to present a summary of the most recent evidence on IEQ in RCFs and design recommendations to meet the particular needs of the elderly. The secondary purpose is to identify any existing gaps in the evidence and provide guidance on where new research is needed to strengthen it.

2. Material and Method

The PRISMA scoping review approach was adopted following the PRISMA ScR checklist in this study. Scoping reviews synthesize a body of literature and map key concepts, characteristics, sources, policies, practices, current research, and evidence. Scoping reviews, unlike systematic reviews, do not assess the quality of papers but provide a detailed summary, highlight research gaps, outline research agendas, and provide recommendations (Sav et al., 2017). A scoping review aims to explore the breadth and depth of available literature on a broad topic area, while a systematic review has a focused research question that aims to answer a specific research question. Scoping reviews have become increasingly popular and widely accepted for (Pollock et al., 2021) fields that have not been reviewed comprehensively before (Arksey et al., 2005; Mays et al., 2001).. The methodological framework for scoping reviews established by Arksey and O'Malley was used in this study, which was carried out in five stages (Arksey & O'Malley, 2005) as given below:

Stage 1- Identifying the research questions: The following research questions were formulated: "How do the elderly's spatial requirements differ from adults?", "How do current standards, regulations, and applications reflect these requirements?" and "How can designers provide better IEQ in RCFs for the elderly?"

Stage 2- Identifying relevant studies: Identifying relevant studies: The authors classified sub-categories and compiled a list of relevant keywords. The terminology used for elderly facilities, user profiles, and IEQ differs significantly, so keywords are categorized according to main and subfields in order to perform an effective review. The set of keywords (Figure 1) that are found to be relevant were grouped as a set (facility name+ user profile+ IEQ component) during the literature search (Figure 2). Keywords were distributed according to the authors' proficiency, and authors screened the results' titles and abstracts for inclusion and exclusion criteria with the given sets of keywords.

All authors searched the Scopus and Web of Science databases between September 2020 and September 2021.These databases were selected since they include a variety of disciplines and a broad range of publications within the research field.

Facility name	User Profile	IEQ
•Senior living facility	•Older adult	•**Indoor Environmental Quality**
•Attention home	•Aged adult	•Indoor environmental comfort
•Nursing home	•Older people	•Indoor environmental control
•Residential care home	•Seniors	•Interior Comfort
•Retirement home	•Residents	•Physical environment
•Residential care facility	•Elderly	•**Indoor Air Quality**
•Elderly house		•Humidity
•Assisted living facilities		•**Thermal comfort**
•Group Homes		•**Acoustics**
•Homes for the aged		•Sound(scape)
•Intermediate care facilities		•Noise
•Skilled nursing facilities		•**Lighting**
•Long-term care homes		•Visual comfort
		•Lighting
		•Daylight

Figure 1: List of keywords

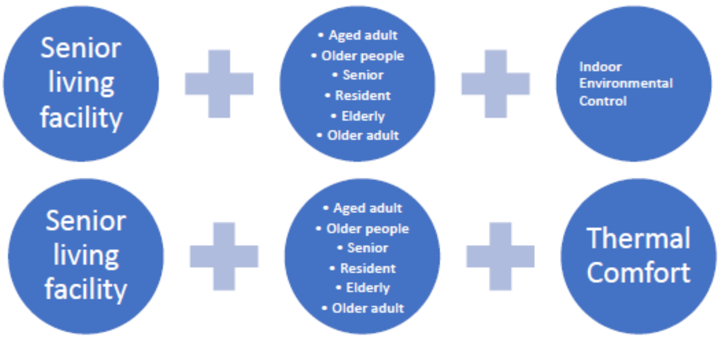

Figure 2: Two example keyword sets that are used during literature search

Step 3- Study Selection: The first author developed the search strategy, while inclusion and exclusion criteria were determined by all three authors. The search procedure was concentrated on searching for keyword combinations given in Figure 2. Only peer reviewed journal articles that were published after 2000, written in English, involved elderly participants, focused on at least one of the IEQ aspects from a spatial (architectural or interior design) perspective, and used elderly care facilities as a setting were included. Papers were excluded if they focused on medical treatments, did not address the elderly, did not deal with any architectural or IEQ design components, or used private houses as a setting. To ensure an inclusive body of literature on the field from various perspectives, both quantitative and qualitative studies, as well as mixed method studies, were included. The complete list of inclusion and exclusion criteria can be seen in Figure 3.

Inclusion Criteria	Written in English
	Published in peer-reviewed journals
	Published after January 1st,2000
	Must have at least one IEQ component that is being evaluated
	Should be conducted in residential care facilities
	population should be older adults (60 or higher)
Exclusion Criteria	studies that do not deal with architectural or interior design components
	medicine focused (medical treatments, psychology, rehabilitation etc) studies
	private houses
	studies that do not include any of the IEQ (lighting, acoustics, thermal comfort and indoor air quality) topics

Figure 3: Inclusion and exclusion criteria applied to select papers

Step 4- Charting the data: Titles and abstracts were read, and articles that met all the criteria proceeded for further screening while the others were categorized as “excluded” or “unsure”.

In the second phase, all three authors assessed the abstracts of each paper that was classified as "unsure" and discussed its eligibility until they reached consensus. Duplicates and articles without full-text access were removed during this phase, and 94 articles were assessed for eligibility. Finally, references from the selected sources were screened for additional relevant articles by the snowball method. The snowball method, also known as snowball sampling or snowballing, is a technique used in research to find additional relevant articles or studies beyond those identified through the initial database search. Through snowball method, 32 studies were found relevant, and eventually 126 articles were included in the study.

In the third phase, selected papers were read in full text, and data was extracted using a data-charting form according to the following: authors, year of publication, country, method used, study population, facility type, IEQ parameters, and key findings. All authors reviewed the papers and continuously updated the data-charting form.

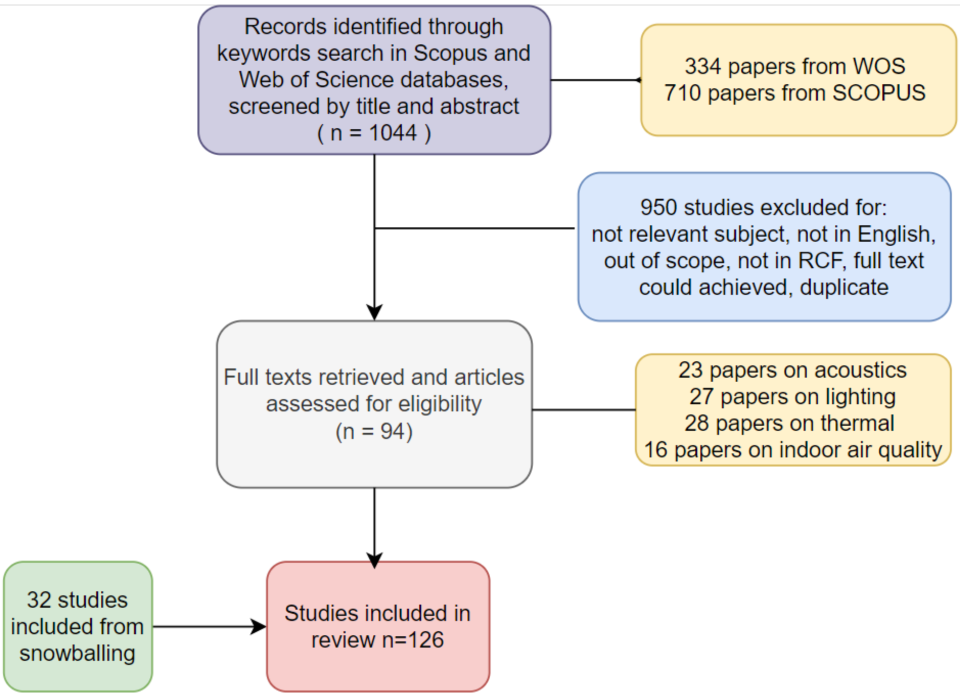

Figure 4: Scoping review phases

Stage 5- Summarizing and Reporting the Results: The studies that were retained for detailed study were grouped according to IEQ aspects; 44 papers in lighting, 39 papers in acoustics, 27 papers in thermal, and 16 papers in IAQ. Lighting is evaluated and reported by the first author, while the second author evaluated thermal comfort& IAQ and the third author evaluates acoustics studies. The remarkable outcomes and highlights of the studies for each IEQ aspect were discussed separately by each author according to the workload distribution that is given above.

The paper was organized into 5 main sections; (a) acoustics; (b) lighting; (c) thermal comfort; (d) indoor air quality; and (e) IEQ in general. Each parameter was discussed with reference to the literature, and final recommendations were made. In the discussion part, a general evaluation, literature gaps, and recommendations regarding RCF facilities are presented.

3. Findings and Discussion

3.1. Acoustics

In this section, acoustic literature findings have been presented, along with the two most common metrics (BNL and RT), and finally, acoustic recommendations and gaps of the field have been provided.

3.1.1. Importance of Acoustics and Sources of Discomfort

Since different groups of people with various disabilities and levels of sensitivity live in RCFs, the acoustic environment gains more importance. Understanding speech in a noisy environment is more difficult for elderly people than for young adults due to hearing loss. When compared with young adults, the elderly need a quieter environment to concentrate and hear other people talking (Harris & Reitz, 1985; Peng et al., 2018; Sloane et al., 2003). However, the acoustic environment of RCF is often disregarded, and specific standards are often missing, which may lead to noisy and unpleasant sound environments for the users (Aletta et al., 2017). Previous studies on the acoustic environment of RCF have mostly focused on perception (Devos et al., 2019; Harris & Reitz, 1985; van den Bosch et al., 2016, 2018) privacy and belonging (Devos et al., 2019; Thomas et al., 2020). Yet, the quality of the acoustic environment is also crucial, both for residents and the staff, who are spending a considerable amount of time indoors (Van Hecke et al., 2019). Poor acoustic conditions in RCFs have a negative impact on residents' and staff's well-being and comfort (Thomas et al., 2018) and lead to barriers in speech communication that decrease the life quality of the elderly. Furthermore, acoustic discomfort brings many psychological difficulties for the elderly, such as low self-esteem, autism, irritability, and stress, but it also impairs elderly people's relationships (Harris & Reitz, 1985; Ventry & Weinstein, 1982).

The talking sounds of nursing staff, squeaking food and medication carts, nursing stations, roommates, television and radio usage, mechanical noise, electronic devices such as air conditioners, electric fans, heaters, electric fires, kitchen facilities, TV, and announcement speakers can be listed as the noise sources in RCF's (Henshaw & Guyet al., 2015; Mui et al., 2008; Thomas et al., 2020; Wong et al., 2014; Xie et al., 2020; Zhao et al., 2020). Besides, the sound of medical appliances and turned on televisions in both communal areas and shared bedrooms, regardless if there is an audience or not, seemed to be a noise source to residents (Zhao et al., 2020). Most of the residents in RCF's are quite sensitive to certain noise and consequently their behaviors are affected negatively by those noises, such as feeling unpleasant, unsafe (Henshaw & Guyet al., 2015; Hsieh et al., 2012; Neikrug & Ancoli-Israel, 2010; Wong et al., 2014; Zhao et al., 2020) or residents woke up at night due to noise disturbance (Zhao et al., 2020). Additionally, unwanted noise can result in physical injuries such as increasing the risk of falling for elderly residents (Leung et al., 2013). Thus, a comfortable acoustic environment influences the well-being of residents and hampers their independence and social interactions.

3.1.2. Background Noise Level (BNL)

BNL is of utmost importance, and there is often a sound pressure limit for acoustic comfort. Sound levels above 50 dB(A) have been linked to annoyance, disturbed sleep, delirium, blood pressure elevations, tachycardia, and possibly ischemic heart disease in healthy populations (Berglund et al., 1995; *GB 50340-2016 Code for Design of Residential Building for the Aged*, 2016). There are several standards and studies on the level of background noise in RCFs. Suggestions vary depending on the function of the building, time of the day, origin of country, and organization (Table 1). For instance, recommended BNL values for the elderly in residential buildings are 40 dBA (daytime) in living rooms and 45 dBA as the maximum limit; however, common rooms and dining rooms are not considered in the study (*GB 50340-2016 Code for Design of Residential Building for the Aged*, 2016; Peng et al., 2018). On the other hand, the World Health Organization (WHO) has established sound level standards for schools and industrial, commercial, shopping, and traffic areas, however, no such standards exist for RCFs. WHO only mentioned that background noise levels in most rooms should not exceed 35 dBA where patients are being treated or observed, and during nighttime peaks should not exceed 40 dB (Schwela, 2001; Xie et al., 2020). Also, the Hong Kong Planning Department stipulates that peak hour noise should be below 55 dBA in the neighborhoods surrounding RCFs (Tao et al., 2020). The Environmental Protection Agency (EPA) in the United States and some other studies (Berglund et al., 1995; Bharathan et al., 2007; Schwela, 2001; The U.S. Environmental Protection Agency Office of Noise Abatement and Control, 1974) recommended that BNL should not exceed 45 dB in nursing homes in daytime hours. In addition, for nighttime, the above-mentioned international standards suggest 20–35 dBA, whereas the EPA suggests a maximum of 35 dBA for sound intensity. Despite that, a number of studies on acoustic comfort in RCFs highlight that background noise levels in RCFs are mostly above the threshold (Devos et al., 2020; van den Bosch et al., 2016; Xie et al., 2020).

Table 1. Background noise level suggestion comparison

	For Elderly Room		**Common Areas**		**Non-specified**	
	Recommended	**Maximum Threshold**	**Recommended**	**Maximum Threshold**	**Recommended**	**Maximum Threshold**
China 2016 (*GB 50340-2016 Code for Design of Residential Building for the Aged*, 2016; Peng et al., 2018)	40 dBA (daytime)	45 dBA	Not considered	-	-	-
(Schwela, 2001; Xie et al., 2020)	-	35 dBA	-	40 dBA (night time)		
(Tao et al., 2020)	-	-	-	-	-	55 dBA
(Berglund et al., 1995; Bharathan et al., 2007; The U.S. Environmental Protection Agency Office of Noise Abatement and Control, 1974)	45 dBA (daytime), 20-35 dBA (nighttime)	35 dBA (night time	-	-	-	-

3.1.3. Reverberation Time (RT)

Reverberation time (RT) measurements of RCFs range from 0.44s to 1.54s (Devos et al., 2020; van den Bosch et al., 2016; Xie et al., 2020) and are 0.55s on average in resident's rooms (Thomas et al., 2018). For instance, in a study that was conducted in five bedroom and nursing areas in Chongqing, China, that the measurements show that RT for bedrooms was 0.44s-0.68s and the nursing stations were 0.63s- 1.54s (Xie et al., 2020). Braam (2006) suggests that reverberation time (RT) in nursing homes should be between 0.4s- 0.7s, and rooms meant for speech require a short reverberation time; a value of 0.5s is suitable for small rooms(Peng et al., 2018). When RT exceeds 0.5 in spaces for speaking, speech intelligibility decreases and acoustical defects such as echoes arise (K. B. Ginn, 1980).

3.1.4. Evaluation and Recommendations for Acoustics

In order to provide acoustical comfort while maintaining speech privacy and sound transmission class ratings between rooms and corridors, design recommendations should be applied (Razavi, 2012). For example, resident room walls should have an STC rating of 45 (optimal), and HVAC systems should have sound attenuation that does not exceed the noise criteria (NC) of 25 STC in bedrooms and 35 STC in amenity places (Benbow, 2018). Some basic precautions may be the most effective measure to reduce noise; such as closing the door (Connell, 2004) or physical separation of residents from each other (also called acoustical separation) (Thomas et al., 2020). During room design, it is recommended to prevent usage of the shared wall by the TV in one room and the headboard in the other room to eliminate transmission of noise through walls. Aside from potential noise sources that can be replaced if possible, soundproof materials can be applied around the noise source if this is not possible. Closing the undercut door, installing a quiet vent silencer, and installing an acoustic curtain or more absorptive materials on the ceiling (such as acoustical tile or absorbing baffles) and floor (such as rubber flooring or carpeting) are the most common techniques for maintaining speech privacy (Gustavsson et al., 2017; Razavi, 2012; Thomas et al., 2018).

Reviewed studies on acoustic comfort were mainly focused on the noise level and reverberation time of the rooms where the elderly sleep, live, and socialize. These two parameters can give very clear and accurate preliminary information about the acoustic comfort of a place, but in some special places, more detailed studies can be done by considering user profiles. Aside from the Lombard slope, the ratio of speech levels to background noise level has only been studied in Devos et al.'s study (2020) in related studies. The Lombard effect is a phenomenon where talkers increase their vocal effort in response to louder noise levels to maintain appropriate conditions for verbal conversation in dining facilities. Since elderly complain about BNL and a lack of verbal communication, spaces should be evaluated by considering the Lombard effect and Lombard slope.

Acoustic problems in RCFs are primarily concerned with noise sources as well as BNL and RT characteristics. However, studies on speech intelligibility must be expanded to assure acoustic comfort. Finally, it is important in RCF material selection since the material used must be durable and easy to clean, yet a material with these features has reflective properties rather than acoustical absorption. Thus, employing reflective materials increases BNL and RT while decreasing speech intelligibility. As a result, material selection in such areas is more challenging compared to other spaces, and the goal should be to produce innovative materials that are sustainable and fulfill these criteria. If more modeling and optimization studies are carried out on material selection, it will be easier to provide acoustic comfort and intelligibility in RCF's.

3.2. Lighting

The findings from the lighting literature, as well as glare, recommended illumination levels, daylight, and finally lighting-related problems with their solutions have all been provided in this part.

3.2.1. Importance of lighting and preventing glare

As people age, they suffer from visual impairments, declined visual performances, optical changes, and visual diseases (such as cataracts, glaucoma, macular degeneration, etc.) (Shikder et al., 2012; Tural & Tural, 2014). Aging eyes require more illuminance to compensate for their deteriorating vision(Leung et al., 2016). For instance, an average 60 year-old eye needs three times more light than an average 20 year-old eye to complete the same task(de Lepeleire et al., 2007; Sinoo et al., 2011). Furthermore, aging can impair adaptation to dark and depth perception; thus, when moving from a bright room to a darker area, an elderly person cannot fully see the environment for a minute or more (de Lepeleire et al., 2007). Dimly perceived visual environments, blurred vision, and adaptation reductions can be associated with an increased risk of fall (De Lepeleire et al., 2007; Hegde & Rhodes, 2010; Leung et al., 2016; Sinoo et al., 2011) and falls account for nearly 71% of causes of severe injury, disability, and accidental death in the elderly (Joseph et al., 2016; Moore et al., 2011; Sagha Zadeh et al., 2018; Shikder et al., 2012).

Providing a good visual environment is not limited to quantity of light alone; quality is equally important. Glare is a physical discomfort caused by too much (artificial or natural) light or contrast in the field of view, which impairs users' ability to see their surroundings (Brawley, 2009; Jakubiec & Reinhart et al., 2011; Tural & Tural, 2014). Elderly people are more sensitive to glare, and their recovery time from glare effects is longer than that of younger adults, which can increase their risk of falling. Besides, some elderly people suffer from frequent nighttime toilet usage, which requires waking up during the night, walking to the toilet, and going back to bed to sleep. This pattern can repeat two or more times in a night, which ends up reducing the time and quality of sleep(White et al., 2013). If the room is too bright, it causes discomfort and makes returning to sleep more difficult, resulting in a tendency to sleep during the day (Lee et al., 2009a; Leung et al., 2020). If it is below the requirements, then going to the toilet can be quite risky in terms of falls and injuries (Lee et al., 2009b).

3.2.2. Illumination Levels

To provide a sufficient, elderly-friendly, and fall-preventing interior, adequate illuminance levels on workplanes should be provided. Lighting standards and codes represent the recommended illuminance values for specific functions (Aalto University School of Science and Technology Department of Electronics Lighting Unit, 2010) considering healthy eyes; however, elderly people require higher light levels, therefore adapted standards should be applied to RCFs (de Lepeleire et al., 2007; Kunduraci, 2017; Leung et al., 2016). There are contradictions in the existing recommended illuminance levels for the elderly (Table 2). For instance, recommended illuminance levels in the Adapted Standard (which is the adapted version of the European standard EN 12464-1 that deals with indoor work places) increased standard illuminance levels by 55%. To exemplify, for entrance halls, it was 200 lux in EN 12464 and increased to 310 lux in the Adapted Standard, while general lighting in rooms ranges from 100 lux to 155 lux, and table-chair lighting is from 500 lux to 775 lux (de Lepeleire et al., 2007). Likewise, IESNA's "Lighting and the Visual Environment for Senior Living" standard suggests a minimum of 320 lux (30 fc) for general areas and 538 lux (50 fc) for specific task areas (Brawley, 2009; Hegde & Rhodes, 2010). Moreover, in a post-occupancy evaluation study in Hong Kong, results indicate that for bedrooms 268-300 lux, for common areas 260-300 lux, and for bathrooms 350-530 lux are preferred by elderly (Leung et al., 2014). Though all these values are similar, in Turner et al.'s study it was suggested that "128-320 lx; 184-460 lx; 256-640 lx; 400-1000 lx; 536-1340 lx; and 656-1640 lx would be insufficient in 45, 55, 65, 75, 85 and 95 year old adults, respectively" (Sinoo et al., 2011; Turner et al., 2010). All the illuminance levels mentioned are higher than the thresholds of existing standards and guidelines, and these level differences point to the need for increased illuminance levels in RCFs (Sinoo et al., 2011).

Table 2. Illuminance level comparison

	For Elderly Room		**Common Areas**		**Non-specified Recommendation**
	Living Area	Bathroom	General	Task Lighting	
(de Lepeleire et al., 2007)	-	-	-	-	Increased standard illuminance levels by 55%
(Brawley, 2009; Hegde & Rhodes, 2010)	-	-	320 lux (30 fc)	538 lux (50 fc)	-
(Leung et al., 2014)	268-300 lux	350 -230 lux	260-300 lux	-	-
(Sinoo et al., 2011; Turner, Van Someren, et al., 2010)	-				Insufficient illuminance levels for different age ranges:
	-				128-320 lux for 45 years
	-				184-460 lux for 55 years
	-				256-640 lux for 65 years
	-				400-1000 lux for 75 years
					536-1340 lux for 85 years
					656-1640 lux for 95 years

3.2.3. Daylight

Daylight has long been associated with human health, well-being, mood, and sleep quality, with its variations in length of exposure, duration, quantity, and spectral composition (Altomonte, 2008; Brawley, 2009; Gharaveis et al., 2016; Mobley et al., 2017; Philips, 2004). Studies highlight that well-evidenced daylight may help to maximize treatment efficiency, reduce perceived pain, stress (Gharaveis et al., 2016; Nioi et al., 2017) and symptoms of depression (Brawley, 2009; Figueiro et al., 2019), increase melatonin, and improve sleep quality (Brawley, 2001, 2009; Gharaveis et al., 2016; Konis et al., 2018; Wang, 2020b; White et al., 2013). Daylight's photobiological (non-vision) effects, such as stimulating circadian rhythm and vitamin D synthesis, are also quite significant (Brawley, 2009; Ellis et al., 2013). With passing years, the circadian clock begins to weaken, and when the circadian rhythm slides out of sync, it leads to disrupted sleep/wake rhythms, melatonin, and cortisol hormone releases (Ellis et al., 2013; Lee et al., 2009b; Sinoo et al., 2011). Besides loss of cognitive ability, depression caused by seasonal affective disorder (SAD) occurs (White et al., 2013). The elderly who spent time in rooms with insufficient daylight described the environment as the "waiting room of death" (Van Hecke et al., 2019). Thus, elderly should be exposed to sufficient daylight throughout the day for their well-being, good sleep, and increasing alertness(Neikrug & Ancoli-Israel, 2010). Despite this, research shows that the elderly in developed countries are only exposed to the sun for 20-120 minutes per day (Sinoo et al., 2011). The studies show that daylight exposure is even more reduced when living in a RCF(Olsen et al., 2016). A study by Ancoli-Israel and colleagues reported that "4% of the elderly were not exposed to daylight at all, and 47% were never exposed to light greater than 1000 lux"(Neikrug & Ancoli-Israel, 2010). On average, elderly people living in RCFs received an average of only 9 minutes of daylight exposure during a day (Brawley, 2009). To compensate for daylight, artificial lighting is being used, but typical artificial lighting does not contain the spectral distribution to which circadian rhythm is sensitive (Brawley, 2009).

3.2.4. Evaluation and recommendations for lighting

A good combination of artificial and natural lighting contributes to active aging and a fulfilling lifestyle (Brawley, 2009). To increase daylight availability, windows should be clearly designed to exclude low-elevation sunlight and glare. Besides, positioning windows at the ends of corridors might cause silhouetting effects(Torrington et al., 2007). When circumstances allow, other daylighting strategies such as skylights, roof windows, or light pipes can be used (Sinoo et al., 2011).

When daylight is insufficient, it should be compensated by artificial lighting to provide the required illuminance levels constantly, and using lighting sensors could both provide control and energy savings (Brawley, 2009; Leung et al., 2019). Lighting switches with sensors that keep illuminance levels above threshold levels while preventing glare could be used (Leung et al., 2019; Sinoo et al., 2011; Torrington et al., 2007). The recommended color temperature of light is neutral white (5000 K), however, the elderly's preference can differ both personally and culturally (Leung et al., 2014). In Wang's study, the same questionnaire was conducted in two RCFs in the USA and China, and results show that Chinese elderly prefer warm colors for lighting compared to elderly in the USA (Wang, 2020c). Similarly, in European RCFs warm white was preferred (3000K) (Sinoo et al., 2011) and high color temperatures (above 6500 K) are found unpleasant. To trigger circadian rhythm with artificial lighting and suit the varying demands of elderly people LED lamps with changing color temperatures could be used (Ellis et al., 2013).

Using light colors for ceilings (reflectance values of 80 and above), walls (65-85%) and floors (30-40%) with indirect distribution of light can provide a bright and spacious space (Brawley, 2009). Especially in wet spaces, high illuminance levels with indirect light distribution, and mate surfaces rather than shiny surfaces must be used for visual comfort (Torrington et al., 2007). Lamps with high color rendering values (80 and above) should be used for color distinction (Brawley, 2009). Glare from natural and artificial light should be avoided, and night lights should be bright and easy to use (Leung et al., 2016; Mobley et al., 2017; Wong et al., 2014).

Lighting studies examined the subject from several perspectives and with diverse characteristics, such as artificial lighting, daylighting, lighting's effect on wellbeing, mood, psychology, and lighting quality.

When the distribution is evaluated, it is evident that the majority of the research concentrated on the quantity of light, such as illuminance and luminance, with only a few daylight metrics receiving attention. This could be due to the fact that there are still many unknowns about vision loss. Age-related vision impairments are fairly frequent and usually begin around the age of 40 and worsen around the age of 60 (Robertson et al., 2010). Because these changes do not happen overnight, the emergence of vision-related disorders in the elderly must be studied further.

One of the major energy consumers is artificial lighting, although, oddly, research on lighting in RCFs rarely mention this issue. This could be attributed to the complexity and uniqueness of RCFs' duty of providing 7/24 optimum visual comfort for the elderly.

3.3. Thermal Comfort

This section presents scholarly findings on thermal comfort, as well as the thermal sensitivity of the elderly, adaptive thermal strategies, and HVAC systems. Finally, thermal comfort recommendations were provided.

3.3.1. Importance of thermal comfort and thermal sensitivity of elderly

Thermal comfort is an important parameter of indoor environmental quality, which is affected by physical, physiological, psychological, and other factors such as age, gender, metabolism, and clothing insulation (Djongyang et al., 2010). Besides behavioral actions such as changing clothing, activity level, posture or location, providing natural ventilation can influence thermal comfort (ASHRAE Handbook Committee, 2001).

Older people's thermal comfort may differ from that of younger individuals since they are more sensitive to the thermal environment due to a reduced metabolic rate (Hoof et al., 2017; Schellen et al., 2010; Tao et al., 2020; Yang et al., 2016). The thermal sensation of the elderly varies depending on the season, with the sensitivity level being higher in the winter (Tao et al., 2020). However, there are discussions on thermal comfort for the elderly. Fanger suggested the neutral temperature, which was defined as the comfort temperature of the occupants, did not differ between elderly and young people (Fanger, 1970) while Mendes et al. (2017) stated that the 20–24°C, which is assumed as a comfort zone, is not warm enough and that 25.3°C was selected as the optimal temperature for sedentary elderly (Mendes et al., 2017). Similar to Mendes et al (2017), Wang et al. (2020) the results show that the thermal neutral temperature predicted by the PMV method is 2.7°C lower than the findings(Wang et al., 2020). A significant number of studies have examined the finding that elderly people prefer an environment approximately 2C° warmer than youngsters (Hoof & Hensenet al., 2006) (Wang et al., 2018).

The thermal environment of the elderly is associated with increased vulnerability and risk to their mental and physical well-being. They may not perceive the changes in the thermal environment, which can cause a potential threat to their health such as heatstroke, major adverse cardiovascular events, and acute kidney injury (Meade et al., 2020). Similarly, thermal discomfort conditions may cause the agitation of dementia residents in RCF, and agitation may be reduced by limiting the range of indoor air temperature variations (Tartarini, Cooper, Fleming, et al., 2017).

3.3.2. Adaptive thermal strategies

In order to provide thermal comfort, occupants have a natural tendency to adjust to changing conditions through behavioral and psychological adaptation, which is referred to as adaptive thermal comfort models (Law, 2013). Occupants' behavior and their developed strategies such as clothing insulation, use of ceiling and portable fans, and window opening practices can be mentioned as adaptive strategies widely used by residents and they are significant for the elderly to provide thermal comfort (Cena, Spotila & Ryan, 1988). Specifically, during summer, changing clothing and opening windows are found as the two most used adaptive strategies (Jiao et al., 2017). Tao et al. (2020) have highlighted that while adjusting clothes is a major strategy, usage of an electric fan and window opening are the two other common strategies among RCF residents (Tao et al., 2020). Multiple studies have stated that layered clothing is an effective and preferable strategy among elderly people (Jiao et al., 2017; Tao et al., 2020; Tartarini et al., 2018). In harsh weather conditions such as in winter, older people may wear seven pieces of clothing to regulate their thermal balance (Tang et al., 2020). In the winter some other adaptive strategies such as mechanical heating and taking a hot bath are used, while in the summer mechanical cooling and electric fans are the major strategies for the elderly (Jiao et al., 2017). Interestingly, despite the changes in climatic conditions in different countries, the same adaptation strategies were developed by the elderly.

3.3.3. HVAC systems

HVAC systems can be mentioned as the most common technological adaptation strategy for thermal comfort (Tartarini et al., 2017). When controlling windows to provide natural ventilation is not sufficient, HVAC systems are necessary to ensure the thermal comfort of the elderly. However, it is not always preferred by the elderly, particularly during the summer, when older people prefer natural ventilation over HVAC systems (Tartarini et al., 2017). One of the reasons for preferring natural ventilation was economic status. Interestingly, the elderly's preferences and actions regarding HVAC systems were associated with their economic status, and the elderly with low income prefer natural ventilation instead of HVAC (Tsoulou et al., 2020). The other reason is related to the control of HVAC systems. Generally, HVAC systems are operated by caregivers, staff (Walker et al., 2016) and the thermal environment of the elderly is controlled by nurses and staff (Yang et al., 2016). Thus, residents highlighted that they preferred making their own choice for their room's indoor environment because staff could sometimes misunderstand their preferences, which caused dissatisfaction with thermal comfort (Cleary et al., 2019). Similar to this, thermal discomfort situations can develop when staff impose their own preferences to control temperature (such as opening windows or turning on air conditioners without consulting residents). On the other hand, older individuals are less accustomed to technology and are not taught how to operate air conditioning unit remote controls, making them unable to meddle.

3.3.4. Evaluation and recommendations for thermal comfort

Although the elderly try to obtain their thermal comfort through individual adaptive strategies, the implementation of technological solutions such as HVAC can enhance thermal comfort without the need for adaptive strategies (van Hoof et al., 2019). To provide efficient use of HVAC systems, training staff members and the elderly in terms of air conditioning units can be helpful (Wu et al., 2019). In addition to that, understanding the needs of the elderly and their habits is significant. Though these behaviors, habits, and strategies may differ by region, season, person, or other climatic factors, they must be envisaged in the design process, and both staff and residents should be trained. Also, there must be specific comfort regulations for the elderly that can be modified for all regions and climates.

Thermal comfort research can be divided into three categories: determining the parameters to assure thermal comfort, the causes and effects of comfort and discomfort, and techniques to minimize these impacts on the aged. Most research looked at all thermal comfort factors together, however some of them were particularly interested on skin comfort factors. The causes of thermal comfort or discomfort in the elderly are essentially connected to their thermal environment sensitivity and perception, which are both extremely diverse. Therefore, it is still necessary to look at individual preferences in research that concentrate on the thermal discomfort of the elderly under various climatic circumstances. Considering that natural ventilation is currently favoured and energy economy is a top priority, adaptive thermal comfort techniques for RCF buildings should be carefully considered.

3.4. Indoor Air Quality

The findings from indoor air quality's influence on health problems and the most common pollutants are discussed in this section, along with literature gaps and recommendations for improving IAQ.

3.4.1. Importance of Indoor Air Quality (IAQ) and pollutants

The indoor air quality where people spend a substantial part of their life is a significant determinant of healthy life and people's well-being. The air pollutants lead to a broad range of health problems and may even be fatal, especially in elderly people (World Health Organization (WHO), 2010). Indoor air pollutants are caused by a variety of sources, including occupant activities and other biological sources, the combustion of substances for heating or fuel, and emissions from building components (Jones, 1999). Allergens, asbestos, CO, CO_2, volatile organic compounds (VOCs), particles (PM10), microorganisms, pollens, and fungi were mentioned as major indoor pollutants and emission sources for buildings (Spengler & Sexton, 1983).

There is a special concern for older adults' indoor chemical and pollutant exposures since they spend most of their time indoors and are exposed to indoor chemicals and pollutants for long periods of time (Tao et al., 2020). Especially the elderly, who are over 80 years old and living in poorly ventilated nursing homes, can have adverse health outcomes for their respiratory system, even at moderate air pollutant concentrations (Belo et al., 2019; Bentayeb et al., 2015; Maio et al., 2015; Simoni et al., 2003). TVOC (total volatile organic compound) exposure and respiratory infection have a significant relationship (Belo et al., 2019), and higher levels of carbon dioxide can cause breathlessness and coughing in the elderly (Belo et al., 2019). It has been stated that there is a strong relation between indoor pollutants and health outcomes such as wheezing, breathlessness, coughing, phlegm, asthma, COPD, and lung cancer (Simoni et al., 2003). It has also been observed that air flow decreases the risk of transmission of COVID-19, one of the deadliest epidemics of recent years. According to the recent study that interrogated the relationship between air flow and COVID-19 infection risk, ventilation, infiltration, and behavior were determined as the most important components for indoor air quality under the pandemic conditions (Browning et al., 2019).

Indoor air quality is affected by the presence of air suspended particles (PM2.5, PM10), VOCs (volatile organic compounds), SVOCs (semivolatile organic compounds), and bacterial and fungal concentrations (Almeida-Silva et al., 2014; Madureira et al., 2015; Mendes et al., 2013, 2016). When the chemical characterization of air suspended particles is examined indoors, it is discovered that PM10 average concentrations in living rooms are higher than in bedrooms due to the occupation for dust re-suspension (Almeida-Silva et al., 2014). Similarly, when SVOCs were measured, it was seen that five times more SVOC was found in corridors compared to bedrooms and living rooms (Arnold et al., 2018). In terms of bacterial and fungal concentrations when indoors and outdoors were compared, as might be expected, indoor concentrations were higher than outdoor concentrations due to occupancy or resuspension (e.g., from carpet) (Madureira et al., 2015; Mendes et al., 2013).

3.4.2. Evaluation and recommendations for ındoor air quality

Occupancy, building envelope, ventilation schedule, climate condition, and room layout are the parameters that can influence the indoor pollutants' concentration (Serrano-Jiménez et al., 2020). The poor ventilation in the buildings can be mentioned as one of the pollutant factors (Almeida-Silva et al., 2014) and it can be modulated by natural ventilation (Almeida-Silva et al., 2015; Bentayeb et al., 2015). The highest CO_2 concentrations have been measured mainly in the bedroom (during sleeping periods), where residents spend most of their time (Serrano-Jiménez et al., 2020). As a result, exposure must be limited by taking precautions, such as providing natural ventilation, using RCF building materials, and controlling VOC sources. It is also recommended to collect periodic samples and investigate the chemical or pollutant concentration in RCF on a regular basis. The staff and building occupants can be trained about the indoor air quality.

Indoor air quality and thermal comfort are investigated simultaneously in some articles since the two topics are connected and both are required to offer a neutral environment. However, compared to other IEQ factors, the quantity of IAQ studies in RCF is small. Choosing the wrong indoor material can harm IAQ and be harmful to senior citizens' health. Studies focusing on indoor air quality should concentrate on modernized indoor materials because the market for building materials is relatively broad and new materials are welcome.

4. Conclusion

The systematic review starts by looking into all IEQ components (acoustics, lighting, thermal comfort, and indoor air quality) for elderly needs, with a specific focus on RCFs. There are many perspectives and issues to look for, and IEQ and its components are cogent factors of elderly satisfaction. Because

IEQ components are affected by a variety of elements (including environmental, personal, cultural, and operational aspects), this study sought to present a comprehensive method that takes all into account. Despite great efforts, more work remains to be done. To expand the literature on IEQ and provide elderly friendly interiors, it is critical to take a user-centered design approach that entails understanding the needs, preferences, and limitations of the elderly population and applying this knowledge to creating functional, comfortable, and safe spaces. Architects and designers can obtain significant insights into the needs and preferences of the elderly by incorporating them in the design process, leading to superior design outcomes. Furthermore, incorporating technology into interior design can considerably improve the living experience of the elderly. For example, smart lighting systems can be implemented to help control illumination levels and improve visibility. Voice-activated assistants, fall detection systems, and home monitoring systems are examples of assistive technology that can be used to promote safety and well-being. Another critical topic that must be addressed is the provision of flexible design solutions for the elderly in order to accommodate their changing demands and preferences. To accommodate changes in mobility and living situations, for example, adjustable lighting systems, flexible seating arrangements, and adaptable storage solutions can be used. These design solutions might assist elderly individuals in maintaining their independence and gaining control over their living spacesFinally, in order to enhance environmental sustainability and reduce energy costs, sustainable design principles can be implemented into interior design for the elderly. Energy-efficient lighting, passive solar design, and green building materials, for example, can assist decrease the environmental impact of buildings and promote sustainability.

A framework has been constructed to identify the significance of IEQ for the elderly, existing problems, recommendations, and gaps in the literature. The authors feel that designing places to meet the needs of the elderly can improve their quality of life and contribute to safe and comfortable aging. In addition to this evaluation, the study intends to offer baseline data for RCF facility designers, researchers, and management by emphasizing issues and outlining suggestions to enhance IEQ in senior living facilities.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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The Place of Hacı Bayram Veli Mosque and Its Surroundings in Ankara City Identity

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Abstract

The city of Ankara has hosted many civilizations since prehistoric times and has many historical buildings from various periods. The Hacı Bayram Veli Mosque, built by Hacı Bayram Veli, the founder of the Bayramiyye (Bayramilik) Sect, is located in Altındağ District, Ulus historical city center, next to the Temple of Augustus. This study starts with a literature and archive review on the city's identity and Hacı Bayram Veli Mosque. It includes the results of a survey study prepared to determine the place of the mosque and its surroundings in the urban identity of Ankara. The survey results were analyzed, and the results were interpreted in terms of Ankara's urban identity. The study draws attention to the Hacı Bayram Veli Mosque and its surroundings, an important focal point for Ankara and one of the indispensable points of the historical city center of Ankara. Although there are various art and architectural history studies on the Hacı Bayram Veli Mosque, there are almost no studies regarding urban identity. In this context, the study is important and will fill a gap in this area.

***Keywords:** Ankara, urban identity, Hacı Bayram Veli Mosque, focal point.*

Hacı Bayram Veli Camisi ve Çevresinin Ankara Kent Kimliğindeki Yeri

Öz

Tarih öncesi çağlardan bu tarafa birçok medeniyete ev sahipliği yapmış olan Ankara kentinde çeşitli dönemlerden kalan çok sayıda tarihi yapı bulunmaktadır. Hacı Bayram Veli Camisi, Altındağ İlçesi, Ulus tarihi kent merkezinde, Augustus Tapınağı'nın yanında yer almakta ve Bayramiyye (Bayramilik) Tarikatı'nın kurucusu olan Hacı Bayram Veli tarafından yaptırılmıştır. Bu çalışma kent kimliği ve Hacı Bayram Veli Camisi üzerine yapılan bir literatür ve arşiv taraması ile başlayıp caminin ve çevresinin Ankara kent kimliğindeki yerinin tespiti için hazırlanan bir anket çalışmasının sonuçlarını içermektedir. Yapılan anket sonuçları analiz edilmiş ve sonuçlar Ankara kent kimliği açısından yorumlanmıştır. Çalışmanın amacı, Ankara kenti için önemli bir odak noktası ve Ankara tarihi kent merkezinin vazgeçilmez noktalarından biri olan Hacı Bayram Veli Camisi ve çevresine dikkat çekmektir. Hacı Bayram Veli Camisine ilişkin çeşitli sanat ve mimarlık tarihi çalışmaları olmasına rağmen bu alanın kent kimliği açısından ele alındığı çalışmalar yok denecek kadar azdır. Bu bağlamda ele alındığında çalışmanın oldukça önemli olduğu ve bu alandaki bir açığı dolduracağı düşünülmektedir.

***Anahtar kelimeler:** Ankara, kent kimliği, Hacı Bayram Veli, Camii, odak noktası.*

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1. Introduction

Urban areas are settlements where most of the population is engaged in industry, trade, or administrative activities and where there is no agricultural activity (Türk Dil Kurumu, 2007). For a place to be defined as a city, non-agricultural production must gain weight in that area, and the means of production and the population must be concentrated there (Hasol, 2002). Lynch (1981) defines identity as "a person's ability to identify or remember a place as different from others." Prohansky et al. (1983) define the city's identity as the basis of personal identity and describe this identity as a collection of thoughts, memories, ideas, interpretations, and feelings about certain settlements. In another approach, it is stated that in order for a field to be a "place", it must have a specialized meaning; that is, the concept of "place" is the integration of meaning and space (Affiliations, 2007). Relp (1976) also explains the meaning of place by examining people's experiences on the ground (Relp, 1976). Norberg-Schulz (1979) emphasizes that the identity of the place is formed because of necessities and that each place has its unique spirit.

Urban identity is the expression of the features formed due to social construction that distinguishes a city from other cities (Ocakçı & Türk, 2012). Being a social construction indicates that identity belongs not only to the city and the elements that make up the city but also to the perception and interaction of the people living there and their experiences. A place can present an identity only through a viewer or commentator (Topçu, 2011). The contribution of the features of the elements that make up the urban identity to the urban memory is directly related to the time-dependent accumulation of the actors who perceive it. Therefore, in addition to the natural or physical elements that make up the visible identity of the city, social-cultural, socio-economic characteristics, and social inputs should be evaluated in identity evaluation (Aslan & Kiper, 2016). People want to belong to the environment and city they live in and to feel that some places belonging to the city are for them, so they participate in life as a part of the city and become aware of the values and elements that can be transferred between periods. Establishing ties with people's past in urban spaces is important in increasing the sense of identity, place, and belonging (Oktay, 2018), which is part of an active time-dependent urban identity formation and cycle.

The formation and shaping of urban identity occur over a long period. The city's geographical features, lifestyle, local traditions, architectural features, and cultural level shape the city. For this reason, the aspects that give the city an identity are evaluated as a whole, not individually (Suher, 2006). A place cannot present an identity without an audience interpreter. Presenting identity is only possible with perception (Bilsel, 2002). Perception is a mental phenomenon and a process that occurs through the audience-interpreter. As a result of the interaction of people with the space in which they operate, perception occurs when the stimulating effects originating from the environment are felt and perceived through their sense organs (Aydınlı, 1982; Bilsel, 2002). This process includes collecting, organizing, and disclosing environmental information (Carmona et al., 2003).

The Hacı Bayram Veli Mosque is an important symbol of the city's Islamic heritage and has played an important role in shaping the cultural and architectural landscape of the city. This study explores the position and worth of Hacı Bayram Veli Mosque in Ankara, considering the urban image and city identity. The Urban identity is related to the feature of buildings but also the perception and thoughts of the city residents. Therefore, first, the urban image and city identity are presented. Then, the literature survey about Hacı Bayram Veli Mosque is given. The method of evaluation and questionnaire are given; consequently, the results and discussions are presented in the article.

2. Material and Method

This study includes investigating the place of Hacı Bayram Veli Mosque and its surroundings in Ankara's urban identity. First, a literature review on urban image and identity was made. Then the development and change of the mosque and its surroundings in history were discussed. Place identity is the sum of the features that make people perceive and consider the differences of it (Lynch, 1981). These features should correspond to their value. Humans perceive these characteristic attributes, interact with them, and become part of their identity. A city's identity, geography, history, culture, architecture, tradition, and lifestyle are shaped over time (Güler et al., 2005; Turan & Ercoşkun, 2017). The value of a place in the identity of a city could be considered by evaluating these features. The history, location, social and cultural aspects, a place's function, and utilization determine its position in the city.

On the other hand, the meaning of these features should correspond to their value of them. Meaning is related to the interaction levels and ways between people of the city and a specific place. Researchers could explore and define the value and position of any place, building, or public area. However, the scientific outcomes of this exploration may not be parallel with the city users. It is important to consider the perception and utilization of a place by people for evaluating the value of this place in city identity. With these outcomes, a questionnaire survey measures city users' interaction and perception of Hacı Bayram Veli Mosque. The value of the building is to be explored by considering the people's responses in parallel with the literature survey.

Survey studies are used to ask many people questions about their behaviors, attitudes, and opinions (Marczyk et al., 2005). The questions, samples, and procedure of the survey are to be structured due to the objectives of the research study. The history, location, and value of the Hacı Bayram Veli Mosque are presented in the section. The survey is carried out to explore the interaction of the people by quantitative approaches. It is divided into four parts: multiple-choice with 2 or 3 answered scales and open-ended questions at the end. The first part is to define the identity of respondents; the second is related to measuring the interaction of users with places of city identity. The third part explores the relationship and perception of respondents to Hacı Bayram Veli Mosque. The final part of getting the important places selections of respondents which are part of the city identity. The explanations about the order of the questions are below:

- Questions 1, 2, and 3, 4 explore age, time of living in Ankara, residency, and working statures.

- Question 5 asks the ratios of knowing, using, or interacting with the places of the city with sub-section.

- Question 6 asks about the knowledge level, use, and interaction with Hacı Bayram Veli Mosques with sub-sections

- Question 7 asks the other significant place thoughts of Ankara

The survey, which was prepared to determine the perception of the building and its surroundings, which is one of the sign elements in the city of Ankara, on the people of the city today, was held between 01/12/2022 and 15/01/2023 under the ethical committee approval. An online survey form was used to collect data, and it was announced via emails and social platforms without focusing on any group or organization. The respondents' personal information was not recorded, and they were informed about the objectives and procedure of the survey. One hundred forty-one responses have been reached for the survey, and the research findings are presented and then discussed within the scope of the study.

2.1. Urban Image and Identity

The concept of the urban image has emerged with the effect on people after the perception process of the urban appearance. The concept of urban image, which can be described as the appearance of a city, its design, and the impression left on people by the architectural features of the buildings that make up the city (Bilsel et al., 1999), is an important process that comes after perception and is effective in the formation of urban identity. The urban image, which expresses the intellectual and emotional traces that urban life leaves on people, is the most important step in recognizing urban identity (Lynch, 1960). Identity is expressed by being unique, which makes any living thing or object in nature different from others and is used in the sense of originality and uniqueness (Prohansky et al., 1983). Urban identity has its characteristics with different interpretations in each city and is shaped by socio-economic, formal, physical, and historical factors. The urban identity, which is formed by the lifestyles of the citizens, which keeps the concept of the developing and sustainable city concept alive, and which is created by a process extending from the past to the future, is meaning-laden integrity and also affects the image of the city (Lynch, 1981; Tekeli, 1991; Çöl, 1998).

The identity of a city could be shaped by; natural and built environment features and space components of them, social environment, cultural values, history, architectural features, life, traditions, the history of the civilization, the time passed from first settlements, the people living, climate, flora, living beings, the relation with other cultures, transportation, being a west or east city, economical features, being a part of a state, earthquakes, wars or invasions, *etc.* (Lynch, 1981; Ocakçı, 1993; Ocakçı & Southworth, 1995; Suher et al., 1996; Suher et al., 1996). These are figured out generally in Figure 1.

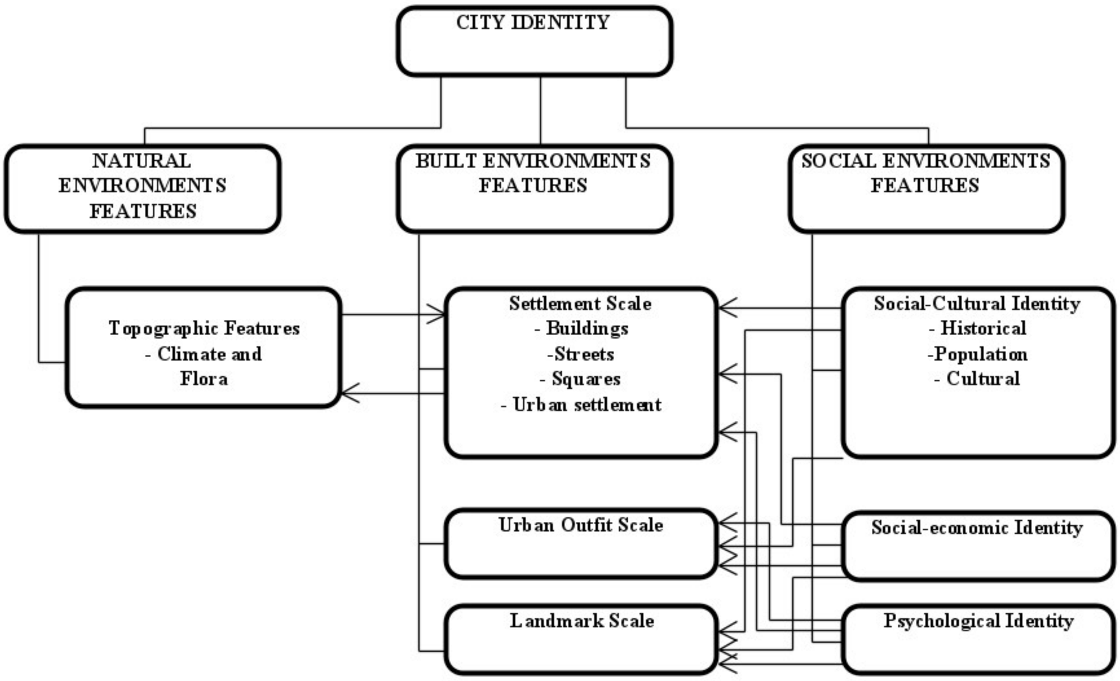

Figure 1. Attributes affecting city identity (Ocakçı & Türk, 2012)

As a result of the work done by Lynch (1960) in Jersey City, Boston, and Los Angeles to define the images of cities, artificial environmental elements that effectively recognize the city image and the formation of the urban identity were determined. These elements are roads, zones, borders, landmarks, and focal points. Nasar (1998) rated these elements, which were determined by Lynch, by considering the level of appreciation of individuals. Ünügür (1996) examines the effect of the built environment on urban identity in three groups: equipment scale, settlement scale, and symbolic buildings.

The city functions as a theater stage for various social activities, and the users' memories create the city's value. Users' daily activities effectively construct and change meaning (Liggett & Perry, 1995). For this reason, the most important element in the environment built by people and contributing to the city's identity is the monumental structures, building groups, and the urban texture formed by these structures, which have an important place in the daily lives of the citizens in that city.

When people become attached to the place they live in, attach values to it, and make various sacrifices for these values, this place will gain an identity. This shows that the urban identity is formed by society (Tekeli, 1991). A person's attribution of meaning to a place is related to the meaning of that city space for the person. Meaning, as the concept of "genius loci" indicates, gives an identity to an urban space, which cannot be directly explained by the people living there, but whose existence is aware of (Norberg-Schulz, 1979). Suppose a building or building group has witnessed or even directly participated in the life of the period in which it emerged in the city and reflects the architecture and culture of the period. In that case, it has a meaning for the city dweller, which means only a nostalgic attitude that respects the dream and includes the collective experience in the current period (Neil, 1997).

Güvenç (1991), who states that urban identity should be perceived as showing continuity from the past to the future, emphasizes the importance of the interaction between identity and history. Ünügür & Beyhan (2005) grouped the factors affecting urban identity as environmental identity, urban identity, and social identity. Since the external appearance features of the environment cause the city's differentiation, it significantly affects the urban identity. Environmental identity defines the natural features of cities (location, climate, geological structure, topography, vegetation). The features of the built environment are examined in two groups: settlement scale and symbolized elements scale. The built environment features at the settlement scale consist of urban textures formed by roads, buildings, green areas, open spaces, squares, and equipment. On the other hand, symbolic built elements are the structures referenced in the city with symbolic features that are easily placed in the memory. As Lynch (1981) stated, these structures, which are landmarks, can be seen from far distances in the city.

While evaluating the place and effect of a place in the urban identity, its qualities and characteristics are important in this context as an element. The history, location, functional, social, and cultural values it has acquired throughout its life, usage patterns, and layers holistically determine its place in the urban identity. On the other hand, the value brought by these qualities, which are evaluated as an object, must have a semantic equivalent. This is about how it interacts with people and is perceived. Its place in the urban identity formed over time can be expressed and put forward by researchers and experts, but it can be of a different value to today's city stakeholders. In order to evaluate the place of an area in the city's identity, how people perceive and interact with it must be evaluated. One of the well-preserved and important examples of Ottoman architecture in Ankara, Hacı Bayram Veli Mosque and its surroundings are an important point for local people and visitors of Ankara to understand the history and culture of the city. In this study, first of all, a literature and archive search was conducted on the building and its surroundings to determine the place of Hacı Bayram Veli Mosque within the city identity of Ankara. Afterward, the value of the building and its immediate surroundings in terms of urban identity was analyzed with a survey study on people who are viewers and commentators.

2.2. Hacı Bayram Veli Mosque and Its Surroundings

The exact date of construction of the first settlement and the Castle in Ankara is unknown. However, it is accepted that the Castle was used as a military garrison by the Hittites due to its strategic location. It is understood from the artifacts belonging to the prehistoric period found in the archaeological excavations in and around the city that the city was a settlement in the prehistoric periods. However, the first known history of the city of Ankara and the Castle begins with the Phrygians (Erzen, 1946). During the Galatians period, Ankara was a castle city surrounded by walls and, at the same time, the region's administrative center (Erdoğan, 1998). The city, which Augustus turned into a Roman province in 25 B.C., had its heyday, especially in the second century. It is known that during this period, the city was settled on the plain at the foot of the Castle, its area grew considerably compared to the previous century, and it appeared to be an open city without any protective walls (Aktüre, 1981). Texier states there were a Hippodrome, theatre, baths, gymnasium, aqueducts, and many temples in Ankara during the Roman period (Texier, 1839; Bosch, 1948). During the Roman Period, the city center was in the arc drawn by the Hatip Stream, northwest of the Castle, where the Temple of Augustus, the Great Bath, the palaestra, and the columned road are located together. As a result of the archaeological excavations, it was determined that there was a dense residential area around the Great Bath, and this section was used in the 2nd and 3rd centuries A.D. (Fıratlı, 1955). The peace period of the city, which lasted for three hundred years, ended with the Sassanids coming from Iran to Anatolia and seizing Ankara in the middle of the 7th century (Wittek, 1936). During these attacks, the city on the plain was badly damaged, and many buildings, especially the great Roman Bath, were burnt down and destroyed. In the middle of the 7th century, the city was withdrawn from the plain to the Castle, protected by thick walls on the hill, and the city on the plain disappeared (Aktüre, 1981).

Hacı Bayram Hill is the mountain where Goddess Kybele resided during the Phrygian period, and the city is located on the plain part of this hill. It is understood from the archaeological excavations, which was carried out in and around the city, that Ankara was an important settlement in this period (Erzen, 1946). Hacı Bayram Veli Mosque (Figure 2 and Figure 3) is Ankara's only "votive place" and functions as a Friday Mosque and is the place where most of the funeral ceremonies are held. It is thought that in this area, before the 1st century B.C., when the city was under the rule of the Romans, there was a temple built in the name of the chief god Men, which was a cult place in the time of the Galatians. When the city came under the rule of the Romans, the people of Ankara built a larger temple in the same place in the name of Augustus, who replaced the chief god of the Empire. In the 15th century, the period of the rise of the Ottomans, the city went out of the walls and settled in a flat area. In this period, a mosque was built next to the old Temple of Augustus, which was half destroyed, by Hacı Bayram Veli, the founder of the Bayrami order, in 1425, two years before his death. Today, the Hacı Bayram Mosque in Ankara is the only building with a "votive place" (Aktüre, 1981).

Figure 2. Aerial view (Kulturportalı, 2022)

Figure 3. Hacı Bayram Complex and Ankara Castle (Ilgigazetesi, 2022)

It symbolically showed the mosque's location in the engraving of the French traveler Paul Lucas, who came to Ankara on September 26, 1705. A painting in the Rijksmuseum in Amsterdam shows the location of the mosque and the L-shaped zawiya on its western façade. A similar building can be seen in the engraving of Charles Texier, who came to Ankara in 1832 (Eyice, 1972). It is thought that this structure was demolished and cleaned during the transfer of the tombs found in the zawiya graveyard in the early years of the Republic period to the garden of Tacettin Mosque (Öztürk, 1986).

Hacı Bayram-ı Veli is one of the monumental personalities of the great Turkish thought system, namely Sufi philosophy, whose foundation was laid in Horosan, rising in the capital Ankara. It is proven with historical records that Hacı Bayram Veli was a professor in Bursa and the Kara Madrasah (Melike Hatun Madrasah) in Ankara. First, Hacı Bayram Veli, who went through a madrasa education and took lessons from the students of people like Davud-ı Kayseri, and had friends like Molla Fenari, learned all the subtleties of the sharia (Bayramoğlu, 1982). The state supported the sect of Hacı Bayram-ı Veli, which acted under religious rules and advised to show compassion towards the poor as an element of stability in Anatolia (Öztürk, 1986). The people of Ankara accepted Hacı Bayram-ı Veli as the spiritual protector of the city.

The Hacı Bayram Veli Mosque should be counted as a complex. The structures that make up the complex are the Hacı Bayram Veli Mosque, the Hacı Bayram Tomb adjacent to the mosque, the Temple of Augustus (Figure 4), which was used as an educational institution under the name of Ak Madrasa during the Ottoman period, and the zawiya in the southwest, where the harem and selamlık were destroyed in 1972 while the surroundings of the mosque were cleaned. The building to the west of the mosque, whose picture is seen in old engravings, is considered a zawiya (Texier, 1839; Öztürk, 1986). The mosque, with its sanctuary and *çilehane*, was a part of the zawiya. İsmail Fazıl Pasha Tomb was added to the complex later (Figure 5). The bath structure adjacent to the harem was the remnant of the building in the southwest of the square. The main building, originally planned as a small mosque, was expanded later due to Ankara's population growth. Its current appearance has the characteristics of the 17th and 18th centuries.

Figure 4. Hacı Bayram Veli Mosque and Tomb (Haber7, 2022)

Figure 5. Hacı Bayram Veli Mosque, Tomb, and Ismail Fazıl Pasha Tomb (Haber7, 2022)

By being adjacent to the Temple of Augustus, the mosque has a longitudinal rectangular plan and external dimensions of 13.5x20 m (Erdoğan, 1998). Various dates have been suggested for the construction date of the Hacı Bayram Beli Mosque. Since there is no definite information, it would be correct to say that it was built in the first quarter of the 15th century (1415-1425) (Cebecioğlu, 1991). According to the repair inscription of the mosque, it was repaired by Şeyh Mehmet Baba in 1126 H/1714 M. (Öney, 1971). Later, it was repaired once again during the reign of Sultan Mustafa 3 (1757-1774) (Erken, 1983). The wooden ceiling resting on the main walls is divided by laths. Six rows of sills surround a hexagonal core in the middle of the ceiling.

The sills are decorated with navy blue, red, and eggplant purple flowers. There is also a small hexagonal hub on the ceiling of the lodge. The side mahfil is a rectangular hub and is a good example of woodworking with its geometric and hand-drawn ornaments. Written and hand-drawn decorations are also seen on the beams and pillars carrying the mahfil. Wooden minbar and plaster mihrab rise to the ceiling (Figure 6). There are geometric shapes with triangular laths on both sides of the minbar. Two rows of sills go around the outside. The six sides of the pavilion part of the minbar are surrounded by moldings and are filled with geometric shapes. The minbar, made with the imitation kundekari technique and painted on wood, is high quality. All embroidery on wood in the mosque was done by Nakkaş Mustafa (Öney, 1971).

There are four rows of wiping around the mihrab. There is a muqarnas deletion at the outermost part, followed by the Kalima-i Tawhid belt. The top of the mihrab ends with a row of palmettes. The five-sided mihrab niche has a muqarnas hood. A row of palmettes was repeated five times on top of the niche. The minaret, built adjacent to the tomb, has a cut stone base and a brick body. The Hacı Bayram Veli Tomb was built to the south of the mosque using the wall. The west side of the square-planned domed tomb is covered with marble, and the south side is covered with white stone.

Figure 6. Mihrab and minbar of the mosque (Archive of the authors)

The construction process that started in the late Ottoman period and around Ulus Square, one of the important focal points of Ankara, continued in the Early Republic period (1923-1950) and continued under the social and economic conditions of the 1950s. Some practices around the Hacı Bayram Veli Mosque and the Temple of Augustus, one of the most important sub-areas of the historical city center of Ankara, caused various destructions in the "Hacı Bayram Tumulus." Toilets, underground parking, and fountains were built beside the Temple of Augustus. The mosque was expanded with additions made in different periods, and a large additional space was built under the ground. The efforts to protect the traditional settlements/housings in and around the mosque have been insufficient until today. However, in recent years, these areas have been largely rebuilt and tried to be brought back to the city (Tunçer, 2019).

The Hacı Bayram Mosque is a prominent Anatolian Turkish/Islamic Architecture work. Its three-pointed arches are made of a brick-stone mixture, various flower motifs on wood, and Kütahya tile coverings from the 18th century. The Temple of Augustus, one of the important structures of the Roman period adjacent to the Hacı Bayram Veli Mosque, is of particular importance in that the testament of Emperor Augustus is located on the temple's walls. The combination of the Roman Period Temple of Augustus, the Hacı Bayram Veli Mosque, and the tomb, which are among the layers of the Hacı Bayram Veli Mosque and its surroundings belonging to different cultures and periods, is concrete proof of the universal multicultural value of this area.

3. Findings and Discussion

Looking at Figure 7, the age distribution of respondents is as follows; 45% of them are between 18-25, 23% are over 56 years old, 16% are between 36-45, 9% are between 46-55, and 7% of them is between 26-35. 83.7% of the respondents live permanently in Ankara, and the rest live temporarily. Besides, 63% of respondents have been living in Ankara for over 20 years, and 17% have been living in Ankara for 10-20 years Figure 8. Therefore, it can be stated that the representation rate of groups for Ankara residency is quite high. The working status of respondents is shown in Figure 9. 46.1% are students, 37.6% are active workers, and 16.3% are retired.

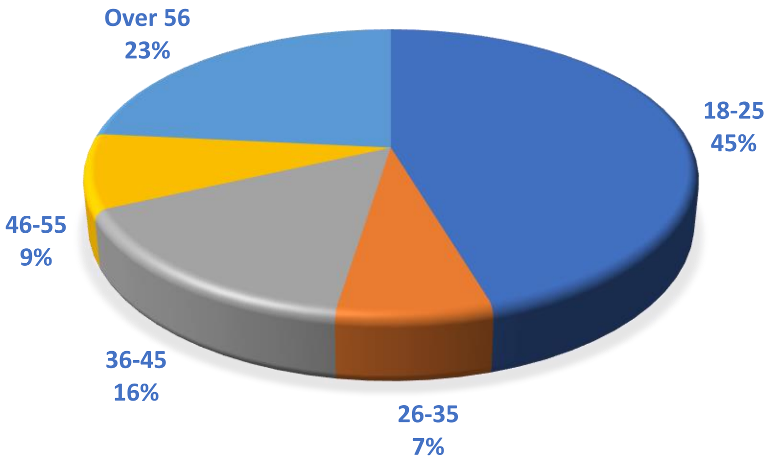

Figure 7. Age distribution

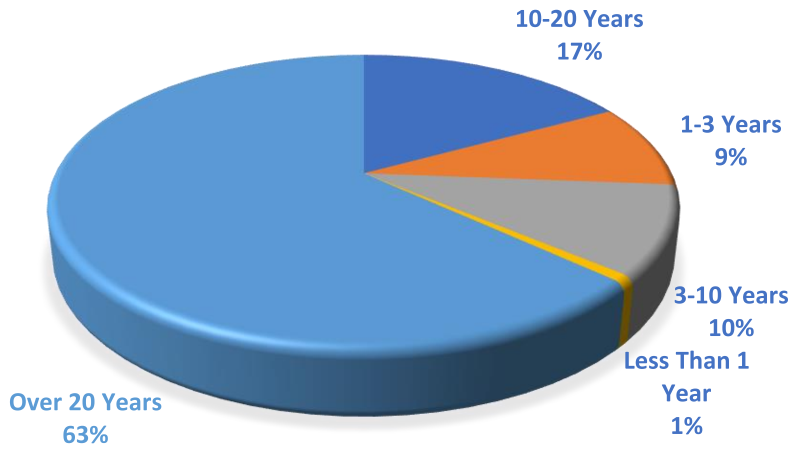

Figure 8. Year of living in Ankara

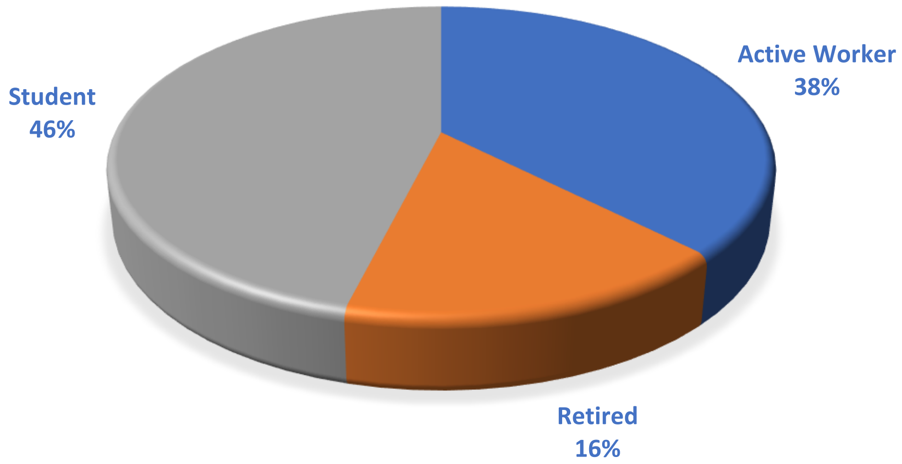

Figure 9. Working status

Respondents are asked to measure the knowledge and interaction level of significant buildings and public spaces where they lived. The answers are merged into frequencies, and one value for indicating the wise to urban places of the hometown is developed. By exploring Figure 10, wise and awareness levels due to age group could be seen. 18-25 age is 41%, 26-35 age is 50%, 36-45 age is 35%, 46-55 age is 41%, and for the respondents over 56 years is 31%. The level of knowledge and interaction of the participants under the age of 35, who can be defined as young, about the important buildings and public spaces in the places where they live, is relatively higher than the participants aged 36-45 and over 56 years of age who are actively working.

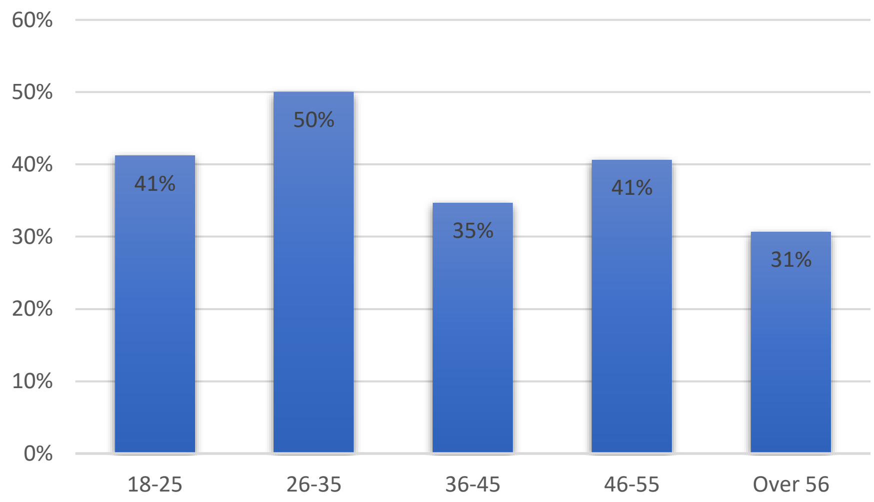

Figure 10. Wise to urban places of hometown

Since historical environments are generally in the center of the settlements where they are located, values such as cultural and natural assets have attracted the attention of societies in every period. Humankind has always been curious to learn about the societies and lifestyles of the previous periods and their reflections on space. The attraction to historical sites from the past to the present decreases over time due to social and economic factors, and this causes a decrease in the place of these areas in social memory (Avcıoğlu, 2016) and city identity. A survey conducted by Özdede et al. (2021) on the ancient city of Denizli reveals that this is the case for the inhabitants of Denizli. In this study, Figure 11 and Figure 12 show the findings according to questions about Hacı Bayram Veli Mosque. Figure 11 shows the 'yes', 'no', and 'neutral' answers due to all respondents, whereas Figure 12 shows the 'yes' answer related to age groups. Only 4.96% of the respondents had heard about the building first, and 88.65% stated that they knew it. 70.92% of them spared time to visit buildings and surroundings, and

69.50% have gone there more than once. 82.27% of respondents know the location of the building, whereas only 43.97% know the history, and 31.9% read about the building. 12.77% of the respondents visit the building regularly, and 13.48 have participated in some activities. It can be stated that the level of awareness, location, and least one visit is comparatively higher than the level of history knowledge and regular visiting for any purpose. By following the situations among the age group, the important statements could be listed as follows: respondents with older ages have a lower level for going to the Hacı Bayram Veli mosque at least once; however, they have a higher value for visiting the building regularly. The knowledge about the history and reading level is comparatively higher in the older age group.

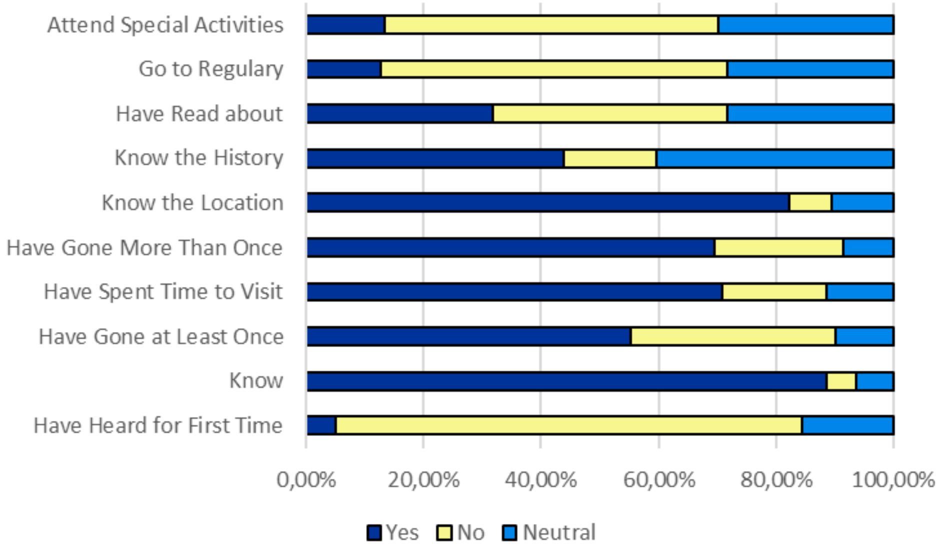

Figure 11. Results for Hacı Bayram Veli Mosque

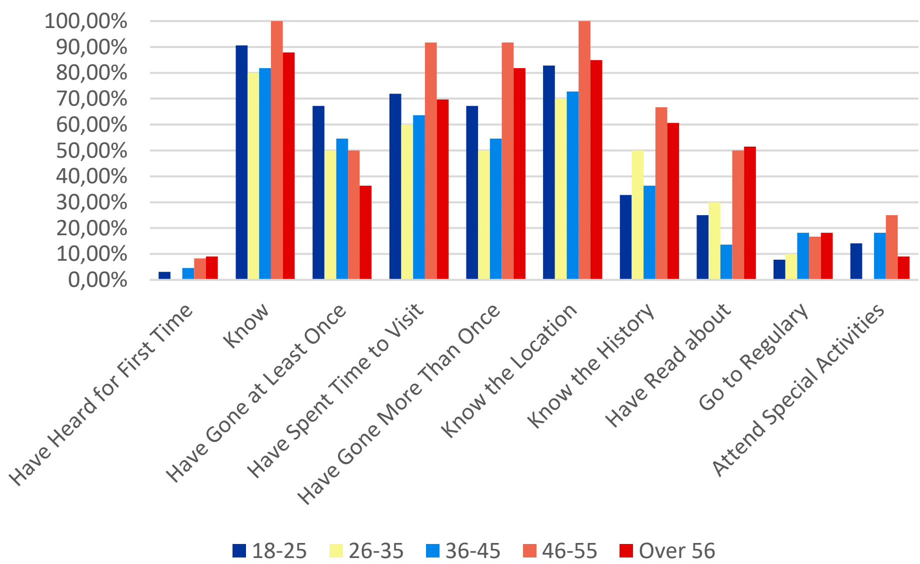

Figure 12. 'Yes' answer due to the ages of Hacı Bayram Veli Mosque

In the last question, respondents were asked to write the buildings or public spaces that they think the level of contribution to city identity and values more. Table 1 and **Error! Reference source not found.** show the places and buildings selection for all respondents and, due to age group configuring the orders based on the selection rates. Exploring the places for the group, it can be seen that Anıtkabir is in the first order, and continuously Ankara Castle, First TBMM, Hacı Bayram Veli Mosque, and Atakule follow. Evaluating the first five selections, except Anıtkabir, all buildings are in the historical city center: Ulus. Some differences can be noticed by looking at the results due to age group. For example, Anıtkabir gets the second order for 26-35 age, and Hacı Bayram Veli Mosque has lower orders in younger ages and higher orders in older ages. For older ages, three places can be stated as being in the historical city center: Ulus out of the first five selections. All cities have heroic stories and heroes in the historical process and impact the formation of the cities' architectural, social, and cultural structures. Some urban spaces have become dominant in people's minds with their structural features, some due to their historical background and some due to religious influences. Within the scope of the doctoral study titled "Mental Map of Ankara" prepared by Karacagil (2021), interviews were held with people about Ankara. As a result of these interviews, it was stated that everyone interviewed knew about Ulus Square, 1st TBMM, Ulus İş Bank, Ziraat Bank, PTT Stamp Museum, 3rd Parliament Building, Republic Museum (2nd TBMM), Painting and Sculpture Museum, Hacı Bayram Mosque, and Anıtkabir. This information coincides with the survey results conducted within the article's scope. This survey shows that the Hacı Bayram Veli Mosque and its surroundings and the historical city center of Ulus still maintain their importance in Ankara's historical city identity and memory today.

Table 1. Buildings/public spaces selections for Ankara 1

	For All	18-25	26-35
1	Anıtkabir	Anıtkabir	Ankara Castle
2	Ankara Castle	Ankara Castle	Anıtkabir
3	First TBMM	Atakule	First TBMM
4	Hacı Bayramı Veli Mosque	First TBMM	Atakule
5	Atakule	Ulus Atatürk Statue	Ulus Atatürk Statue
6	Ulus Atatürk Statue	Hacı Bayramı Veli Mosque	Hacı Bayramı Veli
7	Museum of Anatolian Civilizations	CSO ADA	İŞBANK Ulus
8	CSO ADA	Hamamönü	Cermodern
9	Hamamönü	Cermodern	Ethnography Museum
10	Ethnography Museum	Ziraat Bank	TBMM
11	Cermodern	İŞBANK Ulus	Botanik Park
12	TBMM	Ethnography Museum	CSO ADA

Table 2. Buildings/public spaces selections for Ankara 2

	36-45	46-55	Over 56
1	Anıtkabir	Anıtkabir	Anıtkabir
2	First TBMM	Hacı Bayramı Veli Mosque	First TBMM
3	Atakule	First TBMM	Hacı Bayramı Veli Mosque
4	Hacı Bayramı Veli Mosque	Ankara Castle	Ankara Castle
5	Ankara Castle	Temple of Augustus	Museum of Anatolian Civilizations
6	Museum of Anatolian Civilizations	Opera House	Atakule
7	AOÇ	TBMM	Kocatepe Mosque
8	CSO ADA	Museum of Anatolian Civilizations	TBMM
9	Rahmi Koç Museum	Gençlik Park	Hamamönü
10	Opera House	Presidency of The Republic of Türkiye	Ethnography Museum
11	İŞBANK Ulus	Hamamönü	Arslanhane Mosque
12	Cermodern	Gazi University Rectorate	Ulus Atatürk Statue

4. Conclusion and Suggestions

In this study, which deals with the Hacı Bayram Veli Mosque and its surroundings, one of the first settlements of Ankara, which has hosted many civilizations since the first ages, it is seen that the said area still maintains its importance. The mosque has played an important role in the formation of the cultural and architectural appearance of the city and remains an important focal point for the community. Despite the interventions and changes, the Hacı Bayram Veli Mosque and its surrounding structures continued to exist as important components of cultural identity and urban memory. With the survey study, it is determined that the structures of the Republican period, such as Anıtkabir, the 1st Parliament, Ulus Atatürk Statue, and Atakule, especially for the groups under the age of 46, come to the fore. It was seen that the awareness of the area by the participants was quite high. Although the rate of knowing and recognizing the building is quite high, it has been observed that the rate of those who read about it and know its history is lower. The study shows that the younger generation between 18-35 is more likely to recognize and know urban areas in their cities than the generation over 36 years old. However, when looking specifically at the Hacı Bayram Mosque, it is seen that those who know the history of the building and have read about it are higher in the 46-55 and over 56 age groups. In the big cities where rapid change has been experienced in recent years, it is seen that the symbolic elements that have an important place in the urban identity have begun to disappear for various reasons, or their effects have decreased. In order to protect the cultural assets and landmarks that impact the city's identity, it is very important to carry out studies that will provide an understanding of the importance of these structures in the education system and educate children in this respect. In addition, it is necessary to include activities that can be carried out with different disciplines that can increase awareness of urban identity and urban imagery and that can be attended by all age groups (such as seminars, workshops, excursion programs, *etc*.). It is important to establish a cultural policy to develop the urban culture and the awareness of being a citizen and to receive support from universities and professional organizations. In the necessary studies to be carried out for the creation of urban identity awareness, the city's identity and urban images should be determined by taking the opinions and thoughts of the city's official and civil actors and dynamics, examining the physical and sociological texture of the city from the past to the future from a wide perspective, and determining the short, medium and long-term vision, strategies and policies for this.

Information Note

The article complies with national and international research and publication ethics. Ethics Committee approval in the study was taken from the Ethics Committee of the University of Ankara Yıldırım Beyazıt with the decision no 2022-18.

Author Contribution and Conflict of Interest Disclosure Information

All authors contributed equally to the article. There is no conflict of interest.

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A Study of the Metro and Housing Value Interaction with Hedonic Price Model: Comparison of Ankara Batıkent and Koru Metro Stations

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Abstract

The effects of urban rail systems on the real estate market were studied by analysing housing prices around Ankara Koru and Batıkent Metro Stations using the Hedonic Price Model. Quantitative data on residential sales were used. The findings reveal that sale values of residences are more elastic in term of metro effect in Batıkent, where middle-lower income groups live, compared to Koru Metro Station, where middle-upper income groups live. As the distance to the metro station decreases in Batıkent, prices increase. These results suggest that subways can help reduce polarization between income groups in cities while increasing accessibility. Providing access to neighbourhoods with both low and high-income individuals by metro increases housing prices more in favour of low-income groups and reduces income polarization between income groups.

Keywords: *Metro stations, housing prices, hedonic price model, accessibility, transportation planning, urban planning.*

Metro ve Konut Değeri Etkileşiminin Hedonik Fiyat Modeli ile İncelenmesi: Ankara Batıkent ve Koru Metro İstasyonlarının Karşılaştırılması

Öz

Kentsel raylı sistemlerin emlak piyasası üzerindeki etkileri, Hedonik Fiyat Modeli kullanılarak Ankara Koru ve Batıkent Metro istasyonları çevresindeki konut fiyatları analiz edilerek incelenmiştir. Konut satış değerlerine ilişkin nicel veriler kullanılmıştır. Bulgular, orta-alt gelir grubunun yaşadığı Batıkent'teki konutların satış değerlerinin, orta-üst gelir grubunun yaşadığı Koru Metro İstasyonu'na kıyasla metro etkisi açısından daha esnek olduğunu ortaya koymaktadır. Batıkent'te, metro istasyonuna yaklaştıkça fiyatlar artmaktadır. Bu sonuçlar, metroların erişilebilirliği artırırken şehirlerdeki gelir grupları arasındaki kutuplaşmayı azaltmaya yardımcı olabileceğini göstermektedir. Hem düşük hem de yüksek gelirli bireylerin yaşadığı mahallelere metro ile erişim sağlanması, konut fiyatlarını düşük gelirli gruplar lehine artırmakta ve gelir grupları arasındaki kutuplaşmayı azaltmaktadır.

Anahtar kelimeler: *Metro istasyonları, konut fiyatları, hedonik fiyat modeli, erişilebilirlik, ulaşım planlaması.*

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1. Introduction

Transportation systems are constantly interacting with their surroundings. The distribution of economic development among regions and the spatial structure of the city are closely related to transportation systems (Rodrigue, Comtois & Slack, 2006). In the relevant literature, it is emphasized that transportation systems should be carried out as a whole with urban planning and environmental policies to be able to create meaningful changes in space, move away from dependence on private cars, and be effective in sustainable and balanced development (Alaylı, 2006; Banister, Anderton, Bonilla, Givoni & Schwanen, 2011; Blunden, 1973; Cervero & Kochelman, 1997; Cervero, 2003; Handy, 2005; Litman & Colman, 2001). The demographic and economic structures of the people, as well as their socio-cultural relationships, are emphasized in the capacity of vehicles and the integration of transportation modes (Çınar, 2003). In these relationships, rail system applications, which are one of the mass transportation systems, are preferred to provide the fastest, most efficient and effective solutions to urban transportation needs (Barış, 1994).

Although rail system investments are high-cost projects, they are being implemented in large cities in recent years due to their ability to increase density around stations, increase the rate of public transportation use, and contribute to spatial development, and they affect land use and urban form. Studies examining the role of rail systems in land use, the development and transformation of the built environment of cities, as well as the accessibility of stations, the values of accessible station locations regarding housing prices, and the impact of urban functions on site selection are increasingly important. To evaluate these effects, analyses are conducted in areas that have gained access to the rail system after completing their urban development, comparing the situation before and after the arrival of the rail system. Many studies have been accomplished on variables that especially affect real estate values. Among these variables, it is seen that not only the structural characteristics of the housing, such as the size of the housing, the number of rooms, and the relative elevation value of the housing compared to other houses, but also spatial variables such as location, transportation facilities, distance to public transportation stations, and distance to the city center are included (Açlar & Çağdaş, 2008; Alas, 2017; Büyükduman, 2014; Bourassa, Hoesli & Vincent, 2003; Wong, Chau, Yau & Cheuna, 2011). In addition, some studies have taken travel times to school, work, and shopping as variables (Keskin, 2008). Generally, larger, well-viewed, and high-rise houses are more expensive. The prices of houses close to public transportation stations are also high (Choy Lennon, Stephen & Winky, 2007). In addition, it is emphasized in the relevant literature that indicator variables based on social class also yield useful results (Douglas, Elizabeth & Geoffrey, 2013).

This study focuses on the impact of metro stations on housing values. The aim is to reveal how the accessibility to metro stations and the structure affect the area, and how the distance and residential values change accordingly. Quantitative data were obtained to determine their effects on the sale prices of housing. As part of the fieldwork, the Batıkent Station on the Kızılay-Batıkent (M1) Metro Line, which is located on the west and southwest corridor created within the framework of a controlled decentralization policy adopted in Ankara's planning studies, aiming to intensify urban development, and the Koru Station, which has a high user profile with a higher living standard than Batıkent and intensive residential use on the Kızılay-Çayyolu (M2) Metro Line, were selected. The residential values near metro stations were analysed with the Hedonic Price Model. Thus, it was revealed how these effects were shaped in areas with different socio-economic structures. In addition to contributing to the literature, this study aims to obtain findings that will contribute to urban planning and urban policy-making around the stations. In this framework, answers to the following research questions were discussed.

- The proximity of housing to metro stations positively affects sales values.
- Increased accessibility through public transportation positively affects the mobility of lower and lower-middle-income groups in ensuring socio-economic justice.
- Providing metro access to neighbourhoods with low-income and/or high-income individuals increases housing prices more in favour of low-income groups and contributes to reducing income polarization with high-income groups.

In parallel to the research questions, the study will focus on the interaction of metros with their surrounding areas and their effects on the sale values of housing. These values will be evaluated within the framework of the structural and spatial characteristics of housing using the Hedonic Price Model.

Firstly, the theoretical discussions on the effects of rail system stations on the housing market, land use affecting the use of rail systems, accessibility-walkability-distance, and demographic structures, as well as the effects of rail system stations on the housing market were discussed. In the next section, the methodology used in the study (Hedonic Price Model) was explained. Then, the sale values of housing around the Batıkent and Koru metro stations in Ankara were evaluated using the Hedonic Price Model. The study was finalized with the conclusion section, which includes evaluations and recommendations.

2. Literature Review: Dynamics Affecting the Use of Rail Systems and Their Impact on the Housing Market

In the relevant literature, transportation-related problems are presented as traffic congestion, air and noise pollution, and many environmental problems such as global warming and climate change (Batur, 2017). Many countries focus on public transportation systems to achieve integrated and sustainable urban development, energy efficiency, and efficiency in time and budget. Especially in developed countries, population growth and irregular rapid urbanization caused by demographic growth lead to the development of a public transportation system that can meet the needs of the population rather than improving the quality of public transportation services (Abd Aziz, Kasim & Masirin, 2019). Rail systems have a positive impact on people's welfare, accessibility and the environment in urban planning and development, as they are an effective transportation mode on development and growth along their routes (Abd Aziz, Kasim & Masirin, 2019). The literature highlights three key components with which urban rail system facilities/stations interact. These are;

- Land use
- Accessibility, walkability and distance
- Socio-economic and demographic structure

In this study, the impact of urban rail system stations on housing prices will be deliberated. Within this scope, the effects of urban rail systems are evaluated in theoretical discussions interactively with these components.

2.1. Dynamics Affecting the Use of Rail Systems

In this section, rail systems are deliberated within the framework of theoretical discussions in interaction with the above components.

2.1.1. Land use

Cities are constantly changing due to natural and human-induced effects. Urban transportation constitutes the basic backbone of this structure. The form of the city is shaped by topography, natural features, economy, historical development process, and transportation network (Vuchic, 2007). The function of land use is important to overcome urban transportation problems, as transportation is a derived demand. In this context, optimum land use is always an important objective of land use planning. Optimum land use means using the land most effectively to achieve a specific goal or creating the most favorable activity on the land to achieve a positive outcome (Abd Aziz, Kasim & Masirin, 2019). Land use shows the spatial accumulation areas of many human actions such as nature, economic, social, cultural, production, consumption, and distribution. Case studies indicate that investments made to improve public transportation, rail system investments without complementary factors cannot promote spatial change, development, and urban growth along the corridor where they are built, and they cannot create the expected density in land use. According to Babalık Sutcliffe (2002), pedestrianization and local policies are complementary to the development of urban rail systems, while according to Pan & Zhang (2008), urban rail systems can contribute to land use and development with the implementation of correct policies.

2.1.2. Accessibility, walkability and distance

The main factors affecting accessibility are expressed as mobility, land use, transportation, and transportation system integration (Victoria Transport Policy Institute, 2016). Easy and comfortable access to business activities, education, employment, and recreational facilities and planning and design solutions that support walkability and neighbourhood scale constitute the essence of urban planning and transportation infrastructure (Murray, Davis, Stimson & Ferreira, 1998; Erdoğanaras, Cihangir-Çamur, Görer-Tamer & Mercan, 2020).

Accessibility is recognized as one of the indicators of development in modern societies, as stated by Avcı (2005). Walkability is also one of the important research topics because creating walkable urban spaces supports pedestrian accessibility (Cihangir-Çamur, Erdoğanaras, Görer-Tamer & Satoğlu, 2021).

The distance to bus stops, accessibility to the destination, pedestrian-oriented designs, density and diversity in land use are factors that affect walkability (Cervero & Kockelman, 1997; Ewing & Cervero, 2010). Good connections are also one of the factors that positively affect walkability (Agampatian, 2014).

Jach (2001) defines urban space as the place where the common sub-consciousness of users is the gift of feelings, rituals, and beliefs that belong to the city. It is the street, the square, the café, the coffeehouse, the neighbourhood market, the bus stop, the car, and the metro. In this context, walkability contributes to urban space. In the research conducted, walkability, mixed land use, and effective use of the area have developed the concept of "Transit-Oriented Development" (TOD) defined by American architect Calthorpe (1994) as "mixed-use communities within a 10-minute walk along regional transportation systems." Vale (2015) has also added the definition of 800 m. distance. This approach, which reduces private car use and supports traditional neighbourhood design by encouraging walking (Belzer & Autler, 2002), has become a serious research topic in recent years, and influenced by both transportation and socio-demographic factors. It is also seen as an important tool for creating sustainable urban areas (Kütük & Yalçıner, 2019; Siddiqui & Eren, 2022).

Cervero (2003) stated that because the intersections of different uses and transportation modes defined as TOD are high-density and pedestrian-friendly environments, an area within a quarter to half a mile of a station has the potential for development; Vuchic (2007) stated that an area where transit will be performed should be about 500m or a 5-minute walk from the stations. According to the Time Savings Standards, the maximum walking distance is generally accepted to be between 400m and 800m (5 to 10 minutes).

Voith (1991) stated that people working in central business districts preferred the rail system line for their housing choices, and Al-Mosaind, Dueker & Strathman (1993) stated that the rail system stop should be a maximum of 500m from the residence. Southworth (2005) suggests that the walking distance to transportation stations should be between 400m and 800m (a walking distance of 10-20 minutes); Dube, Theriault & Rosiers (2013) found that the station should be accessible by walking or short car journeys.

In their research, Yang, Yan, Xiong & Liu (2013) surveyed the factors that affect people's preference for "walking as a mode of transportation" when going to a rail system station and determined that the most important criterion is the "distance to the station" (Figure 1).

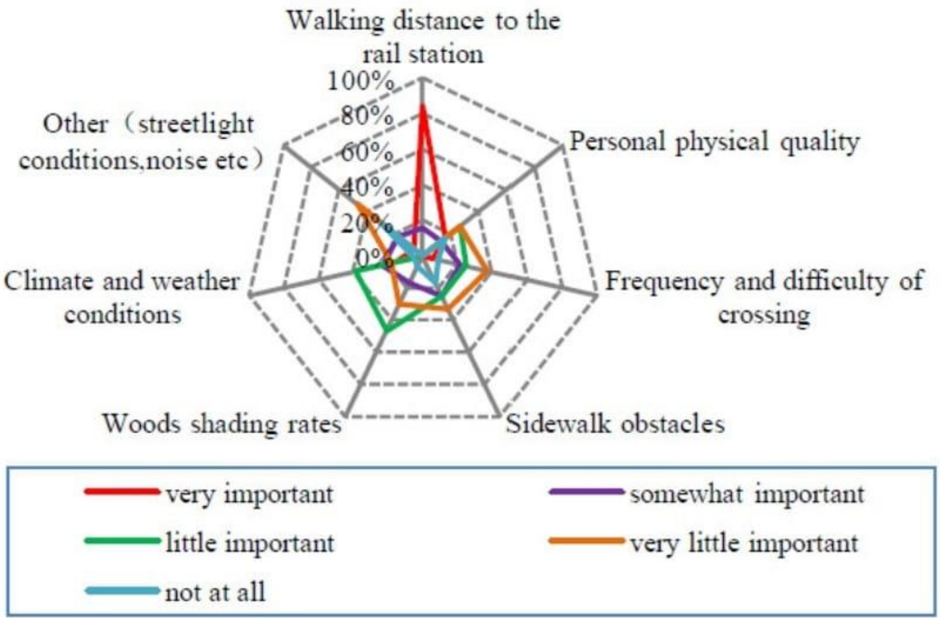

Figure 1. Factors influencing the preference for walking in accessing rail system stations (Yang, Yan, Xiong & Liu, 2013)

According to these studies, socio-economic factors that vary among individuals affect individual preferences in choosing transportation modes between work and home. Therefore, the relationship between rail systems and socio-economic and demographic characteristics is one of the current research topics.

2.1.3. Socio-economic and demographic structure

People's mobility levels vary depending on factors such as age, gender, and occupation. When considering all people, including those with and without disabilities, travel time and cost are decisive factors in meeting travel needs. When people choose a mode of transportation from the transportation systems available to them, they consider the highest benefit for themselves (Dong, Ben-Akiva, Bowman & Walker, 2006). From the perspective of travel mode choice, benefit is related to travel cost and travel time (Manski, 2005). In the relevant literature, two reasons are considered the main determinants: cost and time (Black, 1995; Davidov, 2003). In this respect, when a person chooses between different modes of transportation, they compare them in terms of cost and time (Institute of Transportation Engineers, 1992). Asensio (2002) highlighted that low-income people are more sensitive to travel costs, while high-income people are more sensitive to travel or waiting times. Similarly, Davidov (2003) noted that due to the speed of this mode, high-income people use private cars more than public transport. Therefore, it can be said that the value of time is more affordable for high-income people than low-income people. According to a study conducted in Toronto, Canada, young people walk longer distances than children, elderly people, and families, and women walk shorter distances than men (Alshalalfah & Shalaby, 2007). Bollinger & Ihlanfeldt (1997) found no significant relationship between rail transit systems and demographics and job opportunities, but they did observe an increase in public structures in areas with dense commercial functions. Cervero & Kockelman (1997), Shen (1998), and Geurs & Van Eck (2001) noted that data such as age, income, education, and physical condition affect people's accessibility levels via car or public transportation. They also observed that the ability of people to travel to work in their own residential areas significantly affects overall accessibility. Geurs &Van Wee (2004) argued that factors such as income, status, and education must be taken into account to define accessibility in terms of transportation, and that the socio-economic structure affects walking and car preferences. They also found that age is negatively proportional to many types of physical activity and that other socio-demographic characteristics vary depending on the purpose of the activity and also affect transportation expenses. Banister et al., (2011) found that as family income and education levels increase, the distance between home and work also increases.

2.2. The Impact of Rail Systems on Housing Prices

The literature generally acknowledges that housing values tend to increase in proximity to public transport stations, as they improve users' access to activity areas. Similarly, the connections between the socio-economic and demographic characteristics of the region and the rail system stations and rail lines are discussed, and it is emphasized that rail systems affect property prices. Due to the increase in technological and web resources related to real estate prices and the increase in public access to information, especially the relationship between housing values and the urban rail systems has become an important research topic.

Residential values are mostly evaluated based on the distance factor between houses and the station location (Abd Aziz et al., 2019). It is also noted that with the improvement of service quality, real estate values may increase in the areas on the outskirts of the city, as they become better connected to the rest of the city (Harjunan, 2018; Gallo, 2018). In the Buffalo real estate market, the average value of housing units located close to the train station has been found to increase compared to those located further away from the line (Hess & Almeida, 2016). In another study, proximity to commuter rail stations has a positive impact on land values compared to light and heavy rail (Debrezion et al., 2007). In low- and high-income neighbourhoods close to the railway station, it was found that low-income neighbourhoods were more affected (Bohman & Nilsson, 2016).

In contrast to this result, some researchers show that housing values increase in high-priced neighbourhoods, such as Salon & Shewmake's 2011 study states that a 10% change in the distance leads to a 1% change in house price. Many studies on this subject indicate that there is an increase in the value of housing around the rail system, that there is a negative relationship between the number of users and the distance to the station, and that ease of access is taken into account when buying or renting housing around the station (Dube et al., 2013; Pan, Pan, Zhang & Zhong, 2014; Ransom, 2018; Yen, Mulley, Shaerer & Burke, 2018; Zhang & Wang, 2013).

Medda & Modelewska (2011) found that housing prices within 1 km of a metro station in Warsaw were 6.7% higher than those further away. Hiironen et al., (2015) found an 11-15% increase in housing values in the 400-meter buffer zone with the construction of a new railway station in the city of Helsinki. Sharma & Newman (2018) found a 4.5% increase in land values within the 500-meter buffer zone with the arrival of the railway in Bangalore.

The literature review reveals that there are limited studies on the effects of rail systems, especially the metro transportation mode, on housing market. Therefore, examining the spatial relationship between metro stations and housing market will provide data to guide urban planning and planning decisions, as well as contribute to the existing literature on the effects of metro stations on housing market in high- and low-income neighbourhoods, as each area has unique conditions.

3. Case Study Area and Method

In Ankara, the metro and Ankaray systems were established starting in the 1990s. These systems continue to be developed due to the increasing population and traffic density and the spread of urbanization. The concentration of urban services in Ankara mainly in the city center has led to traffic problems to increase in this area. Bus-based public transportation systems have been inadequate in the face of increasing needs. The compact structure of the city has increased traffic congestion and air pollution problems. In planning studies conducted in Ankara after the 1970s, a controlled decentralization policy was adopted. With this policy, a development strategy was put forward along certain corridors without spreading in space. Within this framework, urban development was proposed along two main corridors, the West Corridor consisting of Sincan and Batıkent routes and the Southwest Corridor where Çayyolu developments took place. While the West Corridor was planned for the decentralization of industry, the Southwest Corridor was thought to include public institutions and university campus areas (Cihangir-Çamur, Erdoğanaras & Demirbilek-Çardak, 2022). While industrial developments in the West Corridor were supported by government incentives, developments in the Southwest Corridor were left to market forces (Kütük & Yalçıner, 2019; Eren, 2021). Two metro lines were proposed to establish the relationship of these corridors with the city center. The Batıkent Metro Station's planning allowed for high-density development with mixed land use for living and working areas. The balance between living and working areas could not be established at the Koru Metro Station, and this area was realized as a lower density and scattered settlement. In addition, while the station in the West Corridor was opened in 1997, the Koru station was opened in 2014. In this study, these two stations were selected as sample areas due to the differences in physical structuring as well as the different socio-economic groups that have chosen to settle in these areas.

Fieldwork was conducted in Kent-Koop Neighbourhood (Figure 3 and 4) where the Batıkent Station of Kızılay-Batıkent (M1) Metro Line, and Koru Neighbourhood (Figure 5 and 6) where Koru Station of Kızılay-Çayyolu (M2) Metro Line, two of the four metro routes in the city, are located. Kent-Koop Neighbourhood is an area where mixed-use (trade+residential) buildings are dense, and low-income groups are prevalent. It is a neighbourhood that has a high proportion of middle-aged (50-54 years) and elderly (55-65+ years) in the population structure and has a household size of 3, with families with three members being dense. Koru Neighbourhood is a region where mainly residential structures are located, and upper and middle-income groups live with low density. The proportion of middle-aged (45-54 years) and elderly (55-65+ years) is denser in the population distribution. The average household size is 2.7, and the number of families with three members is higher. In order to reveal the effects of metro stations on the housing market, Batıkent Station neighbourhood, which is inhabited by lower income groups, and Koru Station neighbourhood, which has a higher income user profile, provide a comparison opportunity in terms of monitoring these effects and provide the opportunity to examine the effects of metro stations on housing markets.

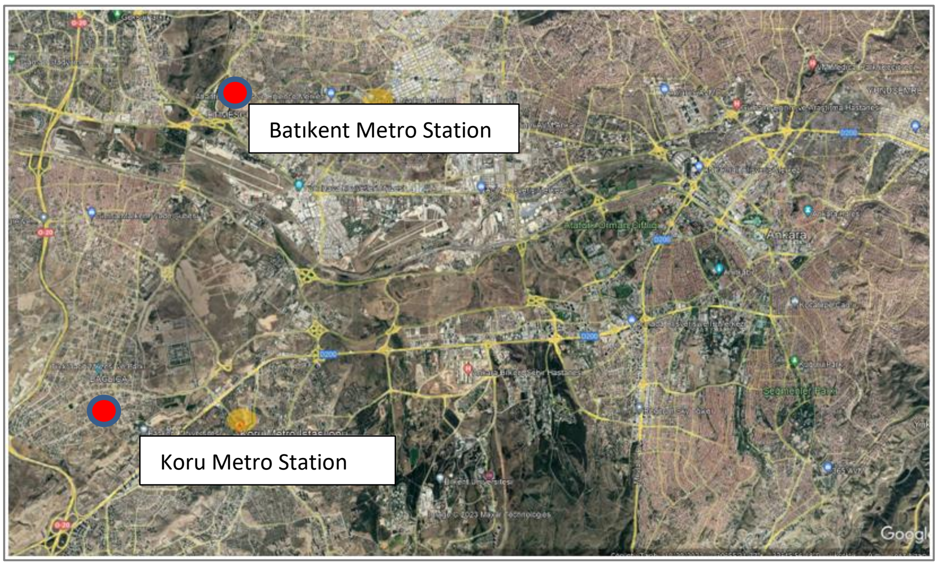

Figure 2. Location of Batıkent Metro Station in the western corridor and Koru Metro Station in the southwestern corridor of Ankara

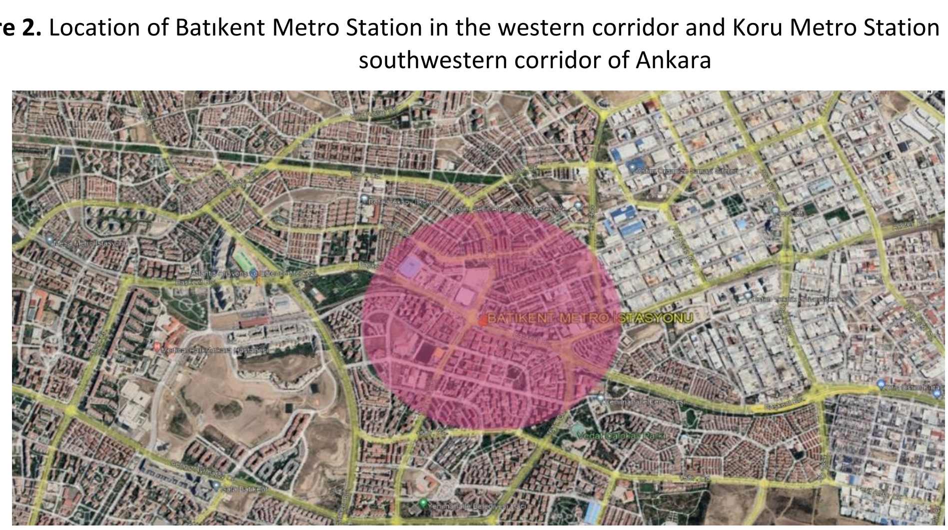

Figure 3. Batıkent Metro Station and surroundings

Figure 4. Comparison of construction around Batıkent Metro Station between 2002 and 2022

Figure 5. Koru Metro Station and surroundings

Figure 6. Comparison of construction around Koru Metro Station between 2002 and 2022

In this framework, the areas where the study will be carried out were selected within the 1500-meter radius, which is considered as a walkable distance to the metro stations. Web site (Sahibinden.com) data were used to reveal the house prices and the components affecting the prices were evaluated by using the Hedonic Price Method.

Hedonic Price Method (HPM)

The HPM establishes a link between the features of a house and its price. Here, the effect of each feature to be added or removed from the house on the price of the house is decomposed. The added features aim to differentiate the goods (Özkan & Yalpır, 2005). As a result, HFM is a method that evaluates the price of a particular good as the sum of the values of its attributes and estimates the value of each attribute using regression analysis. Today, the United Kingdom, Ireland, Finland, France, France and the United States prepare house price indices using the HFM method. Within the scope of the article, it will be examined whether there is an acceptable connection between accessibility and the prices of houses for sale and rent in the area within a radius of 1500 meters around Batıkent and Koru Stations. The model used in this regression is the Logarithmic Linear model.

According to the Logarithmic Linear Model, the dependent variable, i.e. the price, is the logarithm of the price, and the independent variables (whether it is a site complex/apartment, square meter, the floor it is located or owned, the age of the house, the number of rooms and living rooms, distance to the metro station, distance to the school, distance to the bus stop) are in linear form. The logarithmic linear model is interpreted as "a one-unit change in the independent variable $X1$ will lead to a change in the dependent variable P by $\beta1$ percent" (Özçalık, 2018).

$lnP = \alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \ldots \ldots \ldots \ldots + \beta nXn + \varepsilon i$

Below are the nine variables that will be used to test whether there is a significant relationship between the price of the house and the distance of the house to the metro station.

Table 1. Variables used in the Hedonic Method

	Index	Variables	Unit	Description
Building Variables	$\beta1$	Structure Type	Villa, Apartment	Use and Type of Building
	$\beta2$	Price (Dependent variable)	Turkish Lira	House price
	$\beta3$	Area	Square Meters	Total residential area
	$\beta4$	Floor Level	Integer	The Floor Level of the apartment
	$\beta5$	Building Age	Years	Total time since construction
	$\beta6$	Number of Rooms or Independent Sections	Integer	Number of bedrooms, living rooms
Location Variables	$\beta7$	Distance to Metro Station	Meter	Walking distance
	$\beta8$	Distance to School	Meter	Walking distance to educational amenities
	$\beta9$	Distance to Bus Stop	Meter	Walking distance to bus stop

By obtaining data from Sahibinden.com real estate sales websites, a set consisting of a total of 55 data including houses for sale and rent within a radius of 1500 meters centered on the station was prepared. Evaluation was performed based on 24 properties for sale in Batıkent and 18 properties for sale in Korukent. All data were collected on the same day (23.10.2022) at the stations to ensure the same economic conditions were met.

4. Findings and Discussion

Section 4 presents the results and evaluations of the hedonic price method for properties for sale around Batıkent and Koru stations, which are categorized into four subheadings.

4.1. Effect of Batıkent Metro Station on Housing Sale Prices

This section focuses on the evaluation of sale prices for properties in Batıkent using the hedonic price method. In this method, the dependent variable is the property price, while the independent variables are site/apartment status, square meters, floor level, and age of the property, number of rooms, distance to the metro station, distance to educational amenities, and distance to bus stops. As the values of positive factors increase, the sale price of the property increases, and as the values of negative factors increase, the sale price decreases.

Distance to the Batıkent metro station is the sixth independent variable that affects the property sale price. As the distance between the property and the metro station increases, the sale price of the property decreases due to the negative relationship between distance and price.

Table 2. Correlation relationships of Batıkent Metro Station for housing sale prices

	Distance to Metro Station (m)	Site /Apartment	Price (TL)	Square Meter (m^2)	Number of Rooms	Floor Level	Building Age (year)	Distance to Bus Stop (m)	Distance to School (m)
Distance to Metro Station (m)	1	.142	-.162	-.161	-.330	.020	.133	.532**	-.160
Site/Apartment	.142	1	.296	-.108	-.046	.226	.274	.156	.041
Price (TL)	**-.162**	**.296**	**1**	**.609****	**.421***	**.007**	**-.345**	**.173**	**-.103**
Square meter(m^2)	-.161	-.108	.609**	1	.689**	-.307	-.582**	-.111	-.274
Number of Rooms	-.330	-.046	.421*	.689**	1	-.067	-.188	-.260	-.080
Floor Level	.020	.226	.007	-.307	-.067	1	.363	-.233	.251
Building Age (year)	.133	.274	-.345	-.582**	-.188	.363	1	.134	-.194
Distance to Bus Stop (m)	.532**	.156	.173	-.111	-.260	-.233	.134	1	-.239
Distance to School (m)	-.160	.041	-.103	-.274	-.080	.251	-.194	-.239	1

According to correlation matrix (Table 2) there is a very strong positive relation between the variables price and square meter (0.609), a strong positive relation between price and the number of rooms/sections (0.421), positive relation between price and whether it is located in a site or an apartment building (0.296), price and the distance to the bus stop (0.173) and a negative relation between the variables price and the age of the building (0.345), price and the distance to the metro station (0.162), price and the distance to the school (0.103). According to the results of the Hedonic Regression Model, the variables of distance to the school, floor level, and square meter size, location in a site or apartment building, distance to the metro stop, distance to the bus stop, age, and number of rooms explain 53.5% of the variation in the housing price. For the One-Way Analysis of Variance (ANOVA) to determine whether multiple independent variables are significant or not in the created model, the significant value of the F-test is 0.005, which is less than 0.05. Therefore, a statistically significant relationship between the variables in the regression model has been determined.

The significant value (B) of the T-test is greater than 0.05 for variables such as location in a site/apartment building, housing size, number of rooms, floor level, and housing age, indicating that there is no statistically significant relationship between these variables and the housing price. However, the significant value (B) of the T-test is less than 0.05 for the variables of distance to the metro station and distance to the bus stop, indicating that there is a statistically significant relationship between these variables and the housing price.

The table shows the correlation coefficients between the price and different variables of residential properties located near the Batıkent Metro Station. The variables include square meter size, number of rooms, building age, distance to the bus stop, distance to the metro station, distance to the school, floor level, and whether the property is located in a site or apartment building.

The correlation coefficients range from -1 to 1, where a value of -1 indicates a perfect negative correlation, 0 indicates no correlation, and 1 indicates a perfect positive correlation. The table shows that the variables with the strongest positive correlation to price are the square meter size (0.609), number of rooms (0.421), and whether the property is located in a site or apartment building (0.296). The variables with the strongest negative correlation to price are age (-0.345) and distance to the metro station (-0.162).

Table 3. Independent variable relationships of Batıkent Metro Station for housing sale prices

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	13.205	.394		33.482	.000		
	Distance to Metro Station (m)	.000	.000	-.379	-2.152	.047	**.651**	**1.537**
	Site/ Apartment	.140	.072	.297	1.945	.070	**.867**	**1.153**
	Square Meter (m2)	.008	.004	.556	2.099	.052	**.288**	**3.467**
	Number of Rooms	.018	.099	.042	.184	.856	**.389**	**2.571**
	Floor	.021	.010	.338	2.015	.061	**.720**	**1.390**
	Building Age (years)	-.050	.043	-.232	-1.153	.266	**.501**	**1.996**
	Distance to Bus Stop (m)	.002	.001	.520	2.854	.011	**.609**	**1.643**

4.2. The Effect of Koru Metro Station on Housing Sale Prices

The distance of the house for sale to the metro station is an independent variable that affects the housing price in fourth place. As the distance increases, there is an increase in the sale price of the house, so the relationship between distance and price is proportional.

Table 4. Correlation relationship for Koru Station for housing sale prices

Pearson Correlation Coefficient	DISTANCE to METRO STATION(m)	SITE/ APARTMENT	PRICE (TL)	SQUARE METER (m²)	NUMBER of ROOMS	FLOOR	BUILDING AGE (yıl)	DISTANCE to BUS STOP (m)	DISTANCE to SCHOOL(m)
Distance to Metro Station (m)	1	.274	.351	.298	.146	.263	-.368	.284	-.077
Site/ Apartment	.274	1	-.037	.023	.258	.066	.000	-.218	-.281
Price (Tl)	.351	-.037	1	.937**	.695**	-.027	-.563*	.242	-.143
Square Meter	.298	.023	.937**	1	.684**	-.077	-.536*	.381	-.140
Number of Rooms	.146	.258	.695**	.684**	1	-.280	-.409	-.072	-.165
Floor	.263	.066	-.027	-.077	-.280	1	-.440	.168	.046
Building Age (Years)	-.368	.000	-.563*	-.536*	-.409	-.440	1	-.319	.268
Distance to Bus Stop (M)	.284	-.218	.242	.381	-.072	.168	-.319	1	-.174
Distance to School (m)	-.077	-.281	-.143	-.140	-.165	.046	.268	-.174	1

According to correlation matrix (Table 4) there is a very strong positive relation between the variables price and square meter (0.937), price and the number of rooms/sections (0.695), positive relation between price and distance to metro stop (0.351) and distance to bus stop (0.242) and a negative relation between price and building age (0.563), whether it is located in a site or an apartment building (0.037) and the floor (0.027).

According to the summary of the Hedonic Regression Model, variables such as distance from the school, the floor it is located on, square meter size, whether it is located in a site/apartment, distance to the metro station, distance to the bus stop, age, and number of rooms explain 93.2% of the price variable of the houses for sale in Korukent. For one-way analysis of variance (ANOVA) to determine whether a model with multiple independent variables is significant or not, the null (H0) and alternative (H1) hypotheses are tested. Since the F-test's significant value is less than 0.05, it has been determined that the regression model is significant and there is a statistically significant relationship between the variables. The significant value (B) of the t-test is greater than 0.05, indicating that there is no statistically significant relationship between the distance of the house to the metro, whether it is located in a site/apartment, the age of the house, the distance to the bus stop or school, and the price of the house. However, since the significant value (B) of the t-test is less than 0.05, there is a statistically significant relationship between the square meter, the number of rooms, and the floor number of the house and the price of the house. When the square meter value of the house increases by one unit, the price of the house increases by 0.004 units, when the number of rooms increases by one unit, the price of the house increases by 0.344 units, and when the floor number of the house increases by one unit, there is a change of 0.028 units in the price. The Table 5 shows the correlation coefficients between the price and different variables of residential properties located near the Koru Metro Station. The variables include square meter size, number of rooms, building age, distance to the bus stop, distance to the metro station, distance to the school, floor level, and whether the property is located in a site or apartment building. The correlation coefficients of the model range from -1 to 1, where a value of -1 indicates a perfect negative correlation, 0 indicates no correlation, and 1 indicates a perfect positive correlation. The table shows that the variables with the strongest positive correlation to price are the square meter size (0.677), number of rooms (0.414), and the floor (0,291). The variable distance school has a negative correlation (-0.120).

Table 5. Independent variable relationships of Koru Metro Station for housing sale prices

Coefficients						
	Unstandardized Coefficients		**Standardized Coefficients**	**T**	**Sig.**	
	B	**Std. Error**	**Beta**			**VIF**
Constant	**13.629**	.380		35.882	**.000**	
Distance to Metro Station(M)	**-1.345E-5**	.000	-.007	-.090	**.930**	**1.439**
Site/ Apartment	**-.168**	.164	-.084	-1.027	**.331**	**1.646**
Square Meter (M2)	**.004**	.001	.677	6.015	**.000**	**3.155**
Number of Rooms	**.344**	.099	.414	3.484	**.007**	**3.508**
Floor	**.028**	.009	.291	3.105	**.013**	**2.179**
Building Age (Years)	**.029**	.055	.057	.526	**.612**	**2.963**
Distance to Bus Stop (M)	**.000**	.000	.027	.319	**.757**	**1.777**
Distance to School(M)	**-.001**	.000	-.120	-1.613	**.141**	**1.374**

4.3 Evaluation of the Housing Sale Prices around the Batıkent and Koru Metro Stations Compared to the Cases

The residential areas around the Batıkent Metro Station hosts both developing and established housing areas subject to planning implementations related to middle and low-income households. On the other hand, the residential areas around the Koru Metro Station is characterized by low-rise housing units as well as high-rise apartments for upper-middle and high-income households. The hedonic regression analysis of the housing sale prices presents the differences and similarities of the both locations, Batıkent and Koru, in terms of variables affecting the housing sale prices. The most important variables affecting the housing sale prices in Batıkent case are the size of the house, the distance to bus stop, the number of the rooms, the age of the building, whether it is located in a site or an apartment building and distance to metro station. On the other hand it is seen for the Koru case that only the variables related to housing characteristics are affecting the housing sale prices are; the size of the house, the number of the rooms, the floor number and distance to school. Some of the findings of the two cases investigated in this article are parallel to the cases found in the literature. In a middle-low-income residential area (Batıkent), the distance to the bus stop and metro station affects the housing sale prices, whereas in a high-income residential area (Koru), there is no such effect. Studies in the literature indicate that rail system investments affect housing prices, and the accessibility to metro stations also contributes positively to the increase in housing prices, just as the proximity to the city center does (Bajic, 1983; Cervero, 2003; Pan & Zhang, 2008).

Research conducted in Istanbul shows that being close to a metro line has a positive effect on the surrounding housing prices (Şahin, 2019). Similarly, another study examining the effect of Istanbul metro stations on housing prices found that the closer the distance to the station, the higher the housing prices (Cengiz, 2020).

In a thesis study that examined the effects of metro stations and metro lines on the housing sub-market, it was found that there is no significant difference in the prices of the housing around the station areas and metro lines within 250 meters. However, it was determined that the values of the for-sale and rental housing around the station areas were higher than those in areas with similar proximity to the metro line (Alas, 2021). Another study found that proximity to transportation points such as public transportation stations positively affect housing prices, in addition to variables such as size, age, floor number, garden view, sea view, etc. In this study, it was found that housing prices are high around public transportation stations (Choy et al., 2007). Another study conducted in Istanbul states that the housing prices around the station areas increase in areas where housing prices are already high and similar results were obtained for rental values (Alkay, 2011). However, there are also studies that demonstrate the opposite of this general trend, such as the effect of metro stations decreasing housing prices in areas where high-income groups live (Nelson, 1999).

5. Conclusion and Suggestions

In the relevant literature, it is emphasized that metro stations within walking distance cause an increase in housing prices and accessibility is an important criterion in people's transportation mode choices. The results of the Hedonic Price Model applied in this study reveal that the impact of Batıkent and Koru Metro Stations, with different socio-economic characteristics, on housing sales prices varies depending on accessibility within the 1500-meter radius defined as a walkable distance. Batıkent with a mixed-use land pattern and is inhabited by the middle-lower income group, as the distance of the housing to the station decreases, the sale prices of the houses increase. In this case, it can be said that users' lower income levels make them more sensitive to travel costs and less expected to own a car. On the other hand, in Koru, where high-income group lives, the increase in housing sales prices within the 1500-meter radius of the Koru Metro Station as one moves away from the station indicates that housing-related features such as the size, number of rooms, and number of floors are more important in determining housing prices. This situation is also supported by the fact that high-income individuals use private cars more when compared to public transportation and their time is more valuable.

In other words, the relationship between accessibility and housing sales values is lower near Koru Metro Station, where users with a high socio-economic level, while it is higher near Batıkent Metro Station, where users with a low socio-economic level. This situation shows that metro transportation systems are effective in reducing polarization between different socio-economic groups in the city. In the future, conducting similar studies in high and lower socio-economic housing areas using the same method and applying this model at regular intervals will contribute to monitoring socio-economic problems such as polarization in the city and overcoming these problems with transportation policies. Additionally, this study can be expanded to include rental housing prices around metro stations and compare sales and rental values. Similarly, sales and rental values in areas located along the metro line and those far away from it can be compared, taking into account socio-economic differences, to obtain more general results.

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Between Virtual Space and Real Space: Transition Spaces

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Abstract

The space that is virtual in the planning processes is the one that is not experienced physically. With unlimited changes in virtual space 2/3 dimensional sketches/drawings, the desired location is reached in a short time. The structures which are implemented, after the planning process had finished, space is now a real space that can be experienced physically, its boundaries are defined and transformed. However, unlike virtual space, it may require serious cost and time for changes caused by small errors, revisions, or needs that will occur. Starting from this point, decoupling between the transitional spaces in the virtual and real space are described in the study. The main emphasis of the study is to explain how to transition spaces are separated from virtual and real spaces and what are their advantages and disadvantages during use with selected examples. The empirical method, which is one of the quantitative research types, was used. First of all, the meaning pattern of the concept of space was examined within the framework of the concept definitions of virtuality, reality, and transitivity. Virtual, real, and transitional spaces are explained by literature surveys. The transition locations were analyzed with selected samples. As a result, when the characteristics of the spaces are compared, it is seen that the transition spaces, with their flexibility, easy changeability, limitlessness, and timelessness, can analyze the spaces needed before building new buildings. It has been seen that the transition from the physical being space to another space and the space in which the transition is made can be experienced mentally.

Keywords: *Virtual Space, real space, transition space.*

Sanal Mekân ve Gerçek Mekân Ara Kesitinde: Geçiş Mekanlar

Öz

Planlama süreçlerinde sanal olan mekân, fizikken deneyimlenmeyen zihnen 2/3 boyutlu eskiz/çizimlerle sınırsız değişiklikle kısa sürede istenen mekân çözümlerine ulaşılabilir. Planlama sürecinden sonra uygulanan yapılarda mekân artık fizikken deneyimlenebilen sınırları belli ve dönüşebilen gerçek mekanlardır. Fakat yapılacak küçük hatalardan, revizelerden veya ihtiyaçlardan kaynaklı değişimler için sanal mekândan farklı olarak ciddi maliyet ve zaman gerektirebilir. Bu noktadan hareketle çalışmada sanal ve gerçek mekân ara kesitindeki geçiş mekanlar açıklanmıştır. Çalışmanın temel vurgusu geçiş mekanlarının, sanal ve gerçek mekândan nasıl ayrıldığını, kullanım süresince avantajlarının ve dezavantajlarının neler olduğunun seçilen örneklerle açıklanmasıdır. İlk olarak mekân kavramının anlam örüntüsü; sanallık, gerçeklik ve geçişlilik kavram tanımlamaları çerçevesinde incelenmiş; sanal, gerçek ve geçiş mekanlar literatür taramalarıyla açıklanmıştır. Geçiş mekanlar seçilen örneklerle analiz edilmiştir. Sonuç olarak mekanların özellikleri karşılaştırıldığında geçiş mekanlarının; esnekliği, kolay değişilebilirliği, sınırsızlığı ve zamansızlığıyla yeni binalar inşa etmeden ihtiyaç duyulan mekanların çözümlenebileceği fiziki olarak bulunulan mekândan başka mekâna geçişin ve geçiş yapılan mekânın zihnen deneyimlenebileceği görülmüştür.

Anahtar kelimeler: *Sanal mekân, gerçek mekân, geçiş mekân.*

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1. Introduction

The concept of space, which separates people from the environment in which they live with certain boundaries, has brought innovations to globalized life. Technological developments and industrialization that emerged with the industrial revolution started a new era in the World (Yalçınkaya & Karadeniz, 2022). Developing and changing technology has created a new space where there are quite a lot of interactions by giving digital qualities to the spaces. This human-space relationship, Harvey (2003), who argues that space is only a very effective dimension in a person's life without an ontological equivalent, states that social processes and spatial forms are shapes (Güngör, 2019). On the other hand, Soja (1996) talks about Lefebvre's third conceptualization of space based on the “spaces of representation”. all the factors are together in this third-mentioned place. The subject of hybridity, in which coexistence is fictionalized in various forms without obvious distinctions such as subjective-objective, ordinary-unusual, and concrete-abstract, is emphasized. The transition spaces considered within the framework of the study are the spaces decoupled between abstract and concrete. In other words, they are existing or non-existent spaces that can arise in accordance with the need. When time, economy, and preintervention are considered, these structures have a minimum margin of error. They provide easy revision opportunities on projects. They are at the cross-section of experiencing the virtual without transforming without acquiring. The space covered in the study was compared over the selected structures. As a result, compared to other spaces, the differences and similarities of the characteristics of transition spaces are explained. It has been stated that transition spaces will turn into a great advantage for interior designers if it used correctly. Therefore, to understand transition spaces, it is necessary to explain the concepts of virtuality, virtual space, reality, real space, and transitivity.

1.1. Conceptual Definitions

To understand architecture and architectural spaces, space must first be perceived. It is important for people to have a perception of space and to know where it is (Ak, 2006). The ability of a person to perceive space does not consist only of its characteristics. It is also related to the characteristics of the place. Therefore, to understand space, it is necessary to define the physical and fictional characteristics of space. In this section, the concepts and definitions of space related to real space, virtual space, and transition spaces discussed within the scope of the research will be explained. Their characteristics and by which subheadings they are addressed will be expressed. The connections between them will be explained.

1.1.1. The concept of reality and real space

The concept of space, which has been explained in various ways in different disciplines throughout history, corresponds to the place, house, dormitory, and space found in the Dictionary of the Turkish Language Institution (2022). In the same dictionary, reality is defined as basic, principal, principal, and non-artificial. In architecture, reality can correspond to a concrete structure that exists physically, not an abstract one. Lowry (1967) explains physical space as a space that is measured and determined through geometric concepts. Real space, on the other hand, is defined as the space that can be perceived physically, whose boundaries can be determined, that can be physically found within the specified limits, and where it continues and terminates its life (Göktepe, 2013). In real space, place and time are not neglected. It is the transformation of architectural design into a real, physically experienced, concrete structure (Figure 1).

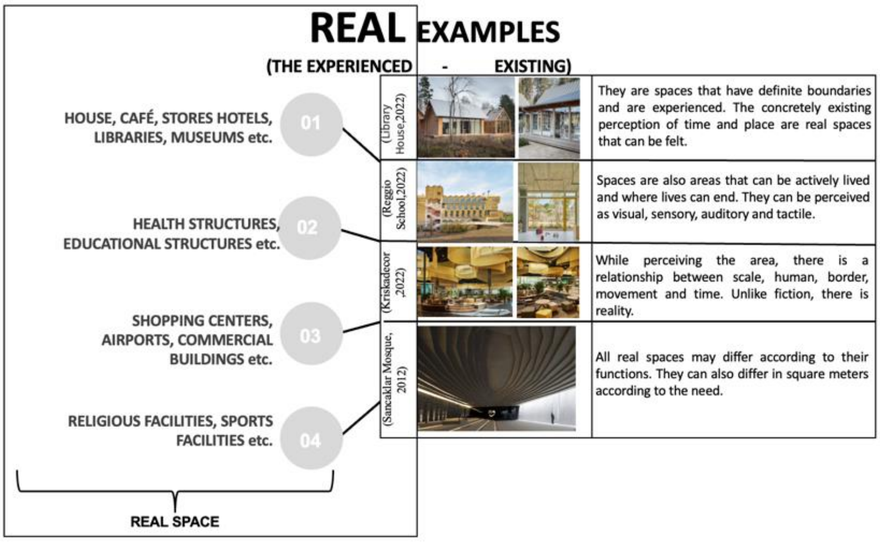


Figure 1. Realspace examples

Realspace; existing physical space is a space that can be perceived visually, dimensionally, auditorily, olfactorily, and tactilely by the user with five sensory organs. Visual perception gives faster and more effective results than our other sensory organs. Because the sense of vision allows more data flow compared to other senses (Yüntem, 2022). While dimensional perception is based on the human scale, auditory perception perceives positive or negative sounds, such as music, noise, or a human voice, coming to the ear. In olfactory perception, for example, it is the recollection of a place experienced through a previously experienced smell in another place when the same smell is encountered. In tactile perception, which is a complement to eye vision, direct contact and interaction with space is the issue. All perceptual sensations can be experienced in physical spaces.

1.1.2. Virtuality and virtual space concept

Before the modern period, the concepts of space and place were used with the same meanings (Güngör, 2019). According to Giddens (1999), with the capitalist economic outputs that dominate the modern period and the world as a whole, space has gone beyond being just a concrete concept and separated from face-to-face interaction. However, space, which is also separated from its physical properties, has become a concept that can be arranged and partitioned in the desired way at any time. The fact that the communication established together with the perception of the new digital culture has reached global dimensions has revealed virtual spaces.

The virtual concept (Kayapa, 2003), which is the opposite of the real concept and not the real concept, is one of the layers of reality (Güngör, 2019). While this concept is also the equivalent of reality, it is also equivalent to the intangible (Franck, 2000). Virtual space, on the other hand, is one with a floor independent of real space, where there are variations, there is no flexibility or distinctness, and there is no definition. There are no physical rules in this cyberspace, which has no boundaries and is free; it was created by thinking like a projection of real space, and there is a new order of reality (Güngör, 2019). Therefore, in this new reality, a space is formed whose boundaries are not defined and which is built without the need for physical shaping and where there are infinite parameters for change.

Time is frozen in virtual spaces. People are not in physical contact. There are forms in which there are no social encounters (Robins, 1999). According to Demirkaya (1999), virtual space: is an environment designed in an electronic environment that connects the level of perception of a person and the virtual level of digital information. However, some factors enable the perception of space in virtual space. Therefore, places that are not physically experienced, but allow a person to perceive space in 2 dimensions or 3 dimensions, can also be shown as examples of virtual spaces.

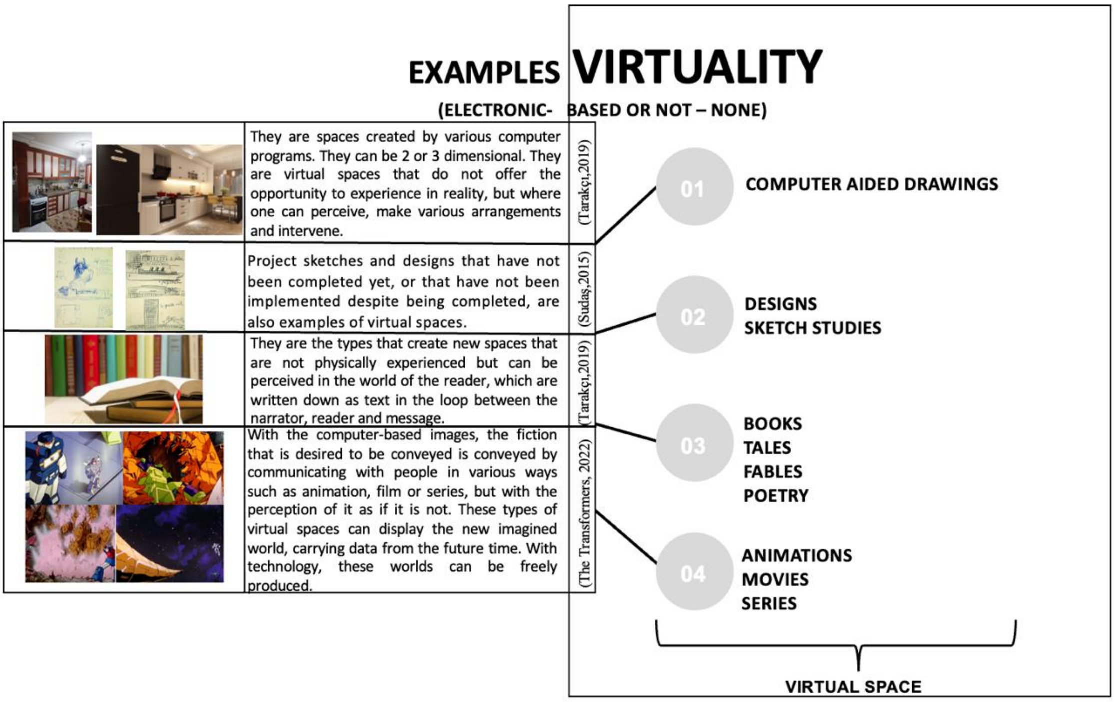


Figure 2. Virtual space examples

The framework of the virtual space considered in Figure 2 within the scope of the study is not just a world based on an electronic basis. In addition, it has been discussed within the framework of working in a space that can perceive a fictional space. For example, sketches that are at the design stage or completed by hand drawing, all 2-dimensional and 3-dimensional drawings created in computer-aided programs, books, fairy tales, fables, poems, animations, movies, or series, have been considered within the framework of virtual space. These spaces can be touched, deleted, changed, edited, and reproduced. In Figure 3, a comparison of real space and virtual space was given, and it was requested that you explain how it was handled within the scope of the study. The concrete, non-electronic environment of real space is space that can be experienced physically, have boundaries, does not change, and the perception of time and place can be grasped. Virtual spaces, on the other hand, are abstract spaces that can be produced with electronic media or can be fictionalized in 2 dimensions, have no boundaries, are dynamic, can be changed, and have no perception of time and place.

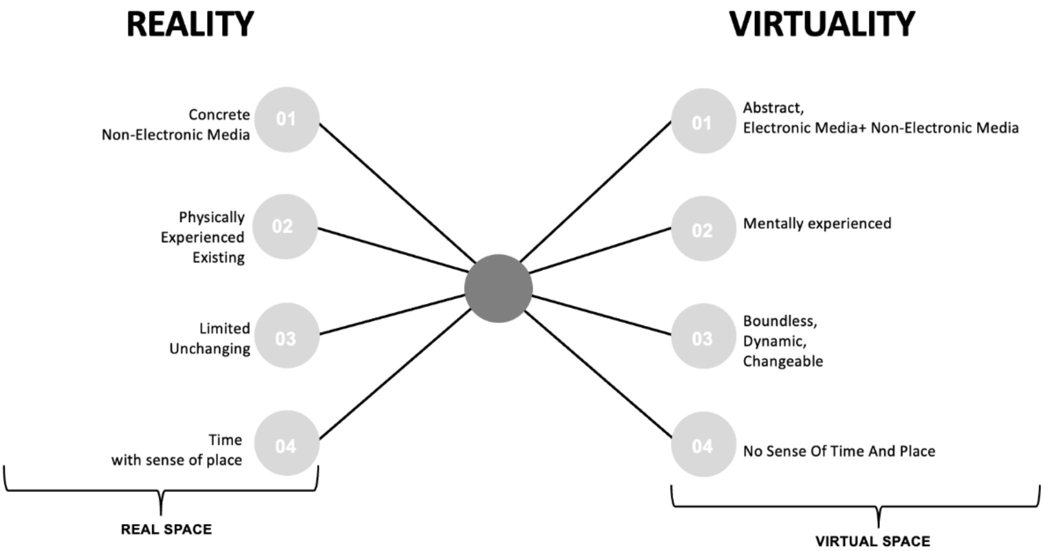


Figure 3. Realspace and virtual space comparison

Starting from this point, the concept of transitional space, which exists but can disappear, change and move, the perception of space and time varies depending on the user, an instantaneous transition from a physically located space to another space, should be explained in the decagonal of virtual space and real space.

1.1.3. Transitivity and the concept of transition space

The word transition is defined in the Dictionary of the Turkish Language Institution (2022); the verb transition is defined as a change in any situation, while transitivity corresponds to a transition state. It can be defined as changing between two states or connecting to the other. Transition space, on the other hand, Ak (2006) says that 'Reflection in the physical environment are cyber-experiences embedded in space and are invisible' In fact, it refers to a new type of space that changes and decays between real + virtual space. Within the scope of the study, transition space is considered as the existing-decaying spaces between the existing, concreteness mentioned in the real space and the abstraction that does not exist in the virtual space (Figure 4). It is the state of existence in another space with a mobile-enabled structure that allows people to physically move from the space they are into another space within the same boundaries, sometimes with or without computer-based movement structurally.

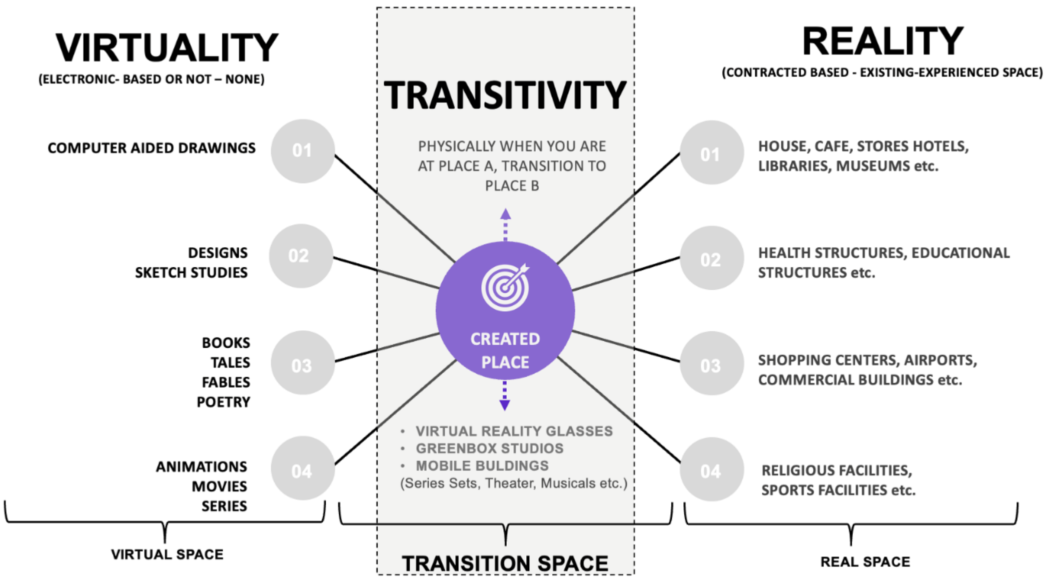


Figure 4. Between virtual space and real space: Transition spaces

2. Material and Method

Information related to the subject within the scope of the study data was collected through literature research. Numerous examples of real spaces, virtual spaces, and transition spaces. By compiling the information obtained through conceptual research, real space, virtual space, and transition spaces are mentioned. In this context, a sample group was formed. While making the selection, examples where the differences between the spaces used in the interior architecture can be explained and different visuals and explanations can be accessed were discussed. Another point (that) is taken into account when selecting samples is that they are created with tools that are often used today. Examples that can express the transition space well have been considered. The empirical method, which is one of the quantitative research types, was used. As a result of the examination, feature comparisons of the spaces in the real space, transition space, and virtual space examples are presented in the tables created.

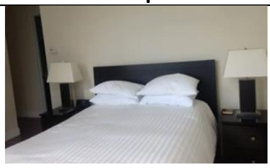
3. Findings and Discussion

As an example of a transitional space, virtual reality glasses are an alternative presentation method used in design processes in different disciplines such as architecture, interior architecture, and city planning. It consists of a case carrying the electronic part, glasses reflecting the screen, and a glove or controller that provides on-screen movement.

Table 1. Example of a transition space: Using virtual glasses (VR)

VIRTUAL REALITY GLASSES (VR)	
	Production Year: 1993
	Inventor: Ivan Sutherland
	Usage Area In Example: Interior Architecture
	Source: (Johanhanegraaf, 2019)

It offers the possibility of a semi-interactive space, such as experiencing it physically and mentally, walking around in it, and making changes. These glasses, which are distinguished by technology from long-time drawing techniques such as sketching, which are treated as a virtual space, save time. Another difference is that hearing and touch perceptions can be experienced with these glasses. The materials used in the real space in the transition spaces and the cost caused by technical errors in the application phase turn into an advantage in this space. With these glasses, which are more easily detected, errors can be seen in advance and prevented. Serious financial savings can be achieved in this way. Instant revisions can be made to the components and elements of the space. This can save time. The disadvantage is that it can lead to disorientation and eye fatigue during long-term use.

Real Space	**Transition Space**	**Virtual Space**
		
(Decorilla, 2016)	(Johanhanegraaf, 2019)	(Decorilla, 2016)

In Table 1, the use of virtual reality glasses, the difference between real/virtual space, advantages, disadvantages, and the way of handling the technology within the scope of the study are explained with visuals.

Greenbox Studios is a shooting trick achieved by overlapping two different images at the same time. In these studios, a special technique and green and blue colors are usually used.

Table 2. Example of a transition space: Greenbox studios

GREENBOX STUDIOS	
	Production Year:1940
	Inventor: Larry Butler
	Usage Area In Example: Studıo
	Source: (SelisMedya,2022)

Although they are physically located in the same place, Greenbox Studios, which allows them to be in a different place with screen tricks, gives a real feeling in terms of sound and image. But touching and feeling are out of the question. The difference that distinguishes it from virtual space is that you can walk around in it and act as if you live in that space while also transporting a person to another place at the same time. There is a question of variability in time and speed in the change of location. In this example of a transitional space without borders, diversity, economy, and easy convertibility are among the great advantages. It requires good equipment and conscious use.

Real Space	**Transition Space**	**Virtual Space**
		
(Sanat Yapım, 2022)	(SelisMedya,2022)	(SelisMedya,2022)

In Table 2, the use of Greenbox Studio, its difference from real or virtual space, advantages, disadvantages, and the way it is handled within the scope of the study are explained with visuals.

Mobile stages are platforms that are ready-made stage systems that come about for entertainment, political, or commercial reasons. Scenes that are portable can be moved through a vehicle, as well as they can be resolved and transported as part of the vehicle's equipment. With the disassembly system, they can re-install and remove the structure with a short installation time. In this sense, these spaces, which save time by preventing a continuous new construction process, are solution-oriented, economical, and practical.

Table 3. Example of a transitional space: Mobile scenes

MOBILE SCENES	
	Production Year: 2016 Invert on: Lee Broom Usage Area In Example: Enstalasyon Studio Source: (Hobson,2016)

Mobile stages, studios, exhibitions, or theaters that are motion-enabled can be moved from one city to another city, as well as offer the possibility of moving from one place to another. The fact that a structure that exists (a vehicle or a micro-volume area) can disappear by moving or transforming and re-decking into another space, that is, it can be installed and dismantled, recreated, or replaced between existence and nonexistence during the process of virtualization, The decoupling of a scene shot on the TV series sets followed by another location shooting in the same area is an example of this variable or nonexistent transition space. This situation profits from time and cost, as well as destroying the perception of borders. Being mobile, which provides variety and functionality, can create changes in the perception of time and place.

Real Space	Transition Space	Virtual Space
		

(Hobson, 2016)

In Table 3, the use of the mobile stage, its difference from real/virtual space, advantages, disadvantages, and the way of handling it within the scope of the study are explained with visuals.

4. Conclusion and Suggestions

Within the framework of the study, real space, virtual space, and transition spaces were conceptually explained and examined through examples. As a result of the study, the characteristics of the places are given in Table 4.

Table 4. Features of spaces

FEATURES OF SPACES		
Real Space	**Transition Space**	**Virtual Space**
Concrete	Concrete + Abstract	Abstract
Physically Experienced	Physically + Physically Experienced	Mentally Experienced
Existing	Between İmaginary space and existing	Imaginart Space
Perception of time	Time variability, leap	Time perception incomprehensible
Limited	Limited + Limitless	Limitless
Definite, permanent, unchanging	Changeable, portable, mobile, temporary	Indefinite, changeable, fluid
3D	3D+4D	2D+3D+4D
Material	Material + Without material	Without material
Not Electronically based	Electronic based+not based	Electronic based+not based
Interactive	Interactive + Non-Interactive	Non- Interactive

Real spaces are concrete-based, physically experiential, existing, time and place perceptible, have boundaries, take a lot of time to change, are 3-dimensional, material, interactive, and non-electronic-based spaces; Virtual spaces are abstract, mentally experienced, disappearing, time and place perception cannot be grasped, unlimited, fluid, changeable, uncertain, have different dimensions, and are electronically based or non-electronically based spaces; Transition spaces, on the other hand, can be experienced both abstractly and concretely, physically and mentally; there can be inter-existence, time variability, and deceleration; boundaries can be defined or unlimited; interactive or not; electronically based or not; changeable, portable, mobile, and temporary spaces. Table 5 shows the comparisons between the locations.

Table 5. Comparison of spaces

COMPARISON OF SPACES			
	Real Space	**Transition Space**	**Virtual Space**
Tactile Perception	✓	✓	-
Visual Perception	✓	✓	✓
Auditory Perception	✓	✓	-
Odor Perception	✓	-	-
Error Tolerance	-	✓	✓
Change in Desing (Revised)	-	✓	✓
Saving on time	-	✓	✓

While there is a completely direct relationship between the types of perception in physically experienced, existing real spaces, it seems that margins of error tolerance, design revisions, and time savings make it more difficult to make changes due to user requests or errors that occur than in other spaces. Transitional spaces are spaces that have a margin of error tolerance while addressing tactile, visual, auditory, and tactile perception sensations, and offer the opportunity to save time by revising the design. Thanks to the correct design, planning, and developing technology, it becomes easier to experience spaces, and being able to intervene and change them instantly reduces the error rate in practice and has a positive impact. With these interventions, time savings are provided, as well as an economically more advantageous situation will be achieved.

As a result, the planning process should be well-designed and considered before the space is created. Although the space that remains virtual during the planning process is not physically experienced, the desired interior solutions can be reached mentally with 2-dimensional sketches, drawings, or unlimited changes in the 3-dimensional environment in a short time. With this study conducted on transition spaces located in the virtuality and reality interface, it has been seen that the flexibility, ease of changeability, immensity, diversity, and timelessness of space facilitate the transition from a physically existing space to another space, where the necessary functions or spaces can be deciphered without building new buildings, and the space that is being transitioned can be experienced mentally. In addition, it is thought that marketing services in the architecture sector can be facilitated by the use of transition spaces, interventions in the spaces that people want can be faster and more practical, and errors can be minimized.

Acknowledgments and Information Note

The article complies with national and international research and publication ethics. The study also did not require the approval of the ethics committee.

Author Contribution and Conflict of Interest Declaration Information

Each author contributed to the article at the same rate. There is no conflict of interest.

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Investigation of Traditional Features' Effect on Modernist Designs in The Framework of Environmental Sustainability

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Abstract

Geography, climate, culture, and technology directly influenced the architectural production of societies. These effects first shaped the production of traditional architecture. After the developments in the industrial revolution, architectural formatting has been open to constant and rapid changes. These changes, dating back to the twentieth century and called modernism, aimed to move away from tradition and design with its forms. Design theorists divide between the view that modernism is directly influenced by tradition and that modernity is an entirely new formation. This research aims to identify the effects of these parameters with the parameters that shape tradition and modernism to shed light on the debates about the effect of modernization. In literature research, the design parameters that can be reached from the past to the present generally do not change in housing structures, and these parameters are included in the concept of environmental sustainability today. Therefore, traditional and modernist design product housing structures have been analyzed through environmental sustainability parameters. Information collected from the literature and selected structures were studied using the comparative analysis method. The results of the analysis will shed light on the discussions about the interaction of traditional and modernist designs with extracts from residents.

Keywords: *Traditional architecture, modernism, modernist architecture, environmental sustainability.*

Konutlarda Geleneksel Özelliklerin Modernist Tasarımlara Etkisinin Çevresel Sürdürülebilirlik Çerçevesinde İncelenmesi

Öz

Coğrafya, iklim, kültür ve teknoloji toplumların mimari üretimini doğrudan etkilemiştir. Bu etkiler önce geleneksel mimarilerin üretimini şekillendirmiştir. Endüstri devrimindeki gelişmeler sonrası mimari biçimlenişler, sürekli ve hızlı değişimlere açılmıştır. 19. Yüzyıl sonları ile 20. Yüzyıla tarihlenen ve modernizm olarak adlandırılan bu değişim, gelenekselden uzaklaşıp kendi biçimlerini tasarlamayı amaçlamıştır. Ancak tasarım kuramcıları, modernizmin gelenekselden doğrudan etkilendiği ile modernizmin tamamen yeni bir oluşum olduğu görüşü arasında ikiye ayrılmışlardır. Bu araştırma gelenekselin modernizme etkisi ile ilgili tartışmalara bir ışık tutabilmek amacıyla gelenekseli ve modernizmi şekillendiren parametreler ile bu parametrelerin etkilerini tespit etmeyi amaçlamaktadır. Literatür araştırmalarında geçmişten günümüze ulaşabilen tasarım parametrelerinin konut yapılarında genelde değişmediği ve bu parametrelerin günümüzde çevresel sürdürülebilirlik kavramının içerisinde yer aldığı tespit edilmiştir. Bu nedenle geleneksel ve modernist tasarım ürünü konut yapıları, çevresel sürdürülebilirlik parametreleri üzerinden analiz edilmiştir. Literatürden derlenen bilgiler ve seçilen yapılar karşılaştırmalı analiz yöntemi ile incelenmiştir. Analiz sonuçları, geleneksel ve modernist tasarımların etkileşimi ile ilgili tartışmalara konut yapıları üzerinden çıkarımları ile ışık tutacaktır.

Anahtar kelimeler: *Geleneksel mimarlık, modernizm, modernist mimarlık, çevresel sürdürülebilirlik.*

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1. Introduction

Architecture is the art of creating structures that adhere to specific measurements and rules. It designs and constructs spaces in which people will conduct all their activities such as sheltering, working, resting, and having fun. It develops as a combination of many factors such as geographical, social, economic, and technological data (Özyılmaz et al., 2008). Architecture evolves in response to changes in the global order. Consequently, it is expressed in the literature by categorizing it into different periods. The construction systems before the industrial revolution in the 19th century are called traditional, and the period that started with the industrial revolution leading the construction sector and lasted until the 1970s is called modernism (Omay Polat & Can, 2008).

Traditional architecture is the built environment that people produce to sustain their daily life. It is the accumulation of knowledge and experience that comes from people's ancestors in the region and is a reflection of the living culture (Kıstır & Kurtoğlu, 2018). Many factors influence traditional architecture, including geographical location, topography, climate, tradition, material, and construction technique. Despite all these factors, environmental factors are the most important in determining the components of traditional architecture. Traditional architecture has been shaped by the pursuit of environmental respect, adaptation, and effective use of environmental data (Muşkara, 2017). Since the middle of the nineteenth century, the rapidly developing industrial revolution and its aftereffects have led some to label traditional practices as primitive and should be abandoned. Modernization, which began with the industrial revolution, transformed agricultural society into industrial society and took architecture to a whole new level with chemicalization and mechanization technologies (Birol, 2006). Thus, traditionalism and modernism came to be seen as opposite approaches, and debates began to judge both approaches by comparing them to one another. One of these debates is the belief that modernist architecture is directly influenced by traditional architecture, whereas modernism is a completely independent formation (Artun, 2019).

Sedad Hakkı Eldem, Sibel Bozdoğan, Ernesto Peresutti, and Josep Lluis Sert can be given as examples to those who think that the architecture of the modernist period was directly influenced by traditional architecture. According to Sedad Hakk Eldem, traditional Turkish houses are quite close to modernist house designs. He stated that traditional Turkish houses are distinguished by bright spaces with plenty of windows, freedom in the plan, emphasis on comfort, keeping decorations to a minimum, sensitivity in material selection, and establishing a connection with nature through spaces such as open canopies, gardens, and courtyards. He also stated that Le Corbusier, a modernist designer, was inspired by traditional Turkish houses in his designs (Bozdoğan, 2009: 19, cited in Ulubay, 2019: 388). According to Sibel Bozdoğan, the rational and utilitarian features of the traditional are reflected in the modern, hence modernism is not a new and foreign approach. According to Ernesto Peresutti, so-called modernist constructions with rectangular or square plans, developing horizontally or vertically, capturing the rhythm of fullness-space, and with white walls are already typical of classic Mediterranean architecture. It has been stated that Gropius, Le Corbusier, and Mies van der Rohe misrepresented modernist architecture as a northern innovation of the twentieth century and that humanity was misled. According to Josep Lluis Sert, if traditional Mediterranean architectural examples are compared to works of modern architecture, they will have many common characteristics. He claimed that, while contemporary architecture is portrayed as a northern invention, it is essentially a styleless Mediterranean architecture (Bozdoğan, 2009: 19, cited in Ulubay, 2019: 388). According to Hassan Fathy, traditional values must be nourished for modern period structures to be nice and beautiful (Bilir, 2019).

Despite the belief that modernism is influenced by tradition, some argue that modernism is an invention. Indeed, some theorists have carried their discourses to the point where the traditional should be completely rejected and destroyed. Raymond Williams defined modernism by emphasizing creativity and rejecting the tradition. Clement Greenberg defines modernism as aesthetics and traditionalism as kitsch. J.M. Richards defined modern architecture as the new understanding of architecture demanded by the twentieth century, rejecting previous architecture (Artun, 2021). The discourses of architects, who are regarded as modernism's forefathers, also emphasize in a non-direct way that modernism is a very different design from traditional. They even want to get rid of the traditional. For example, Le Corbusier stated that he hoped Mussolini would demolish a traditional settlement to make way for the construction of his Radiant City, a utopia city project (Artun, 2019). He also stated that he came in 1925 to witness the demolition of traditional structures and the production of modernist products during Istanbul's reconstruction works (Bozdoğan, 2009). In a speech in which traditional Indian architecture was mentioned, he derisively referred to traditional architecture as "few pieces of stone." (Özkan, 2005: 58-61; Ulubay, 2019). Mies Van Der Rohe claims that he tries to move away from the traditional as much as possible in his works and that this discourse is exaggerated in his works. With his Farnsworth House design, he rejected traditional closed-room systems and instead used glass on the exterior of the building with unprecedented dimensions and transparency (Arkitektuel, 2023). He leaves the interior solutions to the users in his designs, claiming that he gives users design freedom while saving architects from traditional production (Can, 2010).

Although, in recent years, researchers have tried to express the injustice and destruction of the traditional against the modernism (Artun, 2019; Artun, 2021; Bilir, 2019; Kıstır & Kurtoğlu, 2018; Ulubay, 2019). The voice of modernism's internalization and marginalization debates had begun to fade. Because in the 1970s, modernism also faded, left its golden period behind, and became a part of the past (Omay Polat & Can, 2008). However, currently, the demolition of reinforced concrete structures built before 2000 because the structures have completed their economic life and are not safe for use due to natural disasters, especially earthquakes, has made modernist structures in need of protection and defense. At a time when all concepts are becoming more intertwined and complex, it would be beneficial to reopen all discussions to comprehend that modernist structures are now the legacy, perhaps traditional of an era. Because it is impossible to define the battle between modernism and the contemporary without first understanding the battle between traditionalism and modernism. To preserve what is traditional and modern, its substances must be analyzed, and their parameters defined.

Consequently, the purpose of this study is to identify the parameters that shape both traditional and modernism, as well as the effects of these parameters, to shed light on discussions about the interaction of traditional and modernism.

According to the literature, the design parameters that can be achieved in residential buildings from the past to the present do not generally change, and these parameters are now included in the concept of environmental sustainability. The concept of sustainability is defined as the ability to carry out the functions of ecology and ecology-related elements, the stages of its order, and the mission of creation to the future (Yavuz, 2010). The three main principles of sustainability are economic, social, and environmental. Environmental sustainability is one of these principles, and it includes architectural definitions. It focuses on how the built environment will be built and transferred in the future while avoiding harm to nature and considering all living things. Currently, architectural structures' success is measured by their ability to meet sustainability criteria. It is also supported by certificates such as LEED, BREAM, BEST, and WELL. Since the basic needs of the world and humanity are the same, analyzing the buildings with environmental sustainability parameters, regardless of the date they were built, will be a guide for both defining the buildings themselves and comparing them with other buildings. Environmental sustainability parameters compiled from the literature were determined as "being sensitive to ecology, using clean energy resources, using local resources, protecting cultural assets and historical environment, protecting architectural values and morphological features" (Büyükçam & Eyüboğlu, 2022; Durukan et. al., 2021).

It was previously stated in the literature review that the design parameters that can be reached from the past to the present do not generally change in residential buildings. However, it should be noted that another reason for selecting residential buildings is that they have also served as a shelter since the beginning of humanity. Therefore, it is intended to analyze traditional and modernist residential buildings using environmental sustainability parameters. Five parameters were determined to make this determination, and five traditional and modernist building examples were chosen. Residential buildings that reflect their architectural form and traditional or modernist features well and are praised in the literature were chosen as building samples. Although making inferences from so few parameters and structures is insufficient to make a complete generalization the selected parameters and residences will be highly informative due to their specific features.

Environmental sustainability parameters were used to compare the houses, and the effect of the parameters was determined. The analysis findings will shed light on discussions about the interaction of traditional and modernist designs, as well as their implications for residential buildings.

2. Material and Method

This study's methodology consists of four steps. These steps include literature research, determining environmental sustainability parameters, selecting traditional and modernist housing structures to be analyzed, and comparing selected houses based on environmental sustainability parameters (Figure 1).

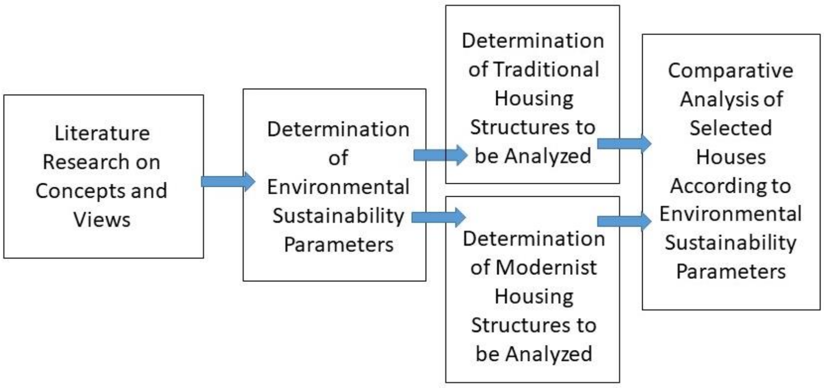

Figure 1. Flowchart of research method

The flowchart of the literature research phase, which is the first phase of the research, consists of two parts (Figure 2). The first part is the exploration of the concepts of traditional architecture, modernist architecture, and environmental sustainability. The second part is the exploration of views discussing the interaction of traditional and modernist architecture. The views of Sedad Hakkı Eldem, Sibel Bozdoğan, Joseph Lluis Sert, and Ernesto Peresutti, argue that modernism is influenced by the traditional; The views of Le Corbusier, Walter Gropius, and Mies Van Der Rohe, which they argue that modernism rejects the traditional, constitute the problem of this research.

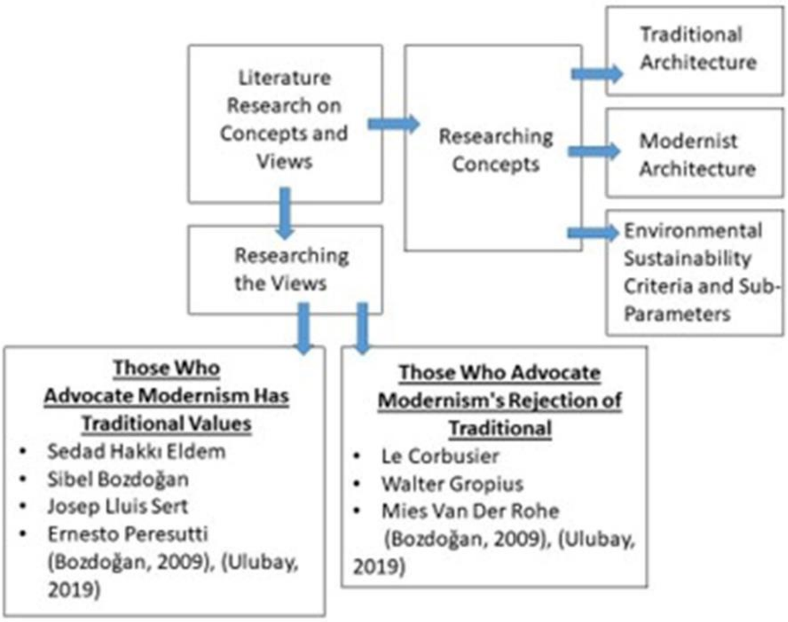

Figure 2. Flowchart of literature research

The analysis parameters were determined in the second phase because it is intended to look at the interaction of traditional and modernist housing structures in terms of environmental sustainability (Figure 3). Environmental sustainability has many parameters such as ecological design, use of clean energy resources, use of local materials and resources, protection of cultural assets and historical environment, preservation of architectural value and morphological features (Büyükçam & Eyüboğlu, 2022). The interaction of traditional and modernist residential buildings was analyzed using ecological design and clean energy usage parameters. Protection parameters, use of existing buildings, and waste management parameters have been neglected as they are the design criteria of the researched buildings. Ecological design and clean energy use parameters are also subdivided to conduct more in-depth research. Green space use, topographic design, and site-specific design are all ecological design parameters. Local materials were considered as part of the site-specific design parameter. Natural climatization and natural lighting are examples of clean energy usage parameters.

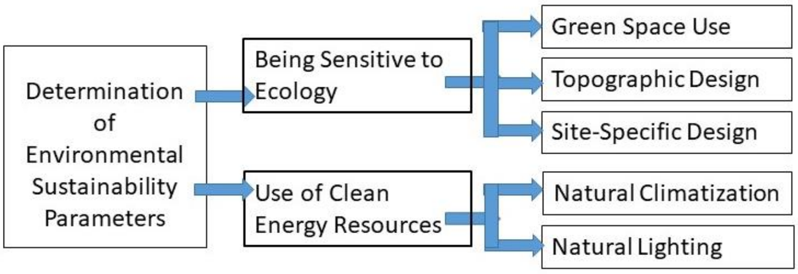

Figure 3. Environmental sustainability parameters

In the third stage, traditional and modernist housing examples are discussed for analysis, with the parameters of environmental sustainability that can be observed. In the selection of the sample, attention was paid to the analysis of the prominent residential buildings in the literature with the specified parameter. While the traditional housing structures to be analyzed were chosen as Özbekler House, Yazd Towers of Silence, Safranbolu House, Diyarbakır House, and Bingöl House; modernist housing structures are determined as Rıza Derviş Residence, Ramkrishna House, Şevket Saatçioğlu Villa, Villa Savoye and Fallingwater House (Figure 4).

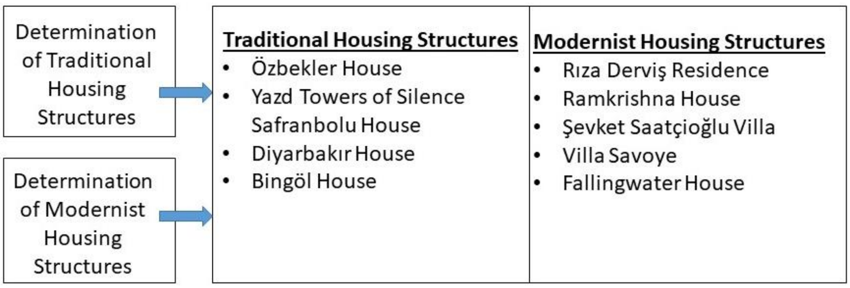

Figure 4. Flowchart of determination of housing structures to be analyzed

Finally, the existence and significance of the parameters determined in the selected houses are discussed. The interaction of traditional and modernist architecture has been attempted to reveal data in terms of environmental sustainability based on the effect of the parameters.

3. Findings and Discussion

For centuries, people have either adapted to their surroundings or attempted to change their surroundings. Natural disasters have reacted negatively to human efforts to change the environment. Therefore, humanity has realized the importance of caring for and understanding the environment. They have created an architecture that respects and incorporates the topography, climate, wind, and sun of the environment in which they live (Canan et al., 2020). However, the long-term occurrence of natural disasters and rapid technological developments encouraged people, and therefore people turned to environmentally harmful production technologies. However, the depletion of fossil resources, the excessive increase in pollution in air and water resources, the gradual restriction of access to clean water, and natural warnings such as global warming and climate change repeatedly warn people to consider their surroundings. People must understand the concept of sustainability to live environmentally conscious lives. The three pillars of the concept of sustainability; economic, social, and environmental sustainability, are guiding concepts and parameters. The principles of environmental sustainability include the measures to be taken in the field of architecture. The use of existing buildings, the use of local materials, waste management, natural climatization, natural lighting, ecological design, and clean energy usage are all aspects of environmental sustainability (Büyükçam & Eyüboğlu, 2022).

This study's findings include an analysis of the environmental sustainability parameters of traditional and modernist architecture on houses. To comprehend the interaction of traditional and modernist residential buildings, ecological design and clean energy usage parameters were chosen. While green space use, topographic design, and site-specific design are ecological design parameters, natural climatization, and natural lighting are considered clean energy usage parameters.

3.1. Ecological Design Parameters

Ecological design parameters were determined as green space use, topographic design, and site-specific design.

3.1.1. Green space use

Green spaces have long been important for human health and environmental quality, and their presence has improved both indoor and outdoor quality of life. It contributes significantly to the field of architecture by cleaning the air, creating shade and cool areas, and strengthening the ground by compacting the soil (Ceylan, 2007). Traditional houses are typically made up of structures with sofas, courtyards, or gardens. In modernist architecture, detached houses utilize the same approach (Akdemir & Aykal, 2021). The traditional architectural product Özbekler House and the modernist period structure Rıza Derviş Residence were examined for this research to assess the impact of green space use. The garden design is given a large place in both housing structures, trees are planted, and other spaces are directed to the garden (Figure 5). It is seen that the use of green areas is given importance in traditional and modernist houses.


Figure 5. Left: Özbekler House (Menteşe Prefecture, 2022); Right: Rıza Derviş Residence (Salt Research, 2022)

3.1.2. Topographic design

Settlements are typically found on slopes, foothills, and stream banks. The most important factors, in this case, are topography, water, and light, but topography already shapes the water and light elements. Because the topography has numerous formations in itself. It is made up of landforms like ridges, valleys, water distribution lines, water collection lines, necks, slopes, skirts, plateaus, fills, and cuts. The temperature, wind speed, and shading time vary depending on the location of the building on the land. The radiation and wind speed increase as the building's elevation increases, while the temperature decreases. The building's orientation toward the south allows it to benefit from solar energy. The northern directions are shady and cool. According to Christopher Alexander, the area can be used efficiently by establishing agricultural areas, city settlements on slopes, and hills on the plains. The architect should also create architectural designs that make use of the sloping area. Only in this way can existing land conditions be improved and new land acquired. Walls, stairs, sloping roads, and ground floor elements can be used to make the topography into a place (Saçık, 2018; Bayraktaroğlu & Arabacıoğlu, 2022).

The traditional Safranbolu house and the modernist residence Şevket Saatçioğlu Villa were designed by the sloping topography (Figure 6). There is a height difference between the house facades depending on the slope settlement. The entrance level is given from the upper road in houses with front and back facades facing the road. The lower road level facade has been converted into a retaining wall. Again, depending on the slope, some houses' ground floor rear walls are buried in the ground. The gardens are terraced by the valley's slope (Saçık, 2018). The Saatçioğlu Villa was built in 1960 on a sloping plot of land with five levels. A gap in the floor allows a tree from the field to enter. The free plan solutions, which are solved at various levels, are also regarded as a site-specific project, with an approach that considers the existing tree (Bingöl, 2018; Kuru, 2018). It is seen that the use of topographic design is given importance in traditional and modernist houses.


Figure 6. Left: Safranbolu House (Wikipedia, 2023); Right: Şevket Saatçioğlu Villa (Arkitera, 2013)

3.1.3. Site-specific design

Each designed building should be unique to the specific location where it will be constructed. Geography, topography, climate, materials, construction techniques, and natural and local features are all considered in site-specific design (Bilir, 2019).

The traditional Bingöl House is made of local materials such as wood, stone, and clay. Because of the cold climatic conditions of its location, the walls were constructed thick, and the windows were shuttered. The house was built at two different elevations to accommodate the sloping terrain (Varolgüneş, 2021). The Modernist Fallingwater takes its name from the waterfall on which it was built. The majority of the rock fragments were left on the plot during construction, and some of them appear to have come out of the pavement. Modernist Fallingwater House’s walls and terraces were built with stones from the surrounding area and the existing plot. With large windows and balconies, it aims to be close to nature. The sound of the waterfall can be heard throughout the house. Even inside the house, one feels as if they are in nature (Arkitektuel, 2017). Therefore, both examples are specific and unique to the place where it is located and was produced for that place (Figure 7). It is seen that the use of site-specific design is given importance in traditional and modernist houses.


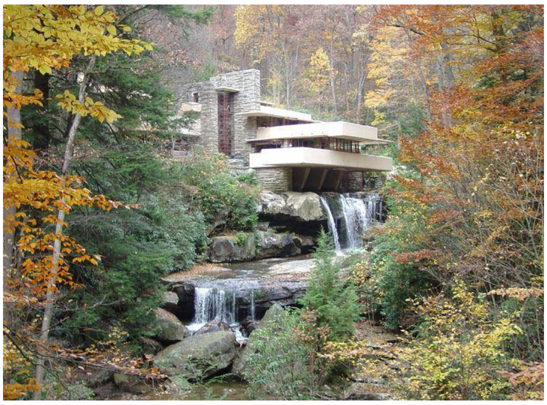

Figure 7. Left: Bingöl House (Varolgüneş, 2021); Right: Fallingwater House (Arkitektuel, 2017)

3.2. Clean Energy Usage Parameters

The approaches that are kept away from the use of fossil fuels and towards clean energy sources are important factors that shape architecture and contribute to its sustainability. Clean energy sources include solar, wind, and plants (Yılmaz, 2019). Natural climatization and natural lighting are examples of clean energy usage parameters. It is seen that the use of clean energy is given importance in traditional and modernist houses.

3.2.1. Natural climatization

The building does not require an additional element for natural climatization. The building solves its air-conditioning problems through design. For example, precautions such as benefiting from the wind thanks to the location or elevation of the land where the building is located, high air permeability level of the materials used in the building, controlled use of wind and sun rays with elements such as eaves, shutters, and blinds, and controlling the sunlight and wind by paying attention to the type and planting places of the trees can be taken (Yılmaz, 2019).

The Ramkrishna House, a modernist period residence structure, has a sloped roof that is used in the natural airflow of the adjustable louver systems (Architectural Digest, 2018). In Yazd City, an example of traditional architecture, wind chimneys called *badgir* on the underground houses cool and direct air into the building (Abu-Hammad & Abu-Hammad, 2017). Both examples include natural climatization (Figure 8). It is seen that the use of natural climatization is given importance in traditional and modernist houses.

Figure 8. Left: Yazd Towers of Silence (IRNA, 2023); Right: Ramkrishna House (Architectural Digest, 2018)

3.2.2. Natural lighting

One of the artifacts associated with the use of natural lighting in traditional buildings is the design of daytime spaces that receive a lot of sun and places that do not need the sun, such as cellars and warehouses, in directions that see the little sun. Eaves and bay windows are used to provide illumination at the desired time and angle. Natural lighting is also preferred using rows and high windows (Aktuna, 2007). The use of wide and high glass on the facades or band windows along the width or height of the building was intended to benefit from natural lighting during the modernist period (Bilir, 2019).

Basement lighting is at ground level in traditional Diyarbakır houses, and windows are opened under the eaves. The goal here is to take advantage of natural lighting as much as possible (Payaslı & Işık, 2003). The use of horizontal band windows in the modernist Villa Savoye is intended to bring light into the interior (Şahin & Satıcı, 2022). Natural lighting was considered in both cases (Figure 9). It is seen that the use of natural lighting is given importance in traditional and modernist houses.

Figure 9. Left: Diyarbakır House (Diyarbakır Hafızası, 2023); Right: Villa Savoye (Arkitektuel, 2016)

4. Conclusion

The traditional and modernist housing structures chosen for analysis in this study were examined through the perspective of environmental sustainability principles. To comprehend the interaction of traditional and modernist residential buildings, ecological design and clean energy usage parameters were chosen. Ecological design and clean energy usage parameters are also subdivided. Green space use, topographic design, and site-specific design are all ecological design parameters. Natural climatization and natural lighting are clean energy usage parameters.

According to the findings of the study, ecological design and the use of clean energy are incorporated into both traditional and modernist housing structures. Green area usage is in Özbekler House and Rıza Derviş Residence; The topographic design is in traditional Safranbolu Houses and Şevket Saatçioğlu Villa; local design in traditional Bingöl House and Fallingwater House, natural climatization in traditional Yazd Houses and Ramkrishna House; natural lighting is prominently observed in the traditional Diyarbakır House and Villa Savoye.

Since ecological design and the use of clean energy are used in traditional buildings with natural and rational methods, it would be appropriate to say that this knowledge and construction techniques may have been gained by humanity over a long period as a result of many experiences and transferred from generation to generation. Although applications for the same purpose can be found in modernist structures, there are differences from traditional ones. However, it is understood that this difference is in the form of elements that serve the same purpose, sometimes changing form and sometimes transferring the function to another building element. When it comes to the analyzed structures, the green space usage of Özbekler House and Rıza Derviş Residence is almost identical. Only in other examples can the garden or courtyard elements change shape. An effort was made to adapt to the topography in the Safranbolu Houses and Şevket Saatçioğlu Villa. While this harmony is achieved in Safranbolu house by using retaining walls at various levels, columns can be observed in Şevket Saatçioğlu Villa. The Bingöl House and the Fallingwater House each have a site-specific design. For example, while the Bingöl House was built with local stone, the Fallingwater House's walls and fireplace were made from nearby rocks. Natural climatization is skillfully provided in traditional Yazd Houses and Ramkrishna Houses. However, while chimneys perform this function in traditional Yazd Houses, the roof performs this function in Ramkrishna House. Natural lighting has been noticed in the traditional Diyarbakır House and Villa Savoye using rational solutions. While the location and dimensions of the windows in traditional Diyarbakır Houses vary depending on the function of the spaces, Villa Savoye has carried the sunlight completely indoors with its wide horizontal band windows that continue along the facade, as it is only a residential function away from production.

As a result, environmental sustainability parameters can be seen in both traditional and modernist architecture. Knowledge and methods used in traditional architecture have been gained over a very long period, possibly as a result of thousands of experiences, since what is traditionally defined as the 19th century and before. Although modernism also denies the traditional, it is clear that it has used the traditional architecture’s ratio and tried solutions in the designs that it provided. If we exclude post-industrial technological inputs such as reinforced concrete, steel, and large-scale glass production in modernist buildings, the environmental sustainability differences are only formal.

Acknowledgments and Information Note

The article complies with national and international research and publication ethics. Ethics Committee approval was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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Examination of Elderly and Disabled Tourism Buildings in Terms of the Concept of Sustainability

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Abstract

Environmental problems and heavy living conditions, which are the result of industrialization and intense urbanization, affect health negatively. In addition, developments in the level of welfare and health have extended the human lifespan and increased the proportion of the elderly population. These developments, combined with people's efforts to be physically and mentally well, have started a movement to regain their health, and over time, the concept of health tourism has emerged. Buildings for health tourism are mixed-function that includes tourism activities as well as treatment units. In this article, a schema has been created by considering the sustainability concept of the buildings that serve the elderly and disabled tourism, which have a place under the title of health tourism. With the evaluations to be made on the schema obtained within the scope of this study, it is aimed to ensure the development of the facilities and suggestions are forth.

***Keywords:** Architecture, old age/senior/elderly and disabled tourism, sustainability, universal design, quality.*

İleri Yaş ve Engelli Turizmi Yapılarının Sürdürülebilirlik Kavramı Özelinde İrdelenmesi

Öz

Sanayileşme ve yoğun kentleşmenin sonucu olan çevre sorunları ve ağır yaşam koşulları sağlığı olumsuz etkilemektedir. Bununla birlikte refah düzeyi ve sağlık alnında yaşanan gelişmeler insan ömrünün uzamasını sağlamış olup yaşlı nüfus oranını artırmıştır. Bu gelişmeler insanların fiziksel ve zihinsel olarak iyi olma çabasıyla birleşerek sağlıklarını kazanmaya yönelik bir hareketliliği başlatmış olup zaman içerisinde sağlık turizmi kavramını ortaya çıkarmıştır. Sağlık turizmine yönelik yapılar tedavi birimlerinin yanı sıra turizm faaliyetlerini de içeren karma fonksiyona sahip yapılardır. Bu makalede sağlık turizmi başlığı altında kendine yer edinen ileri yaş ve engelli turizme yönelik hizmet veren yapıların sürdürülebilirlik kavramı özelinde ele alınarak bir şema oluşturulmuştur. Bu çalışma kapsamında elde edilen şema üzerinden yapılacak değerlendirmelerle tesislerin gelişiminin sağlanması hedeflenmiş olup önerilere yer verilmiştir.

***Anahtar kelimeler:** Mimarlık, ileri yaş ve engelli turizmi, sürdürülebilirlik, evrensel tasarım, kalite.*

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1. Introduction

The concept of tourism is defined in two different ways in the Dictionary of the Turkish Language Association. The first of these definitions is "to travel for resting, having fun, seeing, recognizing, etc." and the second is explained as "Economic, cultural, technical measures and all of the activity to attract tourists to a country or region" (TDK, 2022). It has been defined in different ways in the process, depending on the conditions of the period and the reference point.

One of the first definitions of tourism known in the international literature belongs to Guyer Feuler (1905) and he stated tourism as "a phenomenon unique to modern time which is dependent on the people's increasing need for change and relaxing, the wish of recognizing the beauties of nature and art and the belief that nature gives happiness to human being and which helps nations and communities' approaching to each other thanks to the developments in commerce and industry and the communication and transportation tools' becoming excellent" (Akoğlan Kozak, Evren & Çakır, 2013). In this definition, the economic and sustainability aspects of tourism are not considered. In the following definitions, different aspects of tourism were highlighted with the effect of the conditions of the period.

In 1910, the Australian economist Hermann Von Schullar defined tourism as "the whole activities that relate to the economic direction of the movement that comes from the arrival of strangers from another country, city or region and their temporary stay" (Erkmen, 2019). With this definition, discussions on the economic dimension of tourism began.

Tourism has been expressed as "the whole of relations arising from the event of travel and accommodation made by individuals to another place other than their permanent residence without the purpose of temporary or permanent settlement and earning" at the meeting of the International Association of Scientific Experts in Tourism (AIEST) in 1950 (Erkmen, 2019). Thus, beyond its economic dimension, its social dimension also began to come to the fore.

Especially in the 1980s, the increase in production and use of raw materials, uncontrolled consumption of resources, and environmental problems brought the sustainable tourism approach to the agenda.

As can be seen in Figure 1, the definition of tourism is discussed by emphasizing a certain aspect of tourism in relation to the conditions of the period. Consequently, today the concept of sustainable tourism is an approach that reveals the interdisciplinary aspect of tourism, which includes social, economic, and political situations as well as environmental conditions. Health tourism revealed the relationship of this approach with medicine and science.

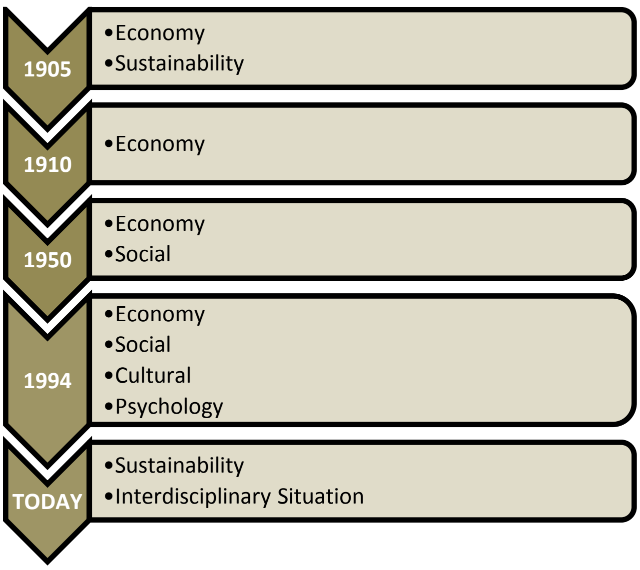

Figure 1. Dimensions of tourism definitions

Throughout history, people have made an effort to maintain their mental, physical, and social well-being, in other words, to maintain their state of being healthy. Since ancient times, they have taken action to treat their diseases. Figure 2 shows the development of health tourism in this context.

Figure 2. Health tourism from the past to the future (Jagyasi, 2010)

Besides the negative factors such as environmental problems, air pollution, stress, and seasonal changes that arise because of industrialization and urbanization, the work and living conditions with the global crisis have a negative impact on the health of people. Apart from mass tourism, people have started to travel to areas where unspoiled nature, environment, climate, and physical characteristics, in order to regain their health or provide fitness (Özer & Soṅğur, 2012). This situation has revealed the concept of health tourism over time.

The World Tourism Organization (WTO) defines health tourism as “going to health centers, especially thermal springs, in order to improve the well-being of the individual” (Eriş & Barut, 2020). Health tourism refers to the whole of events and relations arising from travel, accommodation, and organization, which starts with the aim of promoting health, protecting health, and restoring health in general and includes holiday elements as well as health services (Özer & Sonğur, 2012). Although there are many definitions of health tourism, all of them involve people's trips to a different place from where they inhabited to be treated or maintain their fitness.

Health tourism, whose history goes back to ancient times, is among the first tourism activities. During the Roman period, people demonstrated the pioneering activities of health tourism and thermal tourism by going to hot springs and sea baths. Traces of many baths and similar buildings which belong to this period can be seen in different parts of the former domination areas (Deniz & Doğanay, 2016). The Romans cured some diseases with healing water, and they found that the soldiers who were tired of the war became vital with healing water. In this context, they established important facilities for healing water wherever they went (Talşıgil, 1995). At Figure 3, which is known to belong to the Roman period, the remains of the Basilica Therma building, which is located in the Sarıkaya district of Yozgat, support this view.

Figure 3. Basilica therma (Ertuğrul, 2018)

With the Industrial Revolution, cities began to receive large numbers of immigrants. The urbanization process has accelerated. However, the unhealthy environments made it necessary to travel for health as well as traditional travel such as rest and entertainment.

Health tourism, which started in Europe in the 18th century with the spread of going to hot springs among the people, was made in the 19th century in distant colonies regions for therapeutic purposes (İçöz, 2009). The tourism movement carried out in these periods was individual.

While individual activity was dominant in tourism from the beginning of the 19th century to the 2nd World War, mass tourism began to be decisive after that threshold (Tanyeli, 2004). Mass tourism defines a group with a predetermined itinerary and route. Because of the demands of this group, all-inclusive hotel concepts and holiday resorts have emerged.

In the meeting themed “Travel and Tourism in the Case of Epidemic” held by the World Tourism Organization in Madrid in 2009, it is important for all parties to be in constant communication to build trust in the tourism sector, since viruses and epidemics may cause uncertainties; that it is an important issue to enable people to travel by taking some preventive measures regarding epidemics; it is necessary to benefit from technological opportunities while sharing information on diseases; it has been determined that there is the need for more coordination between health authorities and travel companies. The meeting in question, it was started that there could be problems in the communication of the authorities in the places where epidemic diseases occurred; in this case, although the most authoritative institution is the World Health Organization, each country should apply its regulation;

during the implementation of the procedures, situations such as ensuring a regular flow of information among all stakeholders of the tourism industry, putting into practice the inspection system, undertaking basic responsibilities such as applying basic hygiene rules, and using the lessons learned from bird flu to prepare an action plan for other epidemic diseases were discussed (Baynazoğlu, 2015). Although the World Tourism Organization has prepared an action plan for epidemic diseases, individual activities and alternative tourism types have gained importance with the Covid-19 pandemic announced by the World Health Organization in 2020. Health tourism has an important place among alternative tourism types. Considering both the negative effects of the pandemic and the age distribution of the world population, the importance of health tourism is increasing day by day.

The proportion of the population reaching old age and the onset of old age vary according to the welfare level of societies. Elderly people aim to both regain their health and engage in tourism activities within the scope of health tourism.

It is predicted that the elderly population in the world will be 20 billion in 2050 and 80% of this will be in developing countries (Samancı Tekin & Kara, 2018). Considering the aging of the world population and the fact that there is not any young population to care for this population, elderly and disabled tourism will become more common in the coming years. In addition to these, it gains importance that the relationship of sustainability, with environmental issues and buildings be created within the scope of environmental problems. Building serving elderly and disabled tourism should include both health and tourism functions, the structure and operating scheme should be defined and how these schemes will operate should be arranged.

2. Method

The scope and purpose of the study are to determine the minimum conditions of a building that aims to provide services to the elderly and disabled tourism should have in the context of sustainability. In line with this determined scope and purpose, as the methodology of the study, a literature review was conducted on health tourism in the first stage. Content analysis of the obtained documents was made. Consequently, the criteria of the building and operating scheme were determined.

If the buildings serving the elderly and disabled tourism provide design criteria, the design performance and result will also affect the quality level. The physical properties and related requirements for increasing the quality are discussed. In this context, while the physical-ecological criteria were determined to meet the user's expectations from health and tourism, criteria were determined for the person to feel better psychologically. A schema has been created to increase the performance of a design by combining these two criteria. While creating the diagram, a study was carried out considering the mobility of the person and universal design principles, quality criteria, criteria related to the units of the space to be designed, and criteria related to sustainability, as indicated in the diagram in Figure 4.

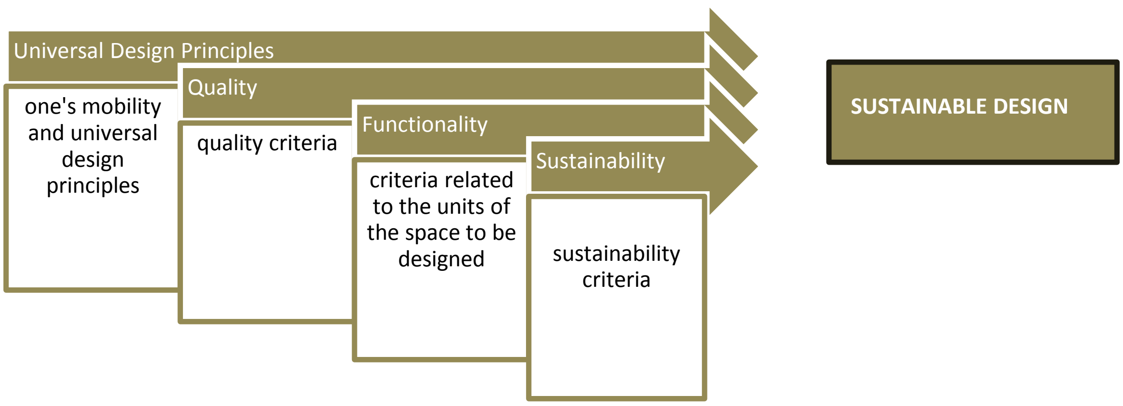

Figure 4. Main Criteria of the schema to be created for sustainable design

Considering the user profile, as a result of the work to be done with the mobility of person and the universal design principles, sustainability towards mobility is achieved by ensuring the good progress or continuity of the individual movements; positive sustainability of the individual's recovery process and the service received by taking into account the quality criteria; sustainability for long-term use of the building with spatial analysis; environmental sustainability is aimed by using sustainable-ecological approaches in design. Sustainable design was achieved with the combination of them, and contribution has been made to the formation of sustainability, environmental sustainability, and schematic sustainability, which are the equivalent of today's tourism definition.

2.1. The Concept of Elderly and Disability

First of all, the concepts of elderly and disability, which are the basic elements of the study, were analyzed in order to ensure that the work to be done in order to meet the spatial design criteria of the buildings serving the elderly and disabled tourism would be efficient.

The life process of a human being consists of infancy, childhood, adolescence, adulthood, middle age, and old age. Old age, objectively, refers to the last stage of human life (Şeker & Kurt, 2018). This process is shaped by environmental factors as well as genetic factors.

As aging is not a one-dimensional process, its definition is handled from different aspects (Özyer, 2016):

- Biological (Physiological) Aging: Biological aging is related to the appearance of the person and decreased function at the organ level and the wear of the tissues. Graying of the hair and wrinkling of the skin staining of the shin are signs of aging, and the ability to use one's limbs decreases.
- Chronological (Calendar) Aging: The age is according to the calendar and the starting point is the birth of the person. It is the answer to the question "How old are you? "According to the chronological age, the onset of old age is 65.
- Psychological Aging: Depending on the increase in experience, behavior and adaptability change with age. During this period, psychological changes occur. Mobility, wish, and desire in the 20s leave their place to the psychology of inefficiency depending on the progress of age.
- Social Aging: It refers to the relation of the individual with his social environment. The person's social relationships, family life, work, roles, and duties change by diversifying, and rich life experiences. It defines the change of social role and status depending on age and the process of adaptation to it.
- Economic Aging: It is the state of being unable to produce an economic benefit as a result of being unable to work with old age, decreasing the income obtained, not being able to resist the decline in income in the face of high inflation, insufficient retirement income, spending more from his income and saving for illness because he will be sick more than in the past.

The World Health Organization defines aging as a "continuous decrease in vital functions, decrease in the productivity of the whole organism and decrease in its ability to adapt to environmental factors." They are grouped as "young old age" between 65-74, "old age" between 74-84, and 85 over as "advanced old age" (Özel İhtisas Komisyon Raporu, 2018). The World Health Organization has made a mathematical evaluation on the subject. However, the proportion of the population reaching old age and the onset of old age vary according to the welfare level of the societies.

The developments in the last century have led to the prolongation of life expectancy and the increase in the average age of the world population. In the globalizing world, besides the economic, cultural, social, political, spatial, and technological phenomena, the aging population also manifests itself as a new phenomenon. When the graph in Figure 5, which was created by considering the data of the Turkish Statistical Institute (TSI, 2023) and showing the age distribution of the Turkish population in 2022, is examined, it is seen that the population in our country is getting older day by day.

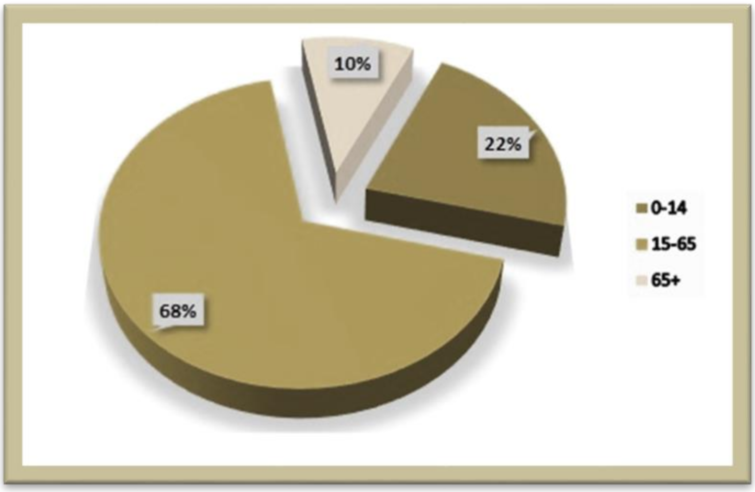

Figure 5. Age distribution of the Turkish population in 2022

The concept of disability is defined in two different ways in the Dictionary of the Turkish Language Association. The first of these definitions is “disabled, afflicted” and the second is explained as “a person who has lost his physical, mental, spiritual, sensory or social abilities to various degrees from birth or later for any reason, and has difficulties in adapting to social life and meeting his daily needs” (TDK, 2022). Although there are many definitions for the concept of disability, it can be generally considered a disability.

2.2. Evaluation of Buildings, Which Are Aiming to Serve Elderly And Disabled Tourism, Within The Framework of Standards and Regulations

Today, elderly and disabled tourism is identified with buildings where thermal tourism and physical therapy services are offered together. In this context, a study has been carried out on the standards related to thermal tourism and physical therapy centers while discussing the standards.

There is limited information about the spatial arrangement of physical therapy centers in the Regulation on Physiotherapy and Similar Institutions which is published in the Official Gazette in 1957 for the spatial arrangement of physical therapy centers. When the graphic in Table 1 is examined, there is information about the place in the 3rd and 7th articles of the regulation.

ARTICLE 3	*Physiotherapy institutions should minimum include electrotherapy, light therapy, massage, and movement therapy section, as well as examination and rest rooms. These sections will be of sufficient width.*
ARTICLE 7	*The spa, which will be accepted and approved as a treatment institution by the Ministry of Public Health and Welfare to granted operating license, will contain at least the following facilities: a)Public pool, b)Private bathrooms, c) Shower, d) Physical therapy means (Diathermy, Ultraviolet, Infra-red, Galvanization etc.), e) If available, installment for mud application and electric mud bath, f) Massage department, The building or buildings, which will contain all these department, will be built and furnished in way that is wide enough, has sanitary and scientific conditions.*

Table 1. Articles related to space of the regulation on physiotherapy and similar institutions

There are two main headings, which are related to spaces, in the 6.14. Physical Therapy and Rehabilitation Services chapter of the Turkish Healthcare Buildings Minimum Design Standards 2010 Guide, which is published by the Ministry of Health. These titles are common areas and treatment areas (Standards, 2022). Table 2 contains information on the spatial characteristics of the area, which are defined as common areas.

6.14.2. COMMON AREAS	
→	*3. 10.1.3 Headquarters or Nurses' Station* *3.10.1.10 Stretcher and Wheelchair Stroge Area* *3.10.2.5 Housekeeping / Cleaning Room* *3.10.2.9 Staff Dressing Room*
→	*6.14.2.2 All areas used for transportation, examination, treatment and care of patients should be arranged in a way that allows to wheelchair and stretcher access.*
→	*6.14.2.3 Office and secretarial space should be provided for filing and patient records.*
→	*6.14.2.4 Reception and control station(s) allowing visual control of the waiting and activity areas (these can be combined with the office and secretaries area) should be provided.*
→	*6.14.2.5 Patient waiting area(s) which is suitable for wheelchair and stretcher usage, should be provided outside the service traffic.*
→	*6.14.2.6 Easy access to toilets and lockers should be provided.*
→	*6.14.2.7 The department must have a meeting room. The meeting room should be arranged in such a way that all types of patients (wheelchair, stretcher, or other paralyzed patients) can access.*

Table 2. Common areas of physiotherapy and rehabilitation service

Table 3 includes information on treatment areas. In this section, information about the qualities and quantities of spaces is given.

6.14.3. TREATMENT AREAS	
	6.14.3.1 Treatment Boxes / Rooms should consist of individual treatment areas where privacy is ensured. In each of these areas require a table or stretcher. The empty floor of these areas should not be less than 6,5 m². If they are planed as a single room, the size of the room should not be less than 8 m². The door width of rooms or department should not be less than 120 cm. Sliding glass doors, or a different mechanism can be used in these areas. Ceiling heights of all therapy areas must be at least 4m. Treatment areas are noisy places. For this reason, sound insulation should be done well.
	6.14.3.3 Clean Cover and Towel Storage: In order to provide materials for including clean cloth and towel cabinet, there should be a clean cloth and towel storage that acts as an interim storage.
	6.14.3.4 Dirty Cover, Towel and Material Storage: There should be a room where the covers and towels are used in the treatment areas are stored for a short time before being transported to their storage.
	6.14.3.5 Patient Dressing-Room: Patient should have an area, where privacy is ensured, to change their clothes before and after treatment. Lockers, toilets, and shower should be provided in these areas. Since some patient who come with stretcher to treatment, space design should be made in accordance with such patients.
	6.14.3.6 Treatment Areas: The type and number of treatment areas are listed below should be as prevenient. *– Electrotherapy/Ultrasonotherapy; should be in the form of a prevenient number of boxes. Each box must be for one person and at least 8 m². Each box must have very good sound insulation.* *– Hydrotherapy: dimensions and characteristics of bathtubs and pools must be prevenient. There should be a mechanism for transporting patients to the pool or bathtub. Areas that provide privacy and allow patients to undress and dress should be planned. They include towel/cloth cabinets.* *– Whirlpool, 4-cell galvanized pool, contrast bath, sauna, paraffin room and Turkish bath; they can be within the hydrotherapy field or in combination. Common areas can be shared.* *– Gym; there should be a hall that allows patient treatment in various branches, is a common area by sharing both material and manpower. The hall must be at least 45 m². The hall includes tools and equipment such as exercise ladder, exercise bike, fitness equipment, full-length mirror, parallel bar, weights with pulley system.*
	6.14.4.1 Where occupational therapy service is provided, it should include work areas, benches and equipment, which are suitable for wheelchair use, besides there should be a system such as an area/building/department where there are various mechanisms that will accustom patients with a different disability to daily life and that they can make exercises.
	6.14.5 Prosthetic and Orthotics: Where the Prosthetic and Orthotics services is provided, at least the following areas should be available: *6.14.5.1 Workspace for technicians,* *6.14.5.2 Evaluation and fitting area with patient privacy,* *6.14.5.3 Space for an environmentally controlled prosthetic/orthotic laboratory for fabrication/modification of devices.*
	6.14.6 Speech and Hearing Therapy: When speech and hearing therapy is provided, at least the following areas should be available: *6.14.6.1 An evaluation and treatment area away from a noisy environment with an acoustic arrangement.*

Table 3. Treatment areas of physical therapy and rehabilitation department

In the Hot Springs Regulation published in the Official Gazette in 2001, basic spatial features have been included and units to be included in hot springs and mineral springs. The definitions of the Regulation regarding the Physical Therapy and/or Rehabilitation unit are given in Table 4.

ARTICLE 12 →	*The physical therapy and/or rehabilitation units in the spa facility should have the following features. The physical therapy and/or rehabilitation unit includes locker-dressing cabinets, showers, toilets, and resting places.* *a) Exercise unit; An area of at least 50 square meters is arranged for collective exercises and instrumental exercises.* *b) Massage unit; the floor area of single rooms or cabins must be at least 5 square meters.* *c) Physical therapy unit; the floor area of single rooms or cabins must be at least 5 square meters.* *d) Hydrotherapy unit (rehabilitation pool unit); It should consist of pools with an area of 2.5 X 2.5 square meters and a depth of 150 centimeters.*

Table 4. Physical therapy and/or rehabilitation units in the hot springs' regulation

In the Health Quality Standards (Current Standards, 2020) fascicle published by the General Directorate of Health Services of the Ministry of Health in 2020, information on the variety and functioning of the service to be provided is given in section 6.14 Physical Therapy and Rehabilitation Services. Regarding the spatial arrangement in this fascicle, the *"Necessary physical and medical equipment should be provided according to the characteristics of the services provided."* statement is included.

Even though there is no regulation regarding the places that will serve the elderly and disabled tourists, the regulations and laws regarding tourism or physical rehabilitation centers and spas are a guide. There is information about the places that the buildings, which will serve this purpose, should contain at a minimum level although there is not a detailed spatial definition in these laws and regulations.

2.3. Sustainability in Elderly and Disabled Tourism

Key parameters are needed to evaluate the buildings that aim to serve the elderly and disabled tourism within the scope of the concept of sustainability. In this context, sustainability, universal design, and quality standards of the facilities were examined and criteria were determined.

2.3.1. Determination of sub-parameters within the framework of universal design principles

Depending on the increase in life expectancy with the developments in technology, even if the individual does not have a health problem, neurological functions begin to regress in the advancing period. However, there is no loss in the limbs, there is a limitation in performing daily activities. In this context, it is important to carry out a study using universal design criteria, considering the mobility of the person in the spaces created.

Especially in the last twenty-five to thirty years, universal design approaches have been discussed in a way that covers everyone, with the legal regulations made in many countries regarding the built environment, products, and services (Aközer, 2007). Universal design aims to ensure usability for everyone.

While making spatial arrangements in our country, standards are used to ensure a universal design. In this context, the standards (MKU, 2022) in Table 5 are mainly used for spatial design. These standards are guidelines and define what is required at a minimum level.

Founded by Ronald L. Mace in 1989 and renamed the Center for Universal Design at North Carolina State University in 1996, the center presented seven principles in 1997 to make universal design more understandable and real. These principles are listed in Table 6 (Dostoğlu, Şahin & Tanyeli, 2009; Hacıhasanoğlu, 2003).

TS 9111/April 1991	**Rules for Arrangement of Buildings for Disabled Persons to Residence** *(Within the scope of this standard, it is stated that the entrances of the buildings should be appropriate width, comfort and danger-free, and the points for comfortable circulation in the building both horizontally and vertically are specified in addition to all these, minimum dimensions are specified to ensure access and comfortable use.)*
TS 12576/April 1999	**Urban Roads-Design Rules for Structural Measures on Streets, Avenues, Squares and Roads for Disabled and Elderly People** (Within the scope of this standard, there is information to ensure that people with limited mobility can move freely in areas such as street, avenue and square. It contains information on the regulations that will allow the use of urban furniture and equipment.)
TS 12460/April 1998	**Urban Roads – Rail Transport System** (Within the scope of this standard, necessary regulations are included people with mobility restrictions on city roads and public transportation. It includes information on the regulations regarding both access to transportation vehicles and their comfort in the process of using transportation vehicles.)

Table 5. Turkish standards for spatial arrangement

Equitable Use	It allows the design to be used by individuals with different abilities. It is foreseen that all users benefit from the design equally. A privileged situation between users should be prevented. Security, privacy, and safety should be offered equally to all users. The design should have the quality to create the same level of attractiveness for all users.
Flexibility in Use	The design should be capable of responding to the preferences and abilities of different individuals. The user should be given the opportunity to choose the one that suits him. Equal use should be provided according to the right- and left-hand dexterity of the person. Measures should be taken to ensure the correct and sensitive use of the user. The product should be suitable for the user's speed.
Simple and Intuitive Use	An easily perceptible design should be made regardless of the user's experience, knowledge, language abilities and current concentration level. Unnecessary confusion in designs should be removed. It should respond to the user's expectations and intuitions. The design should appeal to a wide user group in terms of literacy level and language proficiency. Information should be transferred gradually according to its importance. Stimulants that are effective during or after the use of the product should be active.
Perceptible Information	The design should be able to effectively provide the information necessary for the user, regardless of the environmental conditions and the sensory abilities of the user. To ensure the readability of basic information and for this, different methods of expression (such as pictorial, verbal, textural) should be used. To increase the perceptibility of the product information by the user, it should be separated. (For example, decomposition of directions and instructions for use) The product should be capable of covering the tools and techniques used by users with sensory limitations.
Tolerance for Error	Damage that may occur because of accident or involuntary movements in the design should be minimized. The danger and error margins of the elements used in the design should be minimized, the elements that will be used intensively should be most easily accessible, and the dangerous elements should be eliminated or taken under control. Warning against danger and errors should be clearly stated. There should be mechanisms to prevent the error. In cases that require attention, arrangements should be made to limit the unintentional movement of the user.
Low Physical Effort	The designed product and space should be used comfortably by the user with minimum effort. It should be designed to protect the natural body position of the user. The product must require an acceptable power usage. Repetitive behaviors should be minimized. Situations that require prolonged physical effort should be minimized.
Size and Space for Approach and Use	Access and use should be provided in a way that adapts to the user's body size, posture, and mobility. Provide unobstructed view of key usage items for both sitting and standing users. Usage items should allow access while the user is standing or sitting. It should provide a variety of use according to different hand size and holding ability. Necessary space should be provided for people or assistive devices (such as wheelchairs, walking aids) to assist the user.

Table 6. Universal design principles

Another aspect of the universal design is that it adapts to the changing needs of the user throughout his life. Thus, in a sense, it allows to ensure continuity (Hacıhasanoğlu, 2003). In this context, the creation of spaces that will serve the elderly and disabled tourism in line with universal design principles ensures the continuity of the individual mobility of the users as well as the design.

2.3.2. Creating a minimal function chart

The places that will serve the elderly and disabled tourism today appear as a combination of spa centers and physical therapy centers. On the other hand, the positive effect of natural spring waters on health is used, also it is desired to benefit from the advantages of technology. This situation reveals a mixed-functional design. In this context, when a facility is organized, the minimum requirements for both functions must be met.

Thermal tourism, one of the health tourism activities, is a type of tourism that provides the transportation, accommodation, and hospitality needs of tourists for the use of cold and hot mineral waters for drinking and external applications for health purposes. Thermals are the use of nature-based waters in health activities by making use of their properties such as heat, minerals, and radioactivity, and these activities are handled with scientific principles (Akbulut, 2010). In the Spa Regulation, facilities that serve thermal tourism are generally defined under two main headings as indicated in Table 7.

ARTICLE 5	
→	***Spa facility:*** *It is a facility created according to the nature of the thermal or mineral water or peloid used, with a thermal treatment pool and row baths or peloid therapy units and inhalation or drinking cure units depending on the type.*
→	***Thalassotherapy facility:*** *It is a facility that has a thalassotherapy treatment pool and row baths, and thalassotherapy application units such as natural, inhalation, algae, peloid therapy, heliotherapy.*

Table 7. Thermal springs regulation – types of facilities serving thermal tourism

Spa tourism, which is categorized by the characteristics of the water used today and the types of treatment, is the developed state of the treatment places and bath culture of the old times. Asklepions are the best examples of these.

Historical research and archaeological findings show that the first examples of health structures are the Asclepions consisting of porticoed courtyards surrounded by patient rooms, built in the name of Asclepius, known as the god of physicians in Greek mythology since the 5th century BC. In this building, which we can call the first hospital, patients were tried to be treated with herbs, spiritual suggestions, music, muddy water baths, and psychotherapy, hydrotherapy, and physical therapy methods were used (Diren, 2018). During the Roman period, the importance of hot springs increased even more.

In the Roman period, natural hot water springs and structures began to be resting, morale, and entertainment centers for tired and injured soldiers as well as for treatment (Baykan, 2012). The bath culture continues today. The bath section, where hot water is used, basically consists of three main spaces. These spaces are the cold room, which includes the entrance and dressing section of the building; the warmness section, which provides the transition between coldness and warmth and is also a resting place; and the temperature section where water is used and washing areas are located. (Figure 6)

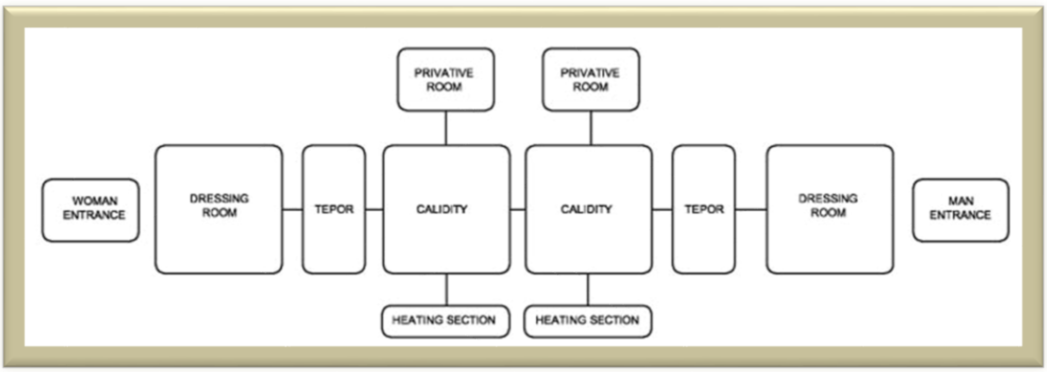

Figure 6. The interior arrangement of Turkish Baths (Apaydın Başa, 2009)

Today, the bath culture manifests itself with spa & wellness centers and these facilities are under the heading of thermal tourism or health tourism. With its vitality-enhancing feature and positive contribution to health, it supports elderly and disabled tourism.

Spa & wellness centers are mostly located within the hotel, and the design approach that is effective in hotel design makes itself felt in the spa & wellness center. Spa & wellness centers include a reception counter and reception area, waiting room, administrative offices, men's and women's locker rooms, dry treatment rooms, wet treatment rooms, and cafe-vitamin bar. Apart from these, it may optionally include meditation areas, fitness and aerobics halls, swimming pools and water sports, beauty salons, service areas (laundry, etc.), and storage areas (Apaydın Başa, 2009). Figure 7 shows the general plan schema of the spa & wellness center.

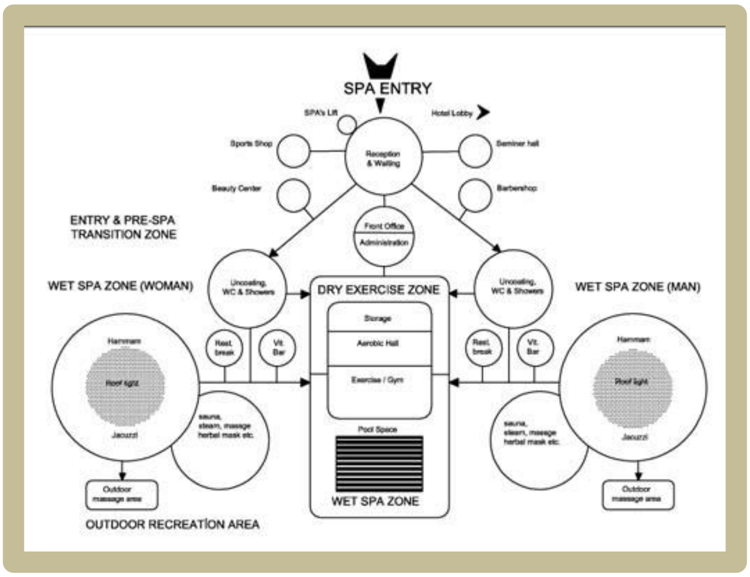

Figure 7. Spa & Wellness Center Schema (Apaydın Başa, 2009)

With the developments in technology, branching in health has increased and branch hospitals have emerged. In the Operating Regulation of Inpatient Treatment Institutions, private branch hospitals are defined as "health institutions where the observation, examination, diagnosis, treatment, and rehabilitation of patients of a certain age and gender group of those suffering from a certain disease, or patients of an organ or organ group are carried out" (MBS, 2022). Physical therapy and rehabilitation hospitals are evaluated within this scope.

Some hospitals aim to determine and treat permanent or temporary disabilities, reduced neurological function of the person for any reason, congenial or later due to illness or trauma. During the treatment process, the person is supported psychologically, socially, and professionally and becomes independent in daily life, which is a part of the treatment (Aydın, 2009). These facilities, where hot water resources can also be used due to their location today, show themselves as facilities that will contribute especially to the tourism of the elderly and disabled, as well as the treatment services.

In a comprehensive physical therapy program, electrotherapy, shock wave, radar, shot wave, ultrasound, cold-hot pack, vacuum interference, tens, diadynamic currents, infrared, electrical stimulation, traction, fluidotherapy (knee and waist), paraffin, massage, cell bath, large galvanic tub, and venues offer a wide variety of treatment services such as instrumental exercise programs and hydrotherapy (Aydın, 2009). Figure 8 shows the general plan chart of the physical therapy and rehabilitation center. The therapy halls and therapy pools in the schema are shaped for the treatment services to be provided.

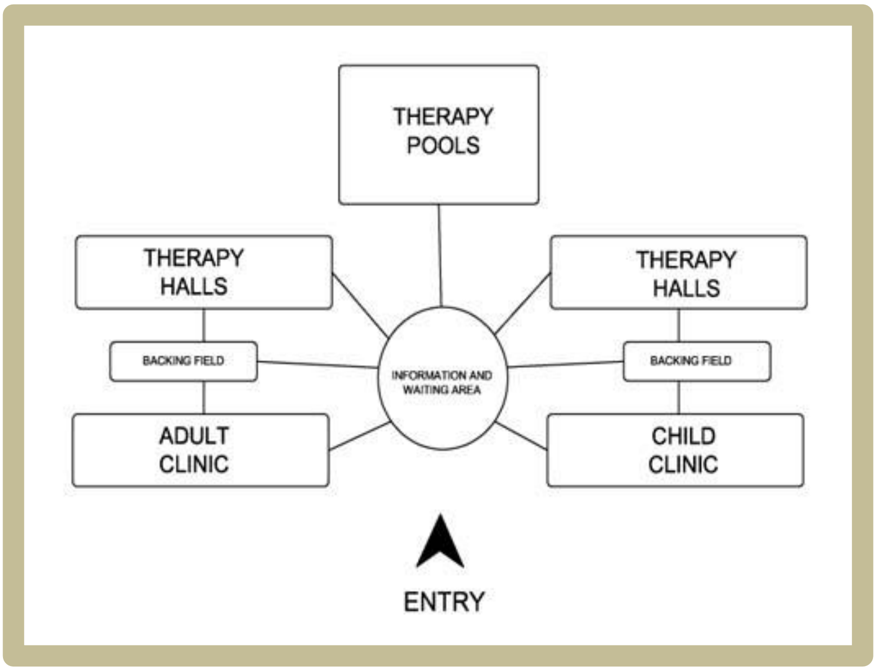

Figure 8. Physical therapy and rehabilitation center schema

2.3.3. Sustainability criteria

The concept of sustainability in the report titled "Our Common Future" published in 1987 by the World Commission on Environmental Development working within the United Nations, the concept of sustainability is defined as "Humanity; it can make development sustainable by meeting their daily needs without compromising the ability of nature to respond to the needs of future generation" (Ekolojist, 2021). The concept of sustainability essentially regulates the future with resource management. In this context, if we consider the concept of sustainability through architectural practice, we can express it as the transformation of the designed building in a way that both meets the conditions of the day and responds to the needs that will arise in the future.

The concept of sustainable architecture defines a process starting from the selection of the site where the construction will be located, local conditions, a design that will respond to current and future needs, the construction process, energy and water consumption, transportation, and waste control organization. Certain standards were needed to evaluate the effects of this process. It would be appropriate to use the criteria defined for hospitals in LEED and BREEAM certificates, which are widely used today, for facilities that will serve elderly and disabled tourists.

The Health Institutions category of the LEED certificate, adapted according to the project type and the use of the building, consists of the parameters of sustainable lands, water efficiency, energy and atmosphere, materials and resources, interior quality, innovation in design, and regional priority credits (Table 8). LEED certification is awarded according to the scoring of the headings in its main criteria (USGBC, 2021).

Sustainable Sites	It aims to protect the regional ecosystem by integrating with the project.
Water Efficiency	It includes studies for water saving indoors and outdoors. Reducing the consumption of clean water is an important thing.
Energy and Atmosphere	In this context, the use of new system includes reducing energy consumption and using renewable energy.
Materials and Resources	It aims to minimize energy consumption during the time period when the material turns into the final product from the production process.
Indoor Environmental Quality	It includes indoor issues, such as air quality, temperature, visual and acoustic comfort. Building with interior quality also protect the health and comfort of building occupants.
Innovation in Design	It is the integration of a new approach in sustainable design into design and the action of different project teams.
Location and Trasportation	It includes the primary consideration of geographical and environmental issues. Its goal is to present projects for innovative building features and sustainable building practices.

Table 8. Health Institutions criteria of LEED

The category of Health Buildings of the BREEAM certificate, which was developed to suit different building types, consists of energy, health and comfort, innovation, land use, material, management, pollution, transportation, waste, and water parameters. (Table 9) BREEAM certificate is awarded according to the scoring of the titles in its main criteria (BREEAM, 2021).

Energy	It supports systems that provide efficient use of energy. It encourages the building to increase its natural energy efficiency and reduce carbon emissions.
Health and Comfort	It is aimed to increase the quality of life by creating a healthy and safe indoor/ outdoor environment for users.
Innovation	It offers the opportunity to go beyond the existing criteria. It provides an opportunity to recognize innovations.
Land Use	The management of biodiversity through sustainable land use is discussed.
Material	It includes materials that have a direct impact on the life of buildings, including the manufacture and recycling of materials supplied in the formation of the building.
Management	It covers the section starting from the design of the building, including the operation process.
Pollution	It is aimed to reduce the wastes arising from the construction and usage process of the building.
Transport	It encourages better access to means of transport. Reducing vehicle roads; it is aimed to reduce carbon emissions by focusing on the accessibility of public transportation vehicles and other alternative transportation solution.
Waste	It promotes sustainability through building and waste and future maintenance and repairs of these wastes in relation to the building. It aims to reduce the amount of waste resulting from the construction and operation of the building.
Water	It aims to minimize the consumption of potable water throughout the life of the building.

Table 9. Health buildings criteria of the BREEAM certificate

Considering the intersecting and different parameters in the LEED and BREEAM certification systems, we can consider the buildings that will serve within the scope of health tourism under ten main headings (Figure 9).

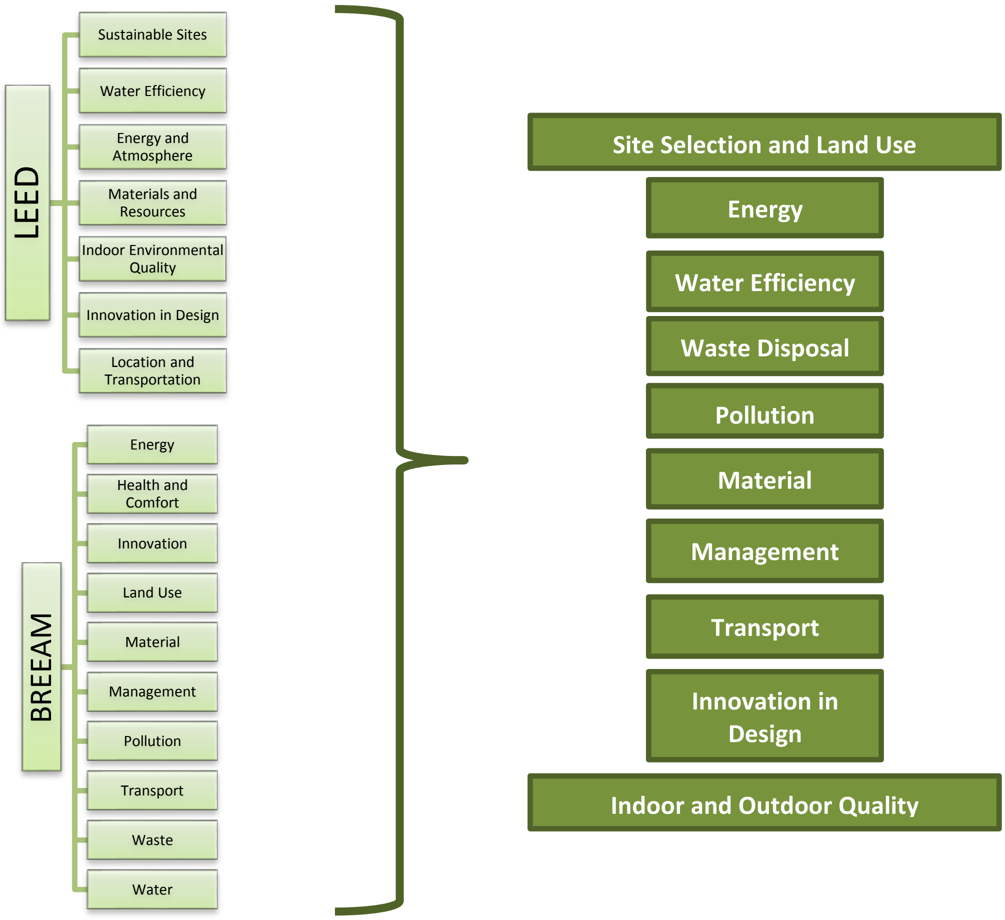

Figure 9. Sustainability criteria

2.3.4. Quality standards

Building that serve health tourism have a priority place in society because they are buildings that provide health services as well as tourism services. Its main purpose is to improve people and make society healthier. In these buildings, where the anxiety levels of the users are high, the indoor and outdoor design should be considered together to provide the best service to the users. These buildings first welcome their users with their facades and close surroundings. Entrance and landscaping should provide an environment where the person will feel safe and reduce their anxiety. In this context, the concept of architectural space should be reconsidered.

Schulz considers architectural space as a piece of space that meets the physiological, psychological, and social needs of the users living in it. Kuban state that architectural space should include the features of human life as well as formal, and that space can exist with movement and light (İnceoğlu & Aytuğ, 2009). These definitions allow that beyond the buildings that define the boundaries of the space, it is an entity that is defined and shaped by the behavior of society. The way they respond to the function they host has enabled these spaces to be addressed with the concept of quality over time.

Quality is the whole of the features that allow the needs to be met. Lynch collects the expected quality criteria in urban spaces under the headings of accessibility, adequacy, suitability, diversity, adaptability, openness, safety, stress, and efficiency (İnceoğlu, 2007). The quality parameters in the architectural space vary according to the usage practice of the space.

There is a prevailing view that well-designed environments provide benefits for both patients and staff. The design is said to reduce anxiety, lower blood pressure and relieve pain. In order to increase the positive effect of the physical characteristics of the health areas on the treatment process, the outdoor spaces should be handled with the same sensitivity.

The open areas of the facilities that will serve the elderly and disabled tourism should be created by considering the effects not only on the patients but also on other users (patient relatives, health personnel, auxiliary personnel, administrative personnel). Considering that the users of these areas are constantly changing and have very different profiles, arrangements should be made. These spaces should not only meet Lynch's urban quality criteria, but also allow active and passive use, and should be well-lit and soundproofed.

The application of the criteria in Table 10 in the design of the built environment will contribute to the creation of an improving environment (Healthplace, 2020).

Active transport for all people	It includes non-motorized forms of transportation that involve physical activity such as walking and cycling.
Aesthetic	It indicates the combined effect of elements such as the architectural and landscape design quality, visibility, and material quality of the site.
Connection	It is the directness of the relationship between the destinations.
Environments for all people	It means that it is safe and easily accessible to all individuals, regardless of age, ability, or income, with an appropriate range of facilities and services that everyone can benefit from.
Mixed density	It is the coexistence of different units.
Mixed land use	Constructing different units and different transportation options together
Parks and open spaces	Natural environments that allow sports and recreation.
Security and surveillance	The person should be made to feel safe.
Social inclution	It should allow the full participation of all individuals.
Supporting the infrastructure	It should include infrastructure units that provide active life such as walking, cycling and public transportation.

Table 10. Built environment quality criteria

In line with the characteristics of a patient-centered healing hospital, accessibility, accessibility and road to the building, the approach to the building, the presence of sufficient parking area, and the convenience, ease, and safety of all functions and equipment in the spaces for all users, including emergencies, children, families with babies and the disabled should be questioned (Sungur Ergenoğlu, 2006). Providing these criteria contributes to the healing process by reducing the level of anxiety.

Considering the above criteria, we can discuss the interaction between exterior and interior space under seven main headings (Table 11).

Location Selection	Facilities that will serve the elderly and disabled tourism should be in easily accessible location. It should have an arrangement to ptrevent the patient from being affected by adverse weather conditions at the the entarence and exit
Transporting and Parking	In the facilities that will serve the elderly and disabled tourism, the continuity of the pedestrian and vehicle roads should be ensured, and the most accurate and shortest way should be provided. Areas where they can park their motor vehicles or transportation vehicles such as bicycles should be created.
Signs	There should be directional signs that can be read easily at all hours of the day in facilities that will serve the elderly and disabled tourism.
Lighting	In the facilities that will serve the elderly and disabled tourism, lighting should be provided in a rate that the person can perceive comfortably and feel safe.
Aesthetics and Comfort	Facilities that will serve the elderly and disabled tourism should be created with recreational areas for users. All individuals should be able to access these areas unaided, and the aesthetic features of the design should be considered.
Material Selection	The selection of material and spatial design should provide comfort conditions, give a sense of hospitality, and help reduce the anxiety level of the person and shorten the recovery period.
Perception of Space	Facilities that will serve the elderly and disabled tourism should be solved in a way that does not allow confusion in a function by considering the user profile.

Table 11. Indoor and outdoor quality criteria of facilities to serve elderly and disabled tourism

3. Assessment of the Schema

The idea of sustainability in every aspect is at the heart of the places that will serve the elderly and disabled tourists. The purpose of its formation is to ensure the continuity of the health of its users positively. The facilities created in this context should be considered in terms of sustainability, universal design, and quality standards.

In the research, it has been seen that some of the sub-parameters of these three criteria overlap with each other in terms of content, although not completely. (Figure 10) Location selection, transportation, and parking, material selection parameters are included in the sub-headings of both sustainability and quality criteria. The innovation parameter in design is within the criteria of sustainability and universal design with an emphasis on flexible design. The readability of the space, signs and signage, and perceptible information paradigms can find a place in the sub-criteria of both universal design and quality criteria.

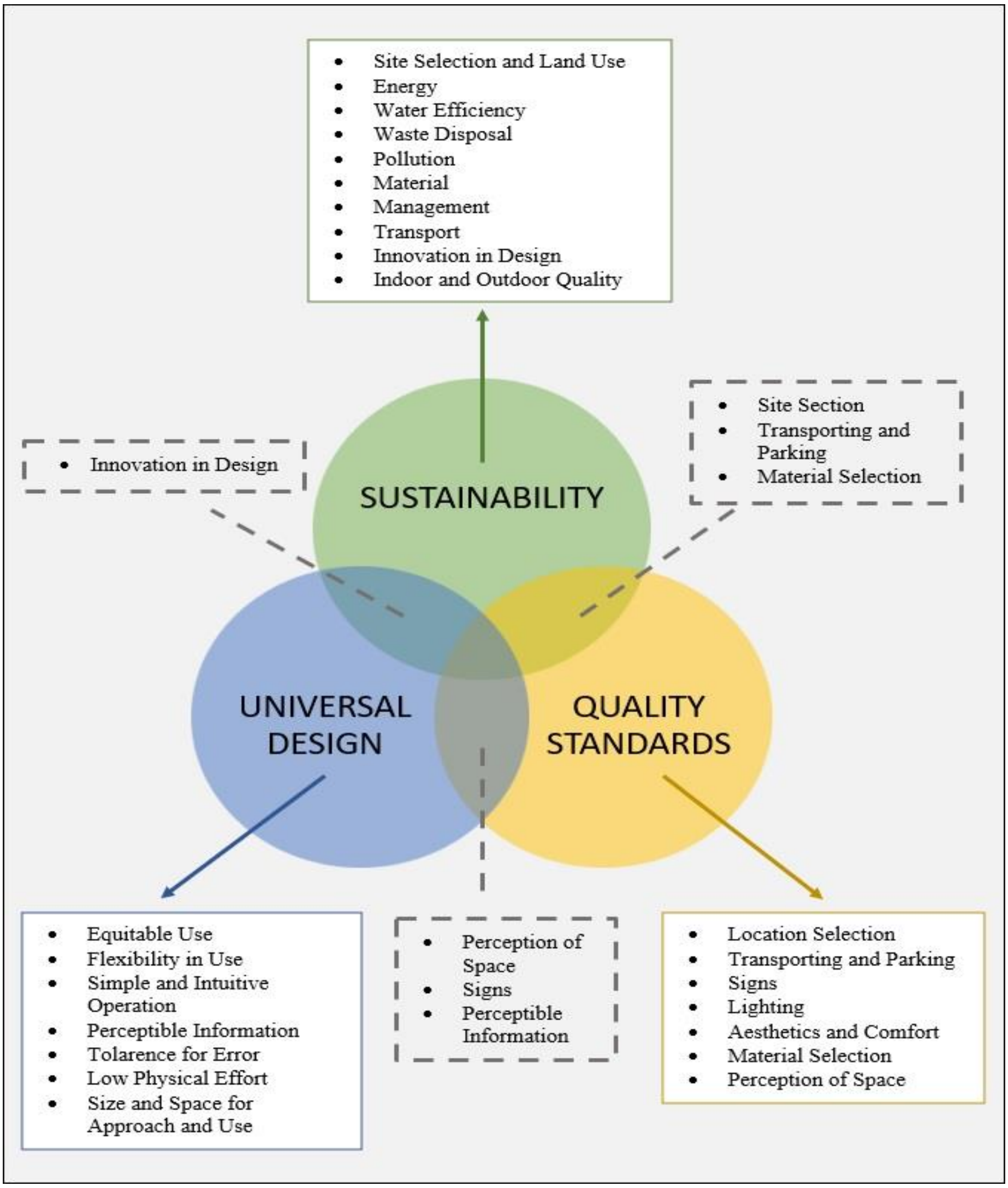

Figure 10. Sustainability-universal design-quality criteria sub-paradigms and common denominators

While creating places that will serve the elderly and disabled tourism, they are created in accordance with the regulations and standards in force. However, regulations and standards generally define minimum levels of qualification. This limits the control of sustainability, universal design, and quality standard in design. A checklist is needed in this context. Evaluation of the design within the scope of the checklist (Table 12) will inform the designer about the level of sustainability, universal design, and quality standards that are met in the study.

The design checklist is coloured for ease of use and the sub-paradigms of the main criteria are identified by the colour of the criterion they intersect, considering the intersection with other criteria. Ideally, all criteria in column 1 of the design checklist in Table 12 should be met. However, it is rarely possible to design that meets all criteria. The parameters marked in column 2 are the criteria that must be present in all cases. When sustainable design is targeted, all of the criteria in the second section must be fulfilled. Considering the intersections of the parameters in the 3rd, 4th, and 5th columns, ideal design examples were obtained. Designs that fulfill any of these pillars are the closest to the ideal. This list can be used in the design phase as well as in the determination of the works to be carried out for the improvement of the facility by determining the status of the facilities already in service.

DESIGN CHECKLIST		1	2	3	4	5
SUSTAINABILITY	Site Selection and Land Use	✓		✓	○	✓
	Energy	✓	✓	✓	✓	✓
	Water Efficiency	✓	✓	✓	✓	✓
	Waste Disposal	✓	✓	✓	✓	✓
	Pollution	✓	✓	✓	✓	✓
	Material	✓		✓	✓	○
	Management	✓	✓	✓	✓	✓
	Transport	✓		○	○	✓
	Innovation in Design	✓		○	✓	✓
	Indoor and Outdoor Quality	✓	✓	✓	✓	✓
UNIVERSAL DESIGN	Equitable Use	✓	✓	✓	✓	✓
	Flexibility in Use	✓		✓	○	○
	Simple and Intuitive Operation			○	✓	○
	Perceptible Infornation	✓		○	✓	○
	Tolarence for Error	✓	✓	✓	✓	✓
	Low Physical Effort	✓	✓	✓	✓	✓
	Size and Space for Approach and Use	✓	✓	✓	✓	✓
QUALITY STANDARDS	Location Selection	✓		○	✓	○
	Transporting and Parking	✓		✓	✓	○
	Signs	✓		✓	○	✓
	Lighting	✓	✓	✓	✓	✓
	Aesthetics and Comfort	✓	✓	✓	✓	✓
	Material Selection	✓		○	○	✓
	Perception of Space	✓		✓	○	✓

Table 12. Design checklist

4. Conclusion

Within the scope of the study, it is aimed to define the design criteria in the context of spatial requirements and to create a scheme to increase its performance in the design of a building that aims to serve the elderly and disabled tourism. These buildings contain many different dimensions and require the designer's mastery of various subjects.

The checklist created for advanced elderly and disabled tourism facilities provides convenience to the designer by providing control of these multi-faceted structures during the design phase. It will enable the deficiencies of the design to be quickly identified and solutions to be offered. It allows the control of multidimensional and complex requirements in a certain order in the preliminary work phase and other stages in the design process. In addition to the service provided, it will contribute to shortening the recovery period with a positive effect on the place. As a result of that, it will be possible to achieve a sustainable design in all aspects, especially ecological, universal design, and quality. The spaces created with such an approach will help to support the healing hospital approach. It will contribute to the update of knowledge and experience sharing by recognizing the products. Additionally, it makes a great contribution to the designer for revealing and exhibiting the planning.

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The article complies with national and international research and publication ethics. Ethics committee approval was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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Effects of Auditory and Visual Setup on the Perception of Space

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Abstract

People perceive, understand, and read the environment through the senses. Vision and hearing, the two most effective senses in sensing space, provide much more effective and lasting information. The mechanism of action of eyesight and hearing and the determination of the factors affecting these senses are especially important in terms of space design. The study, it is aimed to reveal how and to what extent the visual and hearing sensations affect space design in isolation and together. In this way, the contribution of auditory and visual information to improving the human space experience was investigated. To determine this, the positive and negative effects of the auditory and visual information experienced by people were observed. In the study, One-to-one and collective survey method was followed. The application was carried out with 9 sound and 9 visual materials. Sound, visual materials, and a standard questionnaire were applied to 271 participants. As a result of the study, it was revealed that different combinations of sound, image, and the combination of both are effective on people's perception of space and under what conditions the effect occurs.

Keywords: *Auditory landscape, landscape design, sound, space sensation, visual.*

İşitsel ve Görsel Kurgunun Mekân Algısı Üzerindeki Etkileri

Öz

İnsanlar duyuları aracılığıyla çevreyi algılar, anlar ve okur. Uzayı algılamada en etkili iki duyu olan görme ve işitme, çok daha etkili ve kalıcı bilgi sağlar. Görme ve işitme duyularının etki mekanizması ve bu duyuları etkileyen faktörlerin belirlenmesi özellikle mekân tasarımı açısından önemlidir. Çalışmada, görsel ve işitsel duyumların birbirinden bağımsız ve birlikte mekân tasarımına nasıl ve ne ölçüde etki ettiğini ortaya koymak amaçlanmaktadır. Bu sayede işitsel ve görsel bilgilerin insanın mekân deneyiminin iyileştirilmesine katkısı araştırılmıştır. Bunu belirlemek için insanların deneyimlediği işitsel ve görsel bilgilerin olumlu ve olumsuz etkileri gözlenmiştir. Çalışmada; birebir ve toplu anket yöntemi izlenmiştir. 9 işitsel ve 9 görsel materyal ile uygulama gerçekleştirilmiştir. İşitsel, görsel materyaller ve standart anket formu 271 katılımcıya uygulanmıştır. Çalışma sonucunda ses, görüntü ve her ikisinin kombinasyonunun farklı kombinasyonlarının insanların mekân algısı üzerinde etkili olduğu ve etkinin hangi koşullarda ortaya çıktığı ortaya konmuştur.

Anahtar kelimeler: *İşitsel peyzaj, peyzaj tasarımı, ses, mekân hissi, görsel.*

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1. Introduction

From the moment one first begins life, people interact and communicate with the environment. This relationship is realized by the mechanism of perception (Çanakçıoğlu, 2016). The process of understanding the environment takes place by transmitting data from one of our sensory organs to another and finally transmitting it to the brain. This whole process is called perception (Artantaş, 2007). The mechanism of perception defines and helps make sense of the environment together with the sensory organs. Among our five sensory organs, vision and hearing are more effective in perceiving, making sense of the environment, and creating first impressions.

According to Morgan (1994), our perception is to understand, interpret and express our perceptions as a whole. Lang (1987) reflects perception as an active process and the current state of one's past experiences and requirements; Cüceloğlu (1996) as comprehending the surrounding events and objects through the way of reason; Rapoport (1977), unlike other resources, evaluated perception through the appearance of objects and revealed characteristics that vary between individuals.

Perception is selective. In the process of perception, the person perceives what is happening around him in a way that is limited to his senses. It's holistic. In the perceptual process, every event or object is perceived as a whole, not individually. It's organized. In perception, each element is interrelated. It's immutable. In perceptual concepts, immutableness is provided by concepts such as measurement, shape, brightness, color, and texture. It's a stimulus. Reasons such as increased stimulant in perception and missing cause no change in the message that is intended to be transmitted (Erkman, 1973; Morgan, 1994; Cüceloğlu, 1996; Özgen, 2009).

Human perception is constantly changing and evolving. Perception is refreshed in every image, every sound heard, and every object touched. Perception varies according to conditions and individuals. Perception is influenced by external and internal factors. External factors; current ambient conditions, sound, light, color, temperature, internal factors; past experiences and experiences, social and cultural environment, and mood (Acaralp, 2009; Gezer, 2012). We use our sensory knowledge to learn from our surroundings and to make an idea about something. Many sensations such as the tone of the sound, the temperature of the tea, the brightness of light, or pain felt when touching fire come into play with visual perception, auditory perception, taste perception, smelling and tactile perception dimension and perception specific to each sensory organ (Morgan, 1994; Taşkıran & Bolat, 2013). Within all these sensory and perception mechanisms, vision and hearing are considered primary and others are considered secondary sensory organs. Civilization was also founded largely on the senses of vision and hearing (Özer, 2005).

Space and architecture constitute important data in environmental perception. So that Schulz (1971) defines architectural space as the embodiment of existential space. As a result of the interaction of the individual with his environment, an existential space occurs. Architectural space represents a process shaped according to the needs and wishes of the person.

Personal experiences, good observation, and fine details are effective in the perception of architectural space. The greater the relationship with a space, the greater the sense of belonging to the place. Qualitative factors such as color, smell and quantitative factors such as intensity and duration are perceptually located in the memory of the individual. Therefore, these factors create an interactive relationship not only between space but also between space and life in space (Gezer, 2012). In his book 'The Image of City', Lynch (2015) mentions the concept of direction, noting that circulation must take place in that space in order to perceive the space and the direction. Schulz (1971) explains the effect of movement in architectural space as follows; "Man is the focus of the space and the directions of the space continue to change with the movements of man." According to Bell (1999) and Wallace (2012), perception of the environment is largely due to vision and hearing. When vision occurs, the landscape has many effects on visual perception. One of the most important aspects of visual physiology is contrast and visual sensitivity (Yılmaz, 2008). The concept of auditory landscape entered the literature with Schafer's "*The New Soundscape*" (1969). The concept of auditory landscape refers to the perception of these sounds in the field with the combination of many sound elements.

In light of all this data, the effect of audio and visual setup on the concept of perception and how and to what extent this setup affects space design in isolation and together constitutes the general purpose of the research. At the same time, it is the secondary goal to determine the mechanism of influence in shaping the preferability of space with different sound and image alternatives and different combinations of both. For all these purposes, determining with concrete evidence that hearing and vision have different effects in terms of space design and space users indicates the desired result.

2. Material and Method

2.1. Material

When determining the image categories, the images included in Lindquist relating to the research subject were examined and these categories were developed (Lindquist, 2014). In the selection of images, general images that do not change people's perception and are accepted by everyone are preferred. In the study, sound categories were determined and the sound categories that Schafer (1969) classified according to the reference characteristics were generalized and evaluated within the scope of the study. In the study, the use and the image and sound categories that constitute the material of the study are given in Figure 1 and Table 1 together with their characteristics and reasons for their preference.

In his study, Lindquist (2014) divided the work site by landscape categories. He created fictional design images of images obtained from the field and examined the interaction of reality perception with sound in 3D images. He evaluated his work with 252 participants using 3 questions and four audio categories. When the subjects were given sound, the image investigated the perception of reality and preferability.

Image	Reasons for preference	Image	Reasons for preference
	**G1-Water image:** A non-artificial water surface was preferred, which is completely virgin, no elements that can change the perceptions of the participants are allowed.		**G6-Urban image:** A city view with people of different ages, traffic officers, business centers, and motorized and non-motorized vehicles was preferred.
	**G2-Trafic image:** The closest visualization to a real traffic setting, with a high density of motorized and non-motorized vehicles, was chosen.		**G7-Suburban image**: Real rural view, which is dominated by the village texture and makes you feel a natural life, was preferred.
	**G3-Street image:** A visual that does not include any building elements that would change the perception of the participants and that has a real street setup was preferred.		**G8-Square image:** The view of a square with shopping and business centers, which is used as a gathering and resting area, was preferred.

G4-Park image:
A park view with high landscape quality and with groups of people of all ages was preferred.

G9-Trade-craft image:
The image of the area with the businesses and sales staff is preferred.

G5-Nature image: A nature image with a high landscape quality and completely composed of a natural setup was preferred.

Figure 1. The image categories and reasons for preferences (Greenplanner, 2019; Guiaenmarruecos, 2019; Guzelresimler.info, 2019; Manzara, 2019; Nomadicmatt, 2019; Pics4learning, 2019; Pinterest, 2019; Pixabay, 2019; Shutterstock, 2019)

Selected image categories are general images from urban and natural habitats that can appeal equally to everyone. While the audio categories, which are the second part of the working material, were selected; sounds from natural and urban living environments were evaluated, which matched the appropriate image categories. The contents of the selected sounds are as follows.

Table 1. Sound categories and characteristics (A World Sound 1-3, 2018; Black Striker, 2018; Current Posts TV, 2018; Çağdaş Kaya 1-3, 2018; Guzelresimler.info, 2019; Relaxing and Useful Sounds, Noises and Videos, 2018; Sound Effects 1-2, 2018; YouTube 1-2, 2018)

Sounds	Characteristics
1. sound	It is preferred by combining relaxing water sound and rain sound in harmony with the water visual.
2. sound	Motorized and non-motorized vehicle sounds and horn sounds are preferred in accordance with the traffic visual.
3. sound	Human voices and bird sounds are preferred in line with the street-street visual.
4. sound	Street music, bird sounds, and human voices were preferred in line with the park visual.
5. sound	Bird sounds and wind sounds are preferred in harmony with nature.
6. sound	In harmony with the city, motor vehicle sounds, tram sounds, speech sounds and step sounds were preferred.
7. sound	Tractor sounds and lamb sounds were preferred in harmony with the countryside.
8. sound	Speaking sounds, bird sounds and the voices of salespeople were preferred in harmony with the square.
9. sound	In line with trade, crowded human voices and salespeople voices were preferred.

2.2. Method

The method of the study consists of four main stages; in the first stage of the study, the appropriate material selection was made for the research subject. When selecting materials, audio categories and image categories were determined by taking into account the sources reviewed about this research subject (Schafer, 1993; Lindquist, 2014).

In the second stage, adjective pairs that can express these categories and reflect the moods of the participants were created. When creating adjective pairs, the Turkish dictionary of the Turkish Language Institution was used and the emotional adjectives reflecting people's moods were selected according to the scope of the research among 1326 adjective groups. These adjectives were further generalized and reduced to 18 adjective types. Adjective pairs were chosen to be used in the study; It is Happy-Unhappy, Pessimistic-Optimistic, Free-Restricted, Safe-Insecure, Emotional-Rational, Delightful-Unhappy, Relaxed-Tense, Stagnant-Dynamic, and Peaceful-Restless.

In the third phase of the study, the stages of creating, implementing, and analyzing the survey are included. When creating the survey, the audio, visual, and visual-audio categories are divided into three sections. 9 categories were created for each audio, 9 categories for each image, and finally 9 categories for each audio. The survey was conducted with 271 participants. These participants are students of English Language Literature, Food Engineering, Graphic Design, Psychological Counseling and Rehabilitation, Sociology, Plant Protection, Medicine, Nursing, and Landscape Architecture. The implementation of the survey was carried out as follows; the audio and visual material, which will be presented primarily to the participants, has been prepared as a PowerPoint presentation. Stereo speakers were used to play the sounds during the survey. Each sound within the 9 Audio category was played for 8 seconds and the participants were asked to choose adjectives expressing their feelings about the sounds, after which this was applied separately for 9 visual and 9 visual-audio categories.

In the fourth part, which is the final stage of the research, survey analyses were carried out based on the survey data. For these analyses, frequency distribution and the Cros Table test were analyzed using SPSS 16.0 program. In parallel with the audio and visual survey, a standard survey was applied that allows the acquisition of personal information, data such as perception, and instant emotional state.

3. Experimental Results

The questionnaire applied to the participants was analyzed and the obtained data is given in detail in this section. Survey; It consists of 57% women and 43% men. 25% of the participants in the survey are 1st grade, 21% are 2nd grade, 42% are third grade and 12% are 4th-grade students. The survey was conducted in nine different academic departments. The distribution of the participants according to the departments is given in Table 2.

Table 2. Percentage distribution by departments

Department	%	Scope	Total
English Language and Literature	5	Social and humanities	25
Psychological Counseling and Guidance	10		
Sociology	10		
Food Engineering	5	Engineering	13
Plant Protection	8		
Nursing	9	Health	29
Medicine	20		
Graphic Design	7	Design	33
Landscape Architecture	26		

The professions of the families of the survey participants are 25% civil servants and self-employed, 12% private sector, 7% tradesmen, 20% retired, 3% unemployed, and 8% farmers. Also, 88% live in the city and 12% in the village.

Although the left and right brains work together, they specialize independently of each other. According to Sperry (1981), the left part of the brain is responsible for verbal and rational thinking, and the right part is responsible for perceptual and visual thinking. Visual perception occurs in the right brain. During visual analysis, details are noticed, perception is strengthened, observation occurs, and imagination is activated (Laseau, 2001).

Survey participants were also asked which hands they use. Because it is known to be related to the way the brain works. 86% of the participants use their right hand, 7% use their left hand, and 7% use both hands. The participants were also asked about their mood at the time of the survey (Table 3).

Table 3. Percentage distribution by mood

Mood	%
Happy	17
Unhappy	6
Pessimistic	6
Optimistic	13
Free	3
Limited	3
Safe	1
Insecure	1
Emotional	3
Rational	1
Pleasant	4
Seedy	10
Comfortable	5
Nervous	5
Severe	16
Dynamic	2
Peaceful	2
Restless	2

Participants were asked where they would like to live. The participants said 8% were villages, 24% were urban, 8% were in the forest, 48% were coastal towns, and 12% were lakeside. Participants were asked whether they were acting with logic or emotions. The participants answered that they act 39% with their emotions and 61% with logic.

Since the questionnaire measures visual and auditory perception, the position of the participants in relation to the image and sound source during the survey is important. For this reason, the sitting positions of the participants during the survey were also marked. These values are shown in Table 4.

Table 4. Percentage distribution by location

	The image and sound source		
	Left	Middle	Right
Front	%7	%14	%12
Middle	%8	%20	%11
Back	%7	%12	%9

As a result of the frequency analysis, the adjectives that were most, least, and not preferred by the participants in the categories of sound, image, and image-sound were determined (Table 5).

Table 5. Preference and percentage values of adjectives in three category types

Adjectives	Sound (%)									Imagine (%)									Imagine and Sound (%)								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Happy	8	2	41	15	13	11	45	24	4	51	4	18	31	40	5	41	3	25	38	2	34	30	30	6	40	14	18
Unhappy	5	10	4	7	7	8	8	2	15	2	25	4	7	7	15	5	17	6	6	21	8	7	10	15	12	12	15
Safe	1	4	6	1	2	11	9	10	7	4	1	23	15	15	5	11	5	5	3	4	14	11	12	7	11	7	3
Insecure	14	14	3	10	18	9	2	5	16	2	20	3	1	2	20	2	15	8	5	17	3	2	1	15	2	7	10
Pleasant	4	2	13	15	4	11	13	10	5	12	2	10	16	14	1	13	3	15	13	2	15	11	10	6	10	10	13
Seedy	18	18	4	10	14	8	1	7	15	1	14	3	1	1	10	2	14	6	4	18	2	5	4	12		10	9
Comfortable	5	2	8	8	3	5	6	10		6	1	13	13	4	1	10	2	6	6	2	7	12	3	3	6	7	5
Nervous	16	15	1	7	12	12	2	5	11		15	1	1	1	14	1	7	4	4	14	1	3	4	10	2	7	6
Severe	4	2	3	1	4	3	2	4	1	4	1	14	1	2	1	1	6	5	1	3	3	3	2	2	2	9	2
Dynamic	4	7	3	12	2	8	2	3	10	1	7	1	2	1	6	1	7	6	2	10	3	5	3	10	1	7	10
Peaceful	6	1	14	5	2	1	4	4	1	14	1	6	3	9	1	6	1	2	8	1	4	4	8	2	3	1	2
Restless	6	7	1	2	8	5	1	4	4		4		1	1	6	1	7	3	3	4	1	4	2	4	1	2	2
Free	2	3	3	4	3	4	2	2	2	3	1	1	4	3	1	2	2	2	2	2	1	2	2	1	4	2	3
Limited	1	10		2	3	1	1	5	3		3	3	1		3		4	2	1	3	1	1	1	3	1	2	2
Pessimistic	2	2	1	2	3	1		1	1		1	1			2	1	2		1	1	1	1	1	1	1	1	1
Optimistic	1		1	1	2		1	2		1		2	2	1	1	1		3	1			1	1	1	1	1	3
Emotional	1				1	1		1					1			1		1	1			1	1		1		
Rational		2		1	1	1	1	1	1					1	1	1	2	1						3	1	1	

*The gray colored boxes in the table indicate the most preferred adjective in that category.

For the sound category, the most, least preferred, and not preferred adjectives of the participants are given in Table 6.

Table 6. Sound categories

Sounds	Most preferred adjectives	Least preferred adjectives	Adjectives not preferred
Sound 1	Seedy	Restricted, optimistic and emotional	Rational
Sound 2	Seedy	Peaceful	Optimistic and emotional
Sound 3	Happy	Nervous, restless, pessimistic, optimistic	Restricted, emotional and rational
Sound 4	Happy and pleasant	Safe, calm, optimistic and rational	Emotional
Sound 5	Insecure	Emotional and rational	Optimistic
Sound 6	Nervous	Peaceful, restrained, pessimistic, emotional and rational	-
Sound 7	Happy	Unhappy, restless, restrained, optimistic and rational	Pessimistic and emotional
Sound 8	Happy	Pessimistic, emotional and rational	-
Sound 9	Insecure	Still, peaceful, pessimistic and rational	Emotional

For the image category, the adjectives that the participants most, least prefer and do not prefer are given in Table 7.

Table 7. Image categories

Images	Most preferred adjectives	Least preferred adjectives	Adjectives not preferred
Image 1	Happy	Seedy, dynamic and optimistic	Nervous, restless, limited, pessimistic, rational and emotional
Image 2	Unhappy	Comfortable, severe, peaceful, free and pessimistic	Optimistic, emotional and rational
Image 3	Safe	Nervous, dynamic, free and pessimistic	Restless, emotional and rational
Image 4	Happy	Insecure, seedy, nervous, severe, restless, limited and emotional	Pessimistic ve rational
Image 5	Happy	Seedy, nervous, dynamic, restless and optimistic	Limited, pessimistic and emotional
Image 6	Insecure	Pleasant, comfortable, severe, peaceful, free, pessimistic, optimistic and rational	Emotional
Image 7	Happy	Nervous, severe, dynamic, restless, pessimistic, optimistic, emotional and rational	Limited
Image 8	Unhappy	Peacefulandoptimistic	Emotional
Image 9	Happy	Emotional ve rational	Pessimistic

For the image-sound category, the most, least preferred, and not preferred adjectives of the participants are given in Table 8.

Table 8. Image-sound categories

Images-sounds	Most preferred adjectives	Least preferred adjectives	Not preferred adjectives
Image-sound 1	Happy	Severe, limited, pessimistic, optimistic, and emotional	Rational
Image-sound 2	Unhappy	Peaceful and pessimistic	optimistic, emotional and rational
Image-sound 3	Happy	Nervous, restless, free, limited and pessimistic	optimistic, emotional and rational
Image-sound 4	Happy	limited, pessimistic, and optimistic	Rational
Image-sound 5	Happy	Güvensiz, limited, pessimistic, optimistic, and emotional	Rational
Image-sound 6	Unhappy	free, pessimistic, and optimistic	Emotional
Image-sound 7	Happy	Dynamic, restless, limited, pessimistic, optimistic, emotional, and rational	Seedy
Image-sound 8	Happy	Peaceful, pessimistic, optimistic, and rational	Emotional
Image-sound 9	Pleasant	Pessimistic and emotional	emotional and rational

Sound categories according to gender were compared and analyzed. In 9 sound categories, a semantic relationship was found between the 1st sound, 4th sound, and 5th sound ($p<0.05$) (Table 9).

Table 9. Comparison of gender and sound categories

Gender	*Preferred adjectives for sound 1	%	*Preferred adjectives for sound 4	%	*Preferred adjectives for sound 5	%
Woman	Nervous	21.3	Pleasant	16	Insecure	20.2
Man	Seedy	21.6	Happy	20.1	Happy	15.8

(*p<0.05 Significant relationship)

The image categories according to gender were compared and analyzed. Only the 4th image was found significant in 9 image categories ($p<0.05$). 29.8% of women and 25.9% of men felt happy for the 4th image. According to gender, image-sound categories were compared and analyzed. The 1st picture sound and 6th picture sound were found important in 9 categories of picture sound ($p<0.05$) (Table 10).

Table 10. Comparison of gender and image-sound categories

Gender	*Preferred adjectives for the 1st image-sound	%	* Preferred adjectives for the 6th image-sound	%
Woman	Happy	45.2	Insecure	15.4
Man	Happy	29.5	Unhappy	15.8

(*p<0.05 Significant relationship)

The question of "the place of residence of your family (Village \ City)" in the questionnaire; was examined separately in sound, image, and image-sound categories. As a result of the analysis of the comparison of sound and residence, only the 8th sound in 9 sound categories was found to be very important ($p<0.05$). 24.6% of urban residents and 15% of villagers felt happy about the 8th sound. In other sound categories, there was no significant difference between the users' families living in the city or village ($p>0.05$).

In the question "place of residence of the family", no semantic relationship was found in the comparison of residence-image and residence-image-sound ($p>0.05$). Comparative analysis was carried out in the categories of sound, image, and image-sound according to the department of the participants. As a result of this analysis, the most preferred adjectives in categories with significant relationships were determined. In the comparison of the department and sound categories, it was found a very significant relationship for the 1st sound ($p<0.001$). It was determined as a result of the analysis that there is a significant relationship between the 4th sound, 7th sound, 8th sound, and 9th sound. ($p<0.05$) (Table 11).

Table 11. Comparison of department and sound categories

Department	** Preferred adjectives for sound 1	%	* Preferred adjectives for sound 4	%	* Preferred adjectives for sound 7	%	* Preferred adjectives for sound 8	%	* Preferred adjectives for sound 9	%
English language and literature	Insecure	23.5	Happy	23.5	Happy	47.1	Seedy	35.3	Dynamic	23.5
Food engineering	Seedy	35.3	Seedy	41.2	Happy	88.2	Restless	17.6	Seedy	29.4
Graphic design	Happy	27.3	Happy	22.7	Happy	22.7	Pleasant	27.3	Dynamic	22.7
Psychological counseling and guidance	Nervous	21.2	Insecure	27.3	Happy	57.6	Happy	27.3	Insecure	24.2
Sociology	Peaceful	23.5	Dynamic	20.6	Happy	41.2	Happy	23.5	Insecure	29.4
Nursing	Comfortable	20	Pleasant	30	Happy	53.3	Happy	26.7	Nervous	20
Plant Protection	Seedy	32	Happy	28	Happy	36	Pleasant	28	Nervous	24
Medicine	Seedy	16.9	Happy	16.9	Happy	35.4	Happy	24.6	Dynamic	16.9
Landscape architecture	Nervous	22.6	Dynamic	16.7	Happy	29.8	Happy	29.8	Unhappy	17.9

(*p<0.05 Significant relationship**p<0.001 Very significant relationship)

There is a significant relationship between the 3rd image and the 5th image when comparing the department and image categories ($p<0.05$) (Table 12).

Table 12. Comparison of department and image categories

Department	* Preferred adjectives for image 3	%	* Preferred adjectives for image 5	%
English language and literature	Safe	41.2	Happy	41.2
Food engineering	Happy	47.1	Happy	41.2
Graphic design	Safe	18.2	Happy	23.8
Psychological counseling and guidance	Comfortable	21.2	Happy	48.5
Sociology	Safe	41.2	Happy	52.9
Nursing	Happy	16.7	Happy	43.3
Plant Protection	Safe	32	Unhappy	36
Medicine	Happy	23.1	Happy	27.7
Landscape architecture	Happy	16.7	Happy	43.4

(*$p<0.05$ Significant relationship)

No significant relationship was found as a result of the analysis made in the comparison of image-sound by departments ($p>0.05$).

The family occupation question in the questionnaire was compared separately for sound, image, and image-sound categories. No significant relationship was found as a result of the analysis made in the comparison of the family profession and sound ($p>0.05$). In the comparison of family occupation and image categories, it was determined that there was a significant relationship ($p <0.05$) for the 2nd image, and a very significant relationship for the 5th image ($p<0.001$) (Table 13).

Table 13. Comparison of the family profession and image categories

Family profession	*Preferred adjectives for image 2	%	**Preferred adjectives for image 5	%
Officer	Insecure	24.7	Happy	37.5
Self-employment	Unhappy	28.8	Happy	47.6
Private sector	Unhappy	26.3	Happy	42.1
Artisan	Unhappy	33.3	Peaceful	29.2
Retired	Insecure	20	Happy	38.5
Unemployed	Insecure	41.7	Happy	25
Farmer	Unhappy	29.6	Happy	33.3

(*$p<0.05$ Significant relationship**$p<0.001$ Significant relationship)

As a result of the comparative analysis of family occupation and image-sound categories, a significant relationship was found only for the 3rd image-sound category ($p<0.05$) (Table 14).

Table 14. Comparison of the family profession and sound-image categories

Family profession	* Preferred adjectives for image-sound 3	%
Officer	Happy	35.8
Self-employment	Happy	30
Private sector	Peaceful	26.3
Artisan	Happy	20.8
Retired	Happy	43.1
Unemployed	Happy	50
Farmer	Happy	33.3

(*$p<0.05$ Significant relationship)

The "mood" question was compared separately in terms of sound, image, and image-sound categories. In the comparison of mood and sound categories, a significant relationship was found only for the 3rd sound ($p<0.05$) (Table 15).

Table 15. Comparison of mood and sound categories

Mood	*Preferred adjectives for sound 3	%
Happy	Happy	36.4
Unhappy	Happy	23.8
Pessimistic	Happy	33.3
Optimistic	Happy	47.6
Free	Happy	50
Limited	Pleasant	30
Safe	Dynamic	50
Insecure	Comfortable	50
Emotional	Happy	55.6
Rational	Comfortable	50
Pleasant	Happy	57.1
Seedy	Happy	57.6
Comfortable	Happy	29.4
Nervous	Peaceful	28.6
Severe	Happy	37.7
Dynamic	Happy	28.6
Peaceful	Happy	40
Restless	Pleasant	28.6

(*p<0.05 Significant relationship)

In the comparison of mood and image categories, a significant relationship was found only for the 9th image ($p<0.05$) (Table 16).

Table 16. Comparison of mood and image categories

Mood	* Preferred adjectives image 9	%
Happy	Happy	20
Unhappy	Happy	33.3
Pessimistic	Pleasant	19
Optimistic	Happy	23.8
Free	Happy	20
Limited	Pleasant	40
Safe	Happy	50
Insecure	Happy	50
Emotional	Happy	22.2
Rational	Unhappy	33.3
Pleasant	Happy	50
Seedy	Happy	24.2
Comfortable	Happy	17.6
Nervous	Happy	28.6
Severe	Happy	28.3
Dynamic	Restless	28.6
Peaceful	Optimistic	40
Restless	Safe	14.3

(*p<0.05 Significant relationship)

In the comparison of mood and image-sound categories, a significant relationship was found only for the 4th image-sound category ($p<0.05$) (Table 17).

Table 17. Comparison of mood and image-sound categories

Mood	*Preferre adjectives image-sound 4	%
Happy	Happy	29.1
Unhappy	Pleasant	23.8
Pessimistic	Happy	19
Optimistic	Happy	33.3
Free	Safe	20
Limited	Comfortable	40
Safe	Happy	25.2
Insecure	Happy	25
Emotional	Happy	33.3
Rational	Dynamic	33.3
Pleasant	Happy	35.7
Seedy	Happy	33.3
Comfortable	Happy	29.4
Nervous	Happy	35.3
Severe	Happy	28.3
Dynamic	Happy	57.1
Peaceful	Happy	40
Restless	Happy	28.6

(*p<0.05 Significant relationship)

The question "Which hand do you use" has been compared separately for sound, image, and image-sound categories. In the comparison of "which hand" and sound categories, there is a significant relationship only for the 1st image (p<0.001). %18.1 of right-handers felt nervous, % 20.8 of left-handers, and %31.8 of both of them felt seedy for sound 1.

In the comparison of which hand and image categories, it was determined that there was a semantic relationship between the 6th image and the 7th image (p<0.05) (Table 18).

Table 18. Comparison of "Which hand" and image categories

Which hand	* Preferred adjectives for image 6	%	* Preferred adjectives for image 7	%
Right hand	Insecure	18.5	Happy	37.7
Left hand	Insecure	41.7	Happy	66.7
Both of them	Nervous	22.7	Happy	36.4

(*p<0.05 Significant relationship)

No significant relationship was found as a result of the analysis in the image-sound category comparison for the question "Which hand" (p>0.05).

The question "Where you want to live" has been compared separately for sound, image, and image-sound categories. According to the analysis results, there was no significant relationship in the comparison of "desired place to live" and sound categories (p> 0.05). In the comparison of "desired place to live" and image categories, a significant relationship was found only for the 8th image (p <0.05) (Tablo 19).

Table 19. Comparison of "desired place to live" and sound categories

Desired place to live	*Preferred adjectives for image 8	%
Village	Limited	17.6
Urban	Unhappy	17.9
Forest	Nervous	19.2
Seaside town	Unhappy	18.6
Lakeside	Insecure	15.4

(*p<0.05 Significant relationship)

In the comparison of the "desire place to live" and image-sound categories, a meaningful relationship was found for the 2nd image-sound and 7th image-sound. (p<0.05) (Table 20).

Tablo 20. Comparison of "desire place to live" and image-sound categories

Desired place to live	* Preferred adjectives for sound-image 2	%	* Preferred adjectives for sound-image 7	%
Village	Nervous	21.4	Happy	57.1
Urban	Insecure	21.8	Happy	34.6
Forest	Seedy	42.3	Happy	46.2
Seaside town	Unhappy	26.3	Happy	40.4
Lakeside	Seedy	28.2	Happy	30.8

(*p<0.05 Significant relationship)

The question "Which one is in for your foreground" was compared separately for sound, image, and image-sound categories (p <0.05). According to the analysis results, there is a significant relationship only for the 9th sound in the comparison of "foreground" and sound categories. 19.8% of the emotional ones preferred the adjective unhappy, and 18.9% of the logician ones preferred the adjective seedy.

As a result of the analysis performed in the comparison of image and video-sound categories for the "foreground" question, no significant relationship was found (p>0.05).

The positions of the participants in the classrooms were compared separately for sound, image, and image-sound categories. According to the results of the analysis, a significant relationship was found only for the 8th sound in the comparison of position and sound categories (p<0.05) (Table 21).

Tablo 21. Comparison of position and sound categories

Position	* Preferred adjectives for sound 8	%
Front left side	Comfortable	17.4
Front middle side	Happy	37
Front right side	Happy	38.5
Middle left side	Pleasant	25
Middle side	Happy	26.9
Middle right side	Happy	25
Rear left side	Happy	19
Rear middle side	Happy	18.4
Rear right side	Safe	13.8

(*p<0.05 Significant relationship)

No significant relationship was found as a result of the analysis performed in the image category comparison for the locations of the participants (p>0.05).

In the comparison of position and image-sound categories, a significant relationship was found only for the 3rd image-sound (Table 22).

Table 22. Comparison of position and image-sound categories

Position	* Preferres adjectives for image-sound 8	%
Front left side	Happy	30.4
Front middle side	Happy	32.6
Front right side	Happy	33.3
Middle left side	Happy	32.1
Middle side	Happy	35.8
Middle right side	Happy	27.8
Rear left side	Happy	28.6
Rear middle side	Happy	42.1
Rear right side	Happy	34.5

4. Results

The results obtained within the scope of evaluating the sound, image and video-sound categories separately are as follows.

• While a negative adjective was preferred in the 1st sound, a positive adjective was preferred in the 1st image and 1st image-sound categories.
• A negative adjective is preferred in the 2nd sound; 2nd image and 2nd image-sound.
• A positive adjective was preferred in the categories of 3rd sound, 3rd image, 3rd image-sound, 4th sound, 4th image, 4th image-sound, 7th sound, 7th image and 7th image-sound.
• While a negative adjective was preferred for the 5th sound, a positive adjective was preferred for the 5th image and the 5th image-sound categories.
• Negative adjective was preferred for the 6th sound; 6th image and 6th image-sound categories.
• The adjective that is preferred negatively in the 8th image is preferred positively in the 8th sound and the 8th image-sound category.
• Negative preferred adjective for the 9th sound was preferred positively in the 9th image and 9th image-sound category.

In this direction, adjectives varying for three categories are expressed in Table 23.

Table 23. Adjectives preferred for three category types

Categories	Sound	Image	Image and sound
1	Seedy	Happy	Happy
2	Seedy	Unhappy	Unhappy
3	Happy	Safe	Happy
4	Happy	Happy	Happy
5	Insecure	Happy	Happy
6	Nervous	Insecure	Insecure
7	Happy	Happy	Happy
8	Happy	Unhappy	Happy
9	Unhappy	Happy	Happy

In the comparison of sound and image sound, a significant relationship was found between the 2nd sound and 2nd image sound, 3rd sound and 3rd image sound, 5th sound and 5th image sound, 6th sound and 6th image sound ($p < 0.05$). It was found that there is a significant relationship between the 7th sound and the 7th image sound ($p < 0.001$). There is no significant correlation in the comparison of 1st sound and 1st image-sound, 4th sound and 4th image-sound, 8th sound and 8th image-sound, 9th sound and 9th picture-sound categories ($p > 0.05$).

As a result of the statistical analysis, the percentage values in which the adjectives show the greatest variation in the comparison of sound and image-sound of the participants are given in Table 24.

Table 24. Comparative analysis results of sound and image-sound categories

Sound	Preferred adjectives for sound	Preferred adjectives for sound and image	%
2.	Peaceful	Unhappy	96
3.	Restless	Happy	66.7
5.	Emotional	Peaceful	98
6.	Pleasant	Insecure	61
7.	Limited	Safe	96

The most preferred adjectives of the participants in the comparison of sound categories and image-sound categories are as follows.

• Adjectives that are positively preferred for the 2nd sound were preferred negatively for the 2nd image sound. Adjectives that are negatively preferred for the 2nd sound are also preferred negatively for the 2nd image sound.

• Adjectives that are positively preferred for the 3rd sound are preferred positively for the 3rd image sound. Adjectives preferred negatively for the 3rd sound were preferred positively for the 3rd image sound.
• Adjectives that are negatively preferred for the 5th sound were preferred positively for the 5th image sound.
• Adjectives that are positively preferred for the 6th sound were preferred negatively for the 6th image sound.
• Adjectives that are positively preferred for the 7th sound are preferred positively for the 7th image sound. 7. Adjectives preferred negatively for sound were preferred positively for the 7th image sound.

A comparison was made in the image and image-sound categories. A significant relationship was found in 1. image and 1. image-sound, 2. image and 2. image-sound, 3. image and 3. image-sound, 4. image and 4. image-sound, 5. image and 5. image-sound, 7th image and 7th image-sound, 8th image and 8th image-sound, 9th image and 9th image-sound categories ($p < 0.001$). There is no significant relationship in the comparison of the 6th image and 6th image-sound categories ($p > 0.05$).

As a result of the statistical analysis, the adjectives that show the most variation in the comparison of image and image sound are expressed in Table 25 according to the percentage value.

Table 25. Comparative analysis results of image and video-sound categories

Images	Preferred adjectives for image	Preferred adjectives for image-sound	%
1	Seedy	Pleasant	96
2	Comfortable	Insecure	97
3	Happy	Happy	61.8
4	Restless	Pleasant	96
5	Restless	Pleasant	97
7	Emotional	Happy	97
8	Happy	Happy	57.1
9	Restless	Happy	50

The most preferred adjectives and results of the participants in the comparison of image categories and image-sound categories are as follows.

• Adjectives preferred negatively for the 1st image were preferred positively for the 1st image sound.
• The adjective positively preferred for the 2nd image was preferred negatively for the 2nd image sound.
• The adjective that is adversely preferred for the 3rd image is favored for the 3rd image sound.
• Adjectives preferred negatively for the 4th image were preferred positively for the 4th image sound.
• Adjectives preferred negatively for the 5th image were preferred positively for the 5th image sound.
• Adjectives preferred negatively for the 7th image were preferred positively for the 7th image sound.
• Adjectives preferred negatively for the 8th image were preferred positively for the 8th image sound.
• Adjectives that are positively preferred for the 9th image are preferred negatively for the 9th image sound.

According to the 18 emotion adjectives, individual perception maps were created for the three categories within the percentages determined by the participants. The graphical representations of these perception maps are expressed in the following ways, according to the evaluation of perception maps, the most dispersed distribution is the adjective 'happy' and the least dispersed is the adjective 'emotional'. Other types of adjectives have generally moved away from the center and shown distribution. In general, there have been more accumulations in the image-sound association (Figure 2).

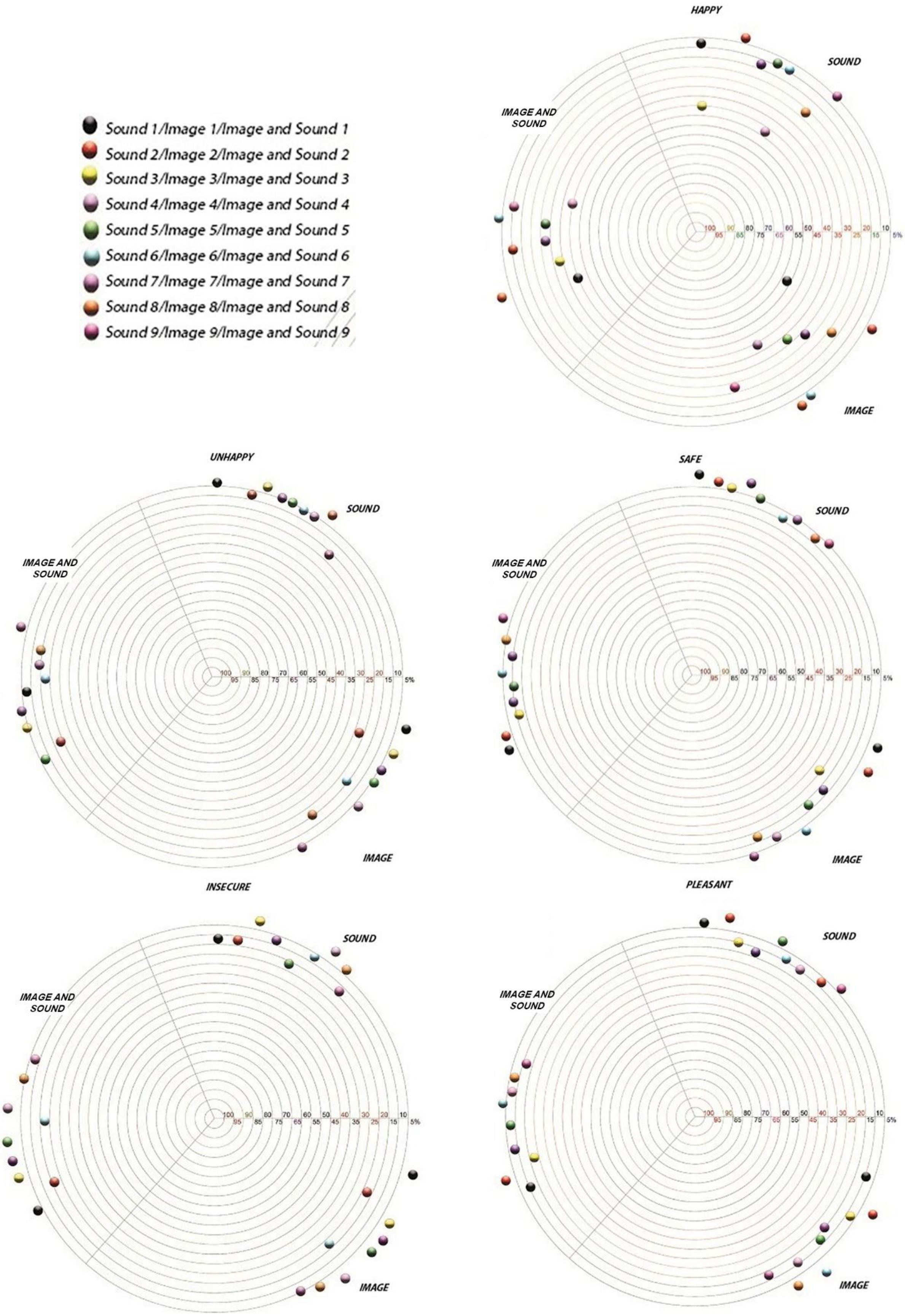

Figure 2. Perception map of three categories according to the percentage values of the adjectives

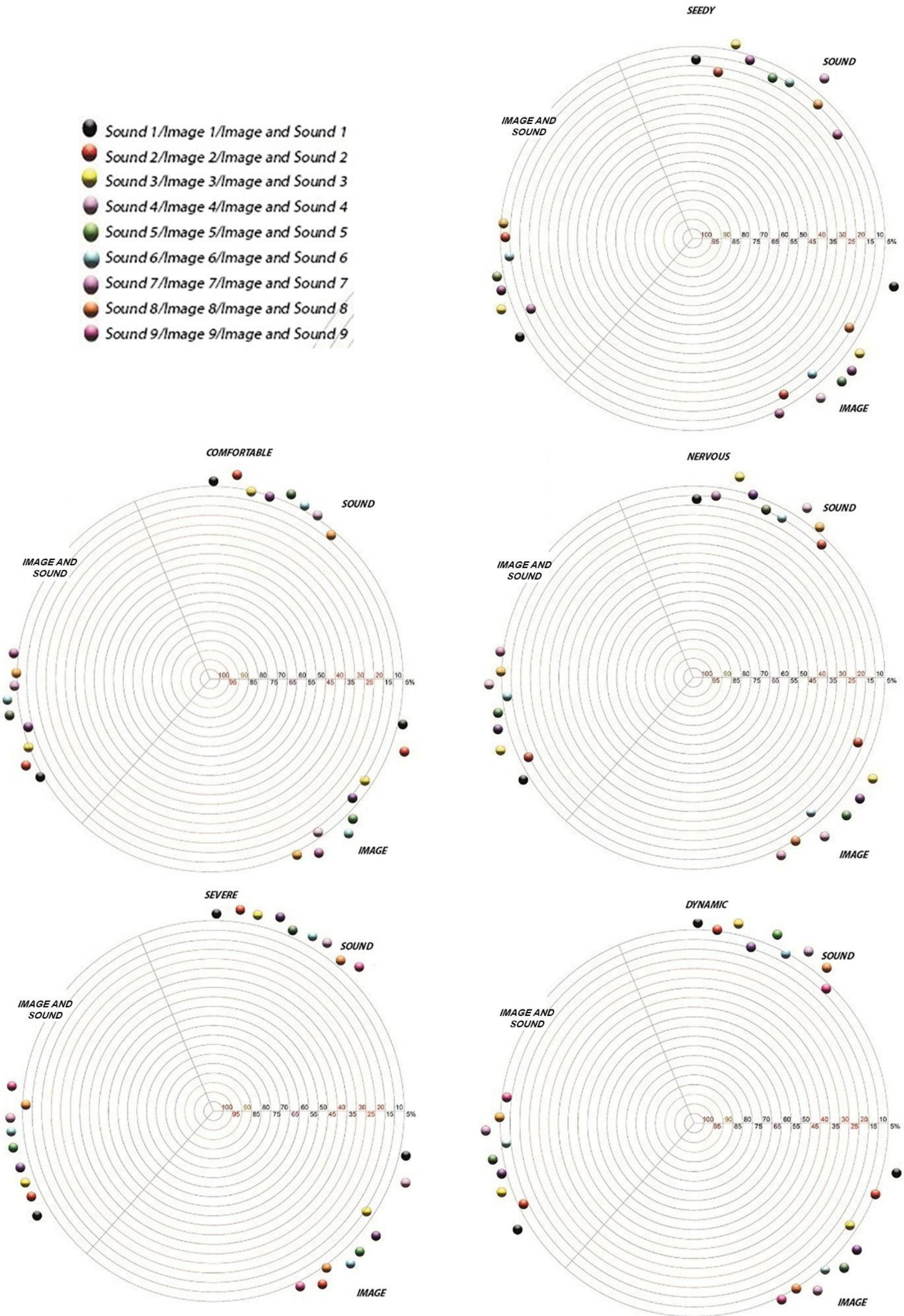

Figure 2 (Continue). Perception map of three categories according to the percentage values of the adjectives

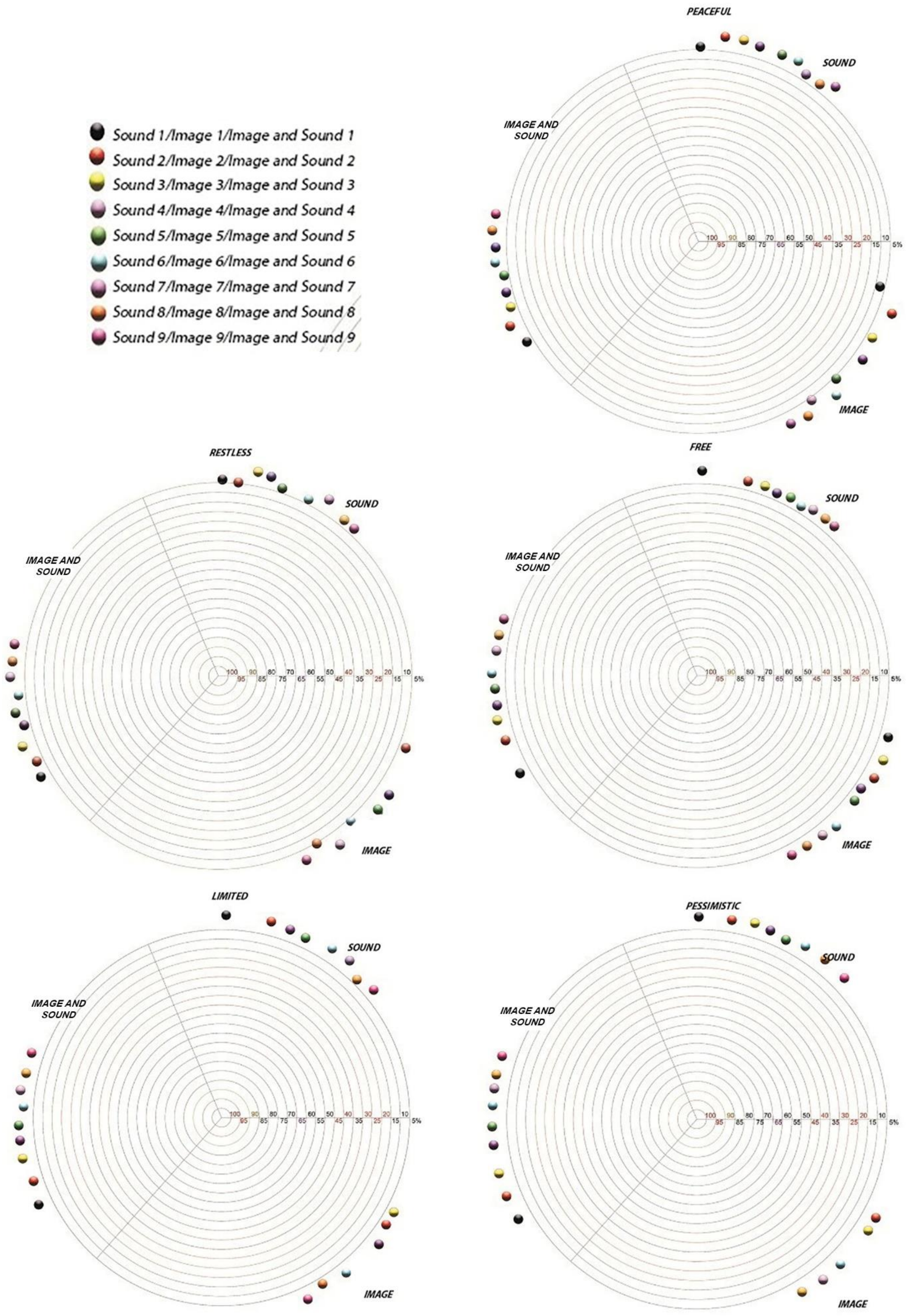

Figure 2 (Continue). Perception map of three categories according to the percentage values of the adjectives

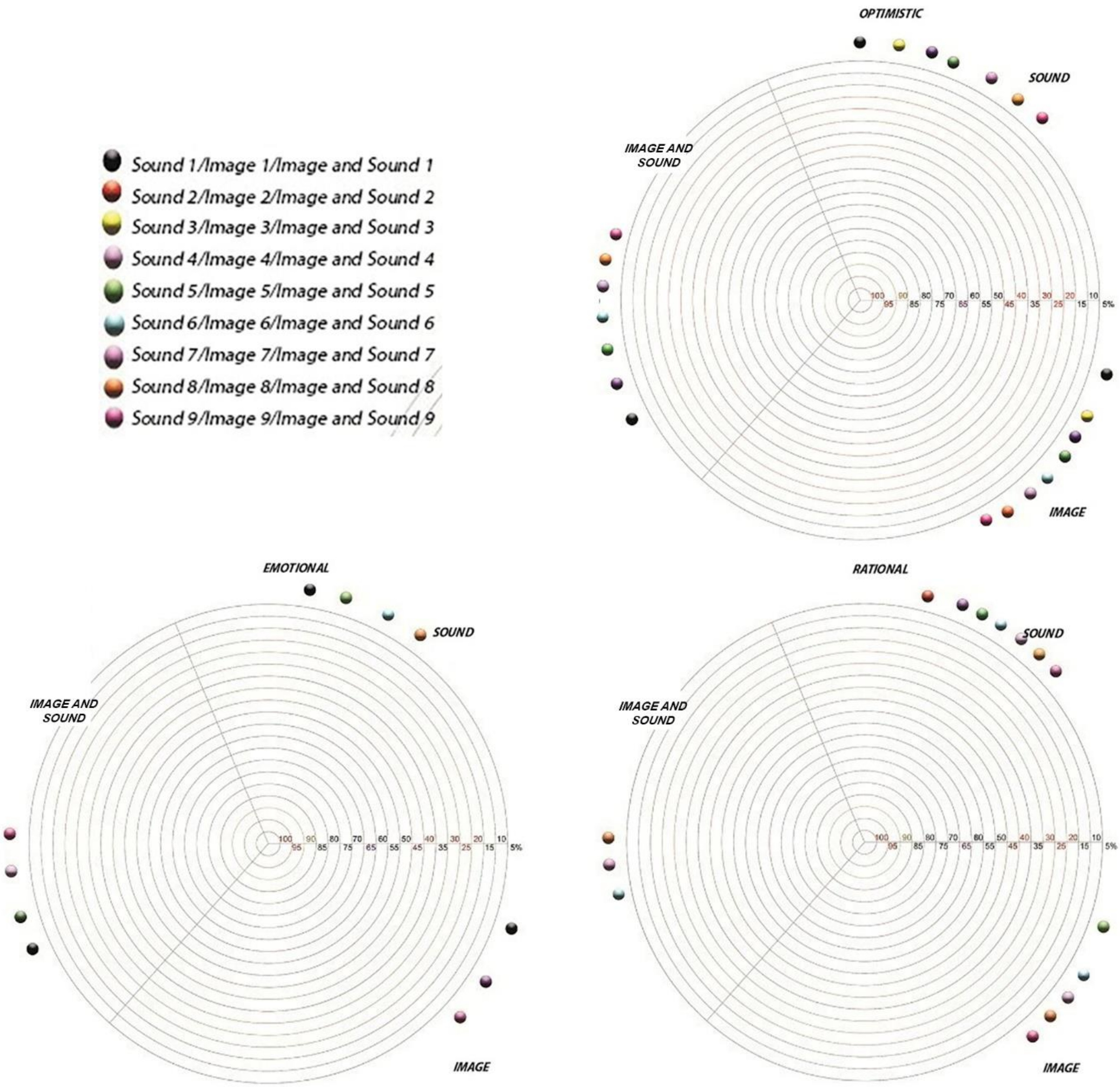

Figure 2 (Continue). Perception map of three categories according to the percentage values of the adjectives

The adjectives preferred by the participants for the audio, visual, and visual-audio categories vary according to gender. Especially for the 5th sound, female participants preferred a negative adjective, while male participants preferred a positive adjective. Positive and different adjectives were preferred in both groups for the image and audio and audio categories.

While whether the families of the participants lived in the village or city varies only for the specified sound categories, this variability for the visual and visual-audio categories was not observed in the adjectives preferred by the participants. As a result of this situation, it was determined that there is a perceptual difference for the sound category depending on the social life experienced.

The adjectives preferred by the participants according to the departments they studied varied in the audio and visual categories, and the educational status affected auditory and visual setup, causing a perceptual difference. This variability is not observed for the visual-audio category.

The adjectives determined by the families of the participants based on their professions differed for the category of visual and visual-audio, and the family profession, i.e., the socio-economic situation, varied perceptually.

The current mood question posed to the participants differs in the preferred adjectives for the audio, visual, and visual-audio categories, and the mental state of the individual changes the preferences perceptually.

It is obvious that right-handed people use the left part of the brain, left-handed people use the right part of the brain, and the right part of the brain develops in the field of design, and therefore visual thinking and visual intelligence are given more space. The left part of the brain also functions logically and analytically. Based on this information, the participants' use of their right hand, left hand and both hands varied in the audio and visual categories, while this variability in the visual-audio combination resulting from matching the appropriate images with the appropriate sounds did not make any difference in which hand the participants used in the adjectives they determined.

The right brain stands out intuitively, and the left brain comes to the forefront logically, so the answers given by the participants for the question "emotional intelligence?", or "logical intelligence?" varied only in the sound category. The question of emotional intelligence and logical intelligence did not affect the answers given by the participants for the visual and visual-audio categories.

As a result of the answers given to the question of where you want to live (village, city, forest, coastal town, and lakeside), the adjectives they determined for the image and image-sound categories varied. As a result, the sound and visual materials prepared made it suitable for areas such as cities, villages, coastal towns, and forests. When the places where the participants want to live to match the appropriate images and sounds, there is a perceptual difference. The question of where to live did not vary only for sound categories. The difference that occurs as a result of the combination of appropriate sounds with appropriate images reveals the importance of the combination of both materials.

The event of image detection varies all over the visual field. Within the cone specified about the event of vision, there are several cones called the surrounding area, the area being looked at, and the center area. The peak angles of these cones constitute the angle of vision. According to these visual angles, differences are seen in the image. For example, the clarity of the image deteriorates as the peak angle grows, and as the viewing angle decreases, the image becomes clearer. As you move from the center to the edges of the visual area, the clarity of the perceived image is disturbed. Based on this information, the adjectives determined by the participants when answering the survey questions varied in the audio and visual categories according to their positions. The difference that appears when the appropriate images are matched with the appropriate sounds is highlighted in the location question.

5. Discussion

As a result of this research, auditory and visual factors were evaluated according to their nature, purpose, and source. As a result of these evaluations, the situations and effects that may occur in individuals only with sound effects, the situations and effects that may occur in humans only with visual editing, and the situations and effects that may occur as a result of the combination of both were evaluated by the survey application and evaluated within the scope of this study to reveal statistical analysis methods and data analyses.

Concrete evidence that hearing and vision have different effects on space design and space users is determined within the scope of this research, and concrete data that both designers can evaluate when designing spaces and contribute to the reading of the perceptual and psychological impact of a designed space on users have been added to the literature.

As a result of the evaluations, the adjectives preferred by the participants in each audio, visual and visual-audio matching generally varied and differed. Perception, as an active process, reflects on the past experiences and needs of the person (Lang, 1987; Koç, 2012). Due to some variables in the environment, differences in human perception can be seen. In perceptual selectivity, factors such as the severity, variability, and size of the stimulus, which are caused by external factors, affect perception. At the same time, the mood that the person feels at that moment and personal values affect perceptual selectivity (Cüceloğlu, 1996; Özgen, 2009). Perception reveals features that vary between individuals (Rapoport, 1977).

As a result of this situation, the perception of the participants varied in three categories. The adjectives that participants determine only when the sound is played and the adjectives they determine as a result of matching the sounds with the appropriate images are generally different. As a result, it was determined that perception differs especially in the combination of image and sound, and its comprehension increases.

Val et al., (2005) visual landscape value is associated with the psychological process as a result of perceptual and emotional concepts. In the study, it was observed that auditory data outweighed the positive in people due to psychological perception. It has been determined that hearing is not acting alone, that the combination of hearing and vision is effective in perception, but also increases comprehension and sense of reality in the combination of image and sound.

As Wallace (2012) noted; it should be known that auditory phenomena should develop depending on visual fiction, auditory data should be included in management studies as well as in the field of planning and design, and the perceptiveness of an area or space will increase and change by adding auditory data to visual studies.

Where the right brain intuitively comes to the fore, the left brain comes to the fore logically (Yakın, 2012). For this reason, the answers given by the participants to the question of "emotional intelligence/logical intelligence" varied in sound and image-sound categories. The question "emotional intelligence/logical intelligence" did not affect the answers given by the participants for the image categories.

Within the scope of this work, when making space designs, it will be important for the design to prefer positive sounds depicting the particular space in a style that reflects the spirit of the space in accordance with the atmosphere of the space. In the same way, when designing an area, more effective and more fact-reflecting designs will come to the fore as a result of the positive interactions of auditory and visual setups. A positive and appropriately used sound will also be effective in determining the characteristics of that space.

The more the relationship is established with a place, the more the sense of belonging to that place. The sound heard or the smell felt in a place is revived as an image in the memory by establishing a relationship with past experiences and accumulations. In line with all these effects, the person and the place are in constant interaction. The place is shaped according to the person. The person also adapts according to the place (Gezer, 2007).

Auditory and visual perception in the field of landscape architecture is found in foreign literature. However, this concept is extremely limited in the literature in Turkey. Although the idea of the study is new, it has been researched in the scope of different disciplines abroad and in Turkey, but the work in the field of landscape architecture is very limited and extremely few. This scope of research will make an important contribution to both the field of design and especially the professional discipline of landscape architecture.

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Furniture Product Management System: An Evaluation Through the Case of "Chair"

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Abstract

Furniture is a set of important tools that enable individuals to perform their actions such as eating-drinking, sleeping, sitting-resting, working, etc., comfortably, and easily in people's daily life. The idea of furniture has emerged depending on human needs and through time improved and diversified depending on economic, social-cultural, and technological developments. The production of furniture products, which consist of products that have emerged to meet human needs, can be made with a "product management system" like all other products. This system, which can be called the furniture product management system, refers to a system in which all processes and sub-processes such as production, post-production, use, and post-use are planned and implemented, starting from the idea stage of the furniture. In this context, in the study, "furniture" was considered within the concept of "product" in terms of being a manufacturable object, and the product management system was adapted to furniture to construct furniture production processes within the framework of a well-organized concept. "furniture product management system" was presented as a model and the system was evaluated on the example of a chair.

***Keywords:** Chair, furniture, furniture & function and space, product management system, furniture production process.*

Mobilya Ürün Yönetim Sistemi: "Sandalye" Örneği Üzerinden Bir Değerlendirme

Öz

Mobilya, insanın günlük yaşamını sürdürebilmesi diğer bir ifadeyle yeme-içme, uyuma, oturma-dinlenme, çalışma vb. eylemlerini rahat ve kolay gerçekleştirebilmesini sağlayan önemli araçlar bütünüdür. Mobilya fikri, insan gereksinimlerine bağlı olarak ortaya çıkmış ve zaman içerisinde ekonomik, sosyal-kültürel, teknolojik vb. gelişmelere bağlı olarak gelişip çeşitlenmiştir. İnsan gereksinimlerinin karşılanması amacıyla ortaya çıkmış ürünlerden oluşmuş olan mobilya ürünlerinin üretimi, diğer tüm ürünler gibi "ürün yönetimi sistemi" ile yapılabilmektedir. Mobilya ürün yönetimi sistemi olarak adlandırılabilecek olan bu sistem, mobilyanın fikir aşamasından başlayıp, üretim, üretim sonrası, kullanım ve kullanım sonrası gibi tüm süreç ve alt süreçlerin planlama ve uygulanmasının yapıldığı bir sistemi ifade etmektedir. Bu bağlamda, çalışmada, "mobilya", üretilebilir bir nesne olması noktasında, "ürün" kavramı dahilinde ele alınmış ve mobilya üretim süreçlerinin iyi organize edilmiş bir konsept çerçevesinde kurgulanması adına, ürün yönetim sistemi mobilyaya uyarlanmıştır. "mobilya ürün yönetimi sistemi" bir model olarak sunulmuş ve sistem sandalye örneği üzerinden değerlendirilmiştir.

***Anahtar kelimeler:** Sandalye*, mobilya, *mobilya & işlev ve mekan, ürün yönetim sistemi, mobilya üretim süreci.*

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1. Introduction

For human beings to survive and ensure the continuation of their generation, they had to be protected from climatic and natural conditions, and this situation revealed the need for shelter. The search for man's need for shelter started with caves, and in the historical process, with the discovery of nature, environment, and “self ”, continued with the places which were created by using natural materials, The fact that people meet their need for shelter and start living in the places they have created has laid the groundwork for the formation of commodities for different needs and various products and goods called “furniture” in the living space (Başbuğ, 2016). Furniture design and production is a complex process that involves a range of creative and technical skills, as well as an understanding of materials, manufacturing techniques, and market trends.

Product management is a critical function for furniture production that seeks to create and maintain a competitive advantage in a dynamic market environment and modern businesses, and its importance is expected to grow in the coming years. The role of product management is to identify production processes, market opportunities, define product requirements, and guide development efforts to create products that meet customer needs and generate revenue.

Based on this framework, this study presents a review of the academic literature on furniture production, product management, and business success, summarizing key insights from the research findings. The analysis highlights the essential role of product management in creating innovative products in the furniture sector that meet customer needs and exceed expectations. The review provides a roadmap for companies seeking to enhance their product management capabilities and processes, highlighting the broad range of skills and processes required to succeed in this critical function.

In this context, in the study which has been based on the master’s thesis prepared by the first writer under the supervision of the second writer, “furniture” as a furnishing element and equipment, will be discussed through the evaluation of the “furniture product management process” model at the point of its impact and importance in design and application disciplines, and eventually, the model will be applied on a furniture sample. It is within the scope of the study that the product management processes are examined and the "furniture product management" processes created in parallel with this, the correct design, detailing, evaluation, and all of these on a chair example.

2. Material and Method

In line with the problem area of the study; literature research on furniture production, product management, and business success, using a three-stage search process has been conducted. First, relevant keywords related to product management, business success, and related areas, such as marketing and innovation have been identified. Second, a comprehensive search of electronic databases such as ULAKBİM, Google Scholar, JSTOR, and EBSCO, using the identified keywords has been made. Third, the results of selecting articles that met pre-defined inclusion criteria, such as peer-reviewed, English language, and published within the last ten years have been screened. Afterward, the works have been followed on-site by participating in the production methods as an observer in the furniture production areas (furniture studios) and at the same time by visiting many furniture stores. In this direction, the study was designed within the research model presented in Table 1.

The study aims to evaluate the “furniture product management” processes in light of the information obtained by examining the product management and product cycle. The examinations of the effects of the “furniture product management system” on the point of observing the problems that occur in production, determining the reasons for the deficiencies and malfunctions, increasing the efficiency, what measures can be taken to ensure that the production process is healthy and in the determined line, and within this scope, the investigations of the effects and the possible benefits a furniture produced with the determined management processes can provide to the manufacturer and the user, is the main goal of the study.

In the study, it is thought that this thesis will make an important contribution to the furniture production sector by researching, creating, and evaluating the "furniture product management" processes that are created depending on the product management processes.

Table 1. Research model

Process of the Research	Stages of the Research	Scope of the Research
Data Collection	Literature Research	Furniture and Related Terms & Concepts Scope and Characteristics of Furniture Production Process Content Analysis of the Data Obtained during the Literature Research Process
Data Reduction	Literature Research Adaptation of the Model	Content Analysis of the Data Obtained during the Literature Research Process Creating the Conceptual Framework Detection of Problems with Document Scanning and On-Site Observations
Data Display	Adaptation of the Model	Adaptation of the Model Visual Representation of Obtained Data
Conclusion Drawing & Verifying	Analysis Using the Model Results & Findings	Analysis of Obtained Data Results and Evaluation

3. Findings and Discussion

In this section, first of all, the features and components of furniture, which is one of the most important design elements of interior architecture, will be discussed and the production process will be explained. The product management process and the furniture production management system to be followed in this context are defined and its features are specified. The relationship between product management and product cycle and sub-systems in this context has been explained, and the furniture production management system has been applied to the chair.

3.1. Furniture

Furniture is defined by Türk Dil Kurumu (2023) as “all portable items used for furnishing places to sit, eat, work or sleep”. Although the word furniture means a mobile item that can move with a mobile, it is generally considered an equipment element (Tütüncü, 2011). According to another definition, furniture is defined as all the functional, ergonomic, and aesthetic-looking items that are generally made of wood material to meet the social, cultural, and basic needs of people for their daily life safely and comfortably (Tatlısu, 2015). The concept of furniture can be mentioned since the early ages when people started to meet their spatial life needs with tools and goods. Furniture has changed over time in parallel with the living conditions, understanding of civilization, and aesthetic views of societies and has taken different forms (Üst, 2015).

Furniture design has a long and rich history, dating back to ancient civilizations such as Egypt, Greece, and Rome. The ancient Egyptians, for example, were known for their elaborate furniture designs, which featured intricate carvings and ornamentation. During the Middle Ages, furniture design was primarily focused on functional rather than aesthetic considerations, with most furniture being simple, utilitarian pieces. In the 18th and 19th centuries, furniture design underwent a major transformation, with the advent of new materials such as cast iron and steel, and the development of new manufacturing techniques such as the mass production of furniture. This led to the creation of new styles such as Art Nouveau and Art Deco, which were characterized by their ornate and stylized designs.

When examined in terms of its historical development, examples of furniture in different shapes and varieties are encountered from ancient times to the present. In the first shelters, human beings used a number of items to meet their sitting and lying needs. To obtain an item, man has followed nature to "choose" and "make the same" of what he has chosen. In later processes, it was seen that he developed his creativity by adding his creativity to the items he made by analogy. While people's furniture production was only a necessity in the past, furniture has started to be seen not only as a necessity but also as a prestige tool. As the importance of furniture increased, furniture-making began to be accepted as a profession, and this acceptance is thought to have occurred in cultures such as ancient Egypt and Mesopotamia (Sönmez, 2011).

Today, when furniture is evaluated in terms of its meaning and importance in human life, first of all, it is observed that furniture is an important product that meets all other needs, especially the basic needs of people, and makes human life much easier. At the point of user satisfaction, universal comfort criteria and changing consciousness, perception, and principles have also led to the emergence of different perspectives in furniture design and production. Comfort parameters require a special design in terms of furniture and materials (Bilmez, Çelik, Diri & Arpacıoğlu, 2022).

In addition to the design approaches created for new needs, functions, and comfort conditions, furniture has started to be evaluated on a different level, especially with the changes in material variety, quality, and technology. Topal & Arpacıoğlu (2020) stated that before the Industrial Revolution, materials were chosen both pragmatically - for their benefits and usability - and procedurally for their appearance and decorative qualities, besides, it is a determining criterion in the material selection that evaluates the material possibilities at hand, that is, designs made according to a certain concept and function, as well as certain materials. After the Industrial Revolution, the role of materials changed significantly, and architects have begun to face industrial materials instead of relying on an intuitive and experimental understanding of material properties and performance (Topal & Arpacıoğlu, 2020).

When it comes to furniture, the first thing that comes to mind is wooden furniture. The furniture that people need the most is generally; a bed, armchair, table, chair, cupboard, corner set, pouf, nightstand, bookcase, coffee table, school desks and desks, office tables and chairs, patient beds, counters, etc., and mostly wooden materials are used in this furniture. Today, although other materials such as steel, aluminum, glass, and plastic have been used in furniture making, wood remains popular in this regard. Wood material is preferred more in furniture production due to its features such as being easily processed, easily combined with each other, having a high resistance, being easily changed when old, and being painted (Kayapınar, 2011).

3.1.1. Types of furniture

It is seen that furniture is generally divided into two indoor furniture types and outdoor furniture types. Indoor furniture types are generally used in building types such as residential, hospital, school, hotel, office, cafe-restaurant, etc. Outdoor furniture types include urban furniture used in public areas, such as parks, gardens, forests, etc., which are defined as open spaces. The most important feature that distinguishes these two types of furniture from each other is that the furniture is directly affected by climate and natural conditions or is not affected by these conditions at all.

While the furniture used outdoors is directly exposed to rain, snow, wind, frost, humidity, and heat, the furniture used indoors is not affected by external environmental conditions. For this reason, the materials used in indoor and outdoor furniture are quite different from each other. While the materials used in outdoor furniture that are directly exposed to seasonal and environmental conditions are concrete, durable wood, iron, casting, etc., the materials used in interior furniture are wood, plastic, glass, aluminum, plastic, etc.

Another situation that distinguishes these two types from each other is the frequency of use of the furniture depending on the number of users. Frequency of use plays an important role in the strength and durability of furniture. For example, when this situation is evaluated in terms of seating units, there is a lot of circulation of people in the park during the day, so the number of people using the seating unit used in the park during the day is considerably higher than the number of people using the seating unit used in the house. From this point of view, it is seen that the durability of a seating unit used outdoors is higher than a seating unit used indoors.

People meet their sheltering needs through different building types. In this context, furniture used in building types is defined as *interior (indoor) furniture*. Building types are generally residential, office, school, hotel, hospital, cafe-restaurant, theater, cinema, etc. and almost all of them have their special furniture types. For example, a school is a type of building where studying and listening activities take place, and the types of furniture used in these buildings are usually desks, chairs, trainers' chairs, waiting-resting chairs, storage, etc. Considering another type of building, residential furniture is a wardrobe, armchair, coffee table, table chair, dresser, bed, nightstand, sideboard, kitchen cabinet, bathroom cabinet, wing chair, corner set, etc. When evaluated from this point of view, the spatial identities of the building types and the actions and needs of the user in the space determine the shapes and types of indoor furniture types.

Urban areas are the areas open to the use of society where people come together, socialize and spend time together. In outdoor spaces, people need some equipment. This equipment is benches, picnic tables, camellia, pergolas, children's play sets, sports equipment, garbage cans, lighting elements, etc. and these items are defined as urban furniture or outdoor furniture (Feyzioğlu, 2008). In all open spaces of the city, which are called outdoor spaces, mostly fixed service sets and structures for various open space functions, where the user is uncertain, are called urban furniture. *Outdoor (urban) furniture*, together with the concept of the city, are products that are intended to meet the evolving needs of users as a result of certain processes.

3.1.2. Production of furniture

“Production” is defined as “soil, animals, plants, etc. the job of providing products, introducing new things as goods and services, producing them” and “the activities and process of people changing their natural environment to obtain objects necessary for the life and development of society” (TDK, 2023).

Furniture production is generally grouped under two headings, and these are called “mass production” and “special production”. The main feature of this type of production, which is applied in units with a high production amount but low product variety, is the concentration of machinery, facilities, and product flow on a specific product. Furniture produced with the mass production system is furniture that can be produced in large numbers, is frequently encountered, and is always available many times. Special production, on the other hand, is the name given to the system that produces a limited number of products from a product that is desired to be created depending on the requirement. Special production furniture is a more boutique production form compared to mass production, and therefore, it is a system that allows the creation of a limited number of personalized and more original furniture in line with special demands (Başbuğ, 2016).

Today, the furniture design and production industry are a major global market, with a wide range of products and styles available to consumers. Some of the most popular styles of furniture today include contemporary, traditional, and transitional, with designers and manufacturers increasingly focusing on sustainability and eco-friendly materials. One of the biggest challenges facing the furniture industry today is the competition from low-cost suppliers in countries such as China and Vietnam. This has led many designers and manufacturers to focus on higher-end and custom furniture, as well as on new technologies such as 3D printing and augmented reality.

Furniture production generally has a batch production system. There are imbalances between operations in the discrete production system. Performance losses caused by this imbalance (length of lead times, inability to deliver orders on time, low-capacity utilization rates, etc.) can be eliminated by keeping intermediate stocks high or by making a balanced production with effective scheduling methods and product-oriented reorganization measures (Sütçü, Karşıyaka & Burhan, 2019). The importance of the Turkish furniture industry in the national manufacturing industry is increasing day by day. The sector earned 3.1 billion dollars in foreign exchange in 2018, gave a foreign trade surplus of 2.3 billion dollars, and set an export target of 6 billion dollars for 2023 (Orsiad, 2019).

In this context, the production stages of the furniture to be produced should be planned, both in terms of the volume and importance of the furniture industry and the problems of the production system, and the problems that may be encountered during the production stage should be taken into account while still in the planning stage. It is an important point to ensure the continuity of the production process while solving the problems at the same time. In terms of the systematic and planned sustainability of the process, the use of the product management system in furniture production is considered an important point.

3.2. Product Management

"Product" is defined as "the useful thing obtained from nature, the crop" and "the thing obtained by processing raw materials in various industrial areas" (Türk Dil Kurumu, 2023). Product management, which consists of the combination of product and management concepts, covers the definition, planning, and implementation of the production processes of the products depending on a certain order and system.

The product management system is the organization of responsibilities, duties, and employees to market a product or brand. The main purpose of product management is for the organization to be successful in its marketing activities, in other words, to make a profit while selling its products or brands (Ataman, 2006). In the product management system, there must be a "product manager" to plan all stages of the product or to carry out the existing planning, application, post-application, and all other stages as determined and desired. When evaluated in this respect, it is seen that the product manager has an important place in the product management system.

Product management is a critical function for businesses of all sizes and industries. Product managers are responsible for identifying market opportunities, defining product requirements, and guiding development efforts to create products that meet customer needs and generate revenue. The role of product management has evolved significantly over the years, reflecting changes in customer expectations, technological advancements, and business trends.

The management process, in general, includes all stages of a business, from the idea stage to the implementation, planning, and managing of the plans, and when all these come together, it creates a cycle. When this cycle is considered in terms of product management, it is expressed as a "product life cycle" in many sources. This definition, called product life cycle, was created based on the concept of "life cycle". The life cycle is a system that evaluates all the environmental aspects of action until the raw material is obtained from nature and all the waste is returned to nature. This system includes the production and use of raw materials, including energy, as well as the processing of the product, and all its effects on air, water, and soil afterwards (Özdemir, 2013). Based on the life cycle system, it is seen that definitions such as "product life cycle" and "product cycle" are made for the system created to obtain products.

3.2.1. Product cycle system

The model is an abstracted form of the system or systems, developed to understand the system, which is defined as the coming together of interrelated components and representing reality. In addition, the model, which is the representative of an ideal environment and is a summary or representation of a real situation, including the variables that are considered important, is not only a representation of all the features of the real situation but rather aims to determine the important components and relationships of the system. In short, the complex and difficult processes of the real system are presented by simplification with modeling (Erdinç & Biçer, 2020).

Based on this understanding, Biçer Özkun (2011) presents and defines the "product cycle system", which was presented as a model in her doctoral study, as a system consisting of 4 phases (sub-systems) interacting with each other; production, application, utilization, and post-utilization. This system, which is defined as the product cycle, can be adapted and used for every product that can be produced.

The "production" subsystem, which is the first stage of the product cycle; consists of the pre-production process, which includes the design of the product and the sub-processes of raw material preparation, and the production process, which includes the sub-processes of production, packaging, storage, and sales. Application subsystem; includes the pre-application process, which includes transportation and storage sub-processes, and the application process, which includes on-site and pre-production and application sub-processes. The utilization subsystem; is carried out within the pre-use process, which includes replacement and addition sub-processes, and the usage process, which includes maintenance, repair, and replacement-renewal sub-processes. The post-use subsystem is consists of the post-use process, which includes the sub-processes of leaving in place, dismantling-demolition, and re-evaluation (Biçer Özkun, 2011). According to Biçer Özkun (2011), the “product cycle system” progresses within a certain flow, in a certain order, and within the framework of the continuity and relations of the stages.

3.3. Furniture Product Management System in the Context of Product Management-Product Cycle Relationship

The product management system is considered a convenient system that can be adapted to almost every product and used in different disciplines and applications. The point that furniture is also a product, is seen that all the processes of the product management system can be used under the definition of "furniture product management system" by adapting and applying the typical and unique characteristics of furniture.

The content of the customization of the model has been created with the idea of developing the "furniture product management system and phases" by going through an adaptation process, as well as associating the product management system and phases with the furniture and furniture production process. In this context, a “furniture product management system” can be defined as a system that covers all processes and sub-processes, starting from the design stage of any furniture, such as production, application, utilization, and post-utilization.

3.3.1. Production subsystem and processes of furniture

It includes all phases from the ideation stage of the furniture until it is ready for production. Furniture production system titles cover the processes including the function, raw materials, production method, and facility of the furniture, how it will be packaged, how it will be stored, and how it will be transported.

Functioning Process: Clarification of the function of the furniture also constitutes an important step in how and through which stages it will be produced. At the point of their different functions, it causes many processes of bed and table to be different.

Raw Material Process: It covers the procurement of the raw material of the furniture planned to be obtained and making it ready for the production process. For example, the raw materials of a chair that is planned to be produced with wooden material and a chair covered with leather are different from each other. This situation may cause differences in the raw material processes of the furniture.

Production Process: It covers the processes of establishing the production facility or rearranging the existing production facility depending on the furniture and making it suitable for production after it is clarified how the furniture will be produced (mass production, special production).

Packaging Process: It is the process of packaging the furniture, in other words, protecting it, and this process may vary depending on the material of the furniture. For example, the packaging of a wooden chair and a glass showcase requires more precision in packaging because the material of the glass showcase is more fragile than the chair.

Storage Process: It includes the processes where the furniture, whose packaging process is completed, is taken to protection and stocking. For example, the volume of the space where the furniture will be stored should be adjusted depending on the size of the furniture and the amount of stocking. In addition, factors such as the sensitivity of the furniture to temperature and storage time may differ in the processes.

Shipping Process: It includes the processes of moving the furniture out of stock to the dealers for sale or to the point of sale. For example, the handling and sensitivity of a glass coffee table and a wooden coffee table are different from each other. Naturally, this situation creates a difference in shipping processes.

3.3.2. Application subsystem and processes of furniture

It is the stage where the production phase of the furniture is completed, and the application process is started. It covers the processes such as moving the furniture from the factory warehouse or the warehouse of the sales store to the application center and storing (storing, protecting) in this center until the installation period.

Receipt Process: In this step, the purchased furniture process includes the steps of being picked up from where it is, transported to the point where the application will be made, and delivering it to the buyer.

Storage Process: It is the process of protecting and storing the furniture, which is transported to the application center after the transportation process until the application is made in this center.

Installation Process: It is the process of moving the furniture, which is about to be applied, to the installation phase by removing it from its storage place.

3.3.3. Utilization subsystem and processes of furniture

The systems and processes that emerge with the user's access to the furniture and starting to benefit from it are called the furniture utilization subsystem and processes. These processes include sub-processes such as furniture modification, utilization of furniture, and furniture maintenance and repair.

Modification Process: Before starting to use the furniture, the user may want to use the furniture by making various changes depending on his needs. For example, by mounting additional shelves on a piece of furniture used as a desk, the desk can also be used as a bookcase, in other words, a multitude of functions can be achieved in furniture.

Utilization Process: This process, which can also be defined as the process in which the relationship between the user and the furniture begins, includes the processes in which the furniture meets the user's expectations, and the user obtains the expected efficiency from the furniture.

Maintenance and Repair Process: Due to the occurrence of various problems such as wear, breakage, cracking, and staining during the use of furniture, processes such as maintenance and repair can occur in furniture.

3.3.4. Post-utilization subsystem and processes of furniture

The after-use subsystem and processes of furniture that have completed their life form the last step of the furniture product cycle. Furniture that has expired is replaced by a new piece of furniture with a similar function. Depending on the suitability or condition of the old furniture, its function can be changed, giving it a new function and reuse. In cases where it loses its usability and no transformation is possible, the disassembly-dismantling process begins. After the disassembly-disposal process, furniture waste can be re-evaluated through the recycling process, depending on its material.

Refunctioning Process: After the furniture loses its first function, it may be desired to be reused for another purpose. At this stage, the furniture is re-functionalized and this process; can be done by adding, removing parts, changing the color, or the surface coating.

Disassembly-Disposal Process: It includes processes such as disassembling the furniture, which has completed its useful life, and throwing it away as waste.

Recycling Process: The recycling process of waste furniture not only helps prevent environmental pollution but also ensures the use of recycled waste as raw materials.

3.4. Application of the Model of Furniture Product Management System Through “Chair”

Although the stages are generally the same, there can inevitably be differences in the sub-processes of the furniture product management system, in line with different characteristics in furniture in terms of the design stage, form, material, installation, etc. While the steps of the furniture product management system can be adapted to each piece of furniture, this may cause some differences in sub-processes. For example, furniture product management sub-processes of seating furniture with similar functions and used indoors may vary. There may be different sub-processes between the wooden chair and the leather chair. Because, although the function of the wooden chair and the function of the leather chair are the same, raw materials, production, packaging, assembly, maintenance/repair, etc. differ in sub-processes. In this context, the model of the furniture production system has been applied to the "chair" as it has been presented in the table (Table 2) below.

Table 2. Evaluation of the furniture product management system on "chair"

PRODUCT PROCESS			
Production Subsystem and Processes of Furniture			
Functioning Process	Seating	Seating	Seating
Raw Material Process	Sponge, Leather, Metal, Wood	Wood, Lacquer etc.	Plastic
Production Process	Mass Production Format	Mass Production Format	Mass Production Format
Packaging Process	Modular Packaging Format.	Modular Packaging Format	Individual Packaging Format
Storage Process	Protection and Storage in Packages	Protection and Storage in Packages	Protection and Storage in a Single Package
Shipping Process	Careful Handling	Careful Handling	Careful Handling
Application Subsystem and Processes of Furniture			
Receipt Process	Delivery of the chair without damage	Delivery of the chair without damage	Delivery of the chair without damage
Storage Process	Pre-Installation Storage and Protection	Pre-Installation Storage and Protection	No Installation, No Storage Required
Installation Process	Reuniting and Assembling the Parts	Reuniting and Assembling the Parts	In one piece, no assembly is required
Utilization Subsystem and Processes of Furniture			
Modification Process	Replacing Metal Legs with Wood	Darkening with Lacquer	No Adding, Subtracting, or Color Changes Can Be Made
Utilization Process	Indoors, As Seating Furniture (Chair)	Indoor Use as Seating Furniture (Chair)	Using as Outdoor Seating Furniture (Chair)
Maintenance and Repair Process	Breaking, Tearing, Scratching, etc.	Breaking, Cracking, Scratching, Color Fading, etc.	Breaking, Cracking, Scratching, etc.
Post-Utilization Subsystem and Processes of Furniture			
Refunctioning Process	Removing the Metal Legs, attaching them to a Wooden Surface, and Using them as a Coffee Table	The Backrest Can Be Removed, Darkened with Varnish, and Reused As a Coffee Table	It is not re-functional due to being a one-piece, plastic material
Disassembly-Disposal Process	Requires Disassembly, Discarded in Pieces	Requires Disassembly, Discarded in Pieces	No Disassembly is Required, Discarded as One
Recycling Process	Can Be Converted as Metal Scrap. Again, the wood in the chair can be recycled as waste	Wood Can Be Converted as Waste in Factories And Used As A Raw Material Of Particle Board	Plastic can be converted as waste in factories and used as raw material for sewage pipes

4. Conclusion and Suggestions

The product management system is known as a system that can be used for every product that can be produced. Furniture within the scope of the product can also be produced using this system. While adapting it to furniture, all processes within the "furniture product management" system, which was created by utilizing the "product cycle system" designed by Biçer Özkun (2011), were used. The purpose of creating the furniture product management system and processes is to determine the purpose and where the furniture will be used, to prevent possible confusion in planning and application, and to minimize risks. In addition to adapting the system to furniture, considering the case of the chair is considered important in terms of controlling the applicability and adaptability of the system and processes. As a result of the evaluation, the furniture product management system and the benefits and conveniences of the processes such as production, application, utilization, and post-utilization within this system are described below.

The benefits of furniture product management system and processes to furniture production are as follows:

- Build planning on clear and realistic data.
- Creating the furniture by the requirement.
- Completing the cost of furniture at the end of production by the budget or with the least risk.
- To create an infrastructure suitable for production with the determined production method.
- To ensure that the furniture's raw material is procured and prepared by the process.
- To continue the production process in the determined line.
- To make the packaging format by the fragility of the furniture material.
- Ensure that the furniture is stored for protection and storage purposes, depending on its size and sensitivity to temperature.
- To carry out the transportation process without any problems to the center where it is sold or to be moved to be sold.
- To ensure the correct installation of the furniture in the application center.
- To be able to obtain the expected efficiency from the furniture in the usage process.
- To ensure the reuse of furniture by re-functioning.
- Dismantling and discarding furniture that has completely lost its function.

In addition, the benefits of the furniture product management system to the furniture manufacturer/seller can be specified as;

- Making the process easier with the clarification of the design steps.
- Prevention of cost loss by cost planning.
- Preventing loss of cost and reputation by using the time correctly.
- Increasing the quality of furniture.
- The demand for furniture in the market and the continuity of demand.
- The producer's economic gain from the product.

The benefits of the furniture produced with the furniture product management system to the user are listed:

- Provides the functionality of the furniture to the user's needs.
- The quality of the furniture has provided service to its users for many years.
- Cost-effective production provides ease of purchase.
- Extends the life of furniture with maintenance and repair.
- After completing its function, it can be re-functionalized and used.

The study has uncovered the following key insights:

- Effective furniture product management is essential for organizations to achieve competitive advantage by creating innovative products that meet customer needs and exceed expectations.
- Successful furniture product management requires a broad range of skills, including customer empathy, strategic thinking, technical expertise, and effective communication with cross-functional teams.
- Effective furniture product management processes require close collaboration between product managers and other functional areas such as marketing, engineering, and sales.
- Companies that invest in product management methods, capabilities, and processes are more likely to achieve business success than those that do not.

In conclusion, furniture design and production are a complex and evolving industry that requires a range of creative and technical skills. From its ancient origins to the present day, furniture design has undergone significant transformations, with new materials, manufacturing techniques, and design styles continually emerging. Emerging technologies and new product management methods are likely to shape the future of furniture design and production, offering new opportunities for designers and manufacturers to create innovative products for consumers.

In the final analysis, it is observed that this system is an important system that ensures the regular and systematic production of furniture by the expectations of the manufacturer and the user. In this regard, it is evaluated that it will be beneficial for both sectoral users and researchers. It is very important to address and evaluate these and similar issues that are open to development.

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1st author % 40, 2nd author % 60 contributed. There is no conflict of interest.

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Interpretation of Prior Design in Furniture Design

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Abstract

Since the beginning of life, people have needed furniture to realize their normal activities. The existence of furniture is inevitable for the realization of open, semi-open, and closed spaces. The existence of furniture is not only limited to function and ergonomics but also shaped according to the aesthetic movement of that period, influenced by the architectural movements of the period. Movements have reflected the cultural, social, and economic effect of the society in which they exist on all spatial applications in the field of architecture. Especially after the twentieth century, the leading architects of architectural movements have gone down to the furniture in the buildings they designed. The reason for this is that they did not want any other foreign element in the whole of the buildings they designed. This approach of the architects caused the movements that dominated the period to have a pioneering influence on the scale of interiors and furniture. Designs that were as effective on the furniture scale as they were on the building scale are presented in this study. In the post-20th century furniture movements, the pioneering design is interpreted in a new language without breaking away from the influence of the movement. The study aims to reveal how the pioneering furniture can be adapted to the present day. It is seen that while the chairs, which are the seating elements considered within the scope of the study, are reconsidered, new models are developed on material and color changes without moving too far away from the main design.

Keywords: *Furniture, design, interior architecture education, art movements.*

Mobilya Tasarımında Öncül Tasarımların Yorumlanması

Öz

Yaşamın başladığı çağlardan beri insanlar, normal aktivitelerinin gerçekleştirmek için mobilyaya ihtiyaç duymuşlardır. Yaşanılan açık, yarı açık ve kapalı mekanlarda eylemlerin gerçekleştirilebilmesi için mobilyanın varlığı kaçınılmazdır. Mobilyanın varlığı sadece işlev ve ergonomide sınırlı kalmamış, dönemin mimari akımlarından da etkilenerek o dönemin estetik anlayışına göre de şekillenmiştir. Akımlar; bulunduğu toplumun, kültürel, sosyal ve ekonomik yönden etkilerini mimarlık alanındaki tüm mekânsal uygulamalara yansıtmıştır. Özellikle de yirminci yüzyıldan sonra mimari akımların önde gelen mimarları, tasarladıkları yapılarda mobilyaya kadar inmişlerdir. Bunun nedeni tasarladıkları yapıların bütününde başka bir yabancı öğe istemeyişleridir. Mimarların bu yaklaşımları, döneme hakim olan akımların, iç mekan ve mobilya ölçeğinde de öncül bir etkiye sahip olmasına sebep olmuştur. Yapı ölçeğinde olduğu kadar mobilya ölçeğinde de etkili olan tasarımlar, bu çalışma kapsamında ortaya koyulmaktadır. 20. Yüzyıl sonrasında hakim olan mobilya akımlarında öncül tasarımların akımın etkisinden kopmadan yeni bir dille yorumlanması yapılmaktadır. Çalışmanın amacı, öncül mobilyaların günümüze nasıl uyarlanabileceğinin ortaya koyulmasıdır. Çalışma kapsamında ele alınan oturma elemanı olan sandalyelerin, yeniden ele alınırken ana tasarımdan çok uzaklaşamadan malzeme ve renk değişimleri üzerine yeni modeller geliştirildiği görülmektedir.

Anahtar kelimeler: *Mobilya, tasarım, iç mimarlık eğitimi, sanat akımları.*

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1. Introduction

Furniture has an important place in human daily life. Furniture, which has been used for the realization of actions since ancient times, has been a part of life. Considering that a large part of human life takes place indoors, it can be accepted that furniture is extremely important in the organization. Furniture is the most important spatial element that enables the formation of the spaces in which we live and are encountered in every area where life takes place. Furniture is needed in many areas with different functions from urban spaces to interiors. Furniture, which cannot be considered independent from space, cannot be considered independent from time. At different times and therefore in different periods, the styles and production styles of furniture also change.

In a world of rapid change, some movements sometimes come with the influence of popular culture, while at other times there are movements that can affect large masses in an instant and disappear or change the lifestyle in a revolutionary way. These trends have been met with different effects in all societies and have produced different products. However, no matter what the products are, new trends and as a result, trends have been revealed with the spirit of the age (Afşar 2009; Koç et al., 2017). Architectural works, which are accepted as tangible cultural assets, shape living spaces at all scales, from the smallest living units to cities and even regions. The act of architecture, which reveals these works, which are concrete reflections of culture, is in a mutual interaction with the natural environment as well as with the way societies live (Bayraktaroğlu & Arabacıoğlu, 2022).

Each period has put forward its truths, and this situation has been reflected in architecture and furniture in interiors. Styles-movements shaped by the period have been formed and the effects of these movements have begun to be seen in all areas of life. Each period has transferred different styles of furniture to the next period and furniture has been shaped by the needs and design styles of that period. To understand the effect of period changes, it is necessary to look at the periods in which furniture is affected, in other words, the historical development of furniture. Knowing the periods of furniture is also important in terms of furniture design. The work is shaped according to these periods.

1.1. Historical Development of Furniture

It has been proven through archaeological finds and cave paintings that furniture has been in people's lives since prehistoric times. At first, nature was the mediator of furniture, but gradually the development of furniture as a design element has been seen. While furniture was used only to perform the function in the old times, today it has turned into a design element by including the function in aesthetic concerns.

Furniture developed the Egyptian-Mesopotamian, Greek and Roman lines and reached a high level in terms of design; however, it experienced a period of decline in the dark centuries of the Middle Ages in Europe. After overcoming that period, furniture, which has become more useful, more skillful, and more artistic, has spread from Europe to the whole world (Boyla, 2012).

It is not possible to isolate the art of furniture and the art of architecture from each other. The architectural styles of the time had a dominant influence on the development of furniture throughout the ages. The lifestyle and artistic style of each age was reflected in furniture (Kurtoğlu, 1969).

The 19th century is a period of radical changes in the field of design. In this period, with the developing industry and the effect of new materials, furniture was produced more and faster (Alyanak, 1989). This period is the period of mechanization. At the end of the 19th century, developments began to take place that would lead to the emergence of the concept of contemporary furniture. These developments were born as a reaction to Eclecticism (Can, 1991).

1.2. Movements Influential in the Change of Furniture

Furniture reflects the aesthetic views of the era in which it was made. The characteristics, material, and appearance of the furniture produced can change according to the conditions in which people live, the value perceptions of the current period, and even the caste position of the people. The effects of the economic, cultural, and social conditions of the period can be traced to the furniture (Seçer Kariptaş, 2017).

Before the 20th century, the following periods were effective respectively when we look at the change in furniture:

Ancient furniture (4000 BC – 476 AD)

Medieval furniture (476-1453 AD)

Renaissance furniture (1453-1550 AD)

Baroque and Rococo furniture (1550-1774 AD)

New Age furniture (1774-1789 AD)

Modern Age furniture (1789-1900 AD), (Özbayraktar, 1996)

At the end of the 19th century, the Arts and Crafts movement emerged as a reaction to the contemporary furniture concept. The movement manifested itself in Western countries, especially in England. Following the Great Exhibition of 1851 held at the Crystal Palace in London, designers such as William Morris, Pugin, Ruskin, Walter Crane, Beardsley, and Mackmurdo gave birth to this movement. They aimed to embrace the embroidery of Neo-Gothic and Rococo styles and the linear sensitivity and agility of traditional Japanese printmaking, to reach new interpretations and syntheses, and to design elegant examples of decorative products such as metal, glass, ceramics, textiles, and wallpaper in a combination of art and craft with aesthetics concerns (İnan, 1995). The movement made its name with the ideas of artist and critic John Ruskin and found the opportunity to develop with William Morris putting these ideas into practice (Aslanoğlu, 1983). The Arts and Crafts Movement paved the way for the emergence of the Art Nouveau movement that emerged towards the end of the 19th century. From the 20th century onwards, Art Nouveau, De Stijl, Bauhaus, Art Deco, and Pop Art, which are considered to be the dominant and pioneering design movements, are discussed within the scope of this study.

1.2.1. Art Nouveau (New Art, 1880-1910)

The handcraftsmanship developed by Arts and Crafts and the understanding that leads to good, quality, beauty, and truth in applied arts continued in the Art Nouveau period (Aslanoğlu, 1983). Art Nouveau was a style created by craftsmen, original designs were applied with fine craftsmanship and organic forms. Attention was paid to the integrity of space shaped by functionality in furniture. A piece of furniture was not only used for sitting, it was given additional functions.

Art Nouveau was inspired by wavy lines, plant stems, floral motifs, organic forms, artificial and geometric forms in architecture and interior architecture, furniture and accessories, ornamentation, and jewelry design and formed the style of the period (İnan, 1995). The leading designers of the movement made a name for themselves as both architects and furniture designers. Antonio Gaudi and Charles Rennie Mackintosh, among the most important of these designers, left their mark on the period with their architectural and furniture products.

Two types of Art Nouveau furniture design were seen among different countries and designers. The first group included Emile Gaile of the Nancy school, Louis Majorelle, Antonio Gaudi, and Charles Rennie Mackintosh (Alyanak, 1989). In addition to S-curves, the Nancy school frequently included motifs with abundant leaves and flowers (İstanbulluoğlu, 1995). The second group included Henry Van de Velde, Otto Wagner, Josef Hoffman, and Richard Reimerschmidt, who sought “logical beauty” (Alyanak, 1989). Art Nouveau, being a movement based on handcraftsmanship and not having strong relations with the economy, caused it to remain a short-lived movement.

1.2.2. De Stijl (1917-1928)

Founded during World War 1 by Dutch painters who adopted objective abstraction as a principle, De Stijl emerged as an organized movement from 1917 to 1928. Among the most famous artists of the movement are painter Mondrian, painter-architect-writer Theo Van Doesburg, architect Gerrit Rietveld, and sculptor Georges Vaterloo. De Stijl introduced unifying concepts that influenced all the arts and rejected any recognizable subject matter. De Stijl replaced traditional symmetry with asymmetrical balance (Kantoğlu & Özer, 1967).

The De Stijl movement aims to develop a common language for all societies. For this reason, it used only geometric forms and primary colors as an understanding of shaping (Aslanoğlu, 1983). The main principles of De Stijl were determined and adopted by the artists as simplicity, purity, openness, functionality, reality, objectivity, abstraction, and constructivism (Ünlü, 2015). Gerrit Rietveld, one of the pioneers of the movement, exhibited a formal expression of the De Stijl movement in the Schroder House. It is seen as an exact reflection of the De Stijl movement with both its architecture and furniture.

De Stijl was based on creating and developing the most suitable forms for machine production, and aimed to use as little manual labor as possible. The simple expression of the movement in art, architecture, and interior design led to the establishment of the Bauhaus school.

1.2.3. Bauhaus (1919-1933)

Bauhaus, which had a positive impact on industrial design and architecture education, was founded in 1919 by Walter Gropius in Weimar by merging the School of Applied Arts and the Academy of Fine Arts. Among the aims of the school, which supports creative power and is an experimental design laboratory, are to consider all branches of art, industrial design, and architecture as a whole, to ensure their cooperation with the industry, to reach a universal visual language in the design, to make artists, craftsmen, and architects aware of the realities of the period they live in and to support group work (Aslanoğlu, 1983; Özbayraktar, 1996).

Gropius believed that art should respond to the needs of society and should not be separated from craft. For this reason, in the school he founded, he aimed to provide art and craft education together and to transfer theoretical knowledge as well as practical methods in a correct and developed manner under the roof of the school. When students graduate from this new education system where architecture is at the center, they will have a good command of applied arts and be ready to collaborate with other branches of arts and crafts (Akdere, 2018).

Perhaps the most important difference or chance of Bauhaus from all other educational institutions is its educational staff. The Bauhaus school is a historical turning point where names such as Walter Gropius, Ludwig Mies van der Rohe, Hannes Meyer, Johannes Itten, Wassily Kandinsky, Paul Klee, Lyonel Feininger, Oskar Schlemmer, Laszlo Moholy-Nagy, Josef Albers, Marcel Breuer, Max Bill, Gunta Stölzl and Anni Albers, who are recognized as the pioneers of their branches, conducted their experiments and studies and shared their knowledge and methods (Akdere, 2018). The main reason why founder Walter Gropius brought together intellectuals and artists with ideals was to create the theoretical infrastructure necessary to establish the values of modernism on a solid foundation. Walter Gropius said, "We must not start with mediocrity, we must ensure the support of strong and famous personalities wherever they are" (Droste, 1990, p. 22).

Furniture design in the Bauhaus School begins with the furniture workshop opened by Walter Gropius in Weimar in 1921. In this workshop, industrial standardization of furniture is prioritized. The most important criteria in furniture design are based on functional analysis; the comfort of use and simple design are essential. The furniture workshop master Marcel Breuer, who was highly influenced by Constructivism, kept this constructivist aesthetic alive in all the furniture he designed throughout his life (Şahinkaya, 2009).

Walter Gropius, Marcel Breur, and Mies Van der Rohe are the prominent figures of the Bauhaus movement. Although he was not a part of the Bauhaus movement, Le Corbusier is one of the architects who adopted its principles both in theory and practice. Especially his designs of armchairs and lounge chairs reflect the traces of the movement. Alvar Aalto also designed furniture adopting the movement by using the wood effect in his late-period furniture.

While a modern understanding continued, Art Deco tendencies gradually began to be seen. Without excluding modernism, Art Deco developed its own unique ornamental and decorative style (Can, 1991).

1.2.4. Art Deco (1910-1936)

Following the emergence of Art Deco, it has been accepted as a style in almost all areas from architecture to craft products. The origin of the Art Deco style is traced back to the "Exposition Internationale Des Arts Decoratifs at Industries Modems" exhibition in Paris in 1925 (Polatkan & Özer, 2010). Rhulmann's "Hotel du Collectionneur" pavilion at the "Exposition Internationale Des Arts Decoratifs at Industries Modems" exhibition in 1925 was one of the first known representatives of Art Deco with its terraced elevations and simplicity (Mülayim, 2017).

Art Deco has been expressed as a reflection of the sense of emptiness pushed into the subconscious of Westerners who were caught between two wars and experiencing the social and cultural crisis of the period. The designs are not functional, but luxurious and expensive objects. As a result of this, the most successful area of the movement was silverware and jewelry design (Kapucu, 1995). While Art Deco quoted from various periods of history, they made designs against Bauhaus' attitude in favor of standardization and rationalization (Can, 1991).

Art Deco designs, a form of modernism transformed into fashion, include handmade luxury items as well as mass-produced items. In both cases, the aim was to create an unconventional and elegant aesthetic that symbolized prosperity and refined taste (Tong, 1990). Art Deco designers mostly aimed to design single or limited-edition furniture/items.

Art Deco was influenced by art movements such as Cubism and Fauvism. The reason why it was so easily reconciled with these art movements is that most of the Art Deco creators were artists. Designers, most of whom were painters and sculptors, some of whom were architects, gave products with an artist's approach. As a result, some products were designed far from being functional (Kapucu, 1995).

Among the leading designers of Art Deco are Pieter Zwart, Jean Prouve, Paul Folt, Emile- Jaques Ruhlmann, and Eilen Gray.

1.2.5. Pop-Art (1960-1970)

Pop Art is an art movement that emerged in England in the late 1950s and spread to Europe and America in the 1960s. It usually consists of paintings and very few sculptures. Its main orientation is to depict industrial daily consumer goods with mass communication techniques (Sözen & Tanyeli, 1996).

The term pop art embraces the entire field of contemporary realism that emerged with the discovery of a new meaning specific to nature, which is modern, shows characteristics related to industry and social science, and has urban qualities. Pop art reflects "American daily life with phenomena such as rapid urbanization, politicized youth, alternative thoughts on life and society, and increased consumption" (Bayraktar, 2004).

Pop is an art movement in which artists took elements of popular culture (hence the name pop) and adapted them to their works of art. Consumer culture, mass production, and advertisements were the sources of inspiration as the artists tried to make people notice the world around them; everyday details that they normally overlooked (Yavuz, 2007). Leading designers of Pop Art include George Nelson, Eero Saarinen, Eero Aamio, Sergio Mazza, Charles and Ray Eames, Pierre Paulin, Mario Bellini, Wendell Castle, Verner Panton, Luigi Colani, Peter Murdoch, and Joe Colombo. The Pop Art period ended with the birth of Post Modernism in the late 1970s and early 1980s.

1.2.6. The end of the 20th Century and the reflection of movements to the present

Towards the end of the 20th century, the design reflects an exploration of individualism and pluralism, offering a great variety of styles. Technological developments of the period affect design. Computer environments and programs provide great convenience to designers.

Late 20th-century influenced approaches include Late Modernism, Hi-Tech, Minimalism, and Deconstructivism. They were seen to be more dominant in the fields of architecture and art.

Since the last quarter of the 20th century, due to the dominance of individualism, the emphasis has been on pioneering designers in the process up to the present day.

Towards the end of the 20th century, the design reflects an exploration of individualism and pluralism, offering a great variety of styles. Today, technological developments influence design. Design trends in these years directly reflect social change. Unusual materials and new production methods bring countless possibilities. As in every field, a new universal understanding begins to emerge in design. With the furniture they produce, individual designers go beyond the expectations of society from mass-produced products in terms of research, accumulation, construction technique, use, and presentation.

In the literature section of the study, after having mastered the art movements that started at the end of the 19th century, the antecedent designs will be emphasized. The scope of the study and the study area are expressed in this section.

2. Material and Method

2.1. Workspace: Antecedent Designs in Furniture Design

As a result of the 19th-century industrial revolution, which reached its peak in the 20th century, 20th-century furniture developed in accordance with the needs of the period. The needs of the period include the Modern Architecture movement, which was produced in accordance with technology and construction methods, prioritizing simplicity, functionality, and rationality. Although there have been retrogressions and influences from previous periods, new searches have emerged with the new period.

Within the scope of the study, based on these influences, it is emphasized how the past periods can be interpreted today. The interpretation of the art movements determined as the subject of the furniture design course completed in the fall semester of 2019-2020 is carried out within the scope of this study. As the subject of study, especially prominent trends in furniture were determined.

2.2. Determination of the Preliminary Design of the Movements in the Study

Within the scope of the course, which took place in the Fall Semester of the KTU Department of Interior Architecture, the interpretation of the pioneering designs that emerged with the movements was made from different perspectives. The subject was determined as the 5 most effective periods in terms of the works that emerged in furniture design, including the 19th century and later (Figure 1).

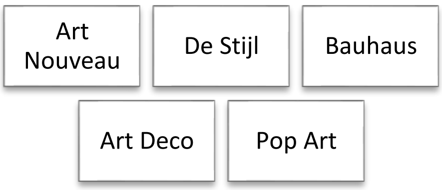


Figure 1. Architectural/Art movements Included in the study

First, students were expected to conduct general research on the periods identified. Then 5 streams were randomly distributed to all students. 68 students took the course in total. Each instructor continued to work with his/her group from the beginning of the course. Groups were limited to 13/14 people. 2-3 students are working on each trend within the groups. Each of the students focused on their furniture movement. After the research process during the first three weeks, each student was expected to identify the leading designs and designers of the movement. Among the leading designs of the movement, 3 designs were first identified and sketches were made on the interpretation of these designs to the present day. What is desired to emerge during the course is to make a work that is not too far away from the movement, where that design will be felt when viewed from the outside, but with an interpretation on it. The scope and progress of the work are expressed in Figure 2.

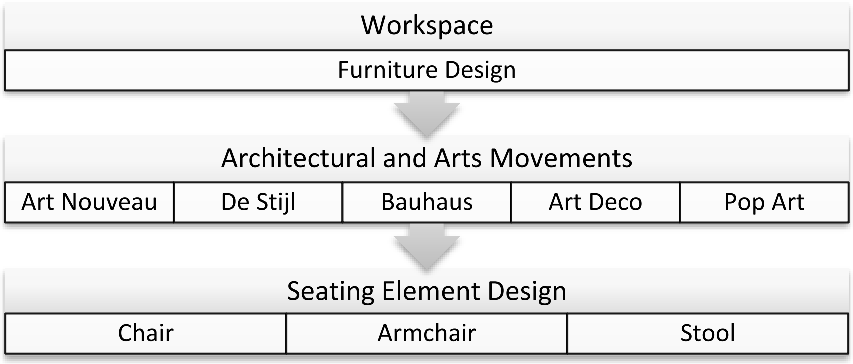


Figure 2. Scope of the study

In terms of subject matter, a limit was set at the furniture design stage and it was decided that the designs to be determined would be seating elements (such as armchairs, and chairs). During the course period, the first sketches were made after determining the prominent furniture of the movements. The first 3 weeks of the 5-week study period focused on research and the last 2 weeks on sketches.

A lot of work was done on the student's interpretation of the sofa/chair model selected in their studies. The design was first clarified and then the applicability of the design was emphasized after the studies that both did not break away from the effect of the design and brought their ideas to the forefront. In this process, color, texture, material, dimensioning, and applicability were completed as a result of mutual discussions. In the studies that used the process well and took their designs one step forward, in addition to the selected armchair or chair, stool design was also realized. The furniture design course resulted in the completion of the process, except for 2 students who could not attend the course.

3. Findings and Discussion

After the 5th 5 period, which includes the 19th century and later and which is the most effective in terms of the works that emerged in furniture design, the selection of furniture belonging to these periods was left to the students. Students first researched to master the Art Nouveau, De Stijl, Bauhaus, Art Deco, and Pop Art periods and presented the prominent pioneering designs of these periods in their research presentations. In the design phase, which started with sketches on a few pieces of furniture from each period; as a result of mutual criticism and interviews, the furniture was finalized. The furniture design group students decided on the models in the table below as the predecessor designs of the movements (Figure 3). The models were determined by the random method from the ancestor of the prominent designs.

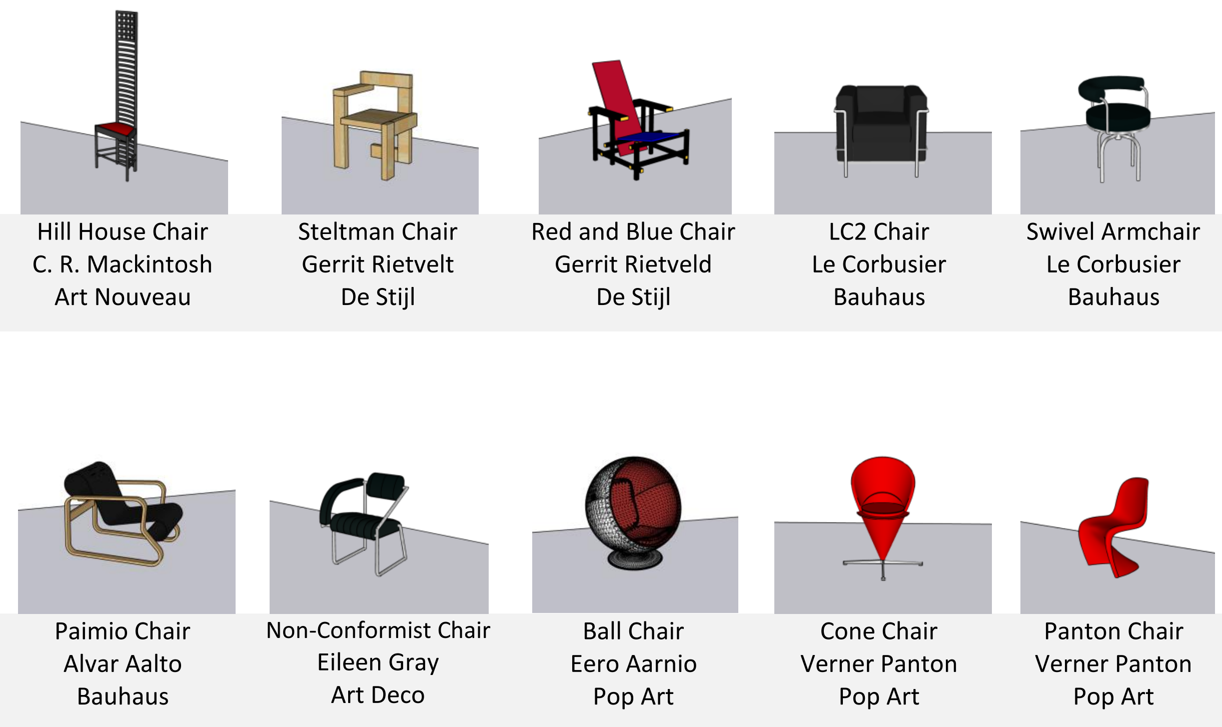


Figure 3. Preliminary designs considered within the scope of the study

As a result of the work that has been going on since the beginning of the semester, the process was completed within the scope of the 4-hour Furniture Design course, which was held once a week, and with interviews outside the course process. In the group of 14 students, 2 students could not participate in the education process. The progress and design process of the remaining 12 students were evaluated. The study results obtained as a result of the reinterpretation of the chair models discussed by the students within the scope of the course are given below.

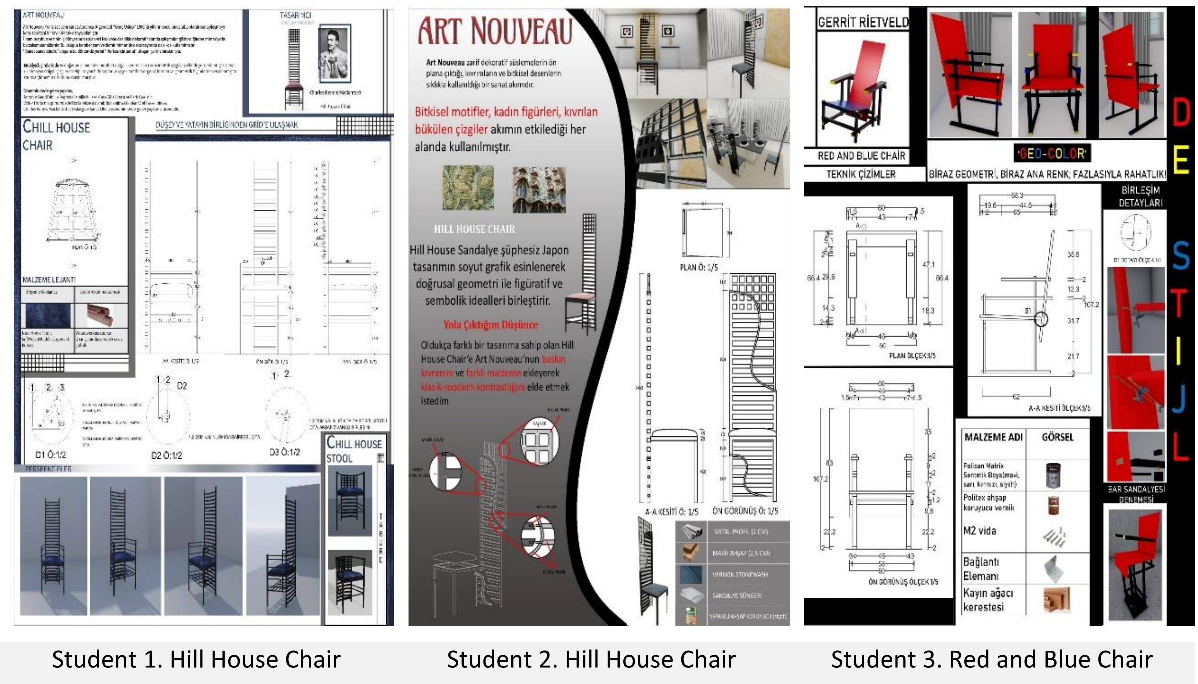


Figure 4. Works produced by hill house chair and red and blue chair

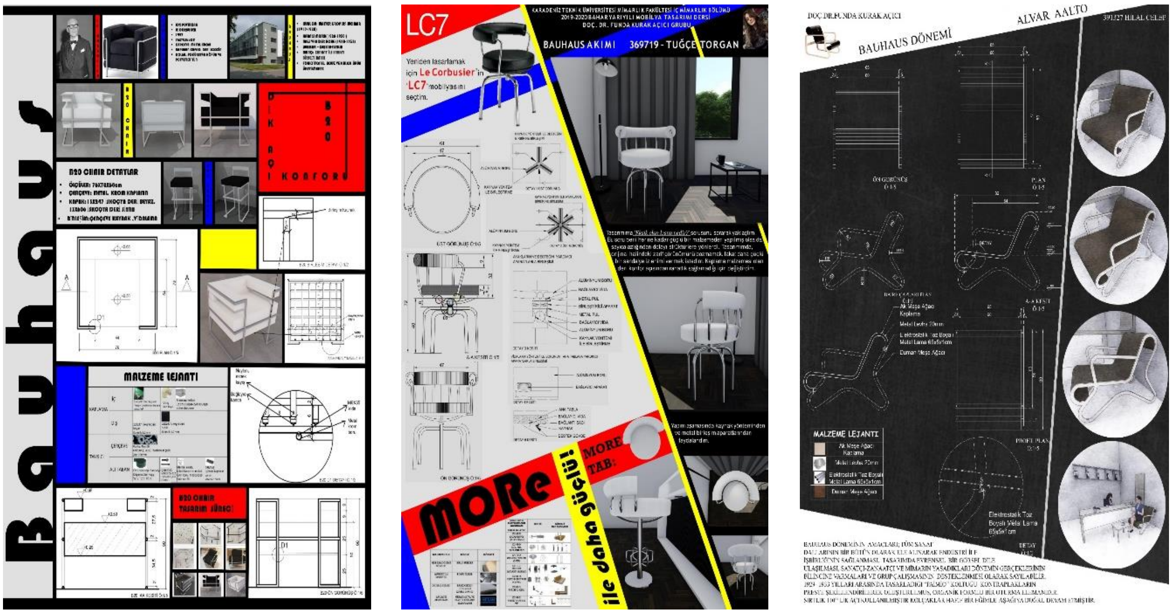
The Hill House Chair, designed by Charles Rennie Mackintosh, one of the pioneers of the Art Nouveau movement, was taken up by two students. Student 1, while preserving the general shape, material, and height of the chair that makes it iconic, differentiated the design with the top section of the back support. In addition, by adding armrests to the chair, he/she transformed the model into a new design without disturbing the characteristics of its period. The student also designed a high bar stool from this product, which ends at the same level as the armrest that he added to the back length of the chair. Student 2 added a curve that refers to the motifs used by the Art Nouveau movement and used it on the upper part of the back support and the lower part of the chair. He/she made a difference in the material by adding a metal profile to the wooden structure of the chair from the back and foot support, (Figure 4).

Student 4. Steltman Chair Student 5. A-27 Chair Student 6. A-27 Chair

Figure 5. Works produced by Steltman chair and A-27 chair

Two different pieces of furniture belonging to the De Stijl movement were handled and interpreted by one student. For the Red and Blue Chair designed by Gerrit Riedvelt, Student 3 reduced the slope of the back support, corrected the slope of the seat by removing it, and simplified the legs of the chair. The same student also designed a bar stool for this model. For the bar stool, he changed the foot section by raising it and completed the design with a simple armrest. He elaborated the design with beech wood and synthetic paint to make it applicable (Figure 4). Student 4, for the Steltman Chair designed by Gerrit Riedvelt, increased the asymmetrical balance in the back support and emphasized the asymmetrical shaping in the footrest by combining the two legs. In addition, while the original design of the chair was made of raw wood, here the design was strengthened by using the effective colors of the De Stijl movement. He/she applied the same design as the one he reproduced as a bar stool, but considering redwood as the material, he left the color plain, (Figure 5).

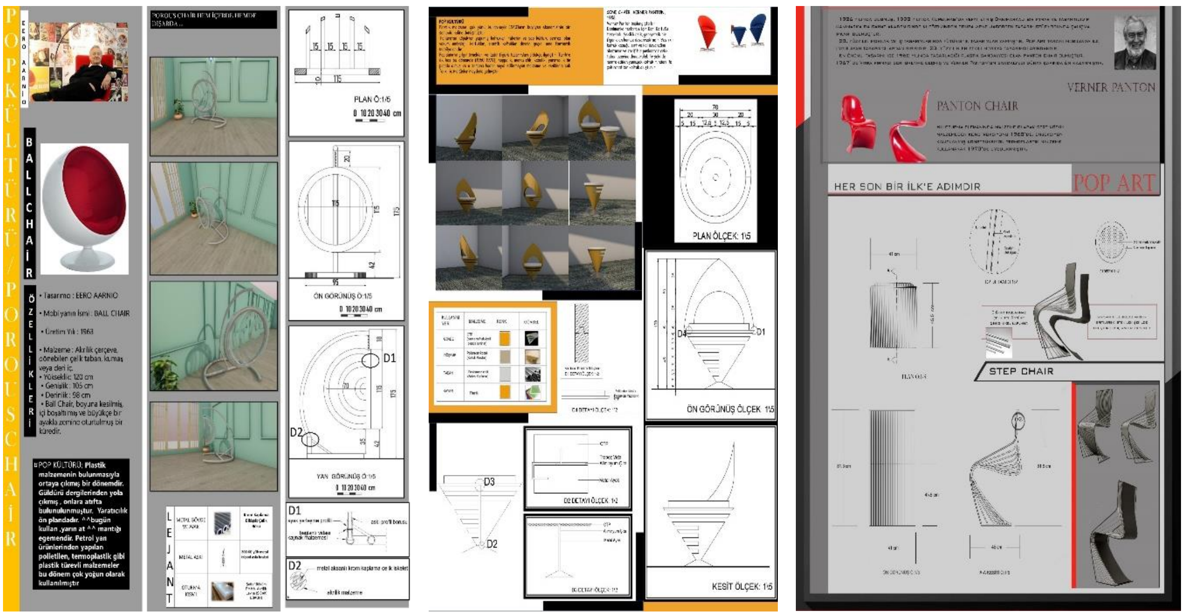
The Non-Conformist Chair (A-27 Chair) designed by Eileen Gray belonging to the Art Deco movement was handled by 2 students. Student 5 lowered the armrest support and combined it with the foot in an oval form to make the asymmetrical balance of the chair with asymmetrical armrests even more dominant. He/she designed the front legs of the chair independent from the back legs and combined the back leg support with the ground at a round angle. In terms of material, he/she preserved the main materials of the chair. Student 6 focuses on the asymmetrical balance of the chair, which is the most dominant design of the chair, by covering the right armrest with fabric up to the floor and making it closed, and completely removing the left armrest. He covered the back support, which was originally hollow, with fabric (Figure 5).



Student 7. LC2 Chair Student 8. Swivel Armchair Student 9. Paimio Chair

Figure 6. Works produced from LC2 chair, Swivel Armchair, and Paimio chair

Two different chair models designed by Le Corbusier, one of the pioneers of the Bauhaus movement, are discussed. Student 7 redesigned the LC2 model by removing it from the form of a completely closed seat and opening a space on the sides of the armrest support. He/she made the structure of the frame-shaped chair thicker and more dominant, ending at the point where the back and armrests of the chair end. He/she also differentiated the legs, which were flat on the ground in the original design, by lowering them to the ground in a rectangular shape in the form of a frame. He/she designed the originally black armchair as a white leather and metal structure. He/she also designed a bar stool of the same model, in which he emphasized its structure by freeing the armrests and side supports from leather. Student 8 redesigned the LC7 model armchair by increasing the number of metal joints only on the foot and back support to preserve the original design. In terms of material, he left the seat the same and designed it in white leather. The student, who also designed the bar stool of this model, created an area on the footrest that is fixed to the floor and has a footrest (Figure 6).



Student 10. Ball Chair Student 11. Cone Chair Student 12. Panton Chair

Figure 7. Works produced from Ball chair, Cone chair, and Panton chair

The Paimio Chair, designed by Alvar Aalto, one of the pioneers of the Bauhaus movement, was analyzed by Student 9. Since the sitting part of the chair reflects the identity of the chair, he preserved that part only by making it full and integrated the design by ensuring the continuation of the front curve in the foot supports. In terms of material, he/she preserved the original design exactly as it was, (Figure 6).

The Ball Chair, designed by Eero Aarnio, one of the pioneers of the Pop Art movement, was taken up by Student 10. The chair, which consists of a seat embedded in a cut-out of a ball, has retained the semicircular part of the chair but has transformed the completely closed mass into a transparent one. He/she redesigned the chair as a standing model with the help of a leg suspended from above. He/she envisioned the chair to be used with a material consisting of a metal structure and an acrylic seat (Figure 7).

Two different chair designs by Verner Panton, another pioneer of the Pop Art movement, were taken up by the last two students. Student 11, while redesigning the Cone Chair, has preserved the whole mass design as a whole and has emptied some areas. He/she left an oval space in the lumbar region of the back of the chair and strip-shaped openings in the part descending to the foot section. Unlike the original, which was produced entirely with a fabric-covered material, the design is completed with a plastic laminate body, polyurethane foam seat cushion, and stainless-steel legs. Student 12, on the other hand, took the Panton Chair. While the material used in the original design of the chair was initially rigid foam, it was later produced using thermoplastic material. The student added side connections that appear as wires going down from top to bottom to provide a light effect while preserving the form designed as a whole in the design. While designing the main body as transparent plexiglass, transitions were made with zinc nickel-plated wire material on stainless steel wire (Figure 7).

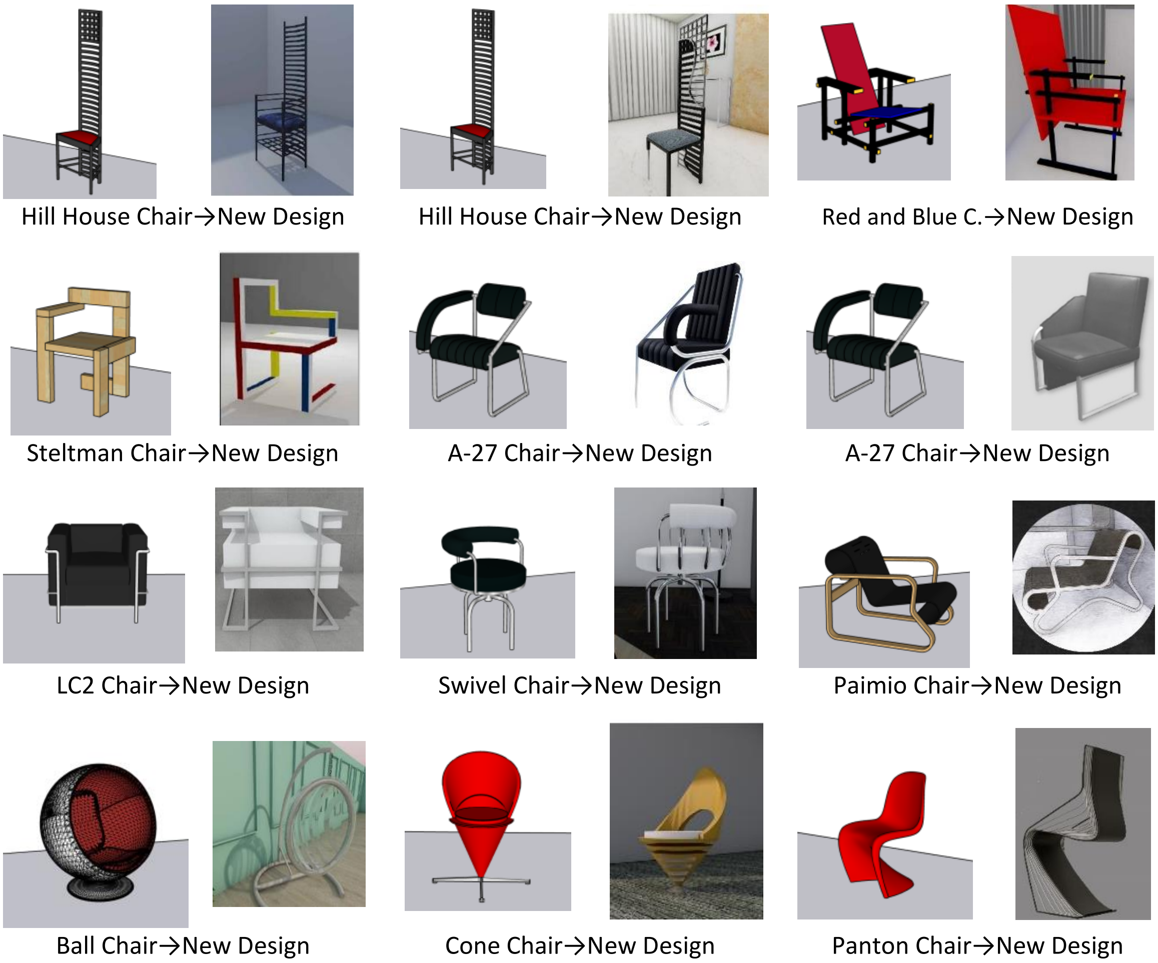


Figure 8. A comparative narrative of the adaptation of iconic chairs to the present

Design language enables people to perceive the object and creates the form (Güneroğlu & Bekar 2019). In this context, there is both a relationship between the forms that emerge and an effort to find a new design (Cordan, 2002; Ertaş Beşir & Bal, 2019). In the effort to find the new, it can also be said that not breaking away from the original form is a tool for finding the design language. While interpreting the iconic chair designs, it has been seen with the study conducted here that it cannot get too far away from their general framework. It is understood that the skeletal system of the chairs was not intervened, but rather differentiated in terms of material and form (Figure 8).

4. Conclusion and Suggestions

Developing as of the 19th century and dominating almost all over the world in the 20th century, architectural and art movements have been seen not only in architecture but also in interior architecture, furniture, sculpture, painting... in every field where art and design are effective.

In the 18th century, as steps were taken in the direction of the industry, new approaches began to emerge with the problems brought by the age and the search for solutions to them. From the beginning of the 19th century onwards, architects and designers have adopted the design approaches of previous eras and revitalized the previous movements from time to time. The 20th century has also differentiated itself as a period in which the spirit of past eras began to be thought to reflect its spirit and innovative approaches were sought.

The fact that the traces left by the movements that set their own rules in every period in the name of design can be reached until today reveals the universal power of design. The timeless aspect of design, especially in architecture, interior architecture, and furniture, confirms the fact that pioneering designs are still used today. Considering both design principles and user tastes (functional and aesthetic aspects of furniture), it can be seen that many pioneering designs are still preferable for interiors today.

In industrial design, the style gained importance in the 1950s, use, and function in the 1960s, aesthetics in the 1970s, meaning in the 1980s, and individual presentations and experimentation in the 1990s. Today, everything develops depending on computer programs. In design, attention is paid to practicality, functionality, and aesthetics. Until the recent past, functionality was accepted as the only one and form followed function. In the 20th century, industrial design ceased to be a field of interest only to engineers, and artists and architects also became involved in industrial design.

Within the scope of the study, the seating elements that made a lot of noise in the periods when they were produced by the designer and are still in use even today, constantly developing and renewed imitations are discussed. The products of architects and designers with pioneering designs in the Art Nouveau, De Stijl, Bauhaus, Art Deco, and Pop Art periods were included in the study.

Especially when the prominent furniture belonging to the movements is identified; it can be felt how aesthetic and functional they can still stand in space even as they were designed. Many designs that are in use today can reflect the perspectives of those periods from one aspect or another. In the comments on furniture made within the scope of the course, the fact that the design itself cannot be too far away from the design itself can be predicted as one of the reasons for this.

Within the scope of the study, it is observed that the students, who dealt with furniture bearing the characteristics of their periods, followed the current trends in color and material, although they could not get too far away from the form in their designs. In approaches where formal concerns come to the fore, the design has been updated especially in terms of material.

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Author Contribution and Conflict of Interest Declaration Information

The article has a single author and there is no conflict of interest.

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Shopping Center Design in the Context of Generation Z Consumer Perception

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Abstract

From the Greek Agora, where we saw the first examples of shopping venues, to the present day, human beings' shopping action and the need for a place to perform this action have always been there. The quality of these shopping places has had to change and transform over time with the changing lifestyle, spatial needs, and consumption styles from generation to generation. The consumer society, which has come to the point of purchasing everything, today's shopping centers are not only needed goods; We can say that they consider these as complexes where recreational activities, where they can maintain their social relations and enjoy, are also purchased. When considered in the context of consumption, hedonic consumption, which is the consumption understanding of the new generation, has begun to replace the utilitarian consumption that was dominant in previous generations. It has also been seen in the studies that the Z generation constitutes an important part of today's shopping malls. For this reason, the existing shopping center design parameters were examined and a synthesis shopping center design criteria table was created. On the other hand, the criteria in the current table were examined, and the examples of shopping malls that entered the literature as 'new generation' shopping centers were examined and the priority design criteria sought by the Z generation in shopping centers were reached.

***Keywords:** Z generation, consumption, design, shopping mall.*

Z Kuşağı Tüketim Algısı Bağlamında Alışveriş Merkezi Tasarımı

Öz

Alışveriş mekanlarının ilk örneklerini gördüğümüz Yunan Agoralarından bugüne kadar, insanoğlunun alışveriş eylemi ve bu eylemi gerçekleştireceği mekân ihtiyacı her zaman olmuştur. Bu alışveriş mekanlarının niteliği; kuşaktan kuşağa değişen yaşam şekli, mekânsal ihtiyaçları ve tüketim biçimi ile zamanla değişmek ve dönüşmek zorunda kalmıştır. Her şeyin satın alınarak elde edilmesi noktasına gelmiş olan tüketim toplumunun, günümüz alışveriş merkezlerini sadece ihtiyaç duyulan malları değil; sosyal ilişkilerini devam ettirecekleri, haz duyabilecekleri rekreasyon aktivitelerinin de satın alındığı kompleksler olarak değerlendirdiği söylenebilir. Tüketim bağlamında düşünüldüğünde, önceki kuşaklarda baskın olan faydacı tüketimin yerini yeni neslin tüketim anlayışı olan hedonik tüketim almaya başlamıştır. Yapılan çalışmalarda da görülmüştür ki Z kuşağı bugünün alışveriş merkezlerinde vakit geçiren önemli bir kesimi oluşturmaktadır. Bu nedenle mevcut alışveriş merkezi tasarım parametreleri incelenmiş ve sentez bir alışveriş merkezi tasarım kriteri tablosu oluşturulmuştur. Mevcut tabloda bulunan kriterler ise 'yeni nesil' alışveriş merkezleri olarak literatüre girmiş alışveriş merkezleri örnekleri incelenerek Z kuşağının alışveriş merkezlerinde aradığı öncelikli tasarım kriterlerine ulaşılmıştır.

***Anahtar kelimeler:** Z kuşağı, tüketim, tasarım, alışveriş merkezi.*

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1. Introduction

"Today, shopping malls are not just a place where shopping activities are carried out, they have turned into important meeting places where many different activities take place with their closed, climate-controlled physical environment and safe social environment. On the one hand, social relations are organized in these spaces with planned physical features, on the other hand, shopping activities and other leisure and recreation activities are offered to increase the pleasure in the space" (Lewis, 1989). In this context, it can be said that shopping centers not only host places where a service or good is bought and sold for a certain value but also become complexes where they can meet the social and cultural needs of today's societies and find the activities, they enjoy by experiencing.

For consumers, the act of shopping always means not only meeting a need but also sometimes emotionally enjoying the shopping experience. In other words, consumers' expectations from shopping can be utilitarian or hedonic (Demirci Orel & Kaçmaz, 2019). In this context, different generations may show different shopping behaviors (hedonic or utilitarian). Undoubtedly, generation Z is the one who makes up most of the user profiles of shopping malls, the number of which has been increasing in recent years. Shopping malls are increasingly targeting the Z generation, who are born into technology, love to shop online, and communicate physically with fewer people (Ölçer, 2019). Therefore, there is a need to re-evaluate the design criteria of shopping venues, as well as the changing consumption behaviors from generation to generation. For this reason, the main problem of this study is to determine the design criteria that the Z generation attaches importance to in shopping centers by considering the consumer perception of the Z generation on the shopping center design criteria that have come from the past to the present.

The change observed in lifestyles from the first designed shopping center to the present, and the fact that each generation has some unique characteristics, has also led to a change in consumer perception. In this context, with the changing needs of each new generation, the way and purpose of using shopping centers cannot be expected to be the same as the previous one. Based on this argument, the study aims to determine the new design criteria that will meet the demands and needs of the Z generation, taking into account the consumer perception of the Z generation on the shopping center design parameters from the past to the present. The scope of the new design criteria is all the experiential elements of the shopping center design in line with the consumer perception of the Z generation.

2. Literature Review

2.1. Generation Z and Hedonic Consumer Behaviors

Based on the year they were born, consumers are classified as the silent generation, baby boom, X, Y, and Z generations. Although there is no definite opinion about the beginning of the Z generation, different sources generally accept the members of this generation as those born after 1990, 1995, or 2000. However, each generation's unique needs, lifestyle, period in which they lived and the events they witnessed were different. These factors have also led to the differentiation of generations in terms of consumer behaviors and purchasing decision processes. Therefore, marketers use generations to identify potential consumers, communicate with them, and segment the market (Yaşa & Bozyiğit, 2012). In line with Karaman's (2021) studies on Baby Boomers, X, Y, and Z generations, consumption behaviors and purchasing processes of generations were examined and the following comparative table was created (Table 1). When Table 1 is examined, it can be said that consumption is much more value-oriented and benefit-oriented in the Baby Boom and X generation, the importance of benefits and values from the Y generation to the Z generation has decreased and more pleasure-oriented consumption behavior has come to the fore.

Table 1. Generations and consumption behaviors (Karaman, 2021)

Baby Boomers	Value-oriented, less price sensitive.
Generation X	They are value-oriented, need reassurance, are skeptical, usefulness and practicality are important and are disloyal.
Generation Y	They use technological tools in communication, they consume immediately, they give importance to trends, they are independent and individualistic, they spend a lot of money, and they are learning-oriented.
Generation Z	Educated, mobile, and connected consumers love innovative and lasting change, are socially conscious, addicted to technology, tolerant, self-confident and sensitive, consume hastily and instantaneously, are creative and can make multiple decisions, are selective, shop themselves and buy better quality products.

One of the concepts that gained importance with the active role of the Z generation as consumers is the concept of hedonic consumption. With the concept of hedonic consumption, it is possible to say that the consumption process gains an emotional or emotional dimension beyond just meeting the needs (Güven, 2009). In this context, all marketing tools designed for the purchase of the product from the place where the shopping is made are the elements that can positively affect the product purchasing process of the Z generation. “The events held in shopping centers allow consumers to have an entertainment experience, arousing curiosity in their customers and causing them to discover new products and new stores. Thus, customers experience a greater sense of satisfaction; he also enjoys the process thanks to many atmospheric elements, from lighting to air conditioning, from the music played to the colors used in the design” (Kesari & Atulkar, 2016). Hedonic consumption motivations that push the Z generation to buy are examined under 5 main headings as originality, making others happy, entertainment, daydreaming and social interaction.

As a result, hedonic consumption motivations (authenticity, making others happy, entertainment, daydreaming, social interaction) are the factors to be considered while designing the shopping spaces of the Z generation.

2.2. Shopping Center Design Parameters

The first precursors of the shopping center phenomenon are the department stores, which started to appear in the USA and Europe in the 1900s and changed the traditional shopping phenomenon (Zukin, 1998). However, the emergence of the shopping malls we know today was founded in the 1950s. Big shopping malls in Turkey have gained an important place, especially since the 1990s, and have become popular by being adopted by the Turkish people (Saygın, 2006.).

Each type of architectural structure has its own set of basic design principles. These principles are from user comfort to physical conditions of the building; They can come from different bases, from aesthetic needs to user profiles. Undoubtedly, shopping malls are among the building types that need to be carefully studied in the light of certain parameters in their design due to their close relations with the city, urban life, and citizens. At this time, when technology provides unlimited opportunities for online shopping and it is easier for people to shop from the screen or with their phones, shopping malls have become a phenomenon beyond shopping and shopping malls have become concept where they meet the social and entertainment needs of their visitors with their indoor and outdoor recreation areas (Uzun et al., 2017). In this context, there are studies on shopping center design parameters that have been put forward from different perspectives in the literature.

One of the most important existing studies on mall design parameters was published at TICASH 2019 by Wiratno et al. (2019). In the article, considering the consumption behaviors of the X, Y, and Z generations, the existing parameters that make up the physical form and architectural features of a shopping mall in Jakarta were evaluated. In the study, the parts of the current shopping mall design parameters that support the consumption behaviors of the X, Y, and Z generations were determined and no suggestions were made about the missing aspects. These parameters are parameters that make up the physical form and architectural features of the shopping mall; exterior, store layout, supporting facilities, management, attraction, circulation, interior, transportation, and structure.

Shopping centers are examined in three groups in terms of their physical form open, closed, and composite. Open shopping malls are generally located in city centers and give priority to pedestrian comfort on all planned roads. It is also suitable for temperate climates as it is air-conditioned with a natural ventilation system, thus saving energy. Conversely, since indoor shopping malls are covered by a roof, air conditioning can be kept under control, but energy costs are quite high. In composite shopping malls, indoor spaces are planned with open spaces to be in the center (Wiratno et al., 2019).

The exterior is always associated with art or aesthetics, since the exterior is the visitors' first mirror, tenants play a very important role in creating an external impression in activities in a shopping mall. “In the outdoor building model of the shopping mall, comfort should always be at the forefront for both tenants and visitors. In this context, access to the building and building form is very important in the outdoor design of the shopping mall” (Wiratno et al., 2019).

The Store Layout Plan is related to the location of the tenants in the shopping center within the shopping center and relative to each other. These; are the location of the attraction points, the regional location of the other spaces, and the circulation features (Wiratno et al., 2019).

Attraction points are important units that attract and guide customers to shopping malls. For this reason, the location, accessibility, and target audience of the attraction points are very important (Wiratno et al., 2019). According to Kevin McGhee (1987), the positions of the attraction points relative to each other can be linear, L-type, and Y-type (Figure 1). In linear positioning, the distance between two shooting points is the shortest. Thus, visitors can provide direct directions to the stores. In an L-type arrangement, when the customer exits from both directions, he encounters another attraction point. Finally, unlike the others in Y-type positioning, regional squares are formed in the center of the attraction points.

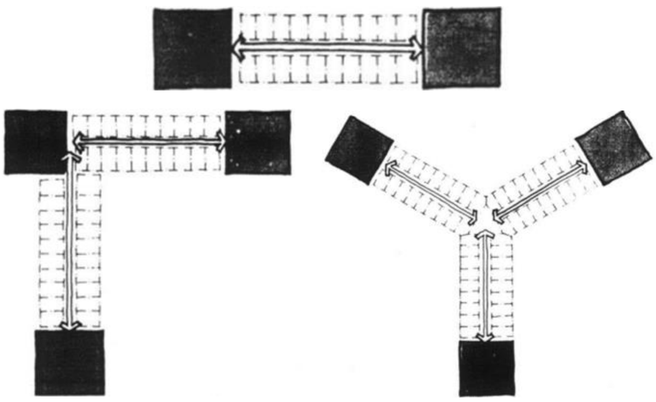

Figure 1. Linear type, L type, Y type (Kevin McGhee, 1987)

The first of the circulation features of the store layout is the features of the circulation elements. The circulation system in a building may consist of corridors, halls, stairs, escalators, ramps, escalators, moving platforms, and elevators, however, it may vary according to the function and form of the building.

Another of the store circulation features is circulation schemes (Wiratno et al., 2019). Here, rather than the feature of circulation, their position relative to each other and the way they lead the visitors to the fore. According to Avriansyah (2010), shopping center circulation systems are of three types: multi-aisle system, plaza system, and market system. In the multi-corridor system, there are many corridors, and the quality of the corridors is the same (Wiratno et al., 2019). For this reason, there is no emphasis on any store or unit (Figure 2).

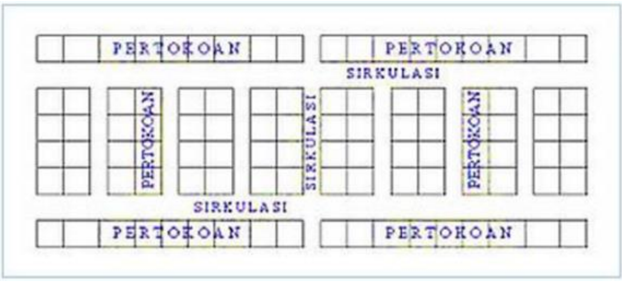

Figure 2. Multi-corridor system (Avriansyah, 2010)

There is a large-scale activity area at the center of the units in shopping malls with a plaza system. The emphasis is on this area, and the other units are positioned far from the center in a hierarchy with corridors in order of importance (Wiratno et al., 2019) (Figure 3).

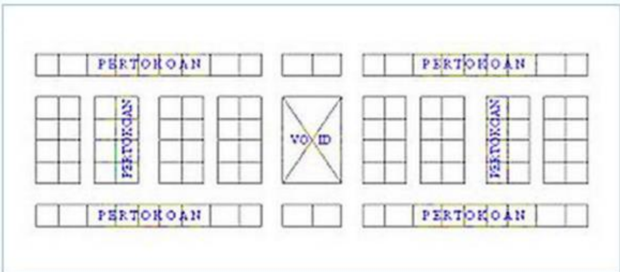

Figure 3. Plaza system (Avriansyah, 2010)

In a shopping center with a market system, there is another axis consisting of one or more atriums in the middle of the store axes. This axis creates a focus by showing a main road feature in circulation (Wiratno et al., 2019) (Figure 4).

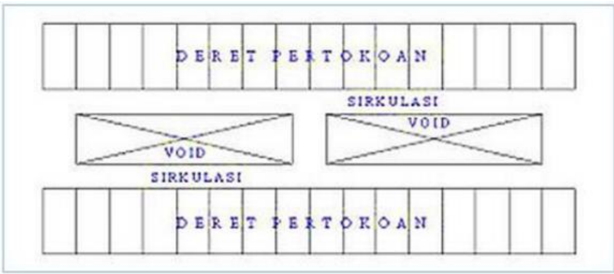

Figure 4. Market system (Avriansyah, 2010)

The possibilities related to the physical comfort of the customer are very important as they indirectly support the shopping action (Wiratno et al., 2019). These possibilities are briefly; visual comfort, auditory comfort, thermal comfort, and universal design (Terece & Berkin, 2019). In addition, the arrangement of the shopping center by considering the location and target audience of the tenant types chosen is also important in terms of not creating a perception of the influx of visitors. Finally, there are the facilities provided to the tenants who are the attraction points. These; tenant type, arrangement principle, target focus, the role of technology, and other types of tenants (Brown & Lubelczyk, 2018) (Table 2).

Table 2. Attractive point features (Brown & Lubelczyk, 2018)

CONSUMER ENGAGEMENT	**Anchor tenants**	Traditional retailers	→ **Retail, residential, entertainment**
	Organizing principle	Retailer and manufacturer 'push'	→ **Consumer 'pull'**
	Primary focus	Selling things	→ **Consumer engagement**
	Role of technology	Powering the system	→ **Connecting buyers, sellers, and places**
	Tenant mix	Mass market	→ **Market of one**

The main factor supporting the success of a shopping center in the current competitive environment is its management, which we can call the brain of that workplace. Management has duties such as pushing consumers to buy goods and promoting the brand image. Wiratno et al. (2019) divided management into three main components: mall general management, customer comfort quality management, promotion, and publications. While it covers the general management of the building, the mission and corporate culture of the institution, property and maintenance management, service and expert staff, experience and relations with the tenants; customer comfort, quality management, safety, cleanliness, and well-organized parking; promotions and publications support shopping mall promotional programs, the quality of exhibitions and large events (Wiratno et al., 2019). Attractive Points are the tenants that create a 'Landmark' effect for shopping malls with a regulated circulation system in the plaza and market system (Wiratno et al., 2019). As mentioned before, circulation is one of the important topics for the shopping center, which is shaped according to the ways that customers will follow in a planned manner. According to Wiratno et al. (2019), the interior design of a shopping mall includes all the arrangements from the concepts of its tenants to the overall shopping mall interior design. Transportation is one of the important outdoor design parameters of a shopping mall. Parameters to be possessed for effective transportation; Its strategic location, environmental quality, distance to important centers, and alternative routes, especially in areas with high traffic density (Wiratno et al., 2019). The structure is a parameter related to the form of the shopping center. As Avriansyah (2010) stated, it offers different shopping experiences depending on whether it is open, closed, or composite.

In a presentation made by Gravell (2014) in ICSC European Retail Property School, while classifying the design trends of Shopping Centers, it exemplified the shopping centers built in recent years, sub-parameters as landmark architecture, color and light, vertical merchandising, sustainability, exploration areas, and technology. In addition to Gravel's classification, Loy's (2010) 'Landmark Architecture', that is, the factors that make up the status of a building as a landmark, scale, design, location, function, landscape, and people.

Kevin McGhee (1987) classified the architectural features of shopping malls as material selection, entrance design, urban furniture, shop front design, floor design, and lighting in outdoor design.

3. Material and Method

As can be seen in Figure 5, because of the literature research, classifications of shopping center design criteria from different perspectives have been revealed. Existing classifications were synthesized, and a control chart was created to help examine the relationship between Generation Z and the shopping center. In this classification, in addition to interior and exterior design at the architectural scale, other features related to the marketing work area such as interior layout features, shopping mall management, and facilities that support sales, which have a large share in regulating the relationship between the shopping center and consumers, are also included.

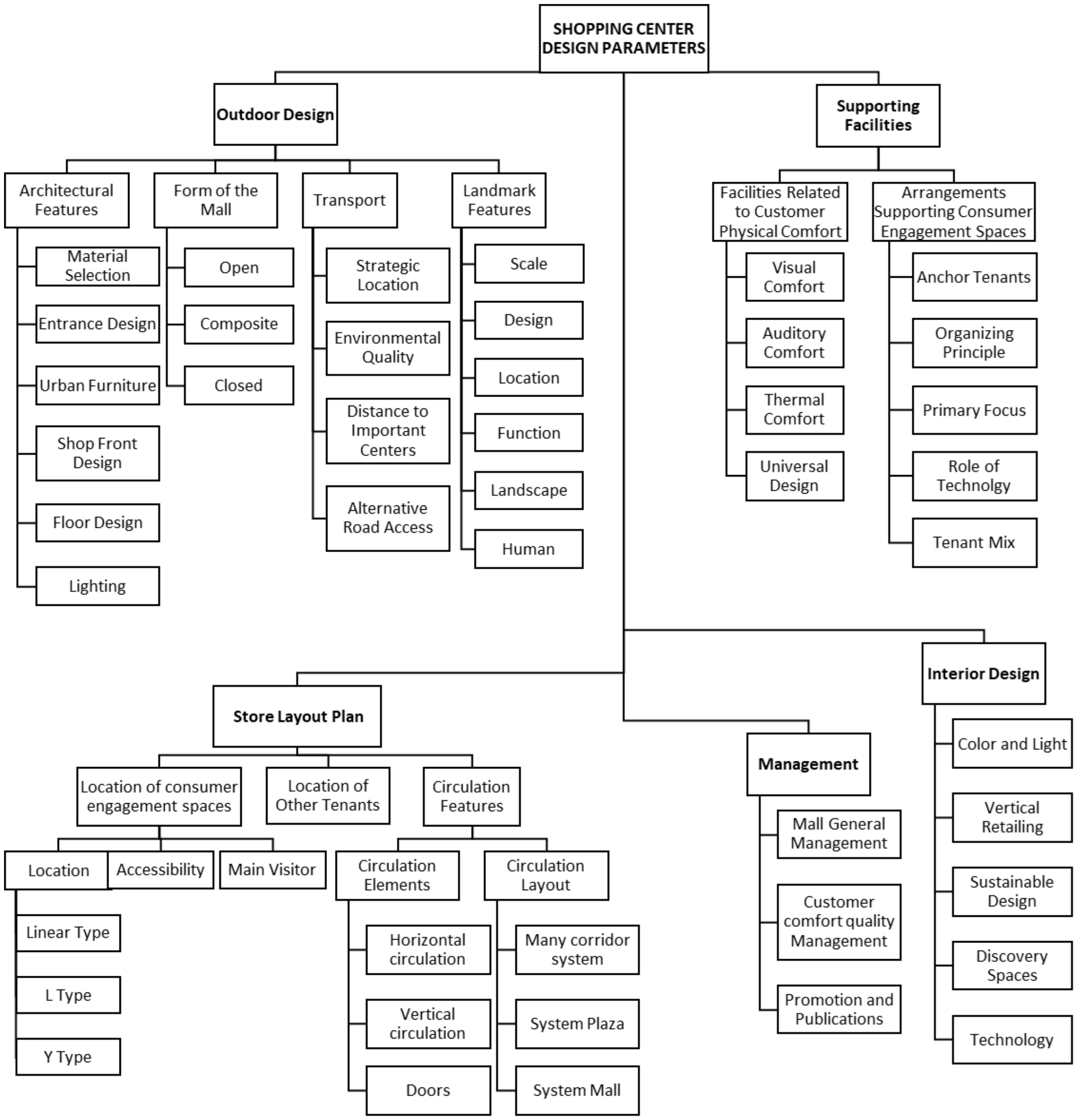

Figure 5. Shopping center design criteria

4. Findings and Discussion

Shopping center projects designed and implemented by selecting the Z generation (new generation) target audience were determined and re-examined within the scope of the synthesized shopping center design criteria. While conducting this examination, help was taken from the control table consisting of the criteria synthesized in the previous title and set forth as in Figure 5. Shopping centers built in as many different geographical regions as possible were selected and re-examined, and the parameters that come to the forefront in all of them formed the basis of the criteria that should be kept at the forefront in the design of shopping centers suitable for the Z generation. Selected shopping malls: Z Center (Croatia/Zagreb), TX Huaihai (China/Shanghai), Meydan AVM (Turkey/Istanbul), La Part-Dieu (France/Lyon), T1 Mall (Estonia/Tallin), BEO Shopping Center (Serbia/Belgrade), American Dream (United States/Miami), Mall of Emirates (United Arab Emirates/Dubai), AEON Malls (Vietnam/Hanoi), Markthal (Netherlands/Rotterdam).

4.1. Examples of Z Generation Shopping Centers

Z Center: It is possible to say that the Z Center shopping center, designed as a new-generation shopping center, attaches particular importance to the exterior design. So much so that the exterior design has focused on the choice of materials, urban furniture, floor design, and lighting from its architectural features. A composite form was preferred as the shopping mall form, in a strategic location in terms of transportation and being a landmark, location, function, landscape, and human factors were emphasized (Figure 6). In addition, additional systems have been used by considering the physical comfort of the customer in terms of thermal comfort, which is one of the supporting possibilities. Finally, it can be said that sustainability is discussed with the use of local materials in interior design (The Plan, 2022).

Figure 6. Z Center (The Plan, 2022)

TX Huaihai: Located in Shanghai, TX Huaihai is located at a strategic point with both indoor and outdoor use. It is located both on an important street and close to important shopping centers. In addition, a dynamic arrangement suitable for continuous change is aimed at the principle of choosing the tenants that will attract the attention of the Z generation from the supporting opportunities. The new generation is attracted to the shopping center by creating exploratory, intriguing, and technological spaces that will evoke the effect of a museum in the interior (Figure 7) (Delacharlerie, 2021).

Figure 7. TX Huaihai (Wonderland, 2019)

Meydan AVM: Providing its visitors with the experience of shopping in the open space to a large extent, Meydan AVM has also carried the shopping function it offers indoors to the outdoors with glass partitioned stores and urban furniture placed outdoors (Figure 8). In addition, it did not limit its target audience to certain classes of society but expanded its tenants by choosing from large retail stores that appeal to the large masses. It has been accepted as one of the good examples in terms of 'sustainable design' in Turkey with its large green roof application, maximum use of daylight in the interior, and other applications (Figure 9) (Babmagazine, 2019).

Figure 8. Meydan AVM

Figure 9. Meydan AVM (Babmagazine, 2019)

La Part-Dieu: In the project of transforming La Part-Dieu shopping center into new generation shopping centers, firstly, the relationship with the city was established. This relationship has been achieved by rearranging the entrances, façade design, and new regulations that make outdoor use convenient. In addition, energy consumption has been reduced with the glass openings created in the pan to increase the use of daylight in the interior (Figure 10).

Figure 10. La Part-Dieu (Lyon Part-Dieu, n.d.)

T1 Mall: Located at the intersection of various transportation axes in the city, T1 Mall is strategically located in the city center. A city was formed inside the outer mass, which was designed as a closed box in form (Figure 11). The sense of urbanity and spaciousness created in the interior design are the main themes that make up the interior atmosphere of the shopping mall. While the inner large atrium (square) and corridors (streets) connected to the atrium are the features that give the feeling of the city, the feeling of spaciousness is provided by the use of high ceilings and the glass spherical openings on the roof. In this way, energy consumption is minimized by taking maximum daylight into the interior. With the presence of works of art centers in the atriums in the interior, a pleasant ambiance was created and contributed to a different shopping center experience (Figure 12) (The Baltic Times, 2018).

Figure 11. T1 Mall (Ober Haus, 2019)

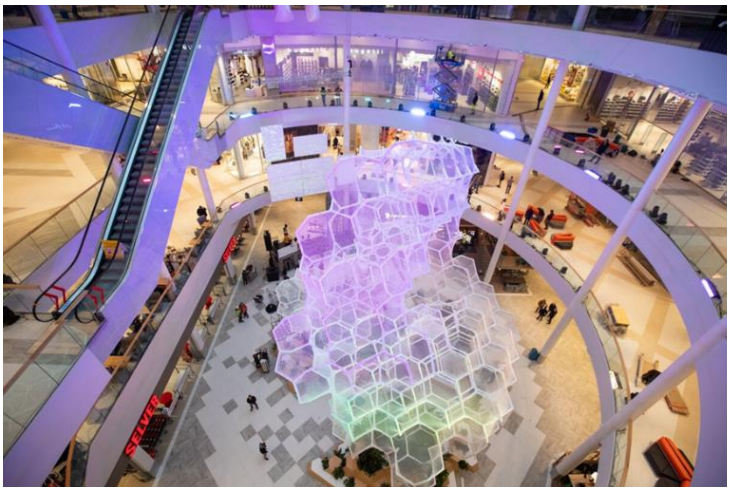

Figure 12. T1 Mall (Treiman, 2018)

BEO Shopping Center: BEO Shopping Center has achieved its integration with the city by using the entrance design and associated street furniture (Figure 13). In addition, it is intensive use due to its location at the intersection of important streets and its proximity to important centers. Designed with the claim of offering a new-generation personalized shopping mall experience, BEO Shopping Center offers its customers maximum natural light and air quality in comfortable interiors by choosing the types of tenants according to certain criteria. In addition, this situation added value to the shopping center in terms of sustainability (Taylor, 2021).

Figure 13. BEO shopping center (Across Magazine, 2020)

American Dream: It can be said that the American Dream shopping center is planned as an attraction center with exploration areas that aim to provide different experiences to its visitors, unlike the current shopping center concept. Set on undeveloped land on the Florida Turnpike, American Dream Miami is more like an amusement park than a traditional dumbbell-shaped mall, and the complex includes a giant indoor pool, water park, indoor ice rink, artificial ski slope, "submarine" rides, dozens of It includes a restaurant and approximately 1,200 shops (Figure 14) (Garfield, 2018).

Figure 14. American Dream (Garfield, 2018)

Mall of Emirates: Different from the classical shopping center concept, Mall of Emirates has determined its target audience with its prestigious brands and appealed to a certain segment. It also aims to provide its visitors with the experience of skiing in Dubai with the Dubai Ski it contains (Figure 15). Easy access by the metro and its location on a central street also positively affect the number of visitors (Dubaihakkinda, 2017).

Figure 15. Mall of Emirates (Dubaihakkinda, 2017)

AEON Shopping Center: In addition to its shopping function, AEON Shopping Center is designed as a new-generation, sustainable living, and entertainment center where visitors can experience Japanese culture and life (Figure 16) (Van, 2019). With these features, it is seen that it is designed with a different approach from the current shopping center perception.

Figure 16. AEON shopping center (Mavink, n.d.)

Markthal Shopping Center: Having developed a new approach to the marketplace shopping order, Markthal Shopping Center has succeeded in creating a new center in the city with its historical texture and functions. In addition, it created a focal point by designing its architecture in the form of an arch to contrast with the surrounding structures. Local brands were given priority by mostly including food and beverage sales areas as a tenant type, and their relationship with local and ethnic identity was strengthened. The display of flowers and food images of famous artists in high resolution on the inner wall of the arch also gave visitors different feelings about the space. On the contrary, the outer surface of the arch is covered with a gray neutral ceramic, contributing to the foreground of the colors in the interior. Historical ruins belonging to different periods of Rotterdam, which emerged during the construction of the building, were integrated into the circulation system, allowing visitors to visit a permanent exhibition at the same time while shopping. Arrangements have been made to allow the use of natural light in the planning of privately owned flats of the building, which was awarded the sustainability certificate with the degree of 'very good' by BREAM. Maximum natural light intake is provided to the market hall with an all-glass coating on the exterior (Figure 17) (MRVDV, n.d.).

Figure 17. Markthal shopping center (MRVDV, n.d.)

10 different shopping malls, which are described as 'next generation' shopping centers in the literature, were examined and the prominent design principles of each were marked in the relevant column in the control table created with the current design criteria (Table 3). In the table, the most emphasized principles were highlighted and evaluated, and the principles that should be emphasized in the design of the 'new generation' shopping center suitable for the Z generation were revealed.

10 different shopping malls, which are described as 'next generation' shopping centers in the literature, were examined and the prominent design principles of each were marked in the relevant column in the control table created with the current design criteria (Table 5). In the table, the most emphasized principles are highlighted and the principles that should be emphasized in the design of the 'new generation' shopping center suitable for the Z generation are revealed. According to the results of the case studies, the parameters observed in 7 or more 10 samples were accepted as 'primary importance', and the principles observed in 4-6 samples were accepted as 'secondary importance'. In this context, the strategic location of shopping centers, the types of tenants, their sustainability, and discovery areas are of primary importance for the design of shopping centers suitable for the Z generation. The use of urban furniture, the composite shopping mall form and the distance of the shopping center to the important centers are among the principles that should be in the shopping centers suitable for the Z generation at the level of secondary importance.

Table 3. Z Generation shopping center design parameters sample analysis result table

				Z Center	TX Huaihai	Meydan AVM	La Part-Dieu	T1 Mall	BEO	American Dream	Mall of Emirates	AEON	Markthal
Outdoor Design	Architectural Features	Material Selection					■						■
		Entrance Design					■		■				
		Urban Furniture		■		■	■		■				
		Shop Front Design											
		Floor Design		■									
		Lighting		■									
	Form of the Mall	Open											
		Composite		■	■	■	■						
		Closed							■				■
	Transport	Strategic Location		■	■		■	■	■		■		■
		Environmental Quality											
		Distance to Important Centers			■			■	■				■
		Alternative Road Access					■	■			■		
	Landmark Feature	Scale						■					
		Design						■					■
		Location		■									
		Function		■									
		Landscape		■									
		Human		■									
Store Layout Plan	Location of consumer engagement spaces	Location	Linear Type										
			L Type										
			Y Type										
		Accessibility											
		Main Visitor				■							
	Location of Other Tenants												
	Circulation Features	Circulation Elements	Horizontal circulation										
			Vertical Circulation										
			Doors										
		Circulation Layout	Many corridor system					■					
			System Plaza										
			System Mall										■
Supporting Facilities	Facilities Related to Customer Physical Comfort	Visual Comfort											
		Auditory Comfort											
		Thermal Comfort		■									
		Universal Design											
	Arrangements Supporting Consumer Engagement Spaces	Anchor Tenants			■	■		■	■		■	■	■
		Organizing Principle			■								
		Primary Focus											
		Role of Technolgy			■								
		Tenant Mix			■								
Management		Mall General Management											
		Customer comfort quality Management							■				
		Promotion and Publications											
Interior Design		Color and Light							■				
		Vertical Retailing											
		Sustainability		■		■	■	■	■			■	■
		Discovery Spaces			■			■	■	■	■	■	■
		Technology			■								

5. Conclusion and Suggestions

As seen in the examples examined (Figure 18), urban furniture stands out as a meeting point for new-generation shopping malls, a socializing place, and an element that increases the quality of life in the city. The fact that the shopping center form is composite, that is, it is designed for the effective use of both indoor and outdoor spaces by the visitors, is also important for the new shopping space phenomenon. In addition to these, the shopping center's location on busy streets, its location on transportation networks, and its proximity to the city center or other important shopping and social interaction points are also features that should be considered for shopping centers to be designed for the Z generation. The fact that the tenants of the shopping and service units of the shopping centers are consciously chosen according to their income groups and target audiences is one of the points to be considered. Finally, it can be said that it is important to design shopping malls integrated with discovery spaces, considering that the Z generation, who are hedonic consumers, can make purchases more easily in places that arouse curiosity. The roles assigned to the shopping center by Generation Z have revealed the necessity of transforming shopping centers into a few experience centers. For this reason, the areas of discovery for the Z generation in shopping centers were questioned through these four concepts: innovation center, attraction center, values center, and life center. The state of being an innovation center in shopping centers is to support the shopping function with areas with the latest technology. Areas related to the attraction include attractions and entertainment activities. Values center refers to areas that reflect the culture of any ethnic group and a social or political message. Finally, for a shopping center to be perceived as a living center, it must have areas that meet daily needs.

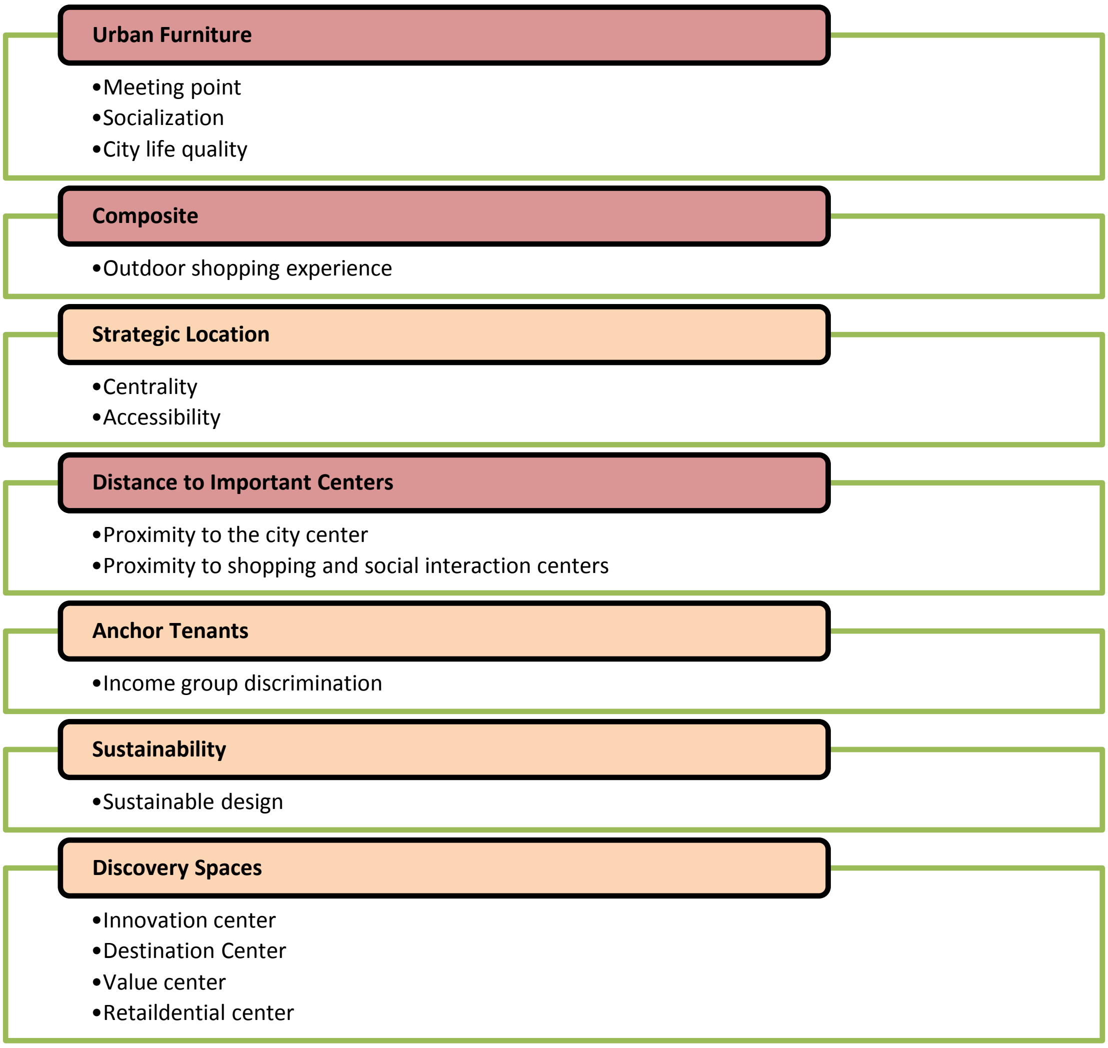

Figure 18. Design parameters and concepts of Generation Z shopping malls with primary and secondary importance

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A New Approach to the Space Design Process in the Interior Architecture Basic Design Studio

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Abstract

The 'basic design' course, which plays a key role in the process of creative thinking and converting thought into an idea in today's architecture and interior architecture departments, has been constructed on a new experimental learning method for this study. The study aimed to acquire a concrete space experience based on the assumed abstract thought, to produce a problem-solving-oriented design by making the student question the original design idea. The education method designed was accordingly carried out in 4 stages in 14 weeks in the 2021-2022 Education Period, Department of Interior Architecture, Selcuk University. For starters, theoretical information was conveyed with Gestalt principles; later abstract and concrete ideas were developed on the design problem, and in the third stage, projects were developed on the process of transition from abstract to concrete space for the solution of the problem, and finally, the results were evaluated. As a result of the studio experience, the students created a working doctrine that will direct the interior design studio works with the designed method, enable the formation of original forms and shapes, enabling them to obtain concrete space from abstract concepts, and design at different scales from equipment to space design.

***Keywords**: Basic design, interior architecture education, problem, organization of space.*

İç Mimarlık Temel Tasarım Stüdyosunda Mekân Tasarım Sürecine Yeni Bir Yaklaşım

Öz

Günümüz mimarlık ve iç mimarlık bölümlerinde yaratıcı düşünme ve düşündüğünü fikre dönüştürme sürecinde önemli bir rol üstlenen 'temel tasarım' dersi bu çalışma özelinde yeni bir deneysel öğrenme metodu üzerine kurgulanmıştır. Çalışmada varsayılan soyut düşünceden yola çıkarak somut bir mekân deneyimi elde etmek, öğrenciye özgün tasarım düşüncesini sorgulatarak problem çözümüne odaklı tasarım üretmek amaçlanmıştır. Bu doğrultuda kurgulanan eğitim metodu; Selçuk Üniversitesi, İç Mimarlık Bölümü 2021-2022 Eğitim Öğretim dönemi 14 haftalık süreçte 4 aşamada gerçekleştirilmiştir. Birinci aşamada; Gestalt ilkeleri ile kuramsal bilgiler aktarılmış, ikinci aşamada; tasarım problemi üzerine soyut ve somut düşünceler geliştirilmiş, üçüncü aşamada; problemin çözümü için soyuttan somut mekâna geçiş süreci üzerine projeler geliştirilmiş, son aşamada ise sonuç değerlendirmesi yapılmıştır. Stüdyo deneyimi sonucunda öğrenciler kurgulanan yöntem ile iç mimari stüdyo çalışmalarına yön verecek, özgün biçim ve şekillerin oluşmasını sağlayacak, soyut kavramdan somut mekân elde etmesine imkân verecek ve donatıdan mekân tasarımına kadar farklı ölçeklerde tasarım yapabilecek bir çalışma öğretisi geliştirmişlerdir.

***Anahtar kelimeler:** Temel tasarım, iç mimarlık eğitimi, problem, mekân organizasyonu.*

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1. Introduction

The TLA (Turkish Language Association) dictionary defines design as "form and imagination envisioned in the mind." Furthermore, according to TLA's philosophical approach, design is "the copy of an object or event that has been perceived previously and has materialized later in consciousness." According to these definitions, design is a holistic link between perception and concept. The 'Basic Design' course is one of the fields of applied education when it comes to design-oriented courses in today's architecture and interior architecture departments. As a result, basic design education has been assigned an important mission in terms of learning to think creatively and holistically and transforming what has been learned into the design.

Basic design pedagogy, according to Boucharenc (2006) is a creative and experimental methodology that fosters a holistic learning style and cognitive skills. Boucharenc stated that it is possible to develop these fundamental design elements and principles through contemporary design practice and various experimental methods in order to fully comprehend the purpose (Boucharenc, 2006). The basic design course is a difficult-to-understand language that students who take design discipline education in the first-year encounter, which causes them to forget what they previously knew about space. Birer & Ertürk (2011) stressed that the command "*forget everything you know now, try to learn again*" aims to give the first year of design education implicitly, and this is possible through the process of "*giving up on what you have learned*". This is referred to as the "*unlearn*" process by Higgott (1996). Another goal is to raise awareness about design strategies, decision mechanisms, and the effects that guide them so that students with different cognitive structures and spatial experiences can be revealed to be creative (Birer & Ertürk, 2011). According to Onur & Zorlu (2017) to properly present creativity, the concept of creativity should be evaluated in terms of the creative person, creative process, and creative product.

The curricula used in architecture/interior architecture education in Turkey changed over time, and different methods were used, particularly in first-year studios (Dostoğlu, 2003). There are exercises to create the visual richness of form at the beginning of the skills that should be learned in first-grade education. No matter how the methods are presented, the exercises to develop form richness aim to develop creativity (Birer & Ertürk, 2011). According to Krier (1992), each design language is a distinct product with its own set of indicators. According to Uraz (1993), this design language can be realized by forming an abstract thought in the mind, the forming tools - the elements that make up the form, and the relationships between them. According to Drak (1973), on the other hand, the designer emphasizes a design within a method to achieve the purpose, and with this method and the sequence of techniques followed, a language is developed for the designer's purpose or message. When one of the basic design principles, rhythm, is used in a design, it is understood that a concept that includes movement and dynamism is being used.

Finding original shape-form works based on an abstract/concrete concept in the design setup and reflecting it in the project concept is rather difficult. A concept is an idea that has been developed from an initial thought about a project. The concept, on the other hand, is the first concrete step created during the concept-to-project transition (Bilir, 2013). The notion is abstract, and the concept is the form that the notion takes in accordance with the design's subjective and objective language (Bilir, 2013). In this sense, basic design elements and principles are a common method for transforming creative thinking and concepts into concrete ideas. There are numerous studies in the literature produced from these methods. Çınar et al. (2017), designed furniture based on biomimesis with the stylization and deformation method as a result of their search for the original form, the combination of basic design methods, and as a result, they designed furniture in original forms. Similarly, Müezzinoğlu et al. (2017) found in their studies that formal abstraction is beneficial in gaining the ability to 'design for the individual' and developing creative thinking, such as design education. Karadağ & Ünal (2020) presented a new framework/structure for abstraction, creating a design language and improving spatial perception with algorithmic design exercises methods in the basic design course. In their study, Çınar & Sungur (2022) stated that as a result of the study, students developed skills that would allow them to create original forms and shapes and thus transform abstract ideas into concrete fields by using a metaphorical approach in the context of object-space relations, in order to guide students' formal decisions in the functional solutions of the problems that arise in the interior design process. Türkmen (2020) found that abstract concepts used as a reference to produce form in basic design education have a negative impact on both design processes and student success levels. As can be seen, different results have been obtained using the basic design principles, which serve as the foundation for many studies, with various methods and setups.

Accordingly, design achievement can be named as the problem-solving activity that emerges in line with the decisions made to solve the designed substance, object, and space per the purpose. Based on this definition, the study aims to develop a new perspective to research, question, and produce solutions to problems and put them into practice by integrating not only visual language but also other sensory perceptions in the basic design education of interior architecture students. In this way, it is assumed that the transformation of the abstract perception created in the mind by a previously perceived object or form into a concrete expression and therefore thought, and the reflection of the spatial organizations to the design, which will be formed by questioning and producing solutions, will be more original and the design process will be more efficient. A program was developed in the study to transform the abstract concept into a three-dimensional perception and problem-solving design. According to the program, the study method was developed by John Hejduk, who will serve as the foundation of the problem-oriented design approach and was determined as a 9-square grid, which was first given as a design problem at the Texas School of Architecture in 1954. According to Hejduk, the 9-square grid method is "a pedagogical problem" (Hejduk & Canon, 1999). The location and time for the implementation of the pre-planned education program were determined according to the program, the physical and technical conditions were met, the students suitable for the program were specified, and the program to be tested was defined. The program was introduced to the experimental group and put into practice. The program was introduced to and implemented in the experimental group.

1.1. Design Education in Interior Architecture

A basic design course is the first step of design education. The application of education requires a system that will be defined theoretically and along specific lines during the application. This system should have a formulation designed for the perception that avoids complexity. The goal of basic design education is to introduce students to the design world's system, in which they will be involved in the continuation of their undergraduate education and professional life, and gain the ability to develop themselves in research, questioning, and judgment. These qualities, which all students should have, are especially important for interior architecture students who want to make a difference with their designs in the future.

According to Aytekin (2019), a basic level of communication language should be instilled in the student in basic design education. This language is possible by gaining the ability to use basic terminology, technical and intellectual methods. Transferring the equipment that will contribute to problem-solving with different art disciplines to the student can be realized by ensuring integrity with a general approach. Design education feeds the intuition of the person and improves the ability to see and solve the problem by eliminating memorization forms and prejudices, and filling the gap that exists (Süzen, 2017, p. 414). According to Esen et al. (2018), the basic design course is of great importance to increase the awareness of students, develop their visual senses, enable them to think differently from the usual, and generate new perspectives on their problems and solutions. In this way, students become aware of self-cognitive equipment and participate in the process of developing a special attitude. This gives the ability to acquire a new language of expression by producing solutions to perception, thinking, questioning, criticizing, and questioning. The student, whose intuitive perception is prominent, learns to see the existing beyond the borders and to express the unknown aspects with lines, which forms the basis of aesthetic thinking and production. Developing subjectivity and originality in the person is the function of the basic design course (Civcir, 2015, p. 7). The design education experience and learning outcomes, which are difficult and complex at first, will cause a shift in the student's perspective and questioning. Based on all of these definitions and predictions, design education demonstrates mental readiness for design through direct or indirect responses to various objects, situations, and the questionability of the existing.

1.2. Problem-Solving for the Interior Architecture Dimension of Design

While the design composition process focuses primarily on parameters such as responding to human needs, comfort, aesthetics, and originality, these stages become a little trickier to evaluate when viewed through the lens of interior architecture. Architectural design, according to Bruce Archer, is "a deliberate problem-solving action." Transferred; (Metlioğlu & Durmaz, 2018, p. 223), state that basic design is known as the building blocks of art, design, and craft production, which bears the first step information for people from various disciplines who produce problem solutions under the definition of a designer. Design education includes the act of designing and is shaped by applied methods. The process, not the result, is important in design education (Aşkın, 2020). The process in question begins the moment the design problem is encountered. In other words, in the design studio, the real problem is transformed into a learning experience. The gained experience is at the heart of all design-related programs (Schön, 1985). The interior design process is primarily concerned with "problem-solving." This necessitates removing some of the problems that exist during the thinking stage and transforming the thought into a design, and designs should be created in this direction.

According to the problem-solving approach in space, the formation process of interior space should begin with questioning the space (Ching, 2016). As the expression "the way of dealing with the problem requires the designer to think and evaluate within some rules" implies, the process of creating interior design necessitates the ability to consider many different inputs concurrently. The need for a multidimensional interior architecture that focuses on human and human needs has also resulted in the emergence of human-oriented design principles. Gaining experience for inputs such as abstract thinking, transforming abstract thought into a concept, a reflection of the concept on the space, functionality in the space, and problem-solving-oriented design approaches are provided in basic design education. It should be clear from the start for whom the design is intended, and solution suggestions should be tailored to the needs of the user type. This necessitates evaluating the design within the context of anthropometry, which deals with the physical dimensions of the user. Anthropometric measurements differ depending on age, gender, and location. The second stage is need-based design, which takes into account many factors such as the size of the space, its function, its location, user profile, user density, and so on. The third stage is to respond to the user's perceptual needs, and the color, texture, light, size, and form of the space become more important in the design to be presented at this stage. People's perception levels and perspectives also differ according to age, gender, physical condition, and even geography. Another consideration is the design's economic dimension. Creating a design suitable for the user's budget is another problem that should be evaluated in the interior design project. The requirement to evaluate all of these parameters separately necessitates the search for solutions to numerous problems in the interior design process.

With this understanding, the architect will be able to think multi-dimensionally about the architectural space, work effectively, make the necessary and appropriate choices, maintain the architectural space with its existing features, or make suggestions that will change the actual qualities of the space. Having rules in interior design ensures that the design process is manageable. The basic design principles, the spatial relations these principles establish, and the functional, structural, and aesthetic qualities they create in interior spaces will contribute to the development of the student's inquiry and production of answers (Turhan, 2018, p. 44).

2. Material and Method

The goal of basic design education is to teach students that there are many things they need to know and that they should constantly research them on their own and strive for lifelong learning. As a result, individuals who can adapt to change will thrive. Even though current innovations and technology play a role in basic design education, the course is not built entirely on digital foundations. Students should take advantage of the underlying constants as they prepare for innovations.

The design model focused on problem-solving in interior design education was carried out with first graders who received basic design education in the spring semester of the 2021-2022 14-week academic year, Department of Interior Architecture, Faculty of Architecture and Design, Selcuk University. In the study, a program was created on transforming the abstract concept into a three-dimensional perception and problem-solving design. According to the program, the 9-square grid method, which will form the basis of the problem-oriented design approach, was preferred. The 9-square grid method is, in Hejduk's own words, a "pedagogical problem". The main goal of the 9-square grid method is to use the structural grid to reveal the student's design potential. Students are expected to learn basic concepts and shapes as well as create various grid combinations. According to Gropius, the purpose of education is to teach a method of approaching problems as opposed to providing specific knowledge and skills. Because learning begins with an attempt to cope with a problem or (Yıldırım, 2018) situation, and changing attitudes is a process related to learning and experiences, the study was designed to develop different perspectives on learning and problem-solving in basic design education (Yıldırım, 2018, p. 355). According to the program, the location and time for implementing the pre-planned training program were determined, physical and technical conditions were provided, the program was introduced to the experimental group, and the implementation began (Figure 1).

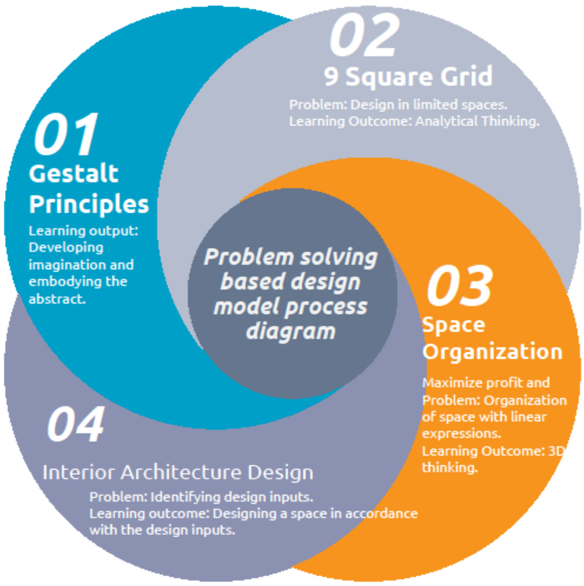


Figure 1. Problem solving based design model process diagram

The process in the training program consists of 4 stages. In the first stage, Gestalt principles, which are the building blocks of basic design education, were divided into weekly programs, and the definition of each principle was explained to the students at the theoretical stage of the lesson, discussed on the subject, and applied drawings and 3D studies were made for the students to embody the abstract and develop their imaginations. Without mentioning the content of the study to be put forward, the students were asked to research construction companies with national or international recognition. As a result of the in-class presentation and evaluation process, the students were asked to access information such as the history of the construction companies they preferred, the product, the content, and the design process. In the continuation of this stage, they were asked to identify 3 abstract concepts that should coincide with the company's vision, history, product variety, and brand identity. The first problem of the study was determined at this stage. Students were asked to specify abstract concepts that did not go beyond the brand's image and to match these concepts with the company's vision. Students' ability to think abstractly from a concrete product was thus tested. They were then asked to transfer the abstract concepts to the two-dimensional plane using a line in the following stage. Students who encountered a second limitation while transferring abstract concepts to the line were encouraged to overlap organic and geometric shape perception with the abstract concept, allowing them to think in a multidimensional manner.

In the second stage, the 9-square grid method, which forms the basis of the study is discussed. The students were asked to transfer the linear expressions of 3 abstract concepts, which they overlapped with their companies, into 9 square grids measuring 3x3 cm. At this stage, the students were faced with another problem regarding the limitation of m² in the space (81 m² in total), and they were informed that the linear expressions to be put forward should be placed per these measurements. At this stage, it is aimed to provide students with analytical thinking skills.

The process of transforming linear expressions into space, which are placed in a 9-square grid, is discussed in the third stage. At this point, the students were instructed to organize the obtained linear expressions by constructing them as closed, semi-open, and open spaces. The students who encountered a new problem here were instructed to think in 3D in order to organize space between specific boundaries.

In the fourth and final stage of the study, the students were asked to transform the space into an exhibition stand by placing welcome, exhibition, and waiting for units in the appropriate areas within the venue organizations approved as a result of the necessary evaluations. First of all, the following elements are important in the exhibition stand that is desired to be displayed;

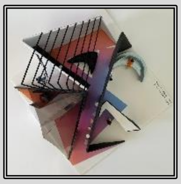
• The company's brand identity; colour, form, light transmittance, texture and size,

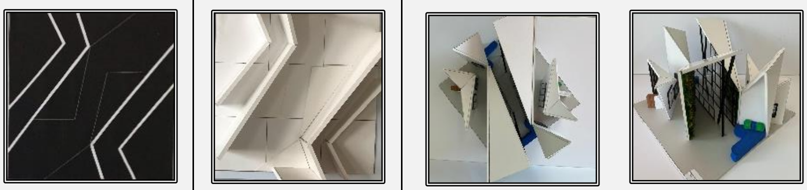
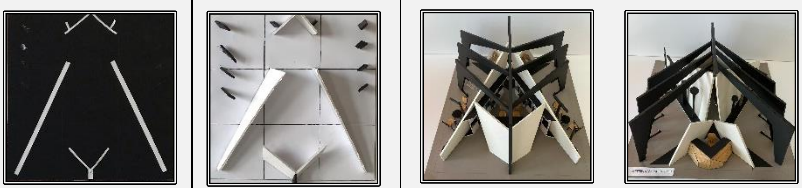
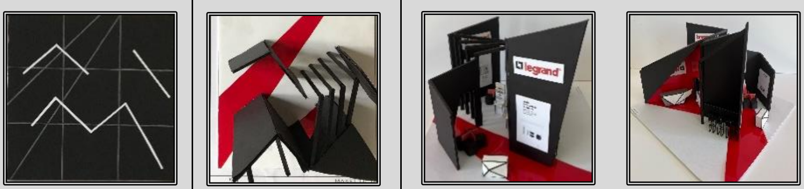
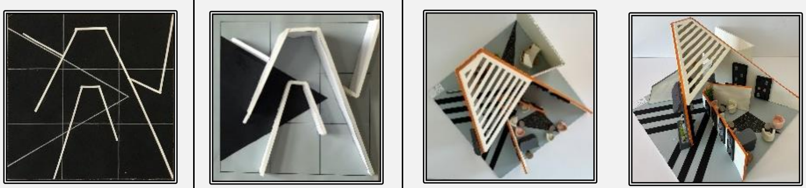
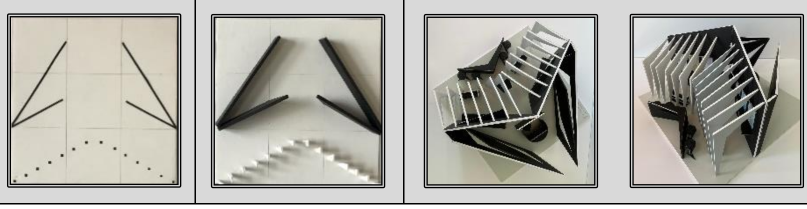
• User profile; physical condition, age, and gender,

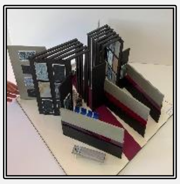
• The function of the space; Furnishing suitable for density and design suitable for material level. In this way, it is hoped that students will learn to research, develop, and produce solutions in the formation of space setups based on problem-based design inputs.

The workshop was carried out with a total of 14 weeks of evaluation and critique, which lasted 10 weeks until the midterm exam and 4 weeks until the final period, was completed by adhering to a method, producing solutions to existing problems, and based on research. Student studies (Table 1) were evaluated by the faculty members of Selçuk University, Faculty of Architecture and Design, Department of Interior Architecture, and the resulting products were exhibited in the faculty.

Table 1. Process and result products of the problem-solving design model in ınterior design education

COMPANY	KEY WORDS	LINE STUDIES	SPACE ORGANIZATION	RESULT PRODUCTS
Legrand	-Privacy -Trust -Development			 
Şişecam	-Fragile -Permeable -Clearness			 
Hologram Plus	-Energy -Dynamic -Harmony			 

Bien	-Balance -Rhythm -Intersection	
Kale	-Order -Repeat -Space	
High Light	-Emphasis -Depth -Transition	
Schüco	-Connection -Boundary -Space	
Roberto Cavalli	-Natural -Aggressive -Impressive	
Simes	-Freedom -Emphasis -Vulnerability	
Legrand	-Privacy -Trust -Development	
Arlight	-Glitter -Hope -Energy	
Tureks	-Fragile -Orientation -Pattern	

Han Stone	-Orientation -Hardness -Unity			 
Jonathan Adler	-Focus -Part/Whole -Harmony			 

3. Conclusion and Recommendations

Education in interior architecture enhances design understanding. The first step of interior architecture education, known as basic design, places a strong emphasis on concept, form, and function. When functionality is involved, there are new issues to be resolved. Design is a process where potential solutions to a problem are first generated in the mind, followed by processes of analysis and synthesis, and the best of these potential solutions is then turned into a design output. In light of this, a problem-based learning approach is a useful tool for fostering the development of creative thinking abilities. (Ocon, 2012). According to Gallagher (2015), the definition of problem-solving and creativity is based on two factors. The first step is recognizing the restrictions, and the second is determining the purpose. By identifying these two components, the problem's solution can be approached more quickly. "Creativity is the work of making predictions, forming hypotheses, testing and arriving at the final result in the process of perceiving missing elements, knowledge gaps, difficulties, and problems," (Torrance, 1988, p. 47). As is clear from the definition, identifying and effectively resolving the issue is fundamental to the creation process. The Rhodes (1961) model states that the act of communicating a novel idea constitutes creativity. The concept here refers to the finished item. To be creative, a person, situation, process, and product must be taken into account as a whole. When these elements are used in combination, success can be attained. Focusing on a single component will negatively affect the creative thinking process of students.

The Basic Design course, which serves as the foundation of interior design education, is the focus of this study, based on a new experimental teaching methodology. The basic design course, the foundation of education in interior architecture, was the setting for the study's training program on problem-solving-oriented creative thinking and design creation. The proposed educational model's results were evaluated at the end of a 14-week process that included the evaluations of interior architecture professors and the learning outcomes attained through oral interviews with the students. Oral interviews with the students were conducted by the lecturers to ascertain the results of in-class learning. As a result of the interviews, the students stated that they learned to research and question a subject. They added that they were told to think critically and come up with answers to the problems given to them, which helped them develop the skills necessary to come up with original, creative designs and boost their motivation. The chosen abstract ideas were transformed into lines, then into 2 dimensions, then into space organization, and finally into actual space, allowing the model to match the perception of 3D with actual space. The results showed that the students who faced a fresh challenge at every stage of the program benefited greatly from the study. These are;

1- The ability to think analytically and produce solutions by developing different perspectives for each identified problem,

2- The ability to form abstract figural expressions based on a concrete product, to think multi-dimensionally and creatively by overlapping an idea with a concept,

3- The ability to think in three dimensions, to create a space organization, to see and transfer thoughts to the space, 4- At the last stage, they gained the ability to determine the boundaries of space and to produce suitable solutions for these limited spaces.

All the competencies gained by the students through the drawing and applied studies carried out in the course overlapped with the results scanned in the literature. Karaşah & Özdemir (2022) conducted a study on the analysis, synthesis, and evaluation process of how they approached the basic design concepts and principles they learned during the term in line with the given problem and how they reached the final product within the scope of the Basic Design course. As a result of the study, it was observed that the students had improved in their ability to conduct research, ask probing questions, create original works, and find motivation. Similarly, a real-time study was carried out using a problem-based learning model to enhance students' high-level thinking and creativity skills (Setyowidodo et al., 2019). Tests, observations, and interviews with the students were used to gather the data, which was then used to evaluate the final design products. It was found that the students improved their knowledge and abilities in terms of creativity and content theory as a result of the study. By giving the students a foundational understanding of interior architecture education, it was ensured that they could relate to the primary art courses required in the upper class, and the study thus met the expectations of interior architecture education. Following the outcomes and conclusions reached after the application, the problem-solving-focused training program will direct the interior design studio studies specifically to interior architecture education, enable the formation of original forms and shapes, allow to obtain concrete space from an abstract concept, and design in different scales from equipment to space design. A practical doctrine has been created. The approach is at a level where it will serve as an example for designers, academics, and students studying design.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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Determination of Environmental Indicators in the Context of Sustainable Urbanization: The Case of Türkiye

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Abstract

The socio-economic conditions provided by the cities become centers of attraction to improve the quality of life of people. On the other hand, the uncontrolled growth of urban areas in meeting the needs of the increasing population has adverse effects on natural resources. Sustainable urbanization aims to increase the socio-economic quality of life by ensuring the rational use of natural resources, minimizing non-renewable resources, and meeting people's basic needs. However, due to the unconscious use of natural resources and increasing pressure on the environment, environmental components are seen as the basis of sustainable urbanization and affect economic and social sustainability development. This study aims to explain the process of determining the indicators related to environmental sustainability. In this context, by examining the studies carried out in the national and international arena, 20 indicator sets were created under eight themes at the national level, which will be beneficial in spatial planning decisions. It is thought that the determined indicator set will make important contributions to institutions and managers from the local level to regional and national levels in spatial planning studies to ensure environmental sustainability.

***Keywords:** Urbanization, sustainable development, sustainable city, environmental sustainability, indicators.*

Sürdürülebilir Kentleşme Bağlamında Çevresel Göstergelerin Belirlenmesi: Türkiye Örneği

Öz

Kentlerin sağladığı sosyo-ekonomik koşullar, insanların yaşam kalitesini artırmak için çekim merkezi haline gelmektedir. Öte yandan artan nüfusun ihtiyaçlarının karşılanmasında kentsel alanların kontrolsüz büyümesi doğal kaynaklar üzerinde olumsuz etkiler bırakmaktadır. Bu bağlamda sınırlı doğal kaynakların gelecek nesillerin ihtiyaçları doğrultusunda kullanılarak sürdürülebilir kentleşme anlayışının benimsenmesi gerekmektedir. Sürdürülebilir kentleşme doğal kaynakların rasyonel kullanımını sağlayan, yenilenmeyen kaynakların kullanımını en aza indirgeyen, insanların temel ihtiyaçlarını karşılayarak sosyo- ekonomik açıdan yaşam kalitesinin arttırmayı hedeflemektedir. Ancak doğal kaynakların bilinçsiz kullanımı ve çevre üzerinde artan baskılardan dolayı çevresel bileşenler sürdürülebilir kentleşmenin temeli olarak görülmekte olup, ekonomik ve sosyal sürdürülebilirlik gelişimini de etkilemektedir. Bu çalışmanın amacı çevresel sürdürülebilirliğe ilişkin göstergelerin belirlenme sürecinin açıklanmasıdır. Bu bağlamda ulusal ve uluslararası alanda yapılan çalışmalar incelenerek, mekânsal planlama kararlarında yarar sağlayacak ulusal düzeyde sekiz tema altında ve toplam 20 adetten oluşan bir gösterge seti oluşturulmuştur. Belirlenen gösterge seti çevresel sürdürülebilirliğin sağlanmasına yönelik yerel düzeyden bölgesel ve ulusal düzeylere kadar kurum ve yöneticilere mekânsal planlama çalışmalarında önemli katkılar sağlayacağı düşünülmektedir.

***Anahtar kelimeler:** Kentleşme, sürdürülebilir kalkınma, sürdürülebilir kent, çevresel sürdürülebilirlik, göstergeler.*

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1. Introduction

Nowadays, more than half of the world's population lives in urban areas. The main reason urban areas, which are developed socio-economic conditions, are centers of attraction for people. In this context, while the urbanization process seems to be in a positive relationship with socio-economic development, the expansion of urban areas has adverse effects on natural resources, such as loss of agricultural lands, increase in CO_2 emissions, and decrease in water resources (Li et al., 2009; Shen & Zhou, 2014). Therefore, all the effects should be handled in line with the principles of sustainable urbanization.

Many studies in the literature show that there are different definitions of the concept of sustainable urbanization. However, the basic approach of sustainable urbanization is based on ensuring long-term human well-being by balancing the economic, social, and environmental dimensions of sustainable development, minimizing negative impacts on natural resources, maximizing resource use efficiency, and accessing essential services (Huang et al., 2015). Shen et al. (2011) emphasized three key components of a sustainable city. For future generations, firstly, it is to ensure the protection-use balance of natural resources. Secondly, to increase the quality of life by taking into account the basic needs of the society, and finally, to develop it by providing economic vitality.

Sustainable urbanization was also referred to through sustainable development in the report “Our Common Future”, prepared in 1987. Some of the issues addressed in the report are as follows; poverty and the pressures on the environment, the rapid increase and concentration of the population blocking the rise of the standards of life quality, the excessive consumption of environmental resources and the urban problem can be given as urban growth and uncontrolled expansion of cities. To solve all these problems, it is necessary to strengthen local governments and increase local opportunities, save energy in energy use, produce policies to prevent population growth and concentration, protect species and ecosystems, and use natural resources efficiently. It is seen that the stated problems and solution proposals shed light on the concept of sustainable urbanization (Karakuzulu, 2010).

Evaluating the sustainable development of cities, should be handled with a quantitative approach because it is known that something that cannot be measured cannot be developed to evaluate sustainable urban development (Gürel Üçer, 2017). Therefore, it is necessary to benefit from indicators contributing to sustainability by considering the environment and development systems, which provide the basis for decision-making at all levels (Pupphachai & Zuidema, 2017).

At the UN World Summit (Rio Conference) held in Rio, Brazil in 1992, the concept of sustainable development was discussed more broadly and the Agenda 21 document, consisting of 40 chapters, was accepted. Within the scope of Agenda 21, it was emphasized that indicators should be used to ensure sustainable urban development (Moldan et al., 2012; Michael et al., 2014; Huang et al., 2015).

Indicators help to evaluate trends, simplify, analyze, communicate problems, and compare sustainability performances by revealing the current state (Jain & Tiwari, 2017). Sustainability indicators add descriptive quality to the information on the current state of an area and quantify and transform it into meaningful information (Tanguay et al., 2010).

The concept of sustainability is mainly discussed in cities because massive cities are both the primary consumers of natural resources and the leading producers of pollution and waste. Ertürk (1996) emphasized the importance of solving urban problems to achieve sustainable development goals and stated that being sustainable in cities requires adopting a sustainable development strategy. In this context, it is necessary to use indicators to measure the sustainability of cities and evaluate their performance. Therefore, indicators provide information that can help us understand a system's sustainability and pressures (Pınarcıoğlu & Kanbak, 2020).

This article discusses the steps to be taken to develop concrete indicators at the global and national levels to achieve sustainability evaluation. Discussions on measuring sustainable development date back to the 1990s and are included in the 40th article of Agenda 21. In this article, it was also emphasized that commonly used indicators related to Gross National Product and measurement of individual resources or pollution would not provide sufficient evidence for the measurement of sustainability, and a call was made for the determination of sustainable development indicators to be used in evaluating sustainability as a whole. Ten years after the decisions taken in Agenda 21, these decisions were reaffirmed at the Conference on Environment and Development held in Rio de Janeiro in 2002. This movement was decisive, and after that international organizations and many countries have begun to explore the determination of sustainable development indicators, and the importance of the studies has increased gradually (Kara, 2019).

Sustainable development depends on natural resources to meet the needs of social and economic development. In this context, the environmental dimension forms the basis of sustainable development due to increasing pressures on natural resources. Therefore, evaluating environmental sustainability progress is critical for achieving sustainable development and guiding policy development and implementation (Wang et al., 2022).

Yılmaz (2019) defines the concept of environmental sustainability in general as a system that considers the protection of life support systems by ensuring the continuity of the essential functions of nature, where renewable resources are consumed without exceeding their renewal rate. In this context, it has been emphasized that the regulation function is fulfilled in ensuring environmental sustainability.

It is emphasized in the literature that the environmental dimension is an important pillar in the evaluation of sustainability. Therefore, the determined indicator sets play an important role in producing policies in this direction by determining the effects of urbanization on the environmental sustainability dimension. Reyhan (2017) stated that environmental indicators are vital to developing environmental policies and reporting the environmental situation. In this context, the environmental indicator set is an essential tool for producing environmental policies, reporting the environmental condition, measuring environmental performance, and monitoring and reporting sustainable development goals.

This study aims to determine the indicators related to the environmental dimension that provides the basis for sustainable urban development. In this context, the literature on the subject was examined. Indicators for the environmental sustainability dimension were determined within a systematic process. At the same time, a holistic evaluation was made by revealing the relations with the sustainable development goals represented by the indicator sets determined for environmental sustainability. Therefore, it is thought that the determined indicator set will make essential contributions to institutions and managers from the local, regional, and national levels in spatial planning studies to ensure environmental sustainability.

2. Material and Method

Thus, environmental indicators play a crucial role in spatial planning processes by determining the city's current state. This study covers the determination of appropriate indicator sets to reveal the environmental effects of indicators that will help the sustainable development of cities. The study material comprises national and international academic studies on sustainable city indicators. The method phase of the study is discussed in three parts, and the method phase is given in Figure 1.

Inventory studies are included in the first part of the method. Literature searches related to this study subject (sustainable city, sustainable city indicators) were done. In addition, all data (natural and cultural components) regarding the current state of the study area should be examined.

The second part of the method explained the process of determining the indicators. The selection process of indicators is not easy as it involves many factors. In this context, indicators must have specific features that they should have. This section covers the stages of the selection process of indicators.

In the third (last) part of the method, the special indicators for Türkiye have been evaluated. A summary has been created in Table 1.

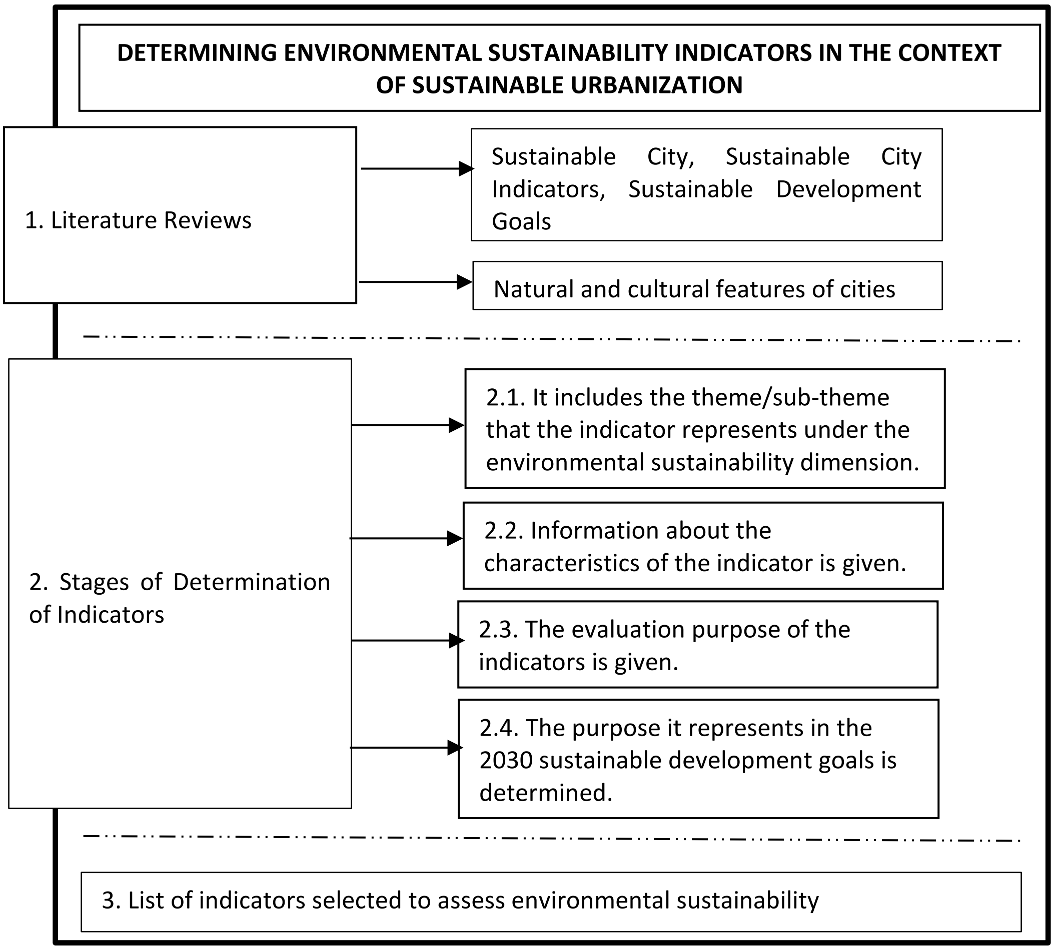

Figure 1. Flow chart of the method

Many studies in the literature reveal the sustainability of cities using indicators. One of the issues that should be considered in the selection process of the indicators is that they should provide us with the most accurate information about the application status. Therefore, indicators must meet specific criteria. On this issue, Mega & Pedersen (1998) stated that indicators should be clear, simple, scientifically meaningful, verifiable, and reproducible (Shen et al., 2011). Therefore, in selecting sustainable city indicators, the principles given in the introduction have been considered by the following criteria (Jain & Tiwari 2017).

Achievable indicators should help to represent problems by being controlled through policy and strategic actions. Measurable indicators should be theoretically sound and quantifiable in an easy way to understand. Policy-relevant indicators should provide relevant information to decision-makers to change policies to achieve desired goals. Specific/interpretable indicators should be easily understood by intended users and applicable to decision-makers. Ability to be predictable with time series data, indicators should be predictable using accepted methods to identify potential changes. The selected indicators must be sensitive to the pressure on the system under study. The comprehensiveness indicator set should provide a holistic view of the system covering causes and effects.

Data availability, data to measure indicators should be readily available from reliable sources at a reasonable cost. Consistent, controversial indicators should be avoided. Local priorities and selected indicators should reflect site characteristics and local community needs. The speed of data availability, time tag between the data collected, and changes in the phenomenon under study should be minimum. Quantitative indicators should present problems quantitatively. There should be a minimum time lag between collected data and changes in the phenomenon under study.

Based on this framework; a unique classification system has been designed to choose environmental indicators contributing to sustainable urbanization. The second stage of the method is explained in detail in Table 1.

Table 1. Sustainable city indicator selection stages

Part	Name of The Column	Description	Contribution
Part 1	Theme	It facilitates the selection of indicators under the topics related to environmental sustainability.	In this context, indicators provide information to decision-makers with their controllable feature, by helping them represent problems.
	Sub-theme		
	Name of the indicator	It is the name of the indicator under the theme.	
Part 2	Unit	The unit of the display must be specified so that users can easily understand it.	Thanks to the interpretability and consistency of the indicators, it is beneficial for decision-makers.
	Data sources	Data on indicators should be obtained from reliable sources, and data availability should be indicated.	Obtaining data from official sources is essential for correctly evaluating indicators.
	Data year	It should be obtained from up-to-date data to observe possible changes.	The minimum time interval between the collected data and the changes in the investigated phenomenon will facilitate the appropriate assessment of the indicator.
	Frequency of use	The frequency of use of the indicator in national and international literature has been examined.	The current situation should be evaluated holistically in the context of indicators generally taken in the literature.
Part 3	Purpose	The benefit it provides in the evaluation of the indicator is stated.	The indicators chosen should be sensitive to their effects on the system under study.
Part 4	Sustainable Development Goals	It reveals the link between the Sustainable Development Goals, consisting of 17 goals, and the indicators.	It is beneficial that the indicator can be controlled through policy and strategic actions and represent problems.

3. Findings and Discussion

This section gives clear explanations of the three stages mentioned in the method.

3.1. Literature Research

Under this title, some information is provided about the literature reviews that form the basis of the study and the studies that are effective in selecting indicator sets.

Many factors enable urban development. Therefore, a systematic process method should be adopted to select the appropriate indicator specific to the cities. Feleki et al. (2018) emphasize creating a methodological approach that will eliminate the free choice of indicators to be evaluated in terms of sustainability and ensure a rational choice. Thus, the indicator set will provide a consistent and comparable evaluation. Likewise, Gonzalez-Garcia et al. (2019) stated that particular processes should be considered when selecting a region's city-specific indicators. He said that to apply similar indicator sets in all cities and make comparisons, cities should also be adapted according to certain characteristics.

There are many frameworks for measuring sustainable development. The main differences between the frameworks to be used for selecting indicators are conceptualizing the dimensions of sustainable development, revealing the connections between these dimensions, and selecting and combining the indicators (Kara, 2015).

Topic/Theme-based frameworks are among the most commonly used frameworks for determining official national indicator sets in many countries worldwide. Theme-based frameworks have significant benefits. First, the theme-based indicators facilitate the relationship between policy processes and goals. Thus, it increases public awareness by providing understandable information for decision-makers. Second, theme-based indicators reveal whether the sustainable development goals have been achieved. Finally, it provides flexibility in adapting new or current targets to planning studies (Kara, 2015).

Theme-based frameworks make it easier to make arrangements on issues related to the city's development policies. To determine the subjects on which the study is based, 18 indicator sets in the literature were examined, and the intensity of use of the themes in these sets was revealed (Tuğaç, 2018). In the said criteria, the subjects based on sustainable development dimensions (environmental, social, economic) guide the studies. Figure 2 gives the percentage of the frequency of use of the themes in the examined indicator sets. Indicator sets discussed in the study are as follows: UN Sustainable Development Indicators, OECD, EU Sustainable Development Indicators, European Environment Agency Indicators, TUIK Sustainable Development Indicators, Millennium Development Goals, EU-2020 Goals, European Commission Green Capital Award, European Commission Green Leaf Award, European Foundation's Urban Sustainability Indicators, Urban Ecosystem Europe, Urban Blue Spaces Plan, Reference Framework for Sustainable Cities, Criteria Set Approach for Sustainability, China Urban Sustainability Index, ELITE Urban Metrics, Environmental Performance Index (EPI), Environmental Sustainability Index (Kara, 2015; Tuğaç, 2018).

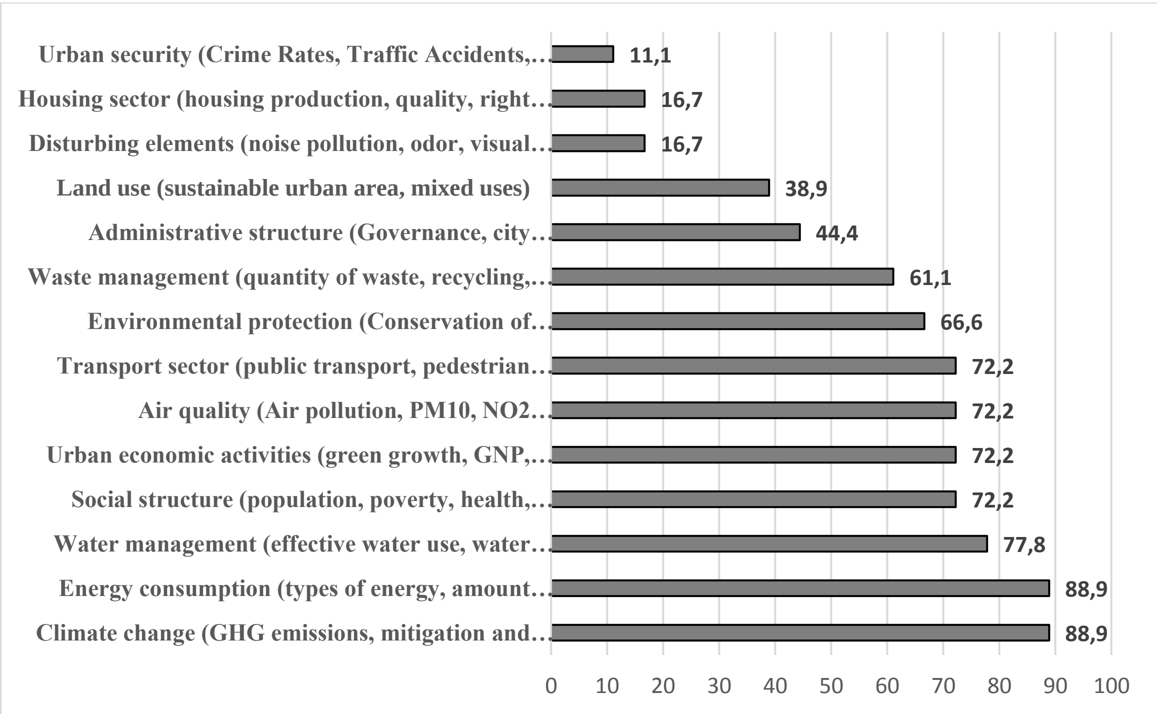

Figure 2. Frequency of use of the themes

3.2. Stages of Determination of Indicators

The prominent themes in evaluating environmental sustainability in the literature focused on issues such as air quality, climate change, energy consumption, water management, environmental protection (biodiversity), and waste management (Figure 2). Information about the themes and the indicators that may be under them is given in the first part of determining the indicators. In this context, atmosphere management, land use, water management, biodiversity, open green space systems, waste management, and renewable energy systems are the determined themes within the scope of the study.

Determining the appropriate indicator sets that can evaluate the city's environmental, social, and economic impacts, depending on the level of development and population density, constitutes an important pillar in ensuring sustainable urbanization. Zhou et al. (2015) emphasize that the effectiveness of the indicators selected to measure the city's sustainability performance has critical importance in making evaluations in line with the sustainable development mission. In this context, in the second part of the stage of determining the indicators, the characteristics of the indicators to be included in the study are included. Here, the basic features of the indicators, such as unit, data source, and year and frequency of use, are included. Thus, it aims to explain the current situation according to the years by providing a reliable data source for the indicators. The frequency of use, on the other hand, gives the importance of the indicator in the literature due to the frequency of occurrence in the sources provided in the upper sections within the scope of this study. Indicators with a frequency of use of more than five were evaluated. However, due to the importance of some indicators, the frequency of use of less than five was ignored.

There are three basic approaches to determining the frequency of use. First of all, in the surveys made with the keyword Scopusta (sustainability city indicator), indicator sets for environmental sustainability were examined from the literature sources between the years 2010-2020 (Rama et al., 2020; Gonz_alez-García et al, 2019; Tang et al., 2019; Feleki et al., 2018; Fouda & Elkhazendar, 2019; Tan et al., 2018; Mapar et al., 2017; Rajaonson & Tanguay, 2017; Ibrahim et al., 2015; Mascarenhas et al., 2015; Michael et al., 2014; Shen & Zhou, 2014; Jiang & Shen, 2013; Marzukhi et al., 2011; Shen et al., 2011; Mascarenhas et al., 2010; Tanguay et al., 2010).

Secondly, the presence of indicators within the scope of the research in the indicator sets developed by international organizations (UN, EU and OECD) has been tried to be determined. Finally, the selection was supported by the studies carried out by national organizations. Thus, the total frequency of use of the indicator in all approaches was revealed (Figure 3).

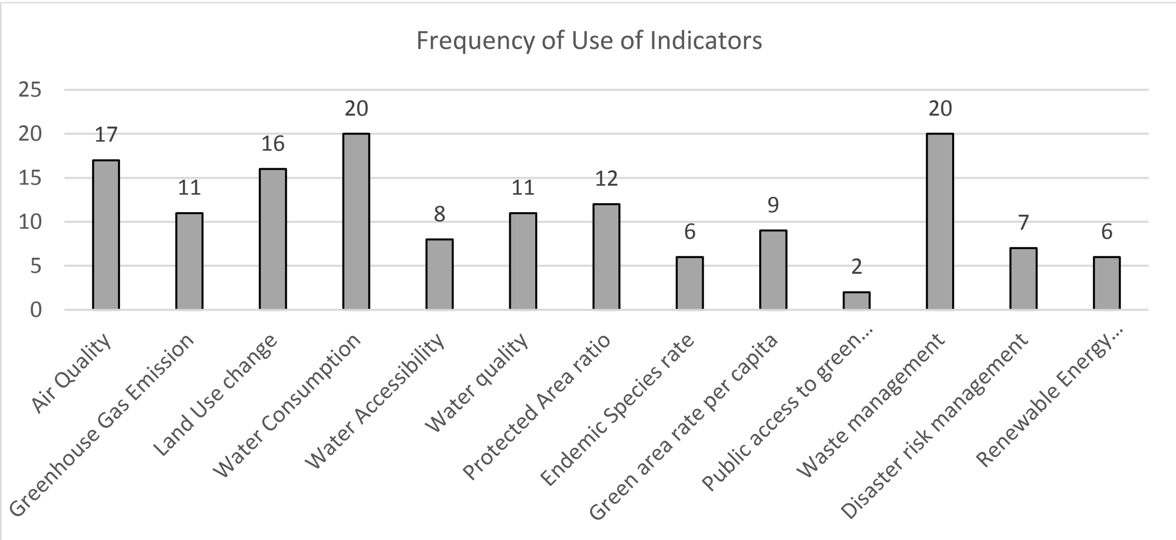

Figure 3. Frequency of use of indicators

When Figure 3 is examined, it is seen that the indicators related to water consumption and waste management are the most common in all the sources examined. It has also been determined that air quality, land use distribution, greenhouse gas emissions, water quality, and protected area ratio are more than ten times used in studies. In addition, as a result of the examinations, it is seen that the studies on the accessibility indicator of green areas do not take place much. However, this indicator is vital to the per capita ratio of open green areas. Yaman & Doygun (2014) state that ensuring the circulation of individuals in public spaces and accessibility in public spaces in sustainable urban development should be arranged in an integrative and fair way, that is, meeting the needs of all users (Cüce & Ortaçeşme, 2020). Therefore, this indicator is evaluated within the scope of the study.

According to Shen et al. (2011), identifying indicators should not just be about managing a large number of indicators, preferably assessing those that are more fundamental and more likely to produce the most accurate information about the state of implementation. In addition, the usability of the data in the indicator development process, its scope, and its basic features should be easily measurable for all decision mechanisms (Michael et al., 2014; Jain et al., 2017).

In the third part of the stage of determining the indicators, there is information about the purpose or benefit of evaluating them and the source they refer to. Thus, as a result of evaluating the indicators, it will guide the planning decisions. Dizdaroğlu (2015) emphasizes the qualities indicators should have as being suitable for making policy decisions, being analytically sound and measurable.

In the last part of determining the indicators, the relationship between the indicators determined in evaluating the environmental dimension of the sustainable development of cities and the sustainable development goals represented. Klopp & Petretta (2017) emphasize that the sustainable development of cities can be under the supervision of sustainable development goals. Thus, it is an essential indicator for integrating development with 17 sustainable development goals globally. In this context, the relationship between sustainable development and environmental sustainability goals is given in Table 2 (Çoban & Uzun, 2022).

Table 2. The relationship between SDG and environmental sustainability

No	SDG	Environmental Sustainability Goals	References
SDG 6	Clean Water & Sanitation	Water is an essential resource for human survival. Access to adequate clean water and sanitation is a fundamental human right. Therefore, the protection and sustainable use of water resources should be ensured.	Carino & Xie, 2013
SDG 7	Affordable & Clean Energy	Considering that energy contributes to climate change and accounts for approximately 60 percent of total global greenhouse gas (GHG) emissions, using clean and affordable energy sources to combat climate change should be increased.	Cîrstea et al., 2018
SDG 11	Sustainable Cities and Communities	Urban sustainability is critical to achieving environmental sustainability. For environmental services and products such as green spaces, air quality, and waste management, plans should be made to "provide" or "guarantee" their assessment.	Thomas et al., 2021
SDG 13	Climate Action	Climate change is one of the most critical problems of our time. Human activities, such as increased greenhouse gas emissions (such as CO2), are accelerating climate change and threatening biodiversity and ecological services. Therefore, climate change is inevitable, and plans must be made to adapt to its effects.	Arora & Mishra, 2019
SDG 14	Life below water	Human activities have had a noticeable negative impact on life in water and land. Our survival must be ensured by protecting both marine and terrestrial ecosystems. Quantifying terrestrial and marine ecosystem services contributes to the sustainable management of natural resources.	Selim et al., 2015
SDG 15	Life on Land		

3.3. List of Indicators Selected to Assess Environmental Sustainability

Urban sustainability indicators and their appropriate selection are important in successfully achieving sustainable development goals. Although there are studies in the literature in which urban sustainability indicators are applied effectively, the fact that the stages of the selection process of the indicators are not shared causes difficulties in creating appropriate indicator sets (Shen et al., 2011). Verma & Raghubanshi (2018) state that the usability (measurability) of the data in the implementation and evaluation process of the indicators depends on the determination of the indicators for the targets and the creation of the appropriate conceptual framework of the indicators. Therefore, the main difficulties in selecting sustainable city indicators are closely related to the measurability of the data in determining and evaluating the indicators. Therefore, in this study, indicators for Türkiye were determined within the framework of the method developed and explained regarding the selection process of environmental sustainability indicators. A theme and sub-theme were determined first in creating show sets for Türkiye. Then, the unit, data source, years, scale, and frequency of use of the indicator determined in this context were determined. Likewise, the purpose of the indicator and its relationship with sustainable development goals are presented (Table 3). In this context, by examining the studies carried out in the national and international arena, a total of 20 indicator sets were created under eight themes that will be beneficial in spatial planning decisions.

4. Conclusion and Suggestions

Sustainable urbanization is defined as a city that considers future generations' needs uses natural resources correctly, minimizes non-renewable resources, meets people's basic needs, and aims to increase the quality of life in socio-economic terms. The United Nations Human Settlements Program (UN-Habitat, 2004) defined sustainable urbanization as a dynamic process combining environmental, social, economic, political, and institutional sustainability (Shen et al., 2011).

As a result of the research, it is seen that there are three basic components, namely economic, social, and environmental, in ensuring urban sustainability. With the increasing population density in urban areas, the increase in environmental pollution, and the unconscious use of natural resources, the importance of the environmental dimension in sustainable urban development is increasing. Therefore, revealing the status of environmental variables helps in ensuring sustainable development. Thus, environmental sustainability shows the result of the interaction between human activities and natural resources (Zhang & Chen, 2021).

Indicators play an essential role to evaluate environmental sustainability in sustainable urban development. Saraç & Alptekin (2017) state that indicators provide simple and valuable information to the public and decision-makers and are seen as a tool to summarize the versatility of sustainable development. In addition, it helps people understand the concept and makes it possible to assess cities or regions regarding sustainability.

Environmental sustainability indicators help to take spatial planning decisions. Therefore, the determined indicator sets play an important role in producing policies in this direction by determining the effects of urbanization on the environmental sustainability dimension.

Spatial planning is making land use decisions prepared to create healthy and safe environments with high quality of life to protect and develop natural and cultural values by supporting sustainable development at the Türkiye, regional and city levels (Yılmaz Kaya & Uzun, 2019). According to this definition, it is obvious that spatial planning parallels the goals of sustainable urbanization.

Table 3. List of indicators selected to assess environmental sustainability

Part 1				Part 2			Part 3	Part 4
Theme	**Sub-theme**	**Indicator**	**Unit**	**Data source**	**Data year**	**Frequency**	**Purpose**	**Sustainable Development Goal**
Atmosphere Management	Air Quality	Average PM10 Concentration	μg/m³	Provincial Air Quality Station	2021	17	This indicator provides a measure of the state of the environment in terms of air quality. Improving air quality is important for promoting sustainable human settlements.	11
	Greenhouse Gas Emission	Carbon Storage Rate	%	USGS	2021	11	This indicator measures carbon dioxide emissions, which are known to be the most important in their impact on global warming. The increase in the concentration of CO_2 in the atmosphere has a very negative effect on economic, social and environmental conditions.	13
Land Use	Land Use Distribution	The covered area ratio of the residential area	%	CORINE	1990-2018	16	This indicator provides information on changes in land use to facilitate sustainable land use planning and policy development. From an environmental perspective, unsustainable land use is a significant factor in land degradation, can threaten ecosystems and lead to natural habitat loss and landscape changes (UN, 2007).	15
		Area covered by forest areas						
		Agricultural areas covered area ratio						
Water Management	Water consumption	Water consumption per person	lt/ capita day	TSI	2020	20	This indicator provides information on consumption in line with daily needs in the city. Depleting water resources can negatively affect sustainability, limiting economic and regional development and leading to biodiversity loss (UN, 2007).	6
	Water Accessibility	Water Access Rate	%	TSI	2020	8	This indicator assesses the accessibility of drinking water in the city. It measures the percentage of households with access to drinking water infrastructure compared to the total households in the city. (Drinking water is evaluated regarding water safety and sanitation (Chan & Lee, 2019).	
	Water Quality	Water Quality ratio		Basin Protection Action Plans	2013	11	Availability and accessibility of potable clean water resources are important for sustainable development (UN, 2007). This indicator assesses the quality of water available to communities for basic needs. Identifies communities where water at the source or supply threatens health by contamination.	
Biodiversity	Ecosystem	Protected Area Ratio	%	Nature Conservation and National Parks	2021	12	The indicator shows the extent to which the proportion of areas important for biodiversity, cultural heritage, scientific research (including baseline monitoring), recreation, maintenance of natural resources and other values are preserved. Protected areas are essential for maintaining ecosystem diversity in countries and ecoregions, and managing human impacts on the environment (UN, 2007).	15
	Species	Presence of endemic species	%			6	This indicator allows monitoring of the extinction risk of species over time. It also demonstrates the effectiveness of local, national, regional and global measures to protect endangered species (UN, 2007).	
Open Green Spaces	Adequacy of open green	Green space per capita	m²	Municipal Boundaries	2020	9	These indicators are connected areas that develop within the framework of minimizing the effects on the natural environment by using the open green areas by protecting the resources and the amount of open and green areas. As well as the ratio of the areas accessible to these areas at the specified distances is essential for sustainable urbanization.	11
	Open green space Accessibility	Public access to green spaces	%	Municipal Boundaries	2020	2		
Waste Management		Impact of irregular solid waste landfills	m	Municipality/ Environmental Status Reports	2021	20	This indicator, the irregular storage of solid wastes, pollutes the underground and aboveground spring waters. Therefore, the areas where the wastes are stored affect the natural ecosystem processes and cause environmental pollution. Thus, disposal without harming the environment is to form	12

							the basis of a livable and sustainable environment.	
Disaster Risk Management	Risks	The density of fault lines	%	AFAD	2021	7	These indicators contribute to a better understanding of the vulnerability to natural hazards in a given country and thus encourage long-term, sustainable risk reduction programs to prevent disasters. High vulnerability means greater exposure to natural disasters without disaster mitigation measures.	11
		Rate of Landslide Susceptibility						
		Rate of Erosion risk area						
		The proportion of the population affected by floods		Flood Management plans	2018			
Renewable energy		Solar Power Plant	MVe	https://www.enerjiatlasi.com/sehir	2021	6	These indicators make a significant contribution to reducing greenhouse gas emissions by replacing fossil fuels with the use of renewable energy sources.	7
		Wind Power Plant						
		Hydroelectric Power Plant						

In the study on Environmental Sustainability indicators, it has been seen that the themes that can be used in Türkiye are related to air (atmosphere management), soil (land use), and water (water management). In addition, biodiversity and open green spaces, which have a critical role in these three themes, have been determined as the main themes of environmental sustainability. Waste management, renewable energy, and risk management related to possible disasters, which are among the important environmental processes in the formation of resilient /resilient cities, have also been determined as the central theme.

The contributions of the indicators determined for sustainable urbanization to environmental sustainability in taking spatial planning decisions are listed below:

- To the creation of strategies for the city’s air pollution by reducing the use of fossil fuels by examining air quality values, etc.,
- To develop strategies to protect and increase carbon storage potentials,
- To establish policies for conservation by examining the changes in agricultural and forest areas for land use over the years,
- To ensure universal and equal access to safe and accessible drinking water for all by assessing the city’s water consumption and accessibility,
- To improve water quality by eliminating unorganized solid waste, minimizing the release of harmful chemicals and substances, halving untreated wastewater, and dramatically increasing recycling and safe reuse globally,
- To develop conservation, planning, and management plans to ensure the continuity of biological diversity by evaluating the fragmentation numbers of habitats,
- To create green infrastructure systems to improve the quality of life by examining open green spaces in terms of adequacy and accessibility,
- To evaluate the effects of landslides, erosion, and fault lines and to develop actions to minimize disaster risk,
- To examine the potential of renewable energy sources, increase the potential with conformity map studies, and integrate spatial plans of different scales with environmental sustainability indicators.

Environmental sustainability is one of the primary components in ensuring urban development. Therefore, evaluating all factors affecting environmental sustainability through indicators will enable us to obtain information about the functioning of the process. As a result, it is thought that these processes will contribute to the city's development, both by the regional organization of the central government and the local governments, with the indicator set to be created for each city and the holistic evaluation of the results.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article contributed. There is no conflict of interest between authors.

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Rethinking the Built Environment in the Context of Covid-19 Pandemic: A Critical Review

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Abstract

The built environment should be re-evaluated in the context of Covid-19 pandemic for preventing the spread of the virus. The study aims to reveal the issues that arise in the context of the Covid-19 pandemic at different scales of the built environment, from urban to interior scale and also to emphasize the importance of designing a sustainable environment by considering the lessons learned. The study highlights the significance of designing a sustainable environment by incorporating lessons learned from the pandemic experience. By investigating and highlighting these issues, the research aims to provide recommendations that can guide future efforts towards creating resilient and adaptive built environments. The method of the study is based on the critical review of the published studies on the issue between April 2020-April 2022 and observations on user experiences. The findings of the study highlight the necessity of further questioning the built environment in light of possible pandemics.

Keywords: *Covid-19, pandemic, built environment, design strategies, urban-architecture-interior scale.*

Covid-19 Salgını Bağlamında Yapılı Çevreyi Yeniden Düşünmek: Eleştirel Bir İnceleme

Öz

Yapılı çevre, kullanıcıların potansiyel olarak enfekte olma durumları göz önünde bulundurularak Covid-19 pandemisi bağlamında yeniden değerlendirilmelidir. Pandemi veya bulaşıcı hastalıkların her an tekrar etmesi olasılığı öngörülerek yapılı çevrelerin yeniden düşünülmesi kaçınılmazdır. Bu çalışma, Covid-19 pandemisi bağlamında yapılı çevrelerdeki sorunları ortaya koymayı ve çıkarılan dersleri dikkate alarak sağlıklı ve sürdürülebilir bir çevre tasarlamanın önemini vurgulamayı, aynı zamanda pandemi sonrası dönem için ortaya konan konulara gelecek için öneriler geliştirmeyi amaçlamaktadır. Çalışma, pandemi deneyiminden öğrenilen dersleri ışığında sürdürülebilir bir çevre tasarlamanın önemini vurgularken, dayanıklı ve uyarlanabilir yapılı çevreler oluşturmaya yönelik gelecekteki çabalara rehberlik edebilecek öneriler sunmayı amaçlamaktadır. Çalışmanın yöntemi, Nisan 2020 ile Nisan 2022 tarihleri arasında bahsi edilen konuyla ilgili yayınlanmış çalışmaların eleştirel incelemesine dayandırılmıştır. Çalışmanın bulguları, mevcut ve olası pandemilere karşı yapılı çevre tasarımlarının, belirtilen farklı boyutlarla, daha fazla sorgulanması gerekliliği vurgulamaktadır. Ayrıca çalışmada, Covid-19 pandemisinden dersler çıkararak olası ihtiyaçlara göre tasarım stratejileri ile ilgili öneriler sunulmaktadır.

Anahtar kelimeler: *Covid-19, salgın, yapılı çevre, tasarım stratejileri, kentsel-mimari-iç mimari ölçek.*

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1. Introduction

Mankind had to fight different pandemics for centuries and has always managed to learn lessons from them. In the light of recent archaeological and genetic research, it has been revealed that plague caused large-scale pandemics in the Eurasian continent since 3000 BC (Varlık, 2020). It is known that more than 13 flu pandemics have occurred since the 1500s (Ateş & Aksoy, 2020). In the 19th century, the spread of many pandemics increased with technological developments in transportation. It is known that the 'Spanish flu' pandemic, which took place between 1918 and 1920, spread very quickly and caused great losses all over the world, resulting in the death of at least 50 million people.

Each pandemic had affected urban planning and architectural design in different approaches and forced them to change and transform. In the historical process, it is known quarantine, isolation, and imprisonment measures have been taken against pandemics and they have affected architectural space organizations. For example, it is known that healthcare buildings were renovated to fight tuberculosis, leprosy, and plague, or special structures were designed for the mentioned disease. In the fight against tuberculosis, since the 1830s, the existing architectural principles related to sunlight and ventilation should be rethought in healthcare buildings. In the 1920s, the concepts of hygiene and health formed the basis of modern architecture and urbanism (Fezi, 2020).

In the early 21st century, pandemics such as the Swine flu, SARS, MERS, and Ebola virus had also a high trajectory of impacts; however, they were limited to the countries it started. On the other hand, COVID-19 quickly spread across the globe. As a result, a state of “new normal” is introduced to societies lifestyles across the globe, which is predominantly characterized by “stay home”, “self-isolation” and “physical distancing” (Nahiduzzaman & Lai, 2020).

Since 2019, when the covid-19 pandemic started to spread, it is experienced that the built environment needs change and transformation with the fear of being infected. It is obvious that built environment dynamics are also affected by this pandemic. However, it will take time to develop a healthy and sustainable built environment to stop the spread of the virus and take measures to avoid being infected.

This study aims to reveal the problems that arise in the context of the Covid-19 pandemic in the built environment, and also to emphasize the importance of designing a healthy and sustainable environment by considering the lessons learned. Within the scope of the study, the impact of the Covid-19 pandemic on the built environment will be examined in three categories: ‘Urban Scale’, ‘Architectural Scale’, and ‘Interior Scale’.

The primary objective of this study is to put forward the issues that have emerged within the built environment during the Covid-19 pandemic. Additionally, the study highlights the significance of designing a sustainable environment by incorporating valuable lessons learned from the pandemic experience. By investigating and highlighting these issues, the research aims to provide actionable insights and recommendations that can guide future efforts toward creating resilient and adaptive built environments capable of effectively addressing public health crises.

2. Material and Method

Starting in 2020, there has been an immediate increase in academic studies on the COVID-19 pandemic. The pandemic gave a new perspective to academic studies. As the method of the study, a meta-synthesis literature survey is completed on the published studies mentioning the effect of Covid-19 on the built environment. The study employed a methodological approach that involved two key components: a critical review of published studies on the subject and the observations from user experiences during the pandemic. The articles published in the journals that are indexed in the 'Web of Science' has been reviewed. ‘Covid-19’ and ‘built environment’ are used as keywords during the selection of the literature survey. 60 articles were reviewed that are published between April 2020 and April 2022, then 22 selected articles are used as the main source. Then, the future recommendations for the issues revealed for the post-pandemic period have been developed in light of the discussions.

For the critical review of published studies, the researchers systematically analyzed relevant literature to gather information regarding the issues. Relevant studies have been assessed to ensure inclusion in the analysis. In addition to the literature review, user experiences are also considered. It is observed how the individuals interact with the built environment during the pandemic. Site visits, interviews, and surveys have been conducted to collect information regarding challenges and experiences faced by users.

Then, a critical review of the published studies and observations are combined to obtain a comprehensive understanding of the issues related to the built environment. Findings derived from the method formed the basis for the aim of the study to emphasize the significance and designing a sustainable environment and provide future recommendations.

According to the findings, the built environment is classified under 3 scales urban, architecture, and interior space. A literature survey was conducted on the published articles related to the effects of the Covid-19 pandemic on urbanism, architecture, and interior scale and represented in Table 1.

Table 1. Relevant research studies on the impact of the Covid-19 pandemic on the built environment

DIFFERENT SCALES OF BUILT ENVIRONMENT	RELEVANT RESEARCH STUDY
Urban Space	(Sharifi & Khavarian-Garmsir, 2020), (Guida & Carpentieri, 2021), (Nahiduzzaman & Lai, 2020), (Broo, Lamb, Ehwi, Parn, Koronaki, Makri & Zomer, 2021), (Eltarabily & Elgheznawy, 2020), (Maturana, Salama & McInneny, 2021), (Fezi, 2020) (Edgars, 2020), (Kelly & Mouritz, 2020), (Honey-Rosés, Anguelovski, Chireh, Daher, Konijnendijk van den Bosch, Litt, Mawani, McCall, Orellana, Oscilowicz & Sánchez, 2020)
Architectural Space	(Megahed & Ghoneim, 2020), (Haas, Faber & Hamersma, 2020), (Frumkin, 2021), (Alraouf, 2021), (Maturana, Salama & McInneny, 2021), (Fezi, 2020), (Edgars, 2020), (Corbera, Anguelovski, Honey-Rosés & Ruiz-Mallén, 2020), (Taheri & Rider, 2022), (Navaratnam, Nguyen, Selvaranjan, Zhang, Mendis & Aye, 2022)
Interior Space	(Tokazhanov, Tleuken, Guney, Turkyilmaz & Karaca, 2022), (Spennemen, 2021), (Cheshmehzangi, 2021), (Signorelli, Capolongo, Alessandro & Fara 2020), (Porter, 2021), (Taheri & Rider, 2022), (Navaratnam at al., 2022)

The effects of Covid-19 on the built environment can be evaluated on three different scales as mentioned above. These:

- Urban Scale
- Building Scale
- Interior Scale

2.1. Built Environment on the "Urban Scale" in the Context of the Covid-19 Pandemic

During the Covid-19 pandemic, it has been suggested and recommended by different authorities and administrations to stay at home. In almost every country in the world restrictions on the "use of public spaces" has been witnessed. Especially in touristic cities, the squares, which were full in all seasons of the year before the pandemic, were empty. In this process, restrictions on the use of public space and physical distancing were the key measures in order to protect public health.

With the limited movement recommendations of the World Health Organization (WHO, 2021), people closed their homes in order not to be infected and did not leave the house unless it was necessary. In this process, many people tried to run their business from home via the Internet. Thus, it has been observed that urban spaces such as streets, parks, plazas, squares, and beaches are emptied in a way that has never been seen before. Cities, especially known for their active street lives, have taken on the appearance of 'ghost cities' as their users stay at home for the collective public good and restrict their out-of-home lives.

All the studies completed so far show it is not clear what will happen after the pandemic. There is uncertainty about how the social relations experienced in public spaces may change in the future. It is unclear whether the effects of Covid-19 on the public sphere will be as profound as in other aspects of our lives (Corbera et al., 2020). It will take years to come to definitive conclusions about how the global pandemic has changed the built environment (Honey-Rosés et al., 2020).

The Covid-19 pandemic is not the first pandemic that humanity has experienced. At the same time, this is not the first time that planning, and design will focus on improving public health (Sennett, 2018). In order to overcome the Covid-19 pandemic and protect against new pandemics, new solutions, and methods can be developed by considering health dimensions of planning and design.

According to Frumkin (2021), features of the built environment that increase disease risk are: crowding, poverty, poor air circulation, and air pollution. A critical reassessment of urban spaces has occurred Covid-19 pandemic and it caused a period of change and uncertainty (Berg, 2020). The pandemic should be perceived as an opportunity to rethink and assess urban planning priorities (Varlık, 2020).

In today's-built environment, it is impossible to ensure total isolation and physical distancing due to high-density development (Nahiduzzaman & Lai, 2020). This pandemic will force city planners and related designers to integrate the concepts that will directly affect public health in the fields of 'social density', 'social distance', 'private zone', and 'privacy and its degrees', in addition to environmental psychology. The current pandemic has given a new perspective to think about urban design and all design dimensions related to public space. This situation will lead to the production of new ideas and new concepts by analyzing the existing ones. Covid-19 can be an opportunity to rethink planning and design issues to create more sustainable cities.

Key questions in the field of urban design relate to 'how long will these effects last' and 'to what extent will they be transformative'. After the restrictions are lifted, the question of what will be the long-term effects of the Covid-19 pandemic on urban design and public space is a question that planners and designers should pay attention to. Will stakeholders working in this field define planning and design issues as 'before the Covid-19 pandemic' and 'after the Covid-19 pandemic'?

Studies carried out since the beginning of the Covid 19 epidemic in 2019, show that the epidemic will change and transform urban design and public space design in various ways and dimensions, especially in terms of perceptual, social, and administrative aspects, with a user-oriented perspective. However, the depth and extent of the transformation are currently unclear as it relates to the future use and perceptions of urban design (Honey-Rosés et al., 2020).

2.2. Built Environment in the "Building Scale" in the Context of the Covid-19 Pandemic

Every phenomenon that affects life also directly affects architecture. Undoubtedly, this pandemic process closely concerns and affects architectural space. The current situation has revealed that architectural spaces need to be re-examined and reconsidered. The pandemic caused a change in accessibility, social gathering, lifestyle, and working environment to prevent the spread of the infection (Navaratnam et al., 2022).

In this context, the buildings that need to be re-examined are 'public buildings', 'health buildings', 'educational buildings', and 'residential buildings' at first. While structures such as public, health, and educational buildings should be reconsidered by focusing on the prevention of Covid-19 transmission and in the light of other relevant factors; there is no doubt that residential buildings should be reconsidered in the light of space organization suitable for new life.

Human interaction with nature has been cut off by designing multi-story structures using artificial lighting and ventilation. It has been ignored that these artificial environmental conditions can cause many chronic diseases and allergies. The need to connect with sunlight, natural ventilation, soil, and water on the ground has been ignored as a basic human need (Rassia, 2020). At this point, Covid-19 has created a reason for architects and related designers to question these approaches again.

During the pandemic, the desire of users to escape from city life was triggered by the urge to belong and a sense of security. In this process, it has been observed that many people desire to live close to nature and to move from cities to rural environments. Residential living spaces, which are sufficient under normal conditions, started to be insufficient for people who stayed in the residence for a long time during the pandemic, causing users to question their living spaces again. In this context, the necessity of reconsidering and evaluating housing structures has emerged.

One of the most important issues to consider in the context of the Covid-19 pandemic is how public buildings should be designed in the future. In this process, concepts such as social distance, social density, quarantine, and public health have been the direct interest of the phenomenon of architecture. It is unclear how the social life, which was transferred to the digital screen during the pandemic, will be after the pandemic.

During the pandemic, museums started to reach more people digitally; digital tourist travel has increased; activities in the field of digital cultural heritage gained momentum. In addition to these, formal, non-formal, and informal education, which is indispensable for life, has been tried to be constructed and carried out on the screen. However, if the existing physical structures, especially the understanding of use in social, cultural, and educational structures, do not change against the dangers of pandemics that can be considered the new normal, it does not seem possible to create structures that will prevent social distance and related transmission and reduce the risk of infection. Both the understanding of use and the design approach need to be changed. In this context, such structures should be rethought and redesigned in a way that is more flexible than the new normal and other possible pandemic situations, suitable for possible new conditions, observing social distance rules, and reducing/preventing the spread of the pandemic.

The Covid-19 outbreak has revealed that healthcare buildings (hospitals, polyclinics, clinics, health centers, etc.) are not well-prepared structures to prevent virus spread. In all countries where the pandemic was seen, the healthcare buildings were insufficient, and therefore, health workers and patients had a hard time. One of the biggest problems experienced in this area in many countries has been that other patients and Covid-19 patients were kept in the same building and under similar conditions in healthcare buildings that were not designed according to the possible pandemic situation. This situation has revealed that healthcare buildings are spaces that need to be reconsidered, rethought, and designed as structures that can easily adapt to such crises.

With the pandemic, the necessity of rethinking architectural space has emerged. The rapid spread of the epidemic has triggered light carrier systems and modular construction. With these approaches, architectural structures such as hospitals and health centers were built in a short time. In addition, the pandemic period reminded designers that existing architectural structures could be rapidly transformed and reused. In this process, a significant increase has been observed in the reuse of existing structures in a short time in line with new functions and needs. Due to the long construction period of a new building, choosing the way to re-function and use it has contributed to creating a sustainable environment by using existing resources.

In this context, one of the most important questions to be asked is undoubtedly the question: How can self-contained structures be designed in case of possible pandemics, where users can be physically and psychologically safe and healthy? All stakeholders working in the field of architecture should focus on developing more human-centered designs that can quickly adapt to crisis conditions in the future.

2.3. Built Environment in the "Interior Scale" in the Context of the Covid-19 Pandemic

Due to the increasingly unsuitable transformation of the built environment, population density, pollution, and the environmental stresses faced by the Covid-19 virus, people felt safer in their homes, which can be described as the safest place for people after the womb (This inference was interpreted based on the works titled The Poetics of Space (Bachelard, 2013) and A Room of One's Own (Woolf, 2017). Since people stayed at home during the lockdown, they felt the need to change the spatial organization of the house. It was observed that users tried to fit all activities such as office-related activities, children's play activities, and sports-related activities into the existing spaces and organize the living spaces again. In other words, living spaces, which were sufficient before the pandemic, were not enough for the people who stayed at home for a long time during the pandemic and it caused the users to reorganize their living spaces again.

When the sudden lockdown was launched, millions of people reorganized their residential spaces in several ways. As a result, residential design and lifestyles were affected by this new challenge. Residential spaces, which were used mainly in the evening, have started to host many other daily functions (Signorelli et al., 2020).

The design of the residential buildings needs to adapt to the new normal since Covid-19 will not be the last pandemic (Spennemen, 2021). Architects and city planners need to find solutions for residential spaces that offer more flexibility for the members of the family to work from home, have online classes, be physically active, and have leisure, in addition to their regular activities at home (Signorelli et al., 2020).

In this process, the biggest problems in indoor areas such as housing were also experienced in quarantine centers. Patients or contacts who had to be confined to a single room for 14 to 21 days tried to spend all their vital needs (physical, social, psychological, etc.) in that room. The above-mentioned needs of the patient or possible patient were tried to be met in interior spaces that were not prepared for this purpose. In this context, it is necessary to design health structures and quarantine centers that offer healthier physical environments and meet all the needs of the users against the risk of continuing or any other possible future epidemic scenarios.

There is no doubt that architectural structures such as 'public buildings', 'health buildings', 'educational buildings', 'office buildings', 'shopping centers', 'stations of vehicles such as airports', 'and supermarkets' are among the places that should be discussed in interior design issues besides housing. Interior organizations should also be designed to adapt to the new situation. Before the epidemic, the way of life in the globalizing world had already begun to change its natural course. The concept of 'home office', which was brought to the agenda for the first time in the context of Environmental Psychology Congresses at LUND in 1991, started to become widespread in almost all regions of the world day by day.

In this period, where people spend their time mostly in residential interiors and try to isolate themselves, it is necessary to consider how the above-mentioned architectural structures can be designed to prevent the spread of viruses (antivirus - indoor built environment) by observing social distance and hygiene rules according to the new normal. Also, the question arises: Is there a need for such a wide variety of specialized architectural structures and specialized interiors? In addition, the question of 'how much will traditional spaces be needed for activities such as office activities and educational activities that can fit into the home?' should also be considered.

3. Findings and Discussions for Post-Pandemic Period

Above, the impact of the Covid-19 pandemic on the built environment has been examined in three categories: 'Urban Scale', ‘Architectural Scale', and 'Interior Scale'. The Covid-19 pandemic has taught that design strategies and related theories need to be reviewed. During the process, the following questions should be asked:

• What are the lessons learned from the crisis experienced with this pandemic in terms of the built environment?

• Is this situation a temporary phenomenon or is it the new normal? In both cases, what should be done in terms of the built environment?

• How the anti-virus-built environment can be developed for stopping the spread of the virus, decrease its effects, and possible new pandemics?

In light of all these discussions, the following suggestions can be made in the context of the built environment in the post-pandemic period:

Frumkin (2021) proposed potential long-term implications of Covid-19 for the built environment as infection-safe buildings, working from home instead of the office, re-envisioned streets, changing models of travel, a new appreciation for green space and nature, a shift from cities to exurbs and rural areas (Frumkin, 2021).

On the other hand, Cheshmehzangi (2021) divides possible development changes into two ‘Construction development changes’ and “Built environment development changes”. The built environment should be transformed into low-density low-rise buildings with strong interaction with nature. The neighborhood culture should be revitalized, ensuring that the users can meet almost all their needs in their region.

Many studies published on the subject so far agreed on the significance of increasing outdoor ventilation and ensuring social distancing without specific consideration of the potential impact of mentioned strategies on the other factors of building and users (Taheri & Rider, 2022). Building designs should focus on the structures that provide air control with natural ventilation to create healthy and hygienic environments. Public buildings should be designed in a way that is more flexible against possible crises, observing social distance rules and reducing/preventing the spread of the pandemic.

Steps should be taken towards considering living spaces according to the new normal, developing theories, and designing them, to be more flexible and multi-purpose than the new normal. These suggestions have been developed under three headings as seen in Table 2 in the light of the discussions.

In this study, which is handled within the framework of the global pandemic, clues are presented about the criteria for designing, constructing, and managing built environments. As Megahed and Ghoneim (2020) stated, while strategies for the future are determined and the vision is revealed, it should be done by considering the capabilities of the community and/or society, and the environment (Megahed & Ghoneim, 2020).

In this context, the epidemic emphasized that urban planners and architects should develop more ideas and work on new designs to reshape physical spaces and cope with possible future pandemics. The experiences have given designers many ideas about how cities and architectural structures can change for the better or the worse in the long run. However, it is still too early to predict or even judge how Covid-19 attributed to urban and architectural design theories will affect the relevant fields (Megahed & Ghoneim, 2020).

The findings of the study highlight important issues that emerged within the built environment. Through a critical review of the published studies and observations of user experiences, several key findings have been identified:

- Inadequate adaptability: the built environment has revealed a lack of flexibility to address challenges that emerged with the pandemic. Existing infrastructures and urban planning strategies were not designed with the ability to transform quickly.

- Health and safety concerns: the pandemic highlighted the significance of health measures in the built environment. Insufficient ventilation and overcrowded spaces were identified as risk factors for the spread of the virus.

- Social dynamics and well-being: the pandemic has emphasized the significance of social interaction in the built environment. Spaces that promote physical distancing without sacrificing social interaction become important.

Table 2. Issues revealed in the different scales of the built environment by the pandemic and future recommendations for the post-pandemic period

SCALE	ISSUES REVEALED BY THE PANDEMIC	FUTURE RECOMMENDATIONS FOR THE POST-PANDEMIC PERIOD
URBAN SCALE	Lack of public spaces that fulfill social distancing requirements	Rethinking public structures in a way that is more flexible against possible crises, observing social distance rules, and reducing/preventing the spread of the pandemic
	City density and overcrowding	Designing low-density cities that expand horizontally and ensuring decentralization by revitalizing the neighborhood culture, ensuring that the users can meet almost all their needs in their region.
	Social distancing issue in public transport	Encouraging the use of more cycling and walking
	Lack of parks and green areas in some cities	Urban planning should be reconsidered by focusing on green spaces.
	Lack of equity in the opportunities especially for the overcrowded and poor areas	Urban equity should be provided because overcrowded and poor areas are most affected by COVID-19 since there is a lack of services.
BUILDING SCALE	Public buildings are problematic in the context of concepts such as social distance, social density, and public health	Public buildings should be rethought and redesigned in a way that is more flexible in the new normal and other possible pandemic situations, suitable for possible new conditions, observing social distance rules, and reducing/preventing the spread of the pandemic.
	The necessity of rethinking architectural structures, construction, and structure issues has emerged.	Since regular construction needs too much time. The use of modular construction and lightweight structures is increased. It is possible to build structures such as hospitals and health centers in a short time with lightweight structures.
	The desire to be in nature is discovered during the lockdown.	Low-density and low-rise buildings can be designed with strong interaction with nature.
	Human interaction with nature has been cut off by designing multi-story buildings using artificial lighting and ventilation.	During the pandemic, the desire of users to escape from city life was triggered by the urge of belonging and a sense of security.
	The artificial environment can cause many chronic diseases and allergies. The need to connect with sunlight, natural ventilation, soil, and water has been ignored as a basic human need.	Healthy and hygienic built environments with maximum connection to sunlight, natural ventilation, soil, and water should be created.
	The Covid-19 outbreak has revealed that healthcare buildings are not well-prepared structures to prevent virus spread.	The necessary steps should be taken towards rethinking and redesigning healthcare buildings that can easily adapt in case of crisis.
	The long construction period of a new building in a crisis such as pandemic	Existing buildings can be reused for new functions to contribute to creating a sustainable environment by using existing resources.
INTERIOR SPACE SCALE	Issue of fitting all activities into houses during lockdown	Rethinking "home" in the context of pandemics. Suggesting design principles of housing in the new normal.
	Working from home and the issues revealed	Home-office should be considered as a new paradigm and spaces should be designed accordingly.
	Lack of flexibility and ability to transform in all spaces	Rethinking interior spaces in the concept of flexibility and ability to transform and taking quick steps towards considering living spaces of all sizes according to the new normal, developing theories, and designing them.
	Lack of facilities in quarantine spaces	Quarantine centers that offer healthy physical environments and meet all the needs of users should be designed for future pandemics.

4. Conclusion

The findings of the study highlight the necessity of further questioning the built environment against the current and possible pandemics. No doubt-built environment is important for overcoming this pandemic, as well as for possible pandemics. The most important lesson of this pandemic is the necessity of protecting human existence by designing physical spaces suitable for all possibilities, in line with their needs. While doing this, parallel approaches should be established with 'sustainable design approaches' without affecting natural resources and harming the environment. If this can be achieved, cities and buildings will continue to serve human existence. Without forgetting these experiences, studies on the developing built environment should continue in all dimensions and with relevant stakeholders for possible future scenarios. Important lessons should be learned from the Covid-19 pandemic to keep these events on the agenda and transform life for the better. The future remains uncertain; therefore, there will be a need for stakeholders from different disciplines to work together in the field of urban and architectural design against what may happen in the future.

Designers must have an awareness of possible viruses and possible pandemics on different scales. The designers must define the problems regarding the pandemics and built environment and develop design strategies according to possible needs by learning lessons from the Covid-19 pandemic. For this purpose, in this study, with a holistic perspective, the studies carried out in the field were systematically reviewed. The results of the subject have the potential to shine a light on the future.

The findings have highlighted the significance of creating resilient environments that prevent future pandemics. To achieve this, collaborative efforts of architects, urban planners, and policymakers are required. Future designs should provide flexibility while ensuring functionality. By implementing these recommendations, it is possible to create healthier, safer, and more resilient spaces that can respond to future pandemics and health challenges. Pandemics can be seen as an opportunity to transform the built environment into a more protective and supportive framework for communities.

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The article complies with national and international research and publication ethics. Ethics Committee approval was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

Both authors contributed equally to the article.

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The Effect of Neuroscience on the Formation of Biodigital Space

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Abstract

Studies in the rapidly developing neuroscience field in the early 21st century provide knowledge about the sensory stimuli the body receives from the environment. From a neurobiological perspective, loops and feedback are interconnected in the brain with matching internal sensory and motor maps. Neuroscience can help architects and neuroscientists design future spaces by interpreting experience and spatial transformation. Through neuroscience principles, space's network structure can be explored. It can enable the space, having a network structure, to transmit dynamically in its structural system. In this research, space's possibility as a self-generating system is examined through autopoiesis, explaining organismic body and life formation concepts. Establishing a relationship between the reproduction life parameters and space design by coding knowledge through digital experiments is aimed since life, vitality, and evolution are code sets. Space understanding with the organismic body increases its sensitivity and offers an opportunity for a re-discussion of space understanding.

Keywords: *Architectural design, neuroscience, connective integrity, biodigital formation, autopoiesis.*

Biodijital Mekân Oluşumunda Nörobilimin Etkisi

Öz

21. yüzyılın başlarında hızla gelişen sinirbilim alanındaki çalışmalar, vücudun çevreden aldığı duyusal uyaranlar hakkında bilgi vermektedir. Nörobiyolojik bakış açısında, döngüler ve geri bildirimler beyinde, eşleşen iç duyusal ve motor haritalar ile birbirine bağlıdır. Deneyim ve mekânsal dönüşüm alanlarını sinirbilim ilkeleri üzerinden yorumlamak, gelecekteki mekân tasarımlarında nörobilim ve mimari arasında işbirliklerine olanak sağlar. Nörobilimden öğrenilen ilkeler sayesinde mekânın ağ yapısı keşfedilebilir. Bunun dâhilinde bir ağ yapısına sahip olan mekânında, kendi yapısal sisteminde devingen olarak bir iletim yapabilmesine olanak sağlayabilir. Bu çalışmada, mekânın kendini üreten bir sistem olmasının olasılıkları, organizmik beden anlayışı, canlılığın oluşumunu açıklayan otopoiesis kavramı üzerinden incelenmektedir. Çünkü yaşam, canlılık ve evrimde kodlamalar bütünüdür. Organizmik beden ile birlikte bir mekân anlayışı, duyarlılığını artırarak gelecekteki mekân anlayışının yeniden tartışılması için bir fırsat sunmaktadır.

Anahtar kelimeler: *Duyusal kodlama, nörobilim, bağlantı bütünsellik, biyodijital oluşum, otopoiesis.*

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1. Introduction

There is a need for change throughout life. Change happens through the transformation of a thing. These changes are neither temporary nor can they be spatially isolated. The changes are like a sequential chain, constantly evolving because life itself is precisely changing. The organism is one of the most important representations of transcending space. An organism needs to change independently of its form in order to survive. Organisms must necessarily be part of a cycle that includes a cellular phase, according to the logic of the formation of the changed entity. Because the most basic element is the cell, and with the cell, togetherness exists. It creates a unique communication code that organisms establish with the cells within them. Cells recognize each other by this unique code. Each communication and coding that the organism establishes affects the cells within its system. By modifying these unique codes, the organism, and hence the cells, becomes a more responsive dynamic context in the event of a problem. Due to the bidirectional dialogue that organisms establish with the environment in order to survive, it works like a homeostatic system, ensuring the continuity and change of the organism over time (Maturana & Varela, 2020).

Maturana describes the organism as an autonomous system. Autonomous systems are systems that are capable of self-management and self-regulation. The organism is also an autonomous system with the ability to control its vital activities such as self-nutrition, growth, reproduction, and homeostasis. According to Maturana, the organism functions as a system that maintains and sustains its structure by interacting with the external world. Since the organism is constantly interacting with external stimuli, it can reconstruct itself to adapt to changing internal and external conditions. Also, Maturana relates the organism not only as a biological system but also to knowledge processing and learning processes. The organism's knowledge of the environment is constantly based on stimuli and the organism's own experiences. Therefore, the organism is capable of self-learning and development by not only receiving knowledge but also interpreting and reconstructing it. When this homeostatic equilibrium state is disrupted by environmental changes, the organism goes through an adaptation process to achieve a new equilibrium state (Maturana & Varela, 2020). The body is where the most changes occur in organisms. In the body, the brain is the place where the factors of change occur most. The biological definition of the brain is not that it is a thinking machine; rather, it receives knowledge and begins to process it. The 100 billion neural networks in the brain are connected to each other with connective integrity (Kılıç, 2019). From a neurobiological perspective, the brain is seen as a dynamic central system where loops, feedback, and matching internal sensory-motor maps are interconnectional. Neurons, which constitute the dynamics of the central system, have a communication network that is covered by the connective integrity of 100 billion neural networks (Kılıç, 2019). The connective integrity relationship enables sensory communication to occur and also ensures that this communication continues dynamically (Kılıç, 2019). It shows that the autonomous structures of organisms and the relations of these structures with their environment contribute to the formation of the organism's connective integrity. The self-regulatory structure of the organism can cause the organism to reorganize its internal structure by changing relations with its environment. This process means that changes in the structure of the organism can influence its behavior, thus further strengthening the connective integrity between the organism and its environment (Maturana & Varela, 2020). Consciousness and mind are created by the sensory communication system, which is cyclical. The biological foundations of the formation of mind and consciousness are also grounded in organizational concepts such as Maturana's theory of autopoiesis. Maturana's organizational approach suggests that the formation of mind and consciousness is not just a phenomenon within the brain or nervous system. It is the mental process that takes place in all possible relations of all interactions within the organismic integrity. At the end of this process, consciousness is introduced as a value (Maturana & Varela, 2020). Consciousness values are formed only by the patterns they create and follow in a single moment. The same pattern does not occur in the next moment. This results in the creation of multiple coded consciousnesses. As a result, a neuro mind is formed in each consciousness. Each neuro mind selects a new pattern, resulting in the formation of a new communication network. Each communication generates thought and meaning, which in turn generates more communication. The mind becomes self-existent in this way. With the knowledge that the body processes in space, it creates new patterns and layers. Space creates its mind with the consciousness it creates through the body because all life is a harmony of codes that exist intertwined. Each code morphs into the other. The body produces itself in every space by processing the connectivity that integrates with itself. The body gives space to its existence. The body's experiences in space alter space. The body gains new experiences as it moves through the changing space. There can be no separation of body and space. Because the body gives meaning to space. Space produces the network that it is meaningful to, and it is through this network that the mind comes into being. In neuroscience, the mind is not produced as a self-created connectivity network. The mind is the result of a connectivity network that occurs after the body interacts with life (Kılıç, 2019). What is called the mind is not the neuronal network in the physical organ we call the brain, but the name of the modeling created and produced by that neuronal network. In this respect, the mind can produce in space, within the interactions between the body and the environment, because space establishes a production dynamism thanks to its knowledge parameters with the body-environment. Each knowledge parameter that enters space forms a relationship with the space's network structure and generates a new network. The interaction between space and life results in the formation of new networks. The relationship between space and life is cyclical and ever-productive because space is life. And life exists in the midst of all the paradigms that surround it.

2. Material and Method

Within the scope of this research, a literature review will be conducted first, followed by an examination of the concepts of space, embodiment, autopoiesis, and neuroscience as they relate to the formation of biodigital space. Based on the concepts and theories examined, a relational research method will be used. Instead of looking for a cause-and-effect relationship, the relational research method examines the correlation between variables that are affected in a variety of contexts. Within the scope of the literature study, the first relationship between space and body will be examined through information and network systems, and a new relationship context will be established through the brain's network system. The second relationship is to examine the context established between space and the organism's organizational system that ensures its survival. The requirements of the organizational system of an organism will provide information on how to establish the biodigital formation of space. Third, the relationship discussed, the sensible coding of the space, the effects of the network connectivity of the space, and the formation of the artificial life of the space were examined. This situation will be examined through Lary Spuybroek's Son –O-House project, and explanatory information will be provided about the context of all the relations established in the space. Finally, all the concepts examined will be conveyed through the simulation experiment study through the autopetic behavior of the space and the biodigital formation of the space. Diagram studies were conducted to understand the concepts obtained from the literature review and the relationships established between these concepts. The study will conclude with an experiment in which the formation of the biodigital space will be seen as a result of all the data obtained.

3. Theoretical Framework

3.1. Network

The fact that the space has a knowledge-based formation allows it to receive and reproduce codes from the body in its relationship with the body, thus allowing its fluidity to continue. This situation allows knowledge to exist as an informational process in the layered structure of space. The process of becoming informed can only be realized by dynamically affecting both sides of the phenomenon being examined and the basic properties of a thing and the rules governing it (Arıdağ, 2018).

The fact that both the body and the space have a layered structure creates a meaning between the space and the body, which is intertwined and exists by complementing each other. This meaning indicates a network parameter. This network is similar to the connectivity network that provides the electrical transmission between nerves in the brain. The network of connective integrity is a knowledge communication network that belongs to life, where the network structures (network) that make it up create themselves and where each whole is part of a higher whole (Kılıç, 2020). It is a system of thought that not only remains in the field of neuroscience but also has the potential to affect all layers of culture and architecture according to nature, and people's perceptions. Connective integrity is a modeling of life, a new configuration of mind (Figure 1). According to the understanding of connective integrity, the most competent, vast, and complex knowledge-processing networked structure is life itself. Space also contains life in its layered and dimensional structure. It creates this life with the connectivity of the spiral network paradigms it has established with the body. Because everything exists with the network in which it exists and is formed by it and constitutes it.

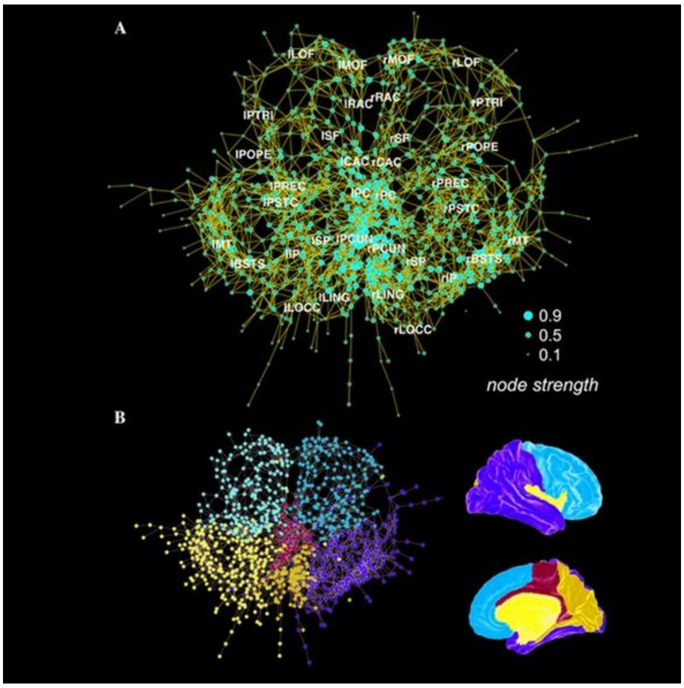

Figure 1. Brain networks (Sporns, 2011)

Its vitality in space is defined by the codifiability of existing knowledge, which is articulated in the body's connectivity network system. The body's experience of space provides knowledge. Knowledge is transferred to space by the body and exists in the body as an entity in the same way that knowledge exists in space. What is referred to as the body in this context is embodiment. Embodiment is what acquires experience through space, transfers that experience to space, and then acquires experience again with the transferred knowledge. Since information is coded in this network, the network structure of space is where embodiment obtains experience. Each coded knowledge is articulated into layers with patterns and overlaps with a new layer. Each new layer is in a mutual relationship with the previous layers of the space. In this way, it increases the dynamism of the space by articulating with the networks that form its features and form the connected integrity of the whole. Thanks to the spatial body with increased dynamism, it re-creates its existence because the increase in dynamism contributes to the emergence of the vital formation of space. The spatial body that constitutes vitality is shaped through the experience in this network.

In their book "The Tree of Knowledge," Maturana, H., a neuroscientist, biologist, cyberneticist, and philosopher, and his mentor Varela, F., state that "knowing is the act of the knower; its roots are in the living being, its organization" (Maturana & Varela, 2020). As a result, through experience and its networked structure, embodied space codes knowledge. With the change in space, the process of knowing creates an identity in the connectivity network of space. In this way, the embodied space chooses between codable knowledge and non-codable knowledge. The space that one can choose creates its mind. Neuroscience defines the mind as a simulation of neuronal network transmission in the brain. The mind is an autopoietic model. As a result, it is defined as a life-defining model. Every connectivity, every self-similarity, can turn into the coding of existence and then into another in the network of existence known as life. Through sensation and sensory coding, the production of mind in the vitality of space and body is possible. With this coding, space exists as a living system with a cyclical vitality**.**

3.2. Autopoiesis

Humberto Maturana and Francisco Varela developed the autopoiesis approach in the 1980s. It is a combination of Greek terms (autos: self, poiesis: organization, production) that means self-organization (Maturana & Varela, (1980). The concept of autopoiesis is based on the idea of a system organization that produces its components. Biologists use the term autopoiesis to describe the sphere of existence of a living organism that oscillates between structure and knowledge exchange. The concept of autopoiesis is also based on the idea that living systems are based on the mechanism of self-reproduction (Maturana & Varela, 2020). One of the most important definitions of autopoiesis is that all living systems and beings are cognitive systems because cognition is always alive (Figure 2). Cognition is a system that can be added to, articulated, and reproduced, and every field and science where cognition is present always points to the existence of the autopoiesis network (Maturana & Varela, 2020).

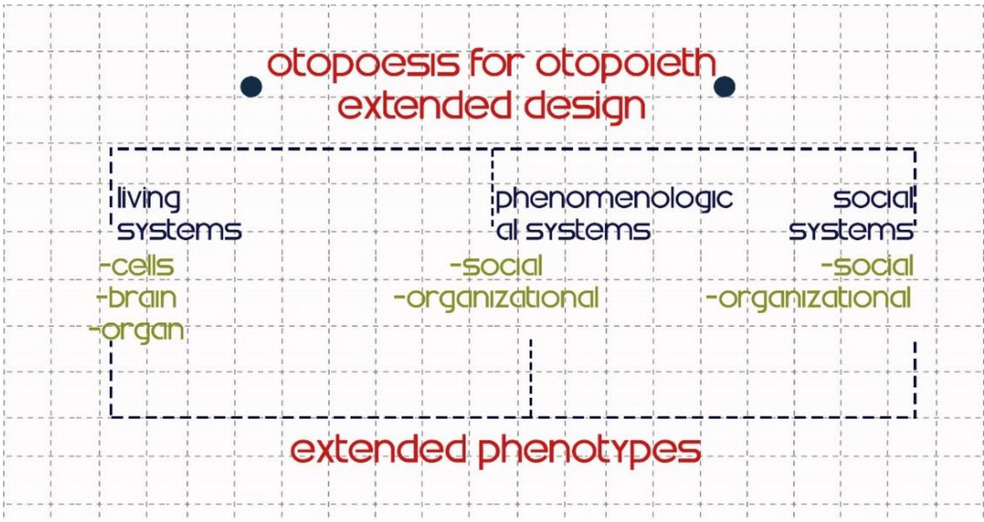

Figure 2. Autopoiesis systems

The idea of autopoiesis is the theory of Maturana and Varela's contemporary vitality systems (Maturana &Varela, 2020). Within the framework of this theory, vitality maintains its continuity only to live and reproduce itself**.** Every system that shows the characteristics of an autopoietic system constantly renews and recreates itself. An autopoietic system is a living system. Living systems also exist as both open and closed systems**.** Its characteristic as an open system is that it is a system that can receive and change data from all its relational contexts, while its characteristic as a closed system is that it can make its products with the knowledge it acquires from itself. Autopoietic systems are in a state of exchange of matter, energy, and knowledge outside their boundaries. This exchange maintains the integrity of the working principle of the system by preserving it within the matter, energy, and knowledge system. The cognitive knowledge of the living being in the system allows for the preservation of integrity. Maturana uses the expression "knowing is doing" to describe the concept of autopoiesis. Maturana's phrase "knowing is doing" implies that knowledge is linked to action and that cognitive processes can be thought of alongside acts, behaviors, and functions. That is, knowing something implies acting as a being capable of doing and interacting with it. Acquiring knowledge is not only a passive process in this context, but it is also an active process that occurs in conjunction with action. Maturana's approach demonstrates that knowledge is not solely a human concept but is also related to how living beings and living systems perceive and comprehend. According to Maturana, the way living beings perceive, understand, and interact with the world has evolved through evolutionary processes, with biological factors also playing a role. According to this perspective, cognition in general refers to an effective doing that allows a living being to survive in a defined environment as its world unfolds before it (Maturana & Varela, 2020).

Life transforms by exhibiting autopoietic behavior in the cognitive process. Transformation by autopoiesis theory is based on the organization that ensures vitality. Maturana also approached the concept of organization from a biological perspective. According to him, organization is a distinctive feature of living things, and the structure and behavior of living things depend on these organizations. Each component of the organism collaborates with the others to form the whole organism. This harmonious work is the basis of the organism's organization. Autopoiesis includes a state of self-production and contributes to each component's ability to produce and transform other network structure components belonging to the function along with each component. The network in the autopoietic system is constantly self-generating as a result of this situation. Cognitive living systems are those in which the components' production is continuous. This cognitiveness always indicates the presence of the cognition autopoiesis network (Capra, 2003).

The nervous system, the largest cognitive system in life, contains billions of cells, all integrated as components of the organism. Cells in the nervous system are able to maintain their boundaries and at the same time, through their interconnections, maintain their cell associations as second-order self-existing systems. As a result, the nervous system is the most prominent example of self-generation. Neurons emerge in the nervous system as part of a networked system. As a mechanism that maintains the organism's structural changes, the nervous system contributes to cell communication reactions. The nervous system is a network of active components in the organization of life, where each change in reactive communications causes another to occur. It generates its own nature of autopoietic systems that create themselves through their organization and produce the structural elements of the system (Petrušonis, 2021). Space has an organization with networks of connective integrity. The space realizes its self-existence in the network of connectivity and the fact that everything that happens is under a state of conservation is specific to cell division in living things, but the space realizes its self-existence through the transfer of knowledge from the organismic body. In other words, space brings its vitalization into existence. In order for a space to be autopoietic, its network structure must be organized, each connectivity network must be able to produce itself, and structural interconnection between environments must be established (Dollens, 2015). Through autopoiesis, structurally coupled systems act as knowledge processing systems, producing new knowledge (pattern), i.e., intelligence. Through self-creation, autopoiesis creates a new coding system. With the knowledge entering the space, it creates a different paradigm of existence. This paradigm is distinct from the information codes that ensure the space's integrity. Autopoiesis results in the formation of new connective integrity in space and the transformation of space.

Diversity provides a type of adaptation for the continuation of self-existing systems. Space has a dynamic relationship context of adaptation with the environment as a result of its autopoietic behaviors in the structure of connective integrity. As a result, space ensures the continuation of its own existence. Using the collective state of many knowledge inputs, the space generates a code for its own production. It is a type of collective consciousness formation that occurs in the conscious mind during its production. The collectivity of its codes produces space. The space is now continuing to form on its own. Nature's own production system is based on the collectivity of space. The ability to exist and produce in nature is due to the fact that it behaves as a Voronoi system due to cellularity. In nature, Voronoi systems are structures that divide an area (e.g., plane or space) based on multiple points (e.g., atoms, molecules, or cells). The Voronoi system represents a zoning structure in which each point is surrounded by other points that are closest to it. This region is located in the center of a region that is closer to all points (Asghar, Jalil & Zaman 2020). This system can be found in many natural settings. Nature also creates production networks, such as self-similarity in the Voronoi system, which is required for its survival. Self-similarity is a property that describes how a part of a structure at one scale is like other parts of the same structure at different scales (Asghar, Jalil, & Zaman 2020). The relationship between Voronoi systems and autopoietic systems is based on their roles in organism spatial organization. Voronoi systems assist the organism in carrying out its functions by ensuring that cells and tissues are arranged in a specific order. On the other hand, autopoietic systems allow the organism to automatically create and maintain a certain order due to its unique structure. These two systems play a role in spatial organization formation. Since both systems contain knowledge-based and vitalizing formations, these systems are utilized in the production of space itself.

3.3. Embodiment

The philosophy of the French philosopher Maurice Merleau-Ponty holds an important place among the theories of embodiment with its phenomenological approach to the notion of the body in an epistemological and ontological context (Merleau-Ponty, 2006). While challenging the sensation-centered approach of traditional epistemology based on the subject-object distinction, Merleau-Ponty's philosophy also challenges the ontological conceptualization based on the mind-body distinction and offers a body-centered approach to the human relationship with the world and thinking processes (Aydın, 2020). The embodiment of space makes sense of its existence through a networked relationship. In sensory research, it is considered as the knowledge of the sensation brought about by embodiment. The phenomenological understanding of the body contradicts the understanding of representation here, claiming that what is assumed to be represented is a product that emerges as a result of the body's interaction with the world, that is, as a result of the body's alignment with its orientation (Uslu, 2016). Knowing, memory, perception, learning, and behavior, for the phenomenological approach, do not correspond to a fixed and determined subject-object relation, but to a relation of embodiment. This depicts a field of experience in which the body is moving, changing, and repeating itself. This field of experience is the foundation that ensures the subject's unity of consciousness and body, the state in which the subject exists as a result of its continuous embodied interaction with the past and present. On this ground, orientation includes the embodied subject's experience of possessing and knowing things as participation in things outside, as well as the experience of being present and aware of things outside with its body. In this sense, it can be said that experience has two faces or is two-sided. These two sides of experience are the expression or definition of orientation as an unmediated and interactive field of experience (Gallagher & Zahavi, 2008). In the study, embodiment through networks of orientational relations; the relationship with the things in the world is considered as a non-fixable, non-determinable, interactional relationship in the process. The relationship of indeterminateness, just like the subject-object, mind-body distinction, Deleuz's singularization by transcending the actual-virtual distinction, these opposites disappear and gain meaning beyond representation. Thinking in the theory of non-representation is fluid and a process rather than something fixed. Due to this fluidity, it can be said that rather than being a theory that explains issues or produces formulas, it is a style, a way of handling events (Uysal & Güngör, 2017). In the research, the embodiment is considered an organismic formation.

Any codifiable experience is linked to the mind because the mind contains dimension and layeredness. The mind's layeredness creates a context through the production of senses and the knowledge coded by experience. This context is a connective integrity relationship. In the transmissions of 100 billion neural networks, the brain, which has the largest network of connective integrity, establishes the context of sensation and mind (Kılıç, 2020). Neurons, the building blocks of neural networks, are also sensory data carriers. Action is contained in carried sensory data. Each action results in transmission. Each neuronal transmission generates thought and meaning. Experience is a meaningful relationship. Essentially, all senses interact. (Pallasma, 2014). Experience requires the interaction of the senses. Environmental experience, spatial qualities, and atmosphere have an important role in spatial experiences. (Şimşek, Balkan & Koca, 2022).

Maturana Varela defines experience as a phenomenon within cognitive processes that arise as a result of the cause-and-effect relationship between organisms and their environment. (Maturana & Varela, 2020). In the relationship between the organism and the environment, the organism takes characteristics of the environment and uses them in its cognitive processes. Cognitive processes shape the organism's experience, and these experiences are mirrored in the organism's mental world. The sensory coding of experiences shapes embodied space. The embodiment, which gains new experience in the shaped and changing space, returns this experience to the space. Space coding are becoming more diverse. This sensory coding process is also considered cyclical.

Sensory coding is a type of information coding. The content of sensory experience is directly related to what is referred to here as knowledge, the content of knowledge. When viewing knowledge as a complex process, the process in which it is located influences the sensory fields of knowledge in space.

Space, with its existence and connectivity in its layered structure, is also within the senses. The first stage of knowledge is the sensory stage or the stage of sensations and impressions. The sensation is dependent on action. Sensibility and action are not mutually exclusive concepts (Özgencil Yıldırım, 2017). The computational modeling of sensing, which has recently become a growing area of interest in robotics research, has also been a source of debate about how to design and model sensing. Thanks to the idea that a strong organizational behavior based on bodily regulation is 'useful' in both biological brains and robotic cognitive architectures (Damasio, 1994), the sensory parameter plays a major role in explaining the shaping of space through sensation. The transfer of sensory parameters will help us see space as a bio-digital formation.

The space saves the various experiences it has with embodiment. As a result, space generates its own episodic memory. The production of sensory code in space is enabled by episodic memory. By creating different experiences and different interactions with each sensory code produced the space becomes a dynamic productive place by creating its own mind. The space, as a dynamic system, uses the knowledge generated by sensory coding realized in its reticulated structure to maintain the continuity of its internal relation. In its internal relationship, space creates new connectivity. By capturing the sensory parameter inputs included in the space as connectivity increases, it creates the mind of the space by providing more than one consciousness formation in the space. One of the goals of sensory coding is the formation of consciousness, which occurs in the space's own connectivity network, transforming the space into a creative active system. A space that is creatively active and dynamic becomes self-existent. This situation has an impact on the space's productivity.

Son-O-House, one of Lary Spuybroek's projects with NOX Architecture, is a house inhabited by sounds, a memory of sounds, and an experience of sounds (Figure 3). Son-O-House, a structure in which Lars Spuybroek, composer Edwin Van der Heide, and visitors collaborate to create a "memory landscape" of sounds in and near space, is not a "real" house, but rather a structure that refers to visitors' bodily movements and a sound work that constantly generates new sound patterns (Bullivant, 2005). The Son-O-House project has a generative and reactive sound environment. The project is activated by sensors that detect the actual movements of visitors and continuously generate new sound patterns. The goal is to have a constantly evolving environment that forces visitors to come back, to perceive the new musical situation, and then to relate and interact with it again.

The 3,300 square meter structure has 23 sensors placed at strategic points to function as an interactive sound work (Bullivant, 2005). The music emitted into the environment indirectly affects the people present. People involved in the project not only hear the sound but also contribute to its creation. Spuybroek describes the structure as "an instrument, score, and studio all at once." The sound system was composed and programmed by sound artist Edwin Van der Heide and is based on the movements of the interference of closely related frequencies. The sound project is continuous, with infinite variations caused by bodily intervention in space. A visitor said that as he rode his bike up to the house, he could hear the installation buzzing like birds in the background. When he entered the space, he noticed that the sounds had changed due to his presence and movements. NOX recorded the sounds made by visitors as they entered or walked around the space, using sensors that indirectly affected the emitted sounds (Bullivant, 2005). As a result of the interaction between the environment and the human body, space has changed by transferring it to space. The structure reflects the changing sounds of each visitor, forming a continuous composition cycle. The network structure of space (sound) has been able to reproduce itself by drawing interaction from the human body and the environment towards its own structure. Space forms the network structure with sounds. Each visitor has an orientation for the sound in the space. They transfer sound from the environment to the space when they enter it. The network of connective totality between space and the human body was completed when they realized the sound emanating from space was one of their own movements. It is a cycle. Now space produces itself.

Figure 3. Sound sensors are placed in the space (Heide, 2021)

As seen in Lary Spuybroek's Son-O-House project, space is sensed. The sensed space produces different and diverse new productions. Through its experience in space and its relationship with time, the body enables the emergence of a new phenomenon. This is because experience is the emergence of meaning from the exchange of knowledge between body, space, and time. The embodiment of space allows the experience to be used as data. Each data triggers a new experience, and each new experience triggers a new generation of data. Every data that enters space produces infinite variations. Space creates its own internal dynamism with the coding of these data (senses). The space with increased internal dynamism becomes self-productive in order to be able to code more.

Thanks to the sensory coding of the space, it transforms and takes shape with the space and its body, and then transforms each received code. The knowledge that enters the space through embodiment contains senses, and the space performs sensory coding using this knowledge. This knowledge coded in space also creates energy transformation in the networked relational integrity of space. This contributes to the dynamism of the connective integrity of the space. It enables an increase in diversity in the mind in dynamic space connectivity. The increase in mind diversity that occurs in space enables the formation of the dimension of cohesion, ensuring that each knowledge input in the mind remains permanent. The presence of permanent knowledge distinguishes subsequent knowledge inputs. Different sensations can occur as a result of the transfer of different knowledge into this space. In other words, embodiment affects the continuity of the coherence dimension in the continuity of the sensation process through this task. The embodiment of space allows the reticulated structures to create their own mind through the dynamism of its multiple dimensions. While this event serves as the foundation for the space's mind formation, the space, as a living system, continues its cycle in its own production (Figure 4).

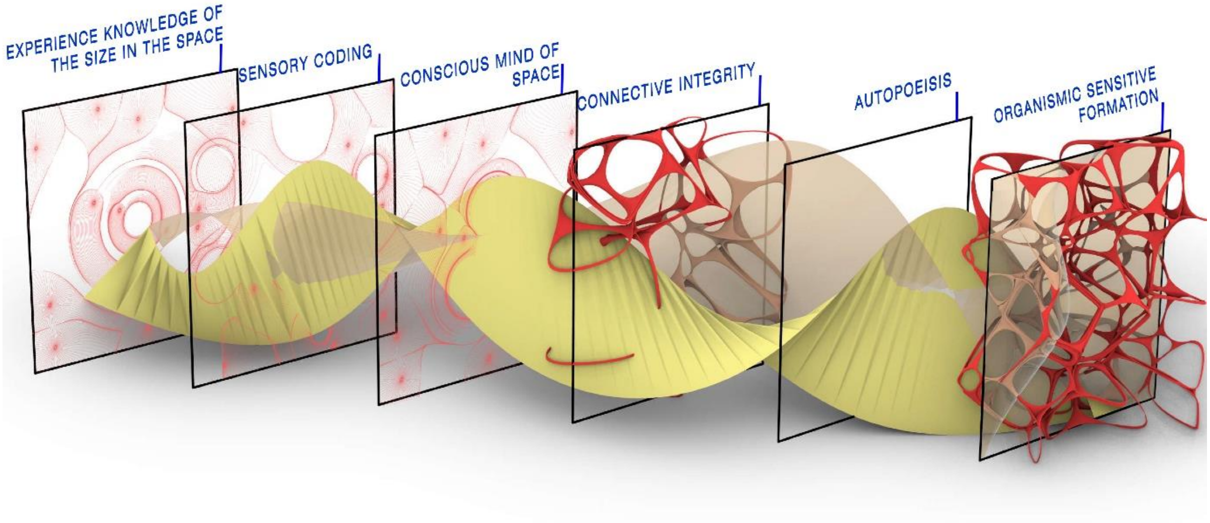

Figure 4. The space's own production continuity cycle process

This cyclical process is critical for the persistence and diversification of mind formation in space. Space must be embodied in order for this diversity to persist and produce itself because to harbor embodiment means to harbor the mind. The space that harbors the mind is dynamic and this dynamism can always be sustained with the continuity of mind formation**.** In this process, the space, whose dynamics increase, becomes a whole together with the codes produced because it is a set of codifications that exist intertwined in all life. The space that harbors a life with the presence of mind allows each code it creates to transform each other. Each transforming code produces new connectivity in the embodied space and sustains the continuity of the relation of connective integrity in space. The connectional space brings about the formation and continuity of a patterned input. Patterned input is necessary for the space to produce**.** This is because many patterned inputs exchange knowledge with each other in order for the space to produce itself. Each input produces a network on its own. The network produced is diversified by joining the network structure already present in the space. The diversified network structure designs the mind of space through the integration of various dynamic components. The designed integration combines the space's input knowledge in a flow with the space's networked structure between the layers. In this way, it creates the connectivity of new spatial production by articulating the networked structure of space (Figure 5).

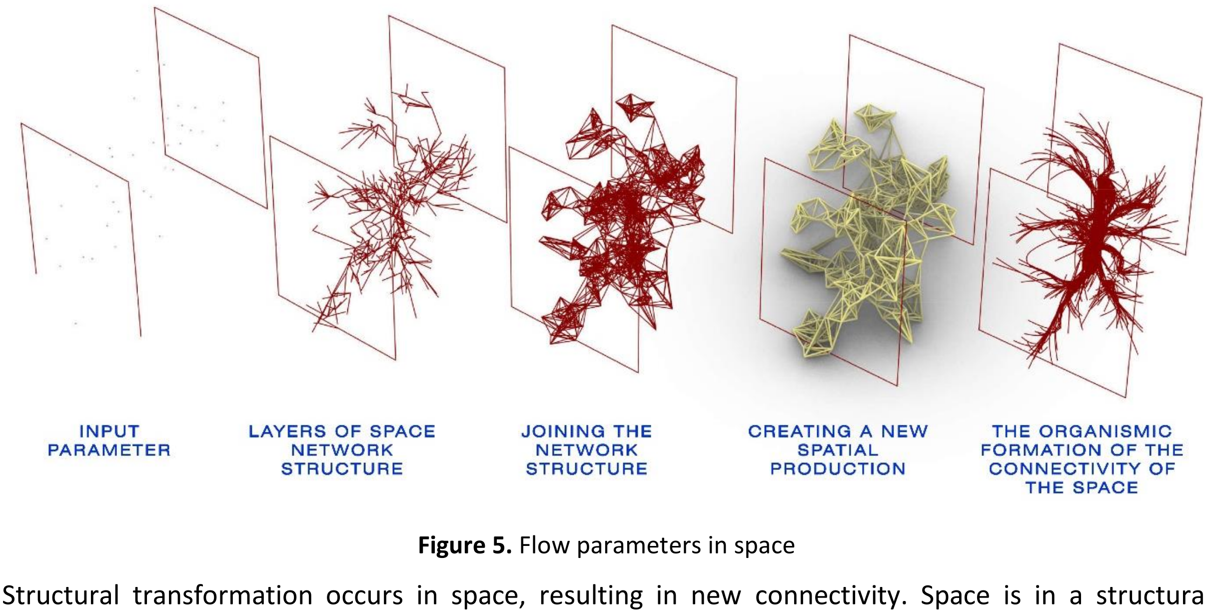

Figure 5. Flow parameters in space

Structural transformation occurs in space, resulting in new connectivity. Space is in a structural transformation and this transformation is also a dynamic movement. This is due to the fact that every structural transformation of space enables it to diversify through new areas of experience and the impact-response it will have on the organismic formation of its relationship with its environment. The mechanical, organismic behavior of the parameters of the vital network transforms the systems of space, environment, and body. With this behavior observed in the space, it can self-exist.

4. Finding and Discussion

4.1. The Experiment of Biodigital Formation of Space

The autopoietic system is based on knowledge theory and the codifiability of knowledge. The theory of knowledge is a theory that is interested in scientific abstractions in order to understand the mysteries of the universe, make sense of it, reveal the true causes of social development, or formulate scientific theories. Abstractions contain practical knowledge. This knowledge includes theoretical thinking and model building. The cybernetic organismic sensory formation of space is aimed at the emergence of the cybernetic organismic sensory formation of space in the experiment conducted to explain the data obtained from the theoretical framework, and the rules of vitality formation predict geometric coding and the discovery of possible spatial patterns. Cybernetics is currently defined as "the branch of science that studies the control and management of all complex systems, both living and non-living" (Jenkinson, 2021). Norbert Wiener, the most prominent representative of the concept of cybernetics and a mathematician who developed theorems, defined cybernetics as a complex, adaptive, autonomous, and circular form of organization and knowledge transfer that allows all its parts to be combined as a complex system in any living or non-living system (Krippendorff, 2007). Humberto Maturana demonstrated the science of cybernetics using organisms. According to Maturana, the functioning of cybernetic systems is ensured by feedback loops. While explaining cybernetic systems, Maturana also emphasizes the difference between first-order cybernetic systems and second-order cybernetic systems (Figure 6).

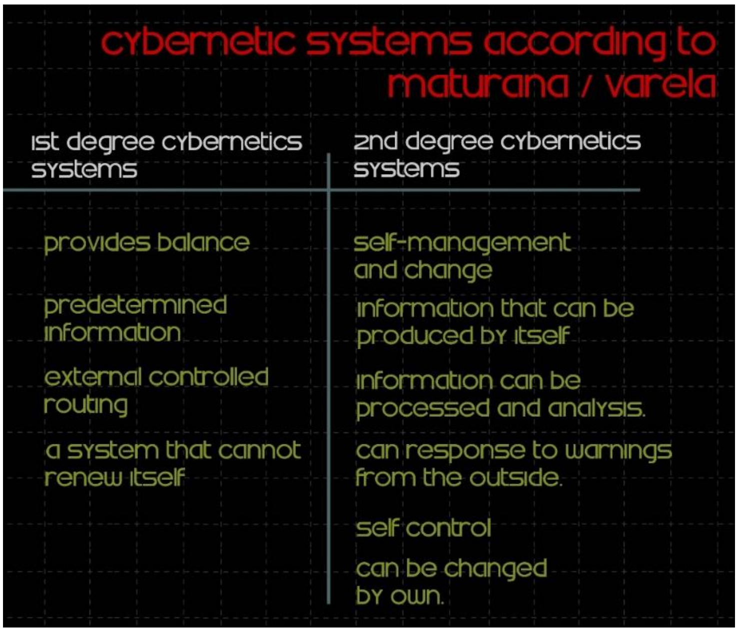

Figure 6. Cybernetic system features according to Maturana & Varela (2020)

First-order cybernetic systems are those that can control and correct themselves using feedback. Second-order cybernetic systems are systems that are aware of their own existence and can use that awareness to change themselves. These systems can produce and reconstruct themselves. According to Maturana, another characteristic of second-order cybernetic systems is that they can know about themselves and use this knowledge to change themselves. Therefore, living organisms and living systems are examples of second-order cybernetic systems (Maturana & Varela, 2020). Living organisms can adapt faster and develop more complex behavioral patterns when they are in an environment where they can change their own structure and control their own behavior. In the experiment, space formation is designed according to the properties of a second-order cybernetic system.

Space is always in a dynamic production process with its second-order cybernetic properties. Space defines the transition to cyberspace in the age of networks through its dynamic, collective, and self-organization by structuring its own integrity. The transition of space to cyberspace is the transition of space from static to dynamic, from passive to active, from fixed to fluid and variable surfaces. The space thus creates spaces for a multi-sensory experience. Turning into cybernetic spaces of experience, space is an interactive and constructive state (Novak, 1995). Experience is redirected and new meanings emerge as a result of its transformation through embodied meaning (Merleau-Ponty, 2006).

The knowledge of space connectivity network functions as a computing system that can learn embodied experiences as input and draw conclusions from these experiences. In space, this knowledge processing system is formed in layered networks. The flow of knowledge moves between layers along a network of connectivity and integrity. This input of knowledge between layers is transformed by space into a new field of experience. These experience spaces are cyberspace experience spaces.

There is a necessary harmony in the embodiment of space. Embodiment shows an enveloping environment. There is a flow of knowledge in the embodiment. This knowledge parameter is the activation of space. Each newly uploaded knowledge creates a new spatiality. Spatiality is the result of a cognitive process. This cognitivism is treated in the experiment as a revelation of the dynamic relationship between the parameters of space within the digital context while adhering to the rules of organismic formation. For this purpose, 3D modeling programs Rhinoceros and Grasshopper with digital interfaces are used.

The system created in the experiment is a universe and the emergence of embodied space will be considered as the evolution that takes place in this universe. In this process, evolution develops an exchange of knowledge between layers. In the context of this exchange, the new model of space used today is viewed from a dynamic emergence perspective rather than a static structure. This perspective sees the patterned diversity that emerges in a non-homogeneous construct over time as a creative act (Arıdağ, 2018) because life changes, transforms, converts, and produces due to its nature. This is a cyclical process. All production takes place within the designed time universe. The universe is created in a circular coordinate system. Each intersecting point in the coordinate system generates points that allow space to be productive. These points are then matched with the data that will be used to calculate productivity. The knowledge matched with the dots is transferred to the embodiment of space as a layer. Space exists because of the relationship it creates between all of these knowledge systems. This knowledge is virtual knowledge. The knowledge parameters, which are considered a subheading of the virtual knowledge, are matched between the points in the coordinate system where they are located (Figure 7). More than one parameter can have multiple matches. These matches create a chaotic situation in space. Every chaotic system somewhere demands equilibrium according to a property of living systems.

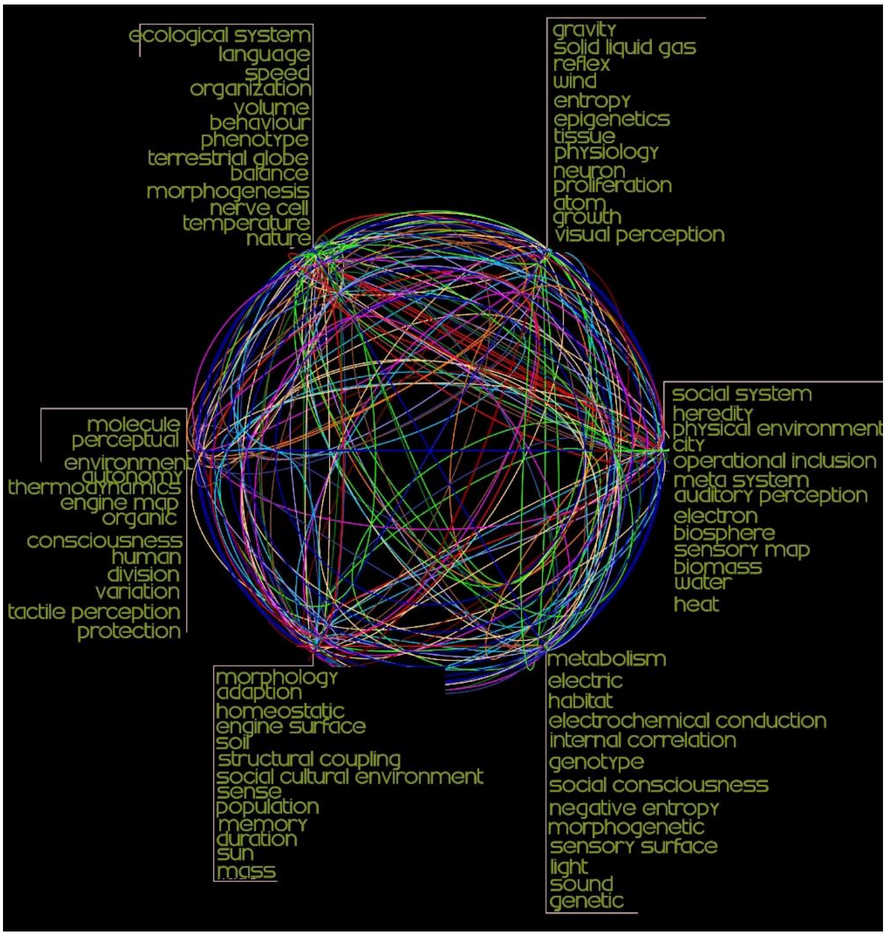

Figure 7. Chaotic situation caused by experimental matching

The experiment initially shows a chaotic situation as a result of the matching between the groupings of all layers. This chaotic state is the result of the intersection of certain parameters of vitality. Intersection points act as synapses in the nervous system. They are involved in the system as nodes and transmission points. In the experiment, these points act as an electrochemical transmission and the beginning of the organization between the brain and organs, just as synapses do in the brain. When conduction occurs, a chaotic situation in space occurs (Figure 8). The experiment chooses among the parameters that will generate spatial productivity in order to bring the chaotic universe into equilibrium. Chosen pairs; specific heat capacity, density, solid, liquid, gas, mass, atom, equilibrium, negative entropy, heat, temperature, thermodynamics, homeostatic, autonomy, physiological, sense, memory, communication, metabolism, growth, reproduction, organization, neuron, electro-chemical, genetics, epigenetics, morphogenetics, motor map, sensory map, heredity, genotype, phenotype, motor surface, sensory surface, internal correlation, structural correlation, procedural inclusion, variation, nerve cell, entropy, tactile sensing, auditory sensing, and visual sensing, produce parameterized knowledge, i.e. the chaotic state. These selections show the context between the parameters of the self-organization of space and the parameters that will change the embodiment of space. Space produces itself through the knowledge that is in itself.

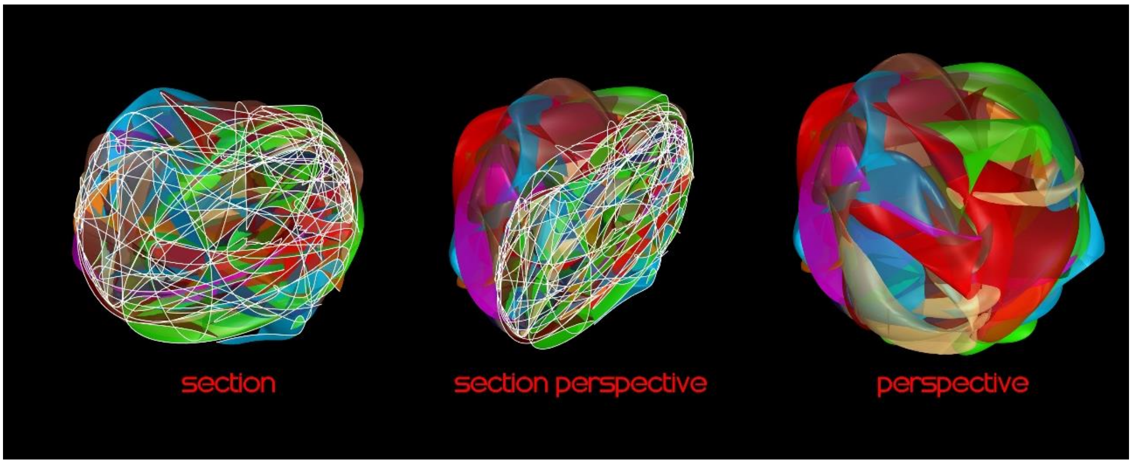

Figure 8. Initial situation before selection in the experiment

In order for the chaotic space to reach equilibrium, selection will be made according to Matura's concepts of vitality. Maturana, too, defines vitality as systems that are constantly renewing and reconfiguring themselves, a process he refers to as "autopoiesis." (Maturana & Varela, 2020). This process allows living things to preserve their unique structures and maintain their continuity. He explains that every self-renewing system carries knowledge, and that knowledge consists of the act of knowing. Every knowing creates an action, a universe, a life, a vitality.

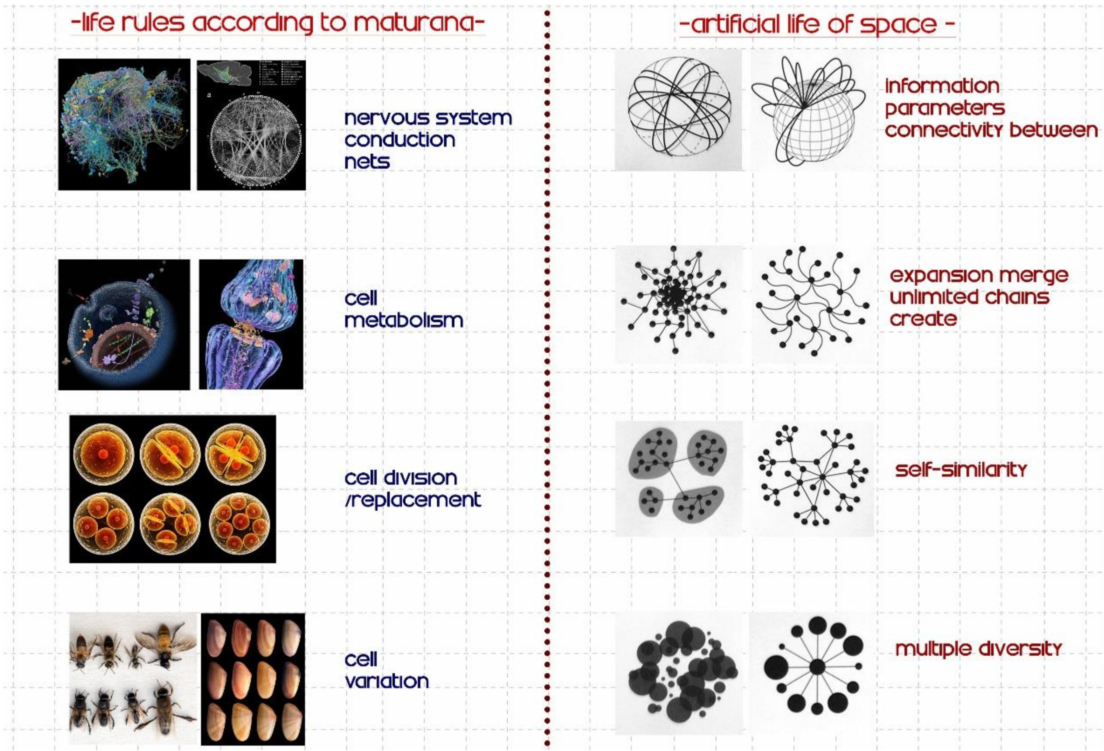

Figure 9. Connection diagram between experiment and cell organization

According to Maturana's theories of vitality, selection takes place between pairs (Figure 9). These selections consist of points in a coordinate system. The points joined in the Rhino program create the artificial life of space. In order to make this combination understandable for the artificial life and production of space, networked knowledge connectivity is created using the “physeralm” plug-in in Grasshopper. Thanks to this plug-in, the simulation of the production network that will be formed in the embodied space can be seen (Figure 10).

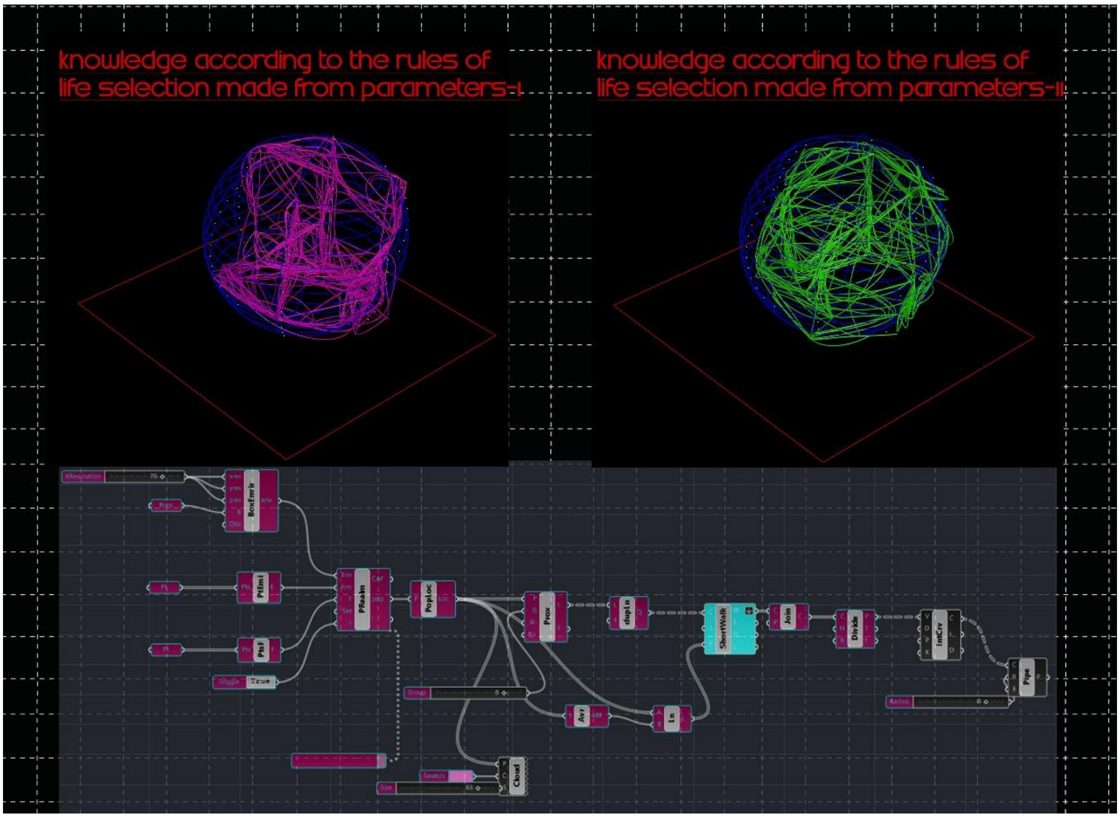

Figure 10. Selection diagram according to the rules of life

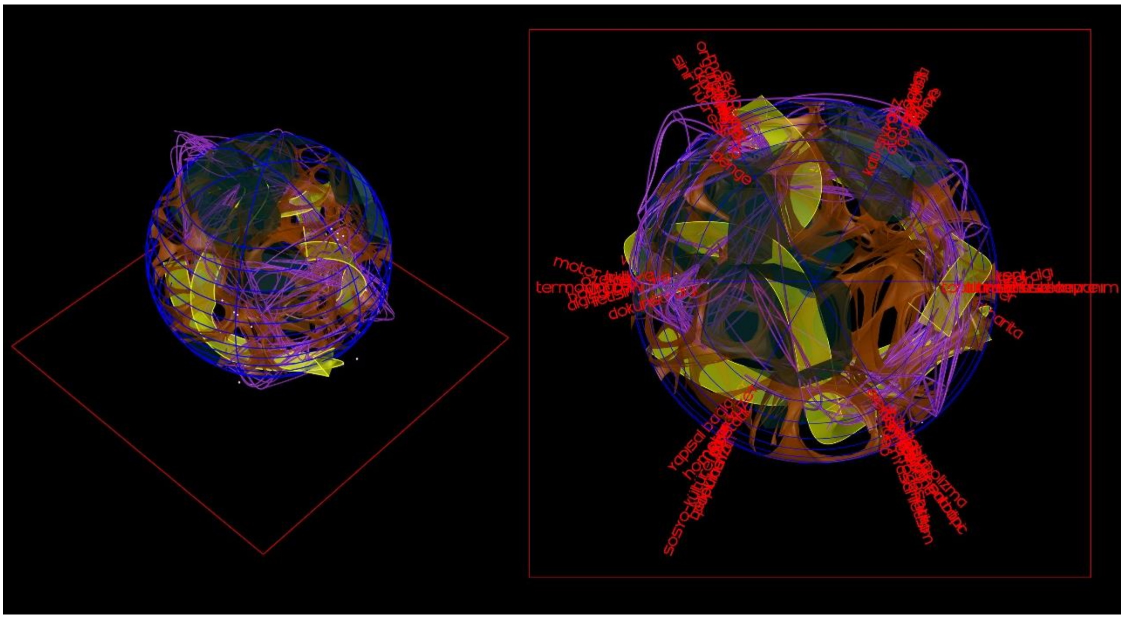

Figure 11. Artificial life of space

Space is not a mere phenomenon or formation, but the scope of a network of connectivity integrity (Kılıç, 2020) that includes many relationships and links. With this networked context, space evolves towards an understanding that expands the body and its senses. While this evolution changes the forms and perceptions of space through its virtual production, the change, and transformation of space also bring its own production (Deleuze, 2016). Thus, this new production offers a dynamic, interactive, adaptive, responsive, transforming, and "new" understanding of a living spatial experience (Figure 11). Space is the subject of experience between the environment and the body. It is related to its own self-production because it involves a network of connections in experience, becoming the dimension of an embodied space. Arıdağ (2021) also bases a new strategy's biology on the concepts of the organism's body, shell, symbiosis, and adaptation. It points to wind, solar, green connections, and system modulation models. In the context of this research, modulation is based on the search for a self-similar Voronoi structure. From the moment the movement of the human body begins to be considered in it, it continues its flow by becoming scaled with new parameters within the embodied space.

5. Conclusion and Suggestions

In general, the theory of evolution has taught us to recognize, measure, and simulate the complex order model that emerges from self-organization and evolutionary processes. According to Schumacher (2015), freedom was obtained by giving up order in the 20th century. But the parametric approach helps develop the idea of order, without giving up freedom in the 21st century. The balance between freedom and order is obtained with the operative matrix. This operative matrix works both by making the dynamic parameters in nature visible by simulation and by running this visibility as the codes of the design process. The operative matrix controls the movement in this dynamic system, allowing new design decisions. Therefore, the design process turns from an analytical and logical structure to an evolutionary and intuitive structure with layers. This enables flexible adaptive variability in the spatial design (Arıdağ 2021).

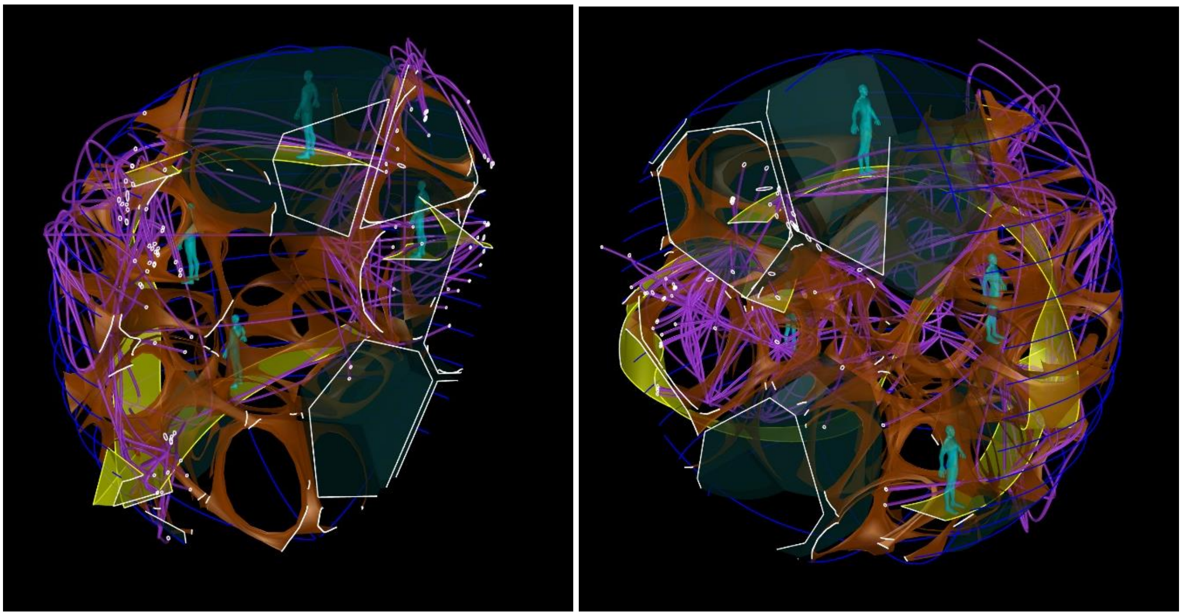

Figure 12. Artificial life in space

James George Frazer defined the concept of evolutionary design as "the acquisition of beneficial properties of an organism as a result of natural selection". According to this approach, certain characteristics of an organism are acquired through the process of natural selection and passed on to subsequent generations. Considering the existence of natural selection through evolutionary design theory, evolutionary design is a creative process in terms of form production, and architectural concepts can be determined as a set of generative rules encoded as codes participating in the evolution process (Frazer, 1995). By defining architecture as an artificial lifestyle, evolutionary architecture describes processes that can develop and evolve in response to the user and the environment. Evolutionary architecture aims to create common behavior and metabolic balance in the natural environment. It directly participates in the design process of nature and behaves similarly to an organism. According to Ho (2001), an organism creates its own space-time through its actions. Therefore, a space that controls its own space-time can evolutionarily produce the design process and itself. According to Ho (2001), the theory of evolution can be a source of inspiration for innovation in architectural design. It can be thought that natural selection and adaptation mechanisms of biological organisms in the evolution process can also be applied in architectural design. It conveys the evolutionary process of space, which creates its own information network in the age of networks and visibility in its own artificial life.

It conveys the evolutionary process of space, which creates its own information network in the age of networks, and its visibility in its own artificial life. In this situation, in the simulation where the formation of the artificial life of the space is observed, it is observed that the information that creates its own network structure creates its own spatiality. The interaction of the data obtained from the information parameters in the changing transforming fields in the network structure occurs in the context of evolutionary randomness. Space acquires new experiences with dynamic, lively, productive incarnation, produces new patterns, and arrives as an autopetic system. It changes the space in the parameters that enable it to act as an autopoietic system that creates the space and enables it to evolve (Figure 12). With the evolution of space, space rebuilds its own existence. Space offers different experiences to the body that acquires and produces experience. This experience changes and transforms every moment. It transforms in its own dynamism by transferring the transforming experience to the space. The productive, networked, and flowing space is adaptable to all conditions. In this way, it continues its evolution. With the data obtained, the perception of the concept of vitality through space and the experiences that will be gained in space has an important place in the explanation of cognitive coding systems. When the theory of space autopoiesis is considered, a dynamic, networked productive space understanding is formed. These concepts reveal that the codes of life, life, and evolution are whole;

- Otopoeisis makes its own dynamic production of space. Because space is a dynamic process that establishes, creates, transforms, and protects its own organization.
- Incarnation is the product of an embodied mind; the body's senses and experiences shape and transform space.
- Atmosphere, reveals the sense in the space. It provides the formation of sensory coding data with the experience gained in the spatial information network.
- Cybernetics, exists in the process that establishes the exchange of the information input of the artificial life of the space between the space itself and the people living in the space, within the framework of mutual observation, and enables the space to return from a chaotic state to a balance.
- Time, on the other hand, exists as a universe that enables the evolution of space to take place by creating meaning in its own organization. Time is the universe of space as cyclical time.

The discovery of the rules of life and reproduction, the space formed by coding information through digital experiments, and the idea that space has an organic structure, unlike the Cartesian dualism understanding, will enable the evolution of future space understanding. Within this information, Maturana's theory of autopoiesis, Ponty's theoretical approach to embodiment, and Deleuze's theory of singularities offer a perspective that contributes to the understanding of biodigital space formation from a neuroscientific perspective. In particular, he emphasizes that autopoietic embodiment actively interacts with all kinds of influences and that these interactions cause the spatial body to constantly reconstruct itself. According to this perspective, the formation of biodigital space is also based on the interaction of the body and embodiment (Figure 1). When we read this through the generative structure of space, communication between the environment and the embodied space is established. The differentiated experience is reconstructed by the embodied space. In other words, space and body cannot be considered separately from each other. Productive space is adaptable in all circumstances. In this way, it continues its evolution. The data obtained, as well as how the concept of vitalization is perceived in space and the experiences to be gained in space, play an important role in explaining cognitive coding systems. Readings on autopoiesis theory and neuroscience theorems, as well as the ability to control the dynamic and chaotic increase of knowledge, result in a networked productive, more responsive understanding of space.

The idea that space is not only a physical dimension but also a part of all systems related to vitality and life, will increase its sensitivity and contribute to the research of future space understandings such as metaphysical space, meta memory spaces, biodigital space, and generative space. If planning, designing, or understanding pluralistic and ecological environments in a societal context is truly desirable, the spatial design strategy put forward in this research could be a way out in an effort to establish a balance between humans and nature.

You can watch the formation video of the simulation from the link below.

https://youtu.be/YT6rySMsIBk

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Life Cycle Assessment of Internal Wall Panels: A Case Study of Sumerbank Kayseri Textile Factory Restoration Process

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Abstract

This study presents a case study that aims to select the ideal internal wall panel option causing less environmental impact for the Sumerbank Kayseri Textile Factory restoration process, which is now used as part of Abdullah Gul University's main campus. Since the university has an environmental agenda, examining the environmental impacts of the materials used for the ongoing restoration process has the potential to contribute to these goals. For this purpose, the three most used interior wall panels in the Turkish building material industry, gypsum, reinforced gypsum, and cement-based panels, were selected within the scope of the case study. The life cycle assessment (LCA) method was used to compare these options, and analyses were conducted using SimaPro software. The data required for life cycle impact assessment (LCIA) were obtained based on market analyses and also from the EcoInvent Life Cycle Inventory Database. At the end of the study, damage assessment, weighting, and midpoint and endpoint data of the characterization results provided by the ReCiPe method were compared and interpreted. According to the overall results obtained for the described case conditions, reinforced gypsum panel causes the most adverse environmental impacts, followed by cement and gypsum panels, respectively.

***Keywords:** Ecosystem quality, human health, internal wall panels, life cycle assessment, resource use.*

İç Duvar Panellerinin Yaşam Döngüsü Değerlendirmesi: Sümerbank Kayseri Tekstil Fabrikası Restorasyon Süreci Örneği

Öz

Bu çalışma, günümüzde Abdullah Gül Üniversitesi yerleşkesinin bir parçası olarak kullanılan Sümerbank Kayseri Tekstil Fabrikası restorasyon süreci için çevresel etkiye daha az neden olan ideal iç duvar paneli seçeneğini belirlemeyi amaçlayan bir vaka çalışması sunmaktadır. Üniversitenin tanımlı çevresel hedefleri olduğu için, devam eden restorasyon sürecinde kullanılan malzemelerin çevresel etkilerinin incelenmesi, bu hedeflere katkı sağlama potansiyeline sahiptir. Bu amaçla vaka çalışması kapsamında Türk yapı malzemeleri sektöründe en çok kullanılan üç iç duvar paneli olan alçı, güçlendirilmiş alçı ve çimento esaslı paneller seçilmiştir. Bu seçenekleri karşılaştırmak için yaşam döngüsü değerlendirmesi (YDD) yöntemi kullanılmış ve analizler SimaPro yazılımı kullanılarak yapılmıştır. Yaşam döngüsü etki değerlendirmesi için gereken veriler, piyasa araştırmasının yanı sıra EcoInvent Yaşam Döngüsü Envanter Veri Tabanından elde edilmiştir. Çalışma sonunda, ReCiPe yöntemi tarafından sağlanan hasar değerlendirmesi, ağırlıklandırma ve orta nokta ve bitiş noktası verilerini açıklayan karakterizasyon sonuçları karşılaştırılarak yorumlanmıştır. Örnek çalışma kapsamında elde edilen genel sonuçlara göre, güçlendirilmiş alçı panel en olumsuz çevresel etkilere sebep olurken, onu sırasıyla çimento paneller ve alçı paneller takip etmektedir.

***Anahtar kelimeler:** Ekosistem kalitesi, insan sağlığı, iç duvar panelleri, yaşam döngüsü değerlendirmesi, kaynak kullanımı.*

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1. Introduction

Materials used for building element construction have a significant effect on the overall environmental impacts of buildings. They may cause damage to human health, ecosystem quality, and resource use in each phase of the building life cycle that starts with the raw material acquisition and continues with production, construction, and operation phases and ends with defined end-of-life scenarios. Therefore, it is critical to understand the overall life cycle impacts of the building materials to make the ideal selection. Within this context, Life Cycle Assessment (LCA) method provides a comprehensive approach when analyzing and assessing the environmental impacts of building materials. The previous studies use the LCA method when evaluating the environmental impacts of different building materials focusing on various aspects, such as structural system selection, assessing thermal insulation, and waterproofing applications, window system renewal, and internal wall or ceiling assemblies.

Some studies focus on structural system selection in terms of their environmental impacts. For example, Balasbaneh, Bin Marsono & Gohari (2019) evaluated the repairs applied in a flood zone for the non-flood situation and when the flood occurs to identify the feasibility of repairs. For this purpose, they assessed typical brick, concrete block, steel wall panels, wood, and precast concrete framing using LCA and Life Cycle Cost (LCC) methods. On the other hand, Ben-Alon et al. (2019) developed a framework for a comparative LCA with embodied energy and air emission perspectives comparing cob earthen, concrete masonry, and wood frame wall assemblies.

Some studies examine the environmental impacts of thermal insulation materials and applications. As one of the examples, Llantoy, Chàfer & Cabeza (2020) focused on thermal insulation materials suitable for the Mediterranean continental climate by developing a comparative LCA. They aimed to provide a new perspective for selecting insulation materials in terms of their environmental performance when used to reduce energy consumption in buildings. Cetiner & Ceylan (2013) also proposed an approach for assessing environmental performance resulting from rehabilitating existing buildings. The study aimed to reveal the environmental performance of window system renewal and thermal insulation application to the existing buildings for reducing heating energy consumption using the LCA method. There are also a few studies that handle waterproofing applications. One example study is provided by Cetiner & Levent (2022), which examined the environmental impacts of waterproofing applications supplied by the Turkish materials industry to be used in flat roofs using the LCA method.

Internal finishes, such as internal wall and ceiling assemblies, are also studied in LCA studies. For example, Rodrigo Bravo et al. (2022) used LCA to compare two gypsum ceiling tiles: a traditional gypsum and a new eco ceiling tile within the cradle-to-grave system boundary. On the other hand, Cascione et al. (2022) used cradle-to-cradle LCA to compare a circular bio-based wall panel prototype with prefabricated wall panels produced using generic building materials and techniques. The study aimed to support the decision-making process for improving the circular bio-based panel's design during the early design stage. Moreover, Buyle et al. (2019) evaluated the environmental and economic benefits and drawbacks of internal wall assembly alternatives focusing on circular design for introducing them to the Belgian construction market.

This study also compares the environmental impacts of internal wall panels using the LCA method. The study's main aim is to select the ideal internal wall panel option having less effect on the environment to be used for the restoration process of the Sumerbank Kayseri Textile Factory building. The building is part of Sumer Bank Kayseri Textile Factory settlement, the first industrial site in Turkey, and a protected heritage site, which now serves as Abdullah Gul University (AGU) Sumer Campus. The factory settlement was opened in 1935 and used as a textile factory until the 2000s. Then it started to be used as AGU Sumer Campus by changing its function after the 2010s. The campus houses newly constructed and historically significant buildings, which have been restored to meet the functional changes. Within the campus design principles, AGU has developed policies to follow United Nation's Sustainability Goals, not just for constructing new facilities but also for restoring the buildings, which are a significant cultural heritage (AGU, n.d.). Therefore, examining the materials used for the ongoing restoration process of the factory building can contribute to the campus's existing and future construction practices in compilation with the university's environmental agenda.

The restoration of the factory building, which is the case of this study, began with strengthening works due to the static test results that showed the vaults did not have sufficient structural strength and stability. During the restoration process, first, shear walls were built between the vaults to strengthen the structure. Then, internal wall panels were used to cover these shear walls to get smooth surfaces. Since the total surface area is so large, the environmental impact of the panels for this application was of great importance when the sustainability concerns of the university and construction practices were considered. Therefore, within the context of this study, LCA analyses of three different internal wall panel options were performed as a case study to select the ideal one regarding overall life cycle impacts. The SimaPro software was used for the LCA analyses, focusing on cradle-to-grave system boundary and using the ReCiPe method with EcoInvent Database. First, the required data for the life cycle impact assessment (LCIA) were collected from internal wall panel producers and sellers based on a detailed market analysis. Then, gathered data were used for the LCIA analyses conducted with the SimaPro software to get the environmental results for internal wall panel options. Finally, results were compared and interpreted according to the damage assessment, weighting, and midpoint and endpoint data of the characterization results provided by the ReCiPe method.

2. Material and Method

2.1. Life Cycle Assessment Method

The LCA is a scientific method used worldwide, defined, and standardized in the International Organization for Standardization (ISO) 14040 series. The term "life cycle assessment" (LCA) refers to a methodology used to calculate and evaluate the environmental impacts associated with a product's life cycle (Rebitzer et al., 2004). It provides compiling and analyzing the inputs, outputs, and potential environmental impacts of a product system throughout its life (British Standards Institution, 2006). It ensures calculating the environmental impacts of any goods or services during the life cycle phases of raw material acquisition, manufacturing, transportation, production, use, maintenance, disposal, and recovery to find the source of the environmental consequences (British Standards Institution, 2006). In addition, the LCA method can guide the designing of a new product, help choose between similar products, services, and processes, and support determining parameters related to product development (Cooper & Fava, 2006). It is also used as a decision support tool due to being an analytical approach for optimizing the environmental sustainability of a product, service, or system (Grant & Macdonald 2009). When it is conducted during the early design process, it provides improvement of goods and services, which is one of the significant goals of LCA applications (Khasreen, Banfill, & Menzies, 2009; Marsh, 2016; Rebitzer et al., 2004).

Four primary stages of the LCA method are "goal and scope definition," "inventory analysis," "impact assessment," and "interpretation" (British Standards Institution, 2006). At the beginning of an LCA study, first, the goal and scope of the study should be defined. The goal of an LCA study identifies the intended use, the justifications for conducting the study, the target audience, and other details like whether it is used for comparative studies. On the other hand, the scope of an LCA study covers the product system(s), functions of the product system(s), the system boundary, functional unit, allocation procedures, impact categories, required data, assumptions, limitations, and type of critical review. Later, inventory analysis is conducted, which covers data collection and data calculation processes for quantifying related inputs and outputs. Then, the life cycle impact assessment (LCIA) phase is performed to evaluate the significance of potential environmental impacts. In this process, environmental impact categories and category indicators are used for the assessment. Finally, the gathered results are interpreted. This interpretation phase combines the inventory analysis and impact assessment results. The results of the interpretation phase should reach conclusions, explain constraints, and offer recommendations while also being consistent with the goal and scope that have been established (British Standards Institution, 2006; Horne, 2009; Khasreen, Banfill, & Menzies, 2009; Rebitzer et al., 2004).

2.2. Life Cycle Assessment Software: SimaPro

In order to conduct an LCA study, many software has been developed (Ozdemir, 2019). LCA software gives different outputs using different methods and databases. Many environmental results can be obtained using LCA software to assess and manage environmental consequences. The SimaPro is one of the most commonly used LCA tools developed by PRé. It collects and analyses data in the scope of environmental impacts to reveal the performance of a product or company. It is used by many companies and organizations worldwide for various applications such as sustainability reporting, carbon and water footprint, product design, and environmental product statements. The SimaPro has a variety of databases that are constantly updated. As a result, it has an extensive and comprehensive database on various subjects such as agriculture, food, energy, materials, and transportation (PRé Sustainability, 2021, 2022).

The SimaPro software has thirteen methods that can be used for LCA analyses, and these methods have been developed according to different characteristics at global and regional levels. The ReCiPe is one of these methods, which provides characterization factors that represent a global rather than European scale while retaining the possibility of applying characterization factors for several impact categories at a country and continental scale developed for life cycle impact analysis (Huijbregts et al., 2016). The primary property of the ReCiPe method is to convert long-life cycle inventory results into a limited number of indicator scores. ReCiPe indicators are determined in two levels, with eighteen midpoint indicators defined as problem-oriented and three endpoint indicators defined as damage-oriented. Consistency in developing midpoint and endpoint models is increased by working across the various impact categories with the same time horizon per cultural perspective (Acero et al., 2016). The midpoint and endpoint indicators are described as characterization, normalization, damage assessment, and weighting. In the characterization results, many effects, such as global warming, water use, land use, and climate change, can be evaluated. Within the scope of the damage assessment, human health is expressed as the number of years of life lost and the number of years lived disabled. At the same time, ecosystems represent the loss of species over a specific area during a particular time. In addition, the resource is expressed as the surplus costs of future resource production over an infinitive time frame. The normalization impact category compares indicator results with a reference or normal value. Weighting allows weighting between impact categories by multiplying the impact or damage category indicator results with weighting factors and adding them to obtain a total or single score (Huijbregts et al., 2016).

3. Life Cycle Assessment of Internal Wall Panels

Different wall panel types with various features are used for architectural details in the building materials industry. Furthermore, depending on the raw materials and additives used in the production process of wall panels, they are developed for different conditions, such as interior and exterior use. Therefore, the most used internal wall panels were first selected from the Turkish building material industry for the Sumerbank Textile Factory restoration process case. Then the LCA framework was designed to conduct targeted LCA analyses.

3.1. Internal Wall Panel Alternatives

The wall panels used to cover an area may have gypsum and cement content of various types. Therefore, different gypsum and cement-based panels are developed to meet different needs. Furthermore, additives enhance basic cement-based and gypsum panels to obtain reinforced panels. Thus, within the scope of this study, LCA analyses of gypsum, reinforced gypsum, and cement-based panels were performed using their characteristics and properties of raw materials, weightings, and sizes. These properties are defined as follows (Table 1):

- The gypsum panels contain hemihydrate, water, paper liner, and additives as raw materials. The raw materials include 50% and 60% of calcium sulfate, 35% and 45% of water, and paper in up to 5% ratios. It is produced in 12.5 mm thickness and 120 cm x 240 cm width and length, with a unit weight of 8 kilograms.
- The reinforced gypsum panels include gypsum, fiberglass, and binder silicone as the raw materials. One panel's average raw material ratios are 60% calcium sulfate, 30% perlite, 10% calcium carbonate, and 0.1% silicone. It has a 12.5 mm thickness with 120 cm x 240 cm panel dimensions and a unit weight of 11 kg.
- The cement-based panels involve raw materials such as cement, fillers, cellulose, and mica. A reinforced gypsum panel contains 40% and 60% cement, 20% and 30% fillers, 10-15% mica, and 8% and 10% cellulose. It is 1 mm thick and 125 cm x 250 cm panel dimensions with having 13 kg unit weight.

Table 1. Properties of selected internal wall panel options

Panel Options / **Properties**	Gypsum Panel	Reinforced Gypsum Panel	Cement-Based Panel
Raw materials	hemihydrate, water, paper liner, additives	gypsum, fiberglass, and binder silicone	cement, fillers, cellulose, mica
Thickness (mm)	12.5	12.5	12
Width x Length (cm)	120 x 240	120 x 240	125 x 250
Weight (kg)	8	11	13

3.2. Life Cycle Assessment Framework

The goal of the LCA study is to select the ideal internal wall panel option for the Sumerbank Kayseri Textile Factory building restoration process through a comparative analysis for meeting the environmental targets of the university in which the building is part of its main campus. Within the scope of the case study, the cradle-to-the-grave system boundary was selected for the LCA, which provides estimating environmental impacts from product source to disposal (McAlister & Horne, 2009). Since the ReCiPe method is chosen for the LCIA, damage assessment, weighting, and midpoint and endpoint data of the characterization results provided by the ReCiPe method were compared and interpreted, focusing on human health, ecosystems, and resources impact categories. The data for the selected internal wall panels were first gathered from internal wall panel producers and sellers for inventory analysis. Then, the obtained data was arranged according to the requirements of the SimaPro software by making the required calculations. For this purpose, it was decided to perform an analysis on a standard measurement reference to make a precise assessment, and the size of 1 m^2 was taken as the reference to convert the data for each panel, as shown in Table 2 and explained below:

- The weight of a 1 m^2 gypsum panel is calculated as 2.77 kg, while a reinforced gypsum panel is 3.1 kg, and a cement-based panel is 4.16 kg.
- The produced waste due to the application of a 1m^2 panel was calculated as 5.23 kg for the gypsum panel, 7.19 kg for the reinforced gypsum panel, and 8,84 kg for the cement-based panel.
- The market analysis assumed that the gypsum panel is transported from 317 km, the reinforced gypsum panel from 700 km, and the cement-based panel from 500 km from the factory to the construction site.
- It is assumed that the storage area is 1 km away from the construction site.
- The distance between the construction site and the landfill area, directed by the municipality, is 35.1 km.

Then, for the LCIA, calculated and arranged data were entered into SimaPro software, and also some data were taken from the EcoInvent Life Cycle Inventory (LCI) Database's library. After the data input, the LCIA analyses of selected internal wall panels were performed using the ReCiPe method. Finally, the gathered results were compared and interpreted to define the ideal internal wall panel option within the scope of the case study.

Table 2. Data used for LCA of selected internal wall panel options

Properties \ Panel Options	Gypsum Panel	Reinforced Gypsum Panel	Cement-Based Panel
Width x Length (cm)	100 x 100	100 x 100	100 x 100
Weight (kg)	2.77	3.1	4.16
Waste (kg)	5.23	7.19	8.84
Transportation from the factory to the storage area (km)	317	700	500
Transportation from the storage area to the site (km)	1	1	1
Transportation from the site to the landfill area (km)	35.1	35.1	35.1

3. Findings and Discussion

LCIA analyses of the selected internal wall panels provided various results for the damage assessment, weighting, normalization, and midpoint and endpoint data of the characterization results defined by the ReCiPe method. Therefore, damage, weighting, and characterization results were used for the interpretations since normalization results provided similar results to the weighting scores.

When the damage assessment results are compared and interpreted, it is seen that the differences between the selected internal wall panels are very low (Figure 1). However;

- For the human health endpoint impact category, the reinforced gypsum panel has the highest impact, followed by the gypsum panel. Finally, the cement-based panel has the lowest result.
- For the ecosystems endpoint impact category, the reinforced gypsum panel has the highest impact, followed by the cement-based panel, and the gypsum panel ranks third.
- For the resources endpoint impact category, reinforced gypsum and cement-based panels have identical results, and the gypsum panel follows them.
- According to endpoint impact assessment results, it can be said that the reinforced gypsum panel has the highest impact for all categories. This is because many additives are used to produce the reinforced gypsum panel to increase its performance against water and humidity. Moreover, the distance required for transporting the reinforced gypsum panels from the factory to the storage area in the construction site is the highest. Therefore, it can be inferred that as the additives used and their usage ratios increase, and the distance for transportation increases, they may cause an increase in the direct harmful effects on the environment.
- According to these results, it can also be said that the ideal panel selection regarding human health is the cement-based panel due to having the lowest results for all categories. This result may be because the number of raw materials and the additive ratios of the cement-based panel have been less than the other panels.

The weighting results clearly distinguish between the damage categories, as seen in Figure 2. According to these results;

- All of the endpoint impact categories show very close results in themselves. However, all panels have higher results than others for the human health category. While the resources category takes second place, the ecosystems category follows it by a very small difference.
- The human health endpoint impact category is related to the midpoint impact categories of fine particulate matter formation, ozone formation, ionizing radiation, stratospheric ozone depletion, carcinogenic and non-carcinogenic human toxicity, global warming, and water use (Huijbregts et

al., 2016; PRé Sustainability, 2022). Therefore, as it is seen in the damage assessment results, the dust-formed raw materials and water consumption required for the production of panels, the particulates produced during raw material acquisition and production stages, and the emissions created during raw material acquisition, production, and transportation phases may cause this result.

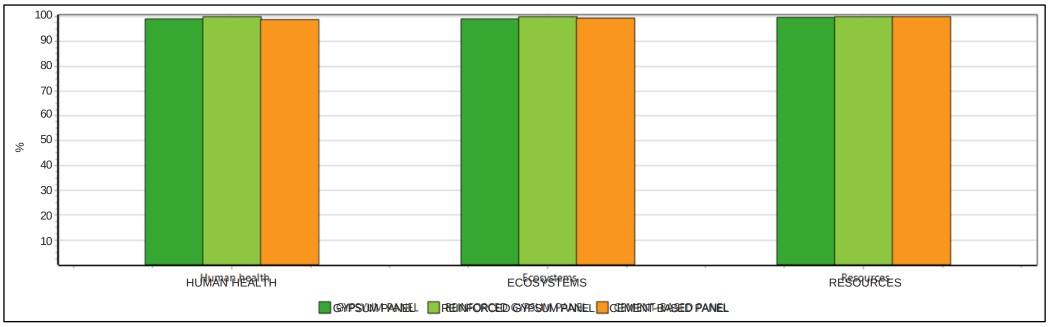


Figure 1. Damage assessment results for the selected internal wall panels

- The resources endpoint impact category is related to the midpoint impact categories of global warming, water use, freshwater ecotoxicity, freshwater eutrophication, ozone formation, terrestrial ecotoxicity, terrestrial acidification, land use, marine ecotoxicity, and marine eutrophication (Huijbregts et al., 2016; PRé Sustainability, 2022). When all of these midpoint impact categories are considered, it can be interpreted that due to the similarities in raw material acquisition, production, and construction stages, as also the transportation requirements, all panels can have the same results for the resources category.
- The ecosystem's endpoint impact category is related to the midpoint impact categories of mineral and fossil resource scarcity (Huijbregts et al., 2016; PRé Sustainability, 2022). Resembling the resources category, having similar properties for the life cycle phases, may cause this result.

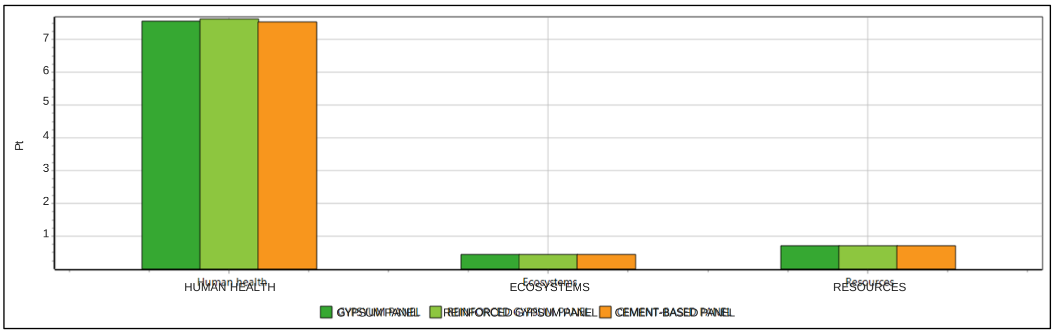
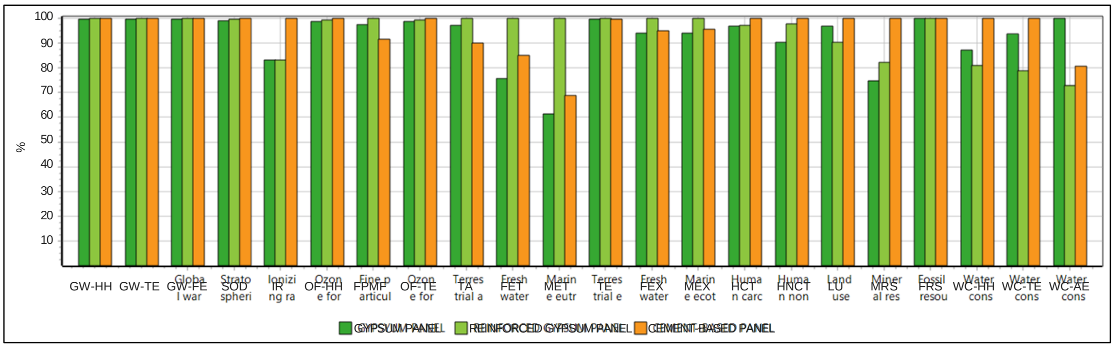


Figure 2. Weighting results for the selected internal wall panels

The characterization results show the role of various midpoint impact categories in detail, as seen in Figure 3. While most midpoint impact category results are the same or almost identical for all panels, some show differences. According to these results;

- The human health midpoint impact categories of ionizing radiation, fine particulate matter formation, carcinogenic and non-carcinogenic human toxicity, and water consumption; resources midpoint impact categories of terrestrial acidification, freshwater eutrophication, marine eutrophication, freshwater ecotoxicity, marine ecotoxicity, land use, and water consumption related to terrestrial ecotoxicity and aquatic ecosystem; and ecosystems midpoint impact category of mineral resource scarcity results have differences for all panels.
- Ionizing radiation and fine particulate matter formation occur due to the emissions and air pollution created. On the other hand, terrestrial acidification, freshwater eutrophication, and marine eutrophication impacts are the results of emissions to water or soil. Moreover, carcinogenic and non-carcinogenic human toxicity, freshwater, and marine ecotoxicity are related

to the emission of a chemical (Huijbregts et al., 2016). The results of these midpoint impact categories are strongly connected with the number and amount of raw materials in the dust form and the amount of chemicals they include. Also, the emissions occur during the transportation, production, and construction phases and while applying end-of-life scenarios.



GW-HH: Global warming-human health; GW-TE: Global warming-terrestrial ecosystem; GW-FE: Global warming- freshwater ecosystem; SOD: Stratospheric ozone depletion; IR: Ionizing radiation; OF-HH: Ozone formation-human health; FPMF: Fine particulate matter formation; OF-TE: Ozone formation-terrestrial ecosystem; TA: Terrestrial acidification; FET: Freshwater eutrophication; MET: Marine eutrophication; TE: Terrestrial ecotoxicity; FEX: Freshwater ecotoxicity; MEX: Marine ecotoxicity; HCT: Human carcinogenic toxicity; HNCT: Human non-carcinogenic toxicity; LU: Land use; MRS: Mineral resource scarcity; FRS: Fossil resource scarcity; WC-HH: Water consumption- human health; WC-TE: Water consumption-terrestrial ecotoxicity; WC-AE: Water consumption-aquatic ecosystem

Figure 3. Characterization results for the selected internal wall panels

- Water consumption impacts human health, terrestrial ecotoxicity, and aquatic ecosystem occurs due to a reduction in freshwater availability which can result in the loss of species and diversity. Besides, land use can cause loss of habitat and soil disturbance (Huijbregts et al., 2016). Furthermore, water is one of the primary raw materials required to produce the selected internal wall panels. Therefore, these midpoint impact categories are also directly related to the number and number of raw materials needed to produce a 1 m^2 panel, which varies for all panels.
- Mineral resource scarcity is directly related to the mineral resource consumption that causes natural resource scarcity (Huijbregts et al., 2016). According to the mineral resource scarcity midpoint impact results, the cement-based panel has the highest score, followed by the reinforced gypsum panel, and the gypsum panel ranks last. These results are explicitly gathered due to the mineral-based raw materials cement-based panel has and mineral-based additives required for reinforced gypsum panel.

4. Conclusion and Suggestions

Within the scope of the study, the selection process of an ideal internal wall panel option having less effect on the environment was performed using the LCA method as a case study considering the restoration process of the Sumerbank Kayseri Textile Factory building. LCA analyses were conducted using the SimaPro software and focusing on cradle-to-the-grave system boundary, and the ReCiPe method with the EcoInvent Database was chosen for the LCIA. A significant number of data was collected from raw material usage rates to waste production amount and transportation distances for a comparative LCA analysis. The LCIA results were gathered based on the damage assessment, weighting, and midpoint and endpoint data of the characterization results provided by the ReCiPe method.

According to the overall results, even though they have different results for the various impact categories, the reinforced gypsum panel is the most harmful to human health, ecosystems, and resources. Cement panels and gypsum panels, respectively, follow it. Based on the defined conditions of the case study, the type of raw materials and additives reinforced gypsum panel requires for the production, and specifically, the total transportation distance of this panel, may affect the results. The cement-based panel also has a similar characteristic but less transportation distance, making it the second. On the other hand, the gypsum panel requires less raw material as the amount, and its transportation distance is also less than the others; therefore, it ranked as the less harmful internal wall panel to the environment within the study's context.

As a consequence, the conducted LCA analyses have enabled making interpretations using environmental impact categories that focus on the life cycle stages of interior wall panel options. In this context, the obtained results supported selecting the ideal interior wall panel to meet the environmental performance target of the Sumerbank Kayseri Textile Factory building restoration process. Furthermore, as the case building is now part of a university campus with environmental targets, it is seen that the LCA method, one of the tools used in environmental management, can potentially lead to new studies. Finally, it can be stated that LCA analysis should be part of the material selection process in order to consider the environmental outcomes of buildings for making optimal decisions related to environmental performance.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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Analysis of Stone Deterioration on the Facades of Hatuniye Madrasah

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Abstract

The durability of natural stone in traditional buildings is important for the structures to survive today. External environmental factors have negative effects on natural stone materials. When the material is exposed to negative factors, deterioration occurs in the stone. It is important to determine this deterioration and its causes correctly and to offer solutions for the transfer of buildings to future generations. Failure to identify the factors that cause deterioration leads to the growth of damages and the formation of new damages. Determining the deterioration on the surfaces of Hatuniye Madrasah and its causes will be useful in terms of preventing problems and making the right interventions. As a result of the analyses, the types of deterioration that occurred on the facades of the building and the changes in the chemical properties of the stone according to the results of the XRF chemical analysis were determined.

Keywords: *Hatuniye Madrasah, stone decomposition, XRF analysis method.*

Hatuniye Medresesi Cephelerinde Meydana Gelen Taş Bozunmalarının Analizleri

Öz

Geleneksel yapılarda doğal taşın dayanıklılığı, yapıların günümüze kadar ayakta kalabilmesi için önemlidir. Dış çevre faktörlerinin doğal taş malzemeler üzerinde olumsuz etkileri vardır. Malzeme olumsuz etkenlere maruz kaldığında taşta bozulmalar meydana gelmektedir. Bu bozulmaların ve nedenlerinin doğru tespit edilmesi ve çözüm önerilerinin sunulması yapıların gelecek nesillere aktarılması için önemlidir. Bozulmaya neden olan etkenlerin tespit edilememesi hasarların büyümesine ve yeni hasar oluşumlarına yol açmaktadır. Çalışmada Hatuniye Medresesi'nin yüzeylerindeki bozulmaların ve nedenlerinin tespit edilmesi, sorunların önlenmesi ve doğru müdahalelerin yapılması açısından faydalı olacaktır. Yapılan analizler sonucunda yapının cephelerinde meydana gelen bozulma türleri ve XRF kimyasal analiz sonuçlarına göre taşın kimyasal özelliklerindeki değişimler tespit edilmiştir.

Anahtar kelimeler: *Hatuniye Medresesi, taş bozunmaları, XRF analiz yöntemi.*

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1. Introduction

Mardin has historically been home to many civilizations due to its location on important trade routes and its geography. The existence of the city is associated with Persian and Roman legends (Çağlayan, 2018). Throughout history, people from different cultures, civilizations, nations, languages, and religions have lived together in peace (Alioğlu, 1989). Islamic rule in Mardin began in the 7th century. In the 12th century, the Artuqids dominated the region and Mardin was the capital of the Artuqids for about 300 years.

The civilizations that lived in Mardin built structures such as mosques, madrasahs, pavilions, churches, monasteries, and tombs in the city. Some of these buildings have survived to the present day. Some of these buildings were used for two or three different functions and are still in use today (Uyar, 2019). Madrasahs have an important place among these works that have survived to the present day in Mardin. Madrasahs, which are among the historical buildings that have survived to the present day, have historically served as educational and cultural institutions (Yardımlı, 2018). Like other historical buildings, madrasahs have survived to the present day by changing in form and function.

Limestone was used in the traditional buildings of Mardin. Limestone deteriorates over time due to internal or external factors (Semerci, 2017). Deterioration can occur due to factors such as adverse climatic conditions, traffic density, and user error (Öcal, 2010; Dal & Öcal, 2013a; Dal & Öcal, 2013b). Each type of deterioration that occurs in a building prepares the environment for another type of deterioration. For example, capillary cracks from heat shock, and seeds carried by birds or insects combine with rainwater to form plants. Dust particles carried by the wind also cause the outer surfaces to erode over time. Degradation is caused by adverse environmental conditions and the rock structure to which the structure is exposed (Price, 1995; Ergin, Gökdemir, Yardımlı & Dal, 2022). Taking steps to prevent these degradations from occurring is effective in reducing damage. If adequate precautions are not taken to prevent damage to the artefact, it leads to serious destruction of the structure over time. It is important to identify the deterioration of cultural heritage buildings, understand their causes, and take appropriate measures to pass them on to future generations (Douglas, Hughes, Jones & Yarrow, 2016). The causes of each degradation and the preventive measures against the factor causing this degradation are different. For this reason, it is important to determine the deterioration with an accurate examination (Dal & Öcal, 2017). As a result of visual analysis, it is necessary to identify and classify the abrasions that occur on the structure. For example, air pollution causes chemical decay in rocks and algae forms in structures that interact with water. This deterioration can be remedied over some time and damage can be prevented. Appropriate solutions should be considered for the conservation design applied to the building. Regularly inspecting the building, choosing the stone materials used correctly, paying attention to the cleanliness of the building, and increasing the robustness of the building help to transfer the building to future generations (Doehne & Price, 2010; Dal & Yardımlı, 2021). The study examines the types and causes of deterioration on the facade surfaces of Hatuniye Madrasah. Changes in the chemical properties of the stones on the facade surfaces were analyzed by measuring them with X-Ray Fluorescence Spectroscopy (XRF chemical analysis method). The study is intended to provide an important basis for the identification of existing problems and their causes in terms of repair interventions.

2. Material and Method

In this study, the deterioration of the facade surfaces of the Hatuniye Madrasah in Mardin is discussed. The deterioration of the stone surfaces was analyzed and the types and rates of deterioration, their diversity, and causes were determined. This study covers the analysis of the courtyard facade and exterior facade surfaces of the building exposed to external environmental conditions. Hatuniye Madrasah has survived to the present day with functional changes by preserving and preserving a large part of its structural integrity.

The study was conducted using the internationally recognized mapping method. In the mapping method, deterioration was identified and classified (Fitzner, Heinriches & Kownatzki, 1997). For the mapping method used on the facades, the deteriorations occurring in the structure were identified and the deteriorations were processed on the facades with AutoCAD 2018 and Adobe Photoshop CS6 programs. The deterioration was analyzed as physical, chemical, biological, and anthropogenic deterioration (Tokmak & Dal, 2020). As a result of observational analysis, the degradation of the chemical structures of the stones that were degraded was analyzed and examined by X-Ray Fluorescence Spectroscopy (XRF chemical analysis method). The degradations occurring in the structure selected in the study indicate the proportions of different elements in the stone by using the XRF chemical analysis method after the visual analysis method. These elements are Mg, Zn, Ca, S, V, V, Mn, Co, Ni, Al, Cu, Fe, Si, P, Cr, Cl, P K, and Ti. Along with these elements, the ratios of MgO, Al_2O_3, ZnO, SO_3, P_2O_5, MnO, CuO, SiO_2, Fe_2O_3, NiO, CaO, CoO, K_2O, V_2O_5, Cr_2O_3 and TiO_2 compounds in the stone were determined, evaluated and analyzed with tables and graphs.

2.1. Study Area Features

2.1.1. History of Mardin Province

The name Mardin was first used as "Maride" by the historian Ammianus Marcellinus in the IVth century (Gabriel, 1940). The name Mardin is known as Mâridin among Arabs and Mârdê among Assyrians (Noyan, 2008; Yousif, 2011). In addition, the province of Mardin is geographically located in the north of the Mesopotamia region, which is characterized as the 'Fertile Crescent' and has fertile soils. It has been home to different cultures and ethnic origins throughout history due to its location on an important transit route and its geography and topography suitable for defence (Alioğlu, 2000).

When the first settlements of Mardin city are examined, artefacts are found until 3000 BC (Aydın, Emiroğlu, Özel, & Ünsal, 2000). In the following years, it was subjected to civilisations such as Huris, Mitanni, Assyria, Medes and Babylonians (Yıldız, 2007); after the Islamic domination, it was under the rule of Umayyads, Abbasids, Hamdanids and Marwanids (Aliveya, 2007) and Artukoğlu under the Great Seljuk Empire (Biçen Çelik, 2021). It can be said that the architectural identity of Mardin was determined during the Artuqid rule in the XIIth century (Dal & Öcal, 2017). After the Artuqids, the city came under the rule of Karakoyunlular, Akkoyunlular, Safavids and finally, the Ottomans (Çağlayan, 2018) and all civilisations left traces (Dolapönü, 1972). While some of these works have survived to the present day, some of them have not survived to the present day due to various reasons. Hatuniye Madrasah was built in the XIIth century and is among the religious buildings that have survived to the present day (Alioğlu, 2000).

2.1.2. Geographical characteristics of Mardin Province

Mardin is located in the Southeastern Anatolia Region of Turkey, on 36^o 54' and 37^o 47' north latitudes and 39^o 55' and 42^o 41' east longitudes. The city neighbouring Syria together with the provinces of Şanlıurfa, Diyarbakır, Batman, Şırnak, and Siirt. Mardin Castle is located in the highest region of the city. It is observed that the first settlements of the city were around the castle (Karataş, 2018). With the increase in the population, settlements started to move out of the castle. There were settlements towards the lower parts of the castle and east-west direction. Since the northern part of the mountain was not suitable for settlement and the south was more suitable for settlement, the city was settled on a high plateau overlooking the Mesopotamian plain (Figure 1). This area where the settlement is located has a sloping terrain. The streets here consist of stairs and steep ramps (Bekleyen, Dalkılıç & Özen 2014).

When we look at the climate of Mardin province, we see a continental climate in the centre and a Mediterranean climate in the districts. Winter months are cold. In the summer season, it is dry and hot due to the effect of the pressure and wind coming from the desert. Looking at the annual average temperature values of the province, it is seen that the highest temperature value is 29.8 ^oC in July and the lowest temperature value is 3.0 ^oC in January (Table 1). When the climatic data of Mardin province between 1941 and 2022 are analysed, it is seen that the maximum average sunshine duration is 12.4 hours in July and the minimum sunshine duration is 4.5 hours in December. Due to the climatic characteristics of Mardin province, degradation of stone material will show its effect more (Karataş, 2018).

Figure 1. Mardin's location in Turkey and Mardin view (Biçen Çelik, 2019)

Table 1. Mardin Province meteorological data evaluation (Measurement Period 1941-2022) (General Directorate of Meteorology, 2023)

MARDİN	Ocak	Şubat	Mart	Nisan	Mayıs	Haziran	Temmuz	Ağustos	Eylül	Ekim	Kasım	Aralık	Yıllık
Ortalama Sıcaklık (°C)	3,0	4,2	7,9	13,5	19,5	25,6	29,8	29,6	25,3	18,6	11,1	5,4	16,1
Ortalama En Yüksek Sıcaklık (°C)	5,8	7,4	11,6	17,4	24,0	30,6	35,0	34,7	30,1	22,9	14,5	8,2	20,2
Ortalama En Düşük Sıcaklık (°C)	0,6	1,4	4,6	9,8	15,1	20,3	24,6	24,7	20,8	14,7	8,1	2,9	12,3
Ortalama Güneşlenme Süresi (saat)	4,5	5,1	5,9	7,3	9,7	12,1	12,4	11,4	10,3	7,7	5,9	4,4	8,1
Ortalama Yağışlı Gün Sayısı	12,11	10,61	11,70	10,28	7,35	1,54	0,48	0,24	0,70	5,12	7,66	10,80	78,60
Aylık Toplam Yağış Miktarı Ortalaması (mm)	115,9	103,2	97,7	81,1	47,3	6,5	3,2	2,3	4,0	33,8	71,9	108,7	675,6

2.1.3. Architectural characteristics of Hatuniye Madrasa

Hatuniye Madrasah is located in Gül Neighbourhood. The madrasah was built during the reign of Kudbettin İl Gazi, the 2nd Artuqid sultan. There are the graves of Kudbettin Il Gazi and his mother Sıtti Raddviye in the madrasah. The building has not survived to the present day with its originality and has been intervened in different years. The entrance of the building has been changed. According to the existing remains, the building belongs to the group of madrasahs with two iwan courtyards extending in the north-south direction. It is understood that it has two storeys according to the remains. The building consists of a tomb, harim, and rooms. There are four rooms in the west and one room in the east; a tomb in the southeast and a harim in the south. The rooms on the west side of the building do not have windows facing the outside and the lighting is provided by the door in the portico. There is a 90x110 cm window in the room in the east direction. Two windows are measuring 100x140 cm in the place used as a tomb. The entrance to the tomb is through the door located in the northeast part of the iwan used as a masjid. The tomb section consists of a tromped dome. The interior of the building is illuminated by two windows, one on the east of the south wall and the other on the south of the east wall. There is an inner courtyard in the north of the building. The second courtyard is located in the south of the building and entrances are provided from here. The inner courtyard of the building was used as a courtyard with porticoes in the past, but in later restorations, the porticoes were covered with walls and the harim, tomb, and mosque sections were added (Figure 2). Although the building was originally two-storeyed, there is no information about how the upper floor was reached as a result of the changes (Altun, 1971; Erdal, 2020).

Limestone was used as the main material of the building. The building has a total of six facades, one on the south facade, one on the east facade, and four facades facing the inner courtyard. Cut stone and cabochon stone were used together on the facades of the madrasah (Figure 3).

3. Findings and Discussion

For cultural heritage, the factors that cause the degradation of stone material are important (Karataş & Perker, 2023). Stone has always maintained its place by changing its shape and function from the past to the present (Tintin, 2012). The first people used the stone for defence purposes, and in later periods, it was used in areas such as future messages and graves. It was also used as housing, decorative products, and symbols. The number of buildings in which stone was used and which have survived to the present day is very few (Sabbioni & Cassar, 2012).

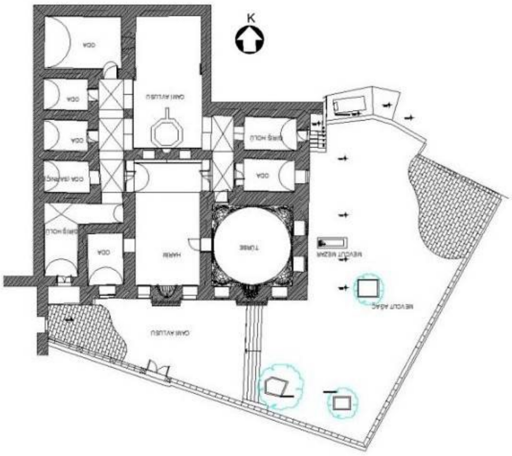


Figure 2. Hatuniye Madrasah plan (Promim Architecture Archive)

Figure 3. Hatuniye Madrasah facades (Biçen Çelik, 2019)

Limestone is one of the building materials that have been used continuously from past to present (Semerci, 2008). Limestone has different chemical and physical properties depending on the region where it is quarried. In Mardin, which is the study area, there are quarries in Ömerli, Kabala, Kızıltepe, and Midyat districts and the properties of the stones in these quarries vary (Semerci, 2008; Küçükkaya, Dal & Umaroğulları, 2006; Ergin, Çelik & Dal, 2020a). It is important to know the physical and chemical properties of limestone to select it in line with the needs of the place where it will be used (Biçen Çelik, 2021).

The stone used as a building material undergoes degradation due to climatic factors such as pressure, temperature, and wind, natural factors and external factors such as human effects (Dal, 2016). As a result of these degradations, the strength of the stone decreases considerably compared to its initial strength. To prevent the degradation of stones and to transfer them to future generations correctly, it is necessary to identify the degradation of the stone and take measures accordingly (Hasbay & Hattap, 2017; Tabasso Laurenzi, 1993). In addition, these degradations cause the formation of another degradation and in some cases accelerate the degradation process (Ergin, Çelik, & Dal, 2020b). In case the necessary precautions are not taken or incorrect applications are made, serious damages and severe destruction occur in buildings (Doehne & Price, 2010; Torraca, 1976; Yardımlı, Hattap, Khooshroo, & Javadi, 2017).

The degradation of structures can be handled in four groups as physical, chemical, biological, and anthropogenic degradation. Physical deterioration is the deterioration that occurs on the surface of the stone as a result of mechanical effects. These can be exemplified as fracture, crack, piece breakage, deformation, abrasion, cut, and honeycombing (Tokmak & Dal, 2020; Dal, 2021).

Chemical degradation is the type of degradation that occurs on the surface of the stone as a result of atmospheric events. Examples such as colour change, salting, crystallisation (blooming), crusting, blistering, sugaring and foliation are examples of chemical degradation (Öcal & Dal, 2012; Ergin, Karahan & Dal, 2020).

Biodegradation is the type of degradation caused by organic substances on the surface of the stone. Moss formation, plant formation, and bioaccumulation are among the types of biodegradation (Rivera, Ramos, Sánchez & Serrano, 2018; Dal, Zülfikar & Dolar, 2020; Dolar & Yardımlı, 2017).

Anthropogenic degradation is the degradation caused by human destruction. Improper application, misuse and periodic wear can be given as examples of anthropogenic degradation (Hattap, 2002).

In this research, the deterioration of Hatuniye Madrasah was examined under three different headings: visual examination, examination using the mapping method and examination using the XRF chemical analysis method.

3.1. Visual Investigation of the Deterioration Occurring in Hatuniye Madrasah

The deterioration of the Hatuniye Madrasah consists of physical, chemical, biological and anthropogenic deterioration. Due to the environmental and internal conditions of the limestone used as the main material of the building, the structure suffered from fragmentation, joint discharges (Figure 4a), capillary cracks (Figure 4b) and abrasions due to the effect of dust carried by the wind (Figure 4c, 4d).

Chemical deterioration types such as salination, discolouration and bacterial growth were observed in Hatuniye Madrasah. The discolouration was observed on the inner courtyard façade (Figure 5a) and the main façade (Figure 5b). Salting (Figure 5c) and bacterial growth (Figure 5d) were also observed.

Plant formation is encountered as biological degradation in Hatuniye Madrasah. The plant formations on the south and east facades of the building are shown in Figure 6.

As a result of anthropogenic effects, degradation due to the use of sharp tools was observed in Hatuniye Madrasah (Figure 7).

Figure 4. Physical deterioration of Hatuniye Madrasah (Biçen Çelik, 2019)

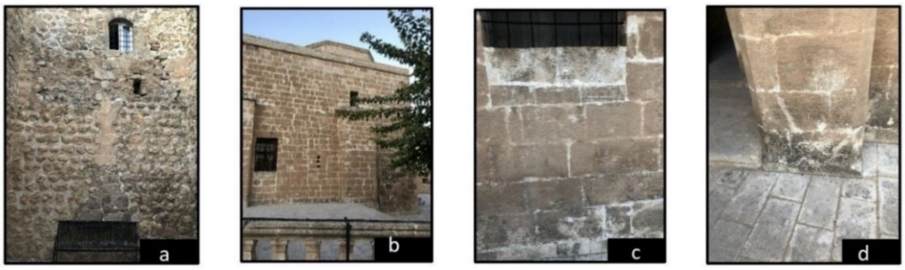


Figure 5. Chemical degradation in Hatuniye Madrasah (Biçen Çelik, 2019)

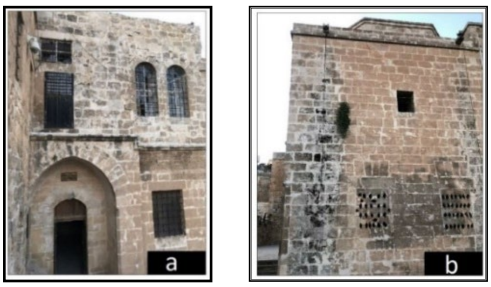


Figure 6. Biodegradation in Hatuniye Madrasah (Biçen Çelik, 2019)

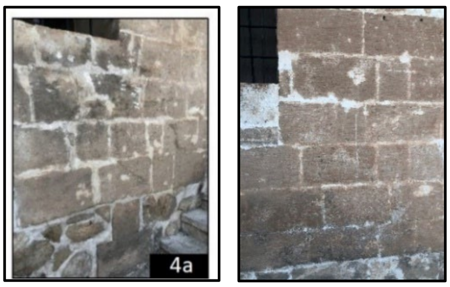


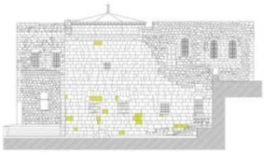
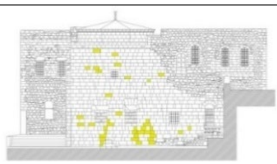
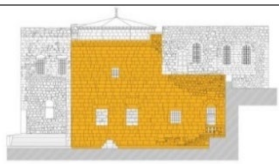
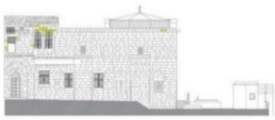
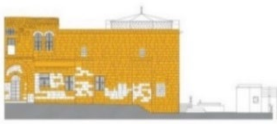
Figure 7. Anthropogenic degradation of Hatuniye Madrasah (Biçen Çelik, 2019)

3.2. Investigation of Deterioration in Hatuniye Madrasah by Using Mapping Method

The degradations occurring in Hatuniye Madrasah are shown in the charts by mapping method. When all the degradations occurring in the structure are taken into consideration, it is seen that chemical degradation is the highest and biological degradation is the lowest.

The physical deterioration in the madrasah is shown in Table 2. Joint discharge, hairline crack fragment rupture and surface abrasions are observed on the facade surfaces. It is observed that surface abrasion is the highest and fragment rupture is the lowest among the physical deterioration in the building. Surface abrasion was observed on the south, east, south-facing courtyard facade and west-facing courtyard facades of the building.

Table 2. Physical deterioration of Hatuniye Madrasah

	Physical Degradation Type	Facade Deterioration Ratio	Rate (%)
EAST FACADE	Joint Discharge		1.2
	Capillary Crack		2.3
	Surface Abrasion		100
SOUTH FACADE	Joint Discharge		0.8
	Capillary Crack		10
	Fragment Breakage		0.9
	Surface Abrasion		89

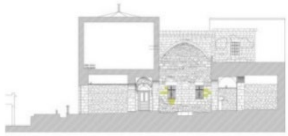
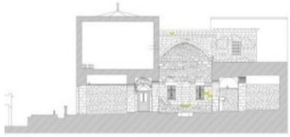
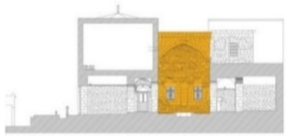
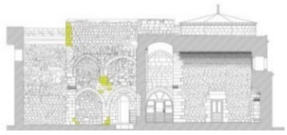
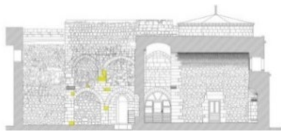
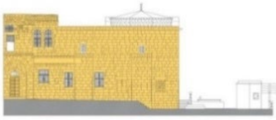
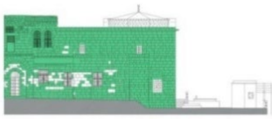
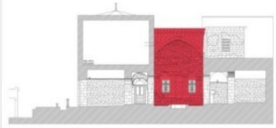
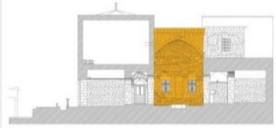
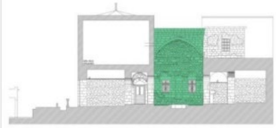
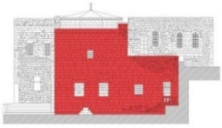
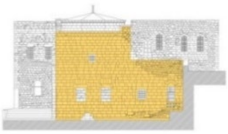
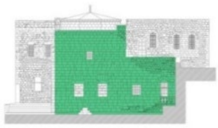
	Physical Degradation Type	Facade Deterioration Ratio	Rate (%)
SOUTH-FACING COURTYARD FACADE	Joint Discharge		1.3
	Capillary Crack		1.2
	Surface Abrasion		100
WEST-FACING COURTYARD FACADE	Joint Discharge		2
	Capillary Crack		1.4
	Fragment Breakage		2.1
	Surface Abrasion		100

Table 3. Chemical degradation in Hatuniye Madrasah

	Chemical Degradation Type	Facade Deterioration Ratio	Rate (%)
SOUTH FACADE	Colour Variation		100
	Salitisation		100
	Bacteria Formation		97

	Chemical Degradation Type	Facade Deterioration Ratio	Rate (%)
SOUTH-FACING COURTYARD FACADE	Colour Variation		100
	Salitisation		100
	Bacteria Formation		100

	Chemical Degradation Type	Facade Deterioration Ratio	Rate (%)
EAST FACADE	Colour Variation		100
	Salitisation		100
	Bacteria Formation		100

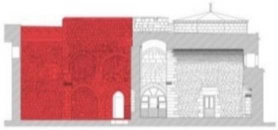
	Chemical Degradation Type	Facade Deterioration Ratio	Rate (%)
WEST-FACING COURTYARD FACADE	Colour Variation		100
	Salitisation		100
	Bacteria Formation		100

Table 4. Biological degradation at Hatuniye Madrasah

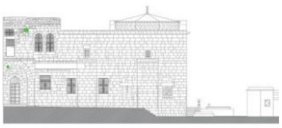
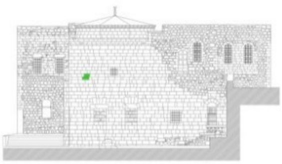
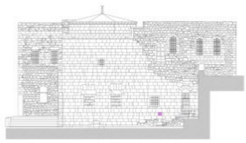
	Biological Degradation Type	Facade Deterioration Ratio	Rate (%)
SOUTH FACADE	Plant Formation		0.4
EAST FACADE	Plant Formation		0.4

Table 5. Anthropogenic degradation at Hatuniye Madrasah

	Anthropogenic Degradation Type	Facade Deterioration Ratio	Rate (%)
EAST FACADE	Sharp Instrument Use		0.1

The chemical deterioration of the building is shown in Table 3. Discolouration, salting and bacterial formation were observed on almost all of the façade surfaces. Discolouration, salting and bacterial formation were observed on all facades of the building.

Plant formation, which is a type of biological degradation in Hatuniye Madrasah, was observed on the south (0.4%) and east facades (0.4%) and shown in Table 4.

Anthropogenic deterioration in the Hatuniye Madrasah due to the use of sharp tools only on the eastern façade of the building is shown in Table 5.

3.3. Investigation of the Deterioration of Hatuniye Madrasah using XRF Chemical Analysis Method

All types of deterioration occurring in Hatuniye Madrasah were analysed with the codes determined by X-Ray Fluorescence Spectroscopy (XRF chemical analysis method). The codes determined (Table 6), the representations of the selected stones on the plan (Figure 8) and on the façade (Figure 9) are given below. The main purpose of analysing the materials of historical buildings is to obtain information about the physical and chemical composition of the materials as well as the production technology (Karataş, Alptekin & Yakar, 2022).

Table 6. Stones selected for the use of XRF chemical method for the deterioration of Hatuniye Madrasah

STONE CODE	TYPE OF DECOMPOSITION	
D0	Clean Stone	
D1a	Abrasion	Physical Degradation
D1b	Capillary Crack	
D1c	Joint Discharge	
D1d	Part Breakage	
D2a	Colour Change	Chemical Degradation
D2b	Salinisation	
D2c	Bacteria growth	
D3a	Microorganism Formation	Biodegradation
D4a	Sharp Instrument Use	Anthropogenic Degradation

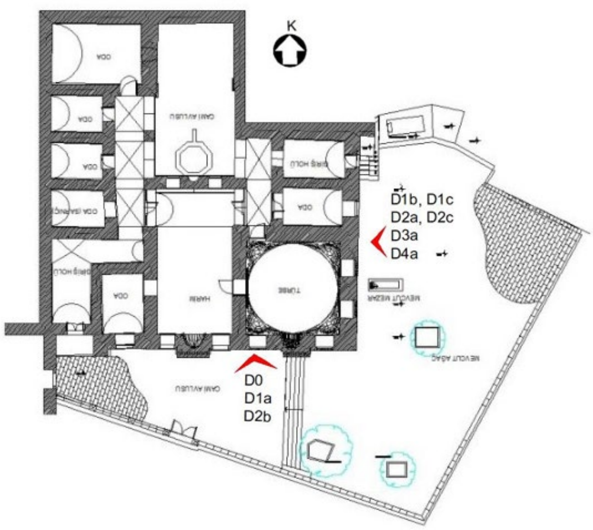


Figure 8. The plan representation of the stones selected for the use of XRF chemical method for the deterioration of Hatuniye Madrasa

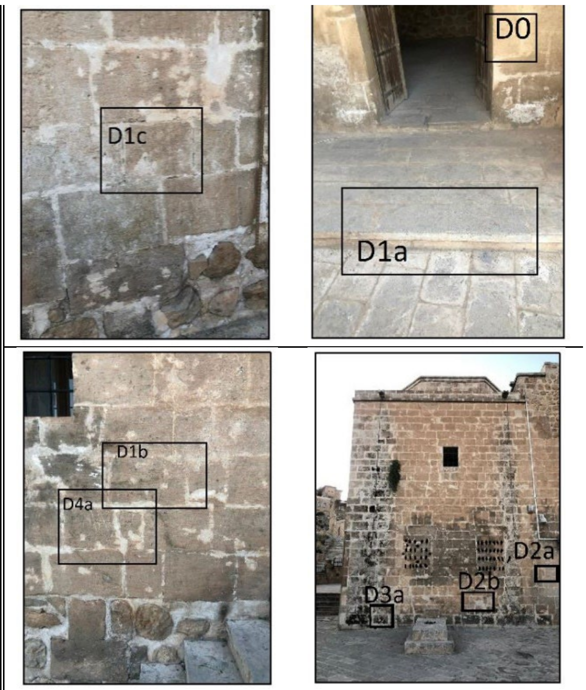
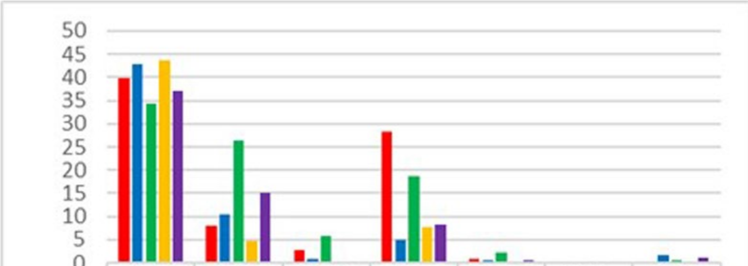


Figure 9. Demonstration of the stones selected for the use of XRF chemical method for the deterioration of Hatuniye Madrasah on the façade

The results of the analysis of the physical deterioration in Hatuniye Madrasah according to XRF analysis method are given in Table 7. According to the results of the analyses, while the SiO_2 ratio in stone D0 was 7.93%, this ratio was 26.27% in stone D1b. In addition, while the SO_3 ratio in D0 stone, which is determined as clean stone, is 28.83%, this ratio is lower in other stones. The high rate of SO_3 causes damage to the stones as a result of air pollution. No serious changes were observed in other components. In stones with different mineral contents, physical degradation such as joint failure, hairline cracks, surface abrasion, fragment breakage and fracture have been observed due to the expansion and contraction of stones due to daily and annual temperature differences (Karataş, Alptekin & Yakar, 2023).

The results of XRF chemical analyses of the chemical degradation in Hatuniye Madrasah are shown in Table 8. According to the results obtained, it was observed that the stone with the lowest SO_3 value was D2b (0.98%). While the CaO ratio is 39.87% in D0 stone, it is 24.91% in D2c stone. Another remarkable change according to the analysis results is in SiO_2. While the SiO_2 ratio was 7.93% in D0 stone, this ratio was 24.91% in D2c stone.

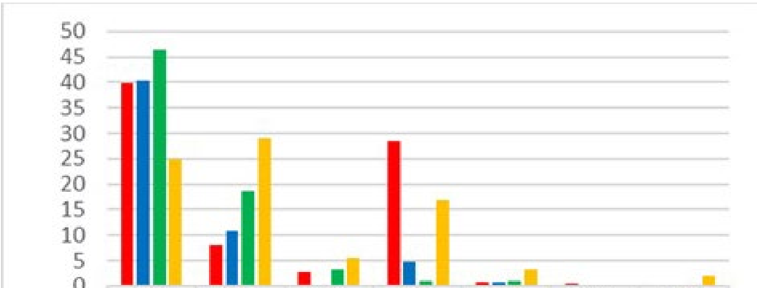
Table 7. XRF and chemical analysis results of the physical deterioration observed on the facades of Hatuniye Madrasah



	CaO	SiO_2	Al_2O_3	SO_3	Fe_2O_3	P_2O_5	K_2O
D0	39,87	7,93	2,73	28,38	0,74	0,36	0,14
D1a	42,93	10,42	0,74	5,01	0,67	0,17	1,69
D1b	34,19	26,27	5,88	18,73	2,11	0,14	0,62
D1c	43,54	4,78	0,14	7,62	0,39	0,029	0,39
D1d	37,01	15,11	0,27	8,3	0,68	0,031	0,97

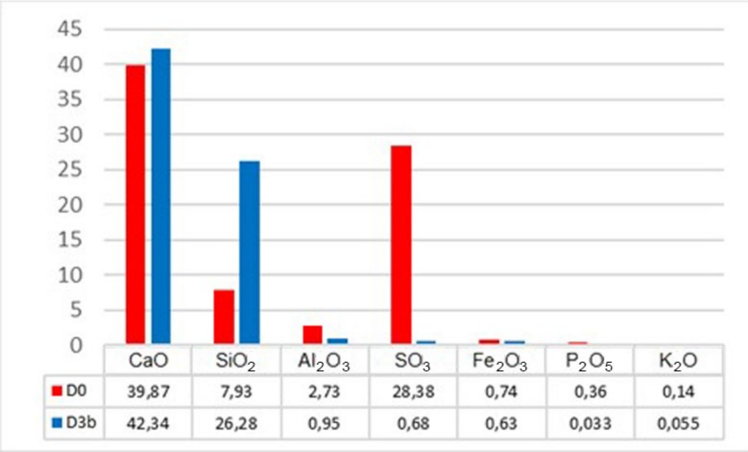
The analysis results of the biodegradation in Hatuniye Madrasah are given in Table 9. According to the results of the analyses, while the SiO_2 ratio was 7.93% in stone D0, it was 26.28% in stone D3a. Silicification of clay minerals and the development of hard layers on the surface of the stone cause the increase in the SiO_2 ratio in D3a stone.

Table 8. XRF chemical analysis results of the chemical degradation observed on the facades of Hatuniye Madrasah



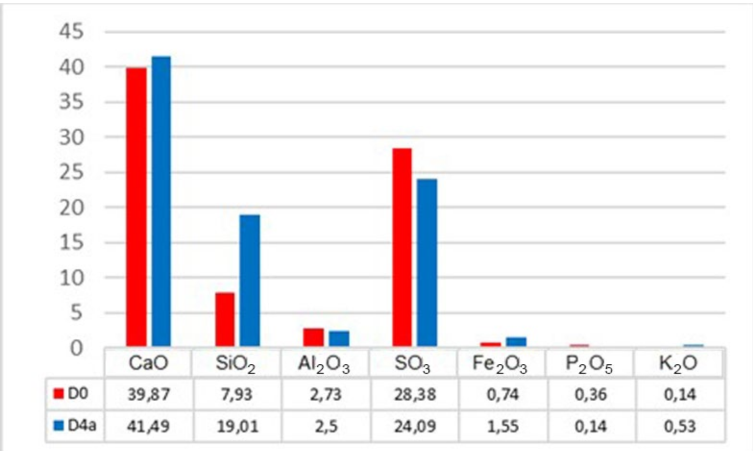
	CaO	SiO_2	Al_2O_3	SO_3	Fe_2O_3	P_2O_5	K_2O
D0	39,87	7,93	2,73	28,38	0,74	0,36	0,14
D2a	40,34	10,92	0,13	4,75	0,74	0,032	0,21
D2b	46,37	18,59	3,12	0,98	0,95	0,033	0,19
D2c	24,91	28,94	5,55	16,85	3,18	0,031	1,86

Table 9. XRF and chemical analysis results of biodegradation observed on the facades of Hatuniye Madrasah



When the anthropogenic degradation of Hatuniye Madrasah is analysed by XRF chemical analysis method, the ratios of CaO, SiO_2 and SO_3 components stand out. There is no significant change in the ratios of other compounds. While SiO_2 ratio was 39.87% in D0 stone, this ratio increased to 19.01% in D4a stone. While the SO3 component was 28.38% in D0 stone, it was 24.09% in D4a stone (Table 10).

Table 10. XRF chemical analysis results of anthropogenic degradation observed on the facades of Hatuniye Madrasah



4. Conclusion and Suggestions

Stone has been used in all areas of our lives by changing its shape and function from past to present. Limestone, a local stone from the Mardin region, was used as the main construction material of the building. The limestone has deteriorated over time. In this study, the deterioration of Hatuniye Madrasah in Mardin province was analysed. These deteriorations were identified through visual analysis and then grouped into specific categories. The deterioration was analysed using façade mapping and XRF chemical analysis methods.

The deterioration of Hatuniye Madrasah was analysed by mapping method. According to these analyses, it was determined that the most visible type of deterioration in the structure is chemical deterioration and the least visible type of deterioration is anthropogenic deterioration. As a result of the analyses, it can be said that the most visible type of physical degradation is surface abrasion and the least visible type of physical degradation is fragment rupture. In chemical degradation, it was observed that the most visible degradation type was discolouration and salting, and the least visible degradation type was bacterial formation. When biological degradation was considered, algae formation and plant formation were observed. As an anthropogenic degradation type, degradation was observed as a result of the use of sharp tools (Table 11).

Table 11. Deterioration on the facades of Hatuniye Madrasah

Hatuniye Madrasa	Physical Degradation				Chemical Degradation			Biological Degradation		Anthropogenic Degradation	
	Abrasion	Capillary Crack	Joint Emptying	Tool Breakage	Colour Change	Salinisation	Bacteria	Plant Formation	Moss Formation	Sharp Instrument Use	Paint Usage
South Front	+	+	+	+	+	+	+	+	-	-	-
Eastern Front	+	+	+	+	+	+	+	+	-	+	-
South Facing Courtyard Facade	+	+	+	+	+	+	+	-	-	-	-
Courtyard Facade Facing West	+	+	+	+	+	+	+	-	-	-	-

The deterioration of Hatuniye Madrasah was analysed by X-Ray Fluorescence Spectroscopy (XRF chemical analysis method). According to the results of the samples taken from the stones determined in the madrasah, the changes in CaO, SiO_2 and SO_3 values are remarkable. According to the results of the analyses, it was determined that the amount of CaO in all stone samples was higher than the number of other compounds. SiO_2 content was 28.94% in D2c stone, 4.78% in D1c stone and 7.93% in D0 stone, which is clean stone. While the SO_3 component was 28.38% in D0 stone, this ratio was found to be low in other stone samples (Table 12).

Table 12. XRF chemical analysis results of the deterioration observed on the facades of Hatuniye Madrasah

Ingredient	D0	D1a	D1b	D1c	D1d	D2a	D2b	D2c	D3a	D4a
CaO	39.87	42.93	34.19	43.54	37.01	40.34	46.37	24.91	42.34	41.49
SiO_2	7.93	10.42	26.27	4.78	15.11	10.92	18.59	28.94	26.28	19.01
Al_2O_3	2.73	0.74	5.88	0.14	0.27	0.13	3.12	5.55	0.95	2.5
SO_3	28.38	5.01	18.73	7.62	8.3	4.75	0.98	16.85	0.68	24.09
Fe_2O_3	0.74	0.67	2.11	0.39	0.68	0.74	0.95	3.18	0.63	1.55
P_2O_5	0.36	0.17	0.14	0.029	0.031	0.032	0.033	0.031	0.033	0.14
K_2O	0.14	1.69	0.62	0.39	0.97	0.21	0.19	1.86	0.055	0.53

According to the data obtained as a result of the examinations, it is observed that the amount of chemical degradation in the structure is higher. Due to the exposure of the structure to atmospheric conditions, it was determined that the amount of discolouration and salting in the structure was higher. It was observed that there was degradation caused by bacterial growths and degradation on the stone surfaces due to air pollution. According to the results of XRF chemical analyses, it was determined that as the clay and carbonate ratio increased, the degradation of the building stones increased, and the degradation decreased with the increase in the silica ratio. It was observed that calcium and silica ratios increased with the decomposition of clay minerals on the stone surface.

It is necessary to use the data and analysis results obtained from this study in the conservation projects to be carried out in the coming years and to develop solution proposals in line with these data. To stop or minimise the degradation of structures, it is important to detect structural degradation. To transfer the building to future generations, it is of great importance to accurately identify and analyse the deterioration and to eliminate them with the right solution methods.

There have been no previous studies on the Hatuniye Madrasah in Mardin. Due to the lack of studies, no comparison can be made. However, as can be seen in the master's thesis of Karataş (2018), similar types of deterioration were observed in mosque structures and madrasah structures in Mardin province. It can be said that geography and climate are effective.

Acknowledgments and Information Note

This article is derived from the Master's thesis titled "Investigation of Stone Deterioration on the Facades of Madrasa Buildings in Mardin Province and Analysis by XRF Spectrometry" completed at Dicle University, Institute of Science and Technology, Department of Architecture. The article complies with national and international research and publication ethics. Ethics committee permission was not required for the study.

Author Contribution and Conflict of Interest Disclosure Information

Ayşe Biçen Çelik contributed 40%, Şefika Ergin 20%, Murat Dal 20% and İlhami Ay 20%. There is no conflict of interest.

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Conservation Courses Effects on Architecture Students Conservation Awareness: Analysis of Isparta and Burdur Houses

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Abstract

As in every part of Anatolia, the building typology is diversified in the Western Mediterranean Region. Isparta and Burdur houses located in this region, as in other Anatolian houses, the construction technique is observed with masonry stone walls on the ground floors and wooden structures plastered with gypsum plaster on the upper floors. Within the scope of this study, a database was created by examining the conservation status of 22 registered buildings in Burdur and Isparta provinces was restored. The study aims to learn the effects of historical residences on architecture students, to reveal the extent to which the state of preservation is assimilated and their approach to conservation. The subjective evaluations of architectural students of both Burdur Mehmet Akif Ersoy University and Suleyman Demirel University regarding the preservation status of these buildings were examined. The evaluation form was filled in by the students who took and did not take the conservation courses. The correct answers of the students were grouped under the headings of separate criteria for each structure and analyzed using SPSS software. As a result of the study, it has emerged that a different evaluation should be made with standard deviation and quarters analysis using SPSS software. The differences in the results of the students who took and did not take the conservation course were presented more clearly with statistical analyses.

Keywords: *Conservation awareness, conservation education, architecture, cultural heritage, SPSS.*

Koruma Derslerinin Mimarlik Öğrencilerinin Koruma Bilincine Etkileri: Isparta ve Burdur Evleri Üzerinden Analizi

Öz

Anadolu'nun her noktasında olduğu gibi Batı Akdeniz Bölgesi'nde de yapı tipolojisi çeşitlenmektedir. Bu bölgede yer alan Isparta ve Burdur evlerinde de diğer Anadolu evlerinde olduğu gibi, zemin katlarda yığma taş duvarlı, üst katlarda ise ahşap strüktürlü, kıtıklı sıva ile sıvanmış yapım tekniği görülmektedir. Çalışma kapsamında Burdur ve Isparta İlleri içerisinde restore edilmiş 22 adet tescilli konutun korunmuşluk durumları incelenerek bir veri tabanı oluşturulmuştur. Çalışmada amaç; tarihi konutların mimarlık öğrencileri üzerindeki etkilerini öğrenerek korunmuşluk durumu ve korumaya olan yaklaşımlarını ortaya çıkarmaktır. Hem Burdur Mehmet Akif Ersoy Üniversitesi, hem de Süleyman Demirel Üniversitesi mimarlık öğrencilerinin bu yapıların korunmuşluk durumlarına ilişkin öznel değerlendirmeleri incelenmiştir. Değerlendirme formu koruma dersi alan ve almayan öğrenciler tarafından doldurulmuştur. Öğrencilerin doğru cevapları her yapı için ayrı kriterlere ait başlıklar altında tablo haline getirilmiş ve SPSS yazılımı kullanılarak analiz edilmiştir. Çalışmanın sonucunda, standart sapma ve çeyrekler analizleri ile farklı bir değerlendirme yapılmış ve koruma dersi alan ve almayan öğrencilerin sonuçlarındaki farklılıklar istatistiki analiz ile daha net olarak sunulmuştur.

Anahtar Kelimeler: *Koruma bilinci, koruma eğitimi, mimarlık, kültürel miras, SPSS.*

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1. Introduction

The cultures harboured by contemporary societies reflect the heritage of those societies from the past to the present. This intersection of culture and heritage constitutes a historical environment that bears the traces of different periods (Güçlü, 1990, p. 60). Turkey is a country with very rich resources in terms of cultural heritage. The protection of the existing architectural environment is the responsibility of members of society and culture living on that land regardless of socio-demographic characteristics (Önal & Numan, 2000, p. 51).

When evaluating conservation based on actions and reactions, there is general agreement that raising awareness is one of the most important actions. Individuals who have an idea about what to conserve and for what purpose have clear perceptions of conservation and may show passive or active participation in studies related to the environment which with they interact. Awareness is made possible with preservation education given to all groups of society, from primary education to higher education levels.

Architecture education in an international context has developed with the use of various protocols, such as the Bologna Process of the European Union and the guidelines of the International Union of Architects (UIA). The UIA advocates an educational approach that will provide integrity by setting standards in architectural education (International Union of Architects, 2023). Educational curricula differ from country to country but, in essence, certain core subjects constitute the shared foundation of those curricula.

Srivastava (2015) stated that conservation awareness will only develop with awareness of responsibility and that educational institutions and instructors have important roles in this context. It is thought that the establishment of interdisciplinary working groups at the level of higher education and the incorporation of this awareness into students' educational processes will contribute to the development of conservation practices (Güner et al., 2012, p. 51).

When the curricula of higher education institutions in Turkey providing educational programs for undergraduate and associate degrees are examined, it is clear that architecture, archaeology, restoration, and other fields are directly related to conservation. Both theoretical and applied courses are included in the categories of compulsory and elective courses in these departments and programs. The course contents address topics such as international and national legislation, the structures of certain historical periods, and conservation techniques. In addition to conservation and survey-restoration courses, which are both theoretical and applied in architectural education, construction in historical environments and efforts to give new functions to existing structures are also addressed in studio courses throughout the educational period to pursue solutions to thematic problems. According to Güner et al. (2011), the curricula addressing conservation in Turkey should be reshaped in such a way as to provide support for agreements and contemporary criteria, and it is also argued that legislation should be included in classroom settings. At the Architecture and Education Congress held in Turkey in 2013, expectations were voiced that an individual who has received architectural education with such an approach in the field of conservation will be conscious and competent in the context of the conservation of cultural heritage (Esin, 2013).

The development and updating of educational models alone are not considered sufficient in this regard. Sustainable conservation will only be possible with the transformation of education into practice in professional life (Cody & Fogg, 2007, p. 266). Another important concept in architectural practice in this regard is the internship period when students receiving an education can experience applications of theoretical knowledge in practice. The internship period in Turkey is divided into two sub-periods of work, with one in the office and one at the construction site, and these internships are conducted with companies in the fields of design, planning, and restoration. Categorizing internship practices in similar ways according to the departments and the anticipated future work of individuals who plan to specialize in the field of conservation before they graduate will both support the theoretical education received by these students and increase their competence. Alkış & Oğuzoğlu (2005) argued that individuals with awareness and education regarding historical environments will play more influential roles in conservation than those educated based on laws and regulations alone

(Alkış & Oğuzoğlu, 2005). The present study, it is aimed to measure the historical and cultural awareness of traditional houses registered in the Burdur and Isparta Provinces of Turkey among students and to evaluate the level of awareness of the conservation of this historical environment in which the buildings are located.

2. Material

All residential units from the past to the present have their typologies with unique and distinctive characteristic features. Topographies of different regions, geographical features, and the socio-cultural and economic structures of different societies facilitated the emergence of various architectural products. Facade typologies, on the other hand, arose according to the relationships of structures with their specific streets, residential parcels, and other structures in the area. The relationships of entrances with their streets and plots, the locations of entrances in structures, the presence of closed and open exits, the type of materials used in walls and joinery, and the ratio, number, and shape of spaces such as doors and windows differ between buildings. In the present study, the protection statuses of registered houses in the Burdur and Isparta Provinces of the Western Mediterranean Region of Turkey before and after the repair of their facades are discussed. For this reason, general information about the relevant facade typologies should also be considered.

When the facade styles of the houses in question are considered, both closed and open exits can be seen. There are windows on all three fronts of the closed exits. These exits may be flat, triangular exits, corner exits, or mitre exits. Furthermore, these exits exist on one front for some houses and two fronts for other houses. The buildings have entrances from the street level in some cases and from higher levels in others. The windows and doors have different proportions and styles. The ground floors were constructed with stone masonry, while the upper floors were built around carrier systems with wooden skeletons. The walls of the ground floors reach 60-80 cm in height. There are courtyards behind or in front of the buildings (Urfalıoğlu, 2010, p. 55).

2.1. Method

In this research, qualitative research methods such as questionnaires and quantitative research methods such as statistics were used. Students from the architecture departments of Mehmet Akif Ersoy University in Burdur and Süleyman Demirel University in Isparta participated in this research. Students were grouped according to their backgrounds in awareness and conservation classes and open-ended and closed-ended questions were asked regarding photos of 22 distinct registered houses in Burdur and Isparta from different periods in terms of design, materials, workmanship, integrity, and value (historical value, aesthetic value, and the reflection of local culture). In the first stage of the research, the selected registered houses were evaluated by architecture students using the survey method and questionnaires. In the second stage, the evaluation forms completed by the students were reviewed and the statistical results of the obtained data were evaluated using the SPSS program which is a statistical software.

2.2. Data Collection by Questionnaire

For the first stage of this research entailing data collection with a questionnaire, an evaluation form was prepared. This form consisted of 3 parts. In the first part, data on age, year of enrolment, gender, whether students had previously taken a conservation course, and whether they knew about the concepts of 'sit' and 'registration' were collected and brief information about the general background of the students was obtained. In the second part, students' perspectives on concepts such as historical buildings, restoration and conservation, and cultural heritage were revealed with the use of historic photographs and subjective questions regarding previous exposure to restoration applications and street rehabilitation, attitudes toward historic structures and their restoration or destruction, attitudes toward buildings in a city being visited for the first time, history and archaeological sites or other places of interest, the preservation of cultural heritage in the students' cities of residence, and their feelings about taking active roles in such processes. Their ideas about the functions that should be given to historical buildings were also obtained with an open-ended question. In this process, the following questions were asked:

- Have you seen restoration work before?

- Have you ever seen street rehabilitation?

- Do you enjoy visiting historical buildings?

- Should historical buildings be restored?

- Should historical buildings be demolished and replaced with modern ones?

- I would like to see historical buildings in a city that I visit for the first time (yes/no).

- I enjoy walking through historical streets and areas (yes/no).

- I enjoy visiting archaeological sites (yes/no).

- I like to go to museums where historical items and objects are exhibited (yes/no).

- I have information about the cultural heritage of the city in which I live (yes/no).

- I would like to help preserve old photographs related to the history of the city in which I live (yes/no).

- What functions should be given to historical buildings?

In the third part of the questionnaire, students' views on the originality and value of historical houses were obtained based on photographs of 22 registered buildings from Burdur and Isparta before and after restoration. The student's views of unique designs, original materials, original workmanship and integrity, historical value, aesthetic value, and local characteristics were collected. Their replies were compared with the correct answers and accuracy rates were calculated. In examining the originality of the buildings after repair, the overall design, materials, and workmanship were described as 'original', 'partially original', or 'not original'. For the originality of the design, the aspect ratio of the building, whether openings such as windows and doors were overhanging, and whether floor heights were conserved or not was the main criteria.

For the uniqueness of the building materials, it was considered whether the wall and joinery materials were repaired with texture and quality of materials close to the original materials. For example, while the original materials of many joineries were wooden, they were later replaced with PVC materials. Cement-based plasters were also applied to some walls in the restoration process. In terms of original workmanship, the workmanship of the walls of the main body of the houses, the decorations and ornaments on the walls, and joinery such as windows and doors were considered. For example, old wooden guillotine windows were replaced with wooden windows made with today's craftsmanship and techniques in some cases. In examinations of the integrity of the buildings, the fragmentation of the main bodies of the buildings and changes in integrity with the addition of historically inappropriate annexes were considered. The students' opinions about the historical value, aesthetic value, and local value of the buildings were also discussed.

In examining the originality of the buildings based on their photographs, students were asked to choose among the following options in terms of design, material, and workmanship: 'The building has preserved its originality - The building has partially preserved its originality - The building has lost its originality'. Options for integrity were as follows: 'The integrity of the building has been positively affected - The integrity of the building has been adversely affected'. Regarding historical value, historical aesthetics, and local qualities, students were offered the following options: 'The historical value of the building has been preserved - The historical value of the building has deteriorated', 'The aesthetic value of the building has been positively affected - The aesthetic value of the building has been adversely affected', and 'The building has local characteristics - The building does not have local characteristics'. Conservation awareness and students' views regarding the protection of cultural heritage were evaluated within two groups including students who had taken conservation courses and those who had not.

2.3. Statistical Analysis Method with SPSS Program

With the help of the SPSS program for statistical analysis, many analysis techniques including reliability analysis, factor analysis, and variance analysis are applied in survey studies. Statistical analysis is used to reveal the distribution of data on a numerical basis. Descriptive statistics are used to obtain the mean, standard deviation, mode, and median values of data. For example, the means of two or more groups can be compared with frequency analysis. Statistical analysis results for multivariate data in survey studies can also be obtained with SPSS.

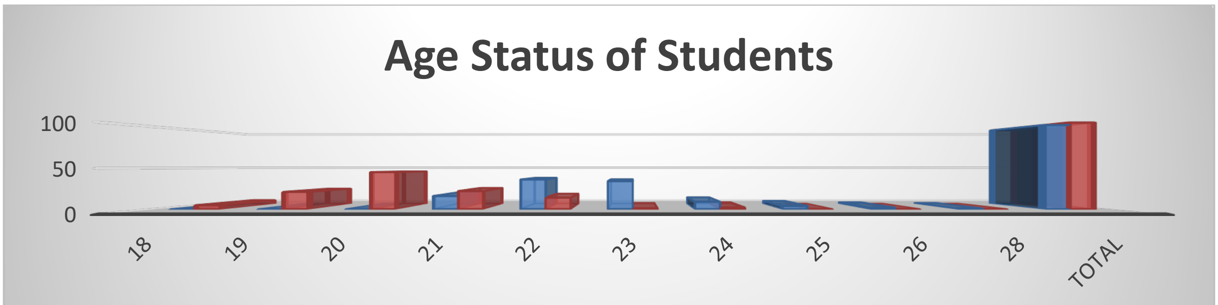
While summarizing study data, different methods such as quartile analysis may be used depending on whether the data are normally distributed or not (Cevahir, 2020, p. 6-12). With this method, the numbers (frequencies) of different variables, ratios of numbers of occurrences to the overall sample size, and percentages (%) of the obtained values can be summarized. Thresholds can then be found. In the present study, the standard deviation, variance, mean, mode, and quartile values of the students' answers in terms of accuracy were analyzed using SPSS. Thus, average values for both the whole population and average values for quartiles were obtained.

3. Evaluation

Open-and closed-ended questions were asked to two groups of students, including 100 from the Burdur Mehmet Akif Ersoy University Architecture Department and 112 from the Isparta Süleyman Demirel University Architecture Department. Some of these students had taken conservation courses and some had not. Students were asked about 22 specific registered houses selected from Burdur and Isparta. These buildings were evaluated by the students in terms of originality (design, material, workmanship), integrity, and value (historical value, aesthetic value, local characteristics) based on photographs of the houses taken before and after restoration. Subjective evaluations of the conservation status of houses that have undergone restoration in the neighbouring provinces of Burdur and Isparta, which have similar characteristics, were provided by these architecture students. It was hypothesized that awareness of conservation would improve with both theoretical and applied education, and this study thus aimed to determine perceptions of conservation among individuals receiving education in the field of architecture.

In the first part of the questionnaire, demographic and educational data of the students were collected. Students who had taken a conservation course were between the ages of 21 and 28, and the majority of these students were 22 years old (36 people) or 23 years old (34 people). Students who had not taken conservation courses were between the ages of 18 and 24, and the majority of these students were 20 years old (40 people). According to these findings, it seems that the average age of students who have taken conservation courses is higher and it may be the case that longer durations of architectural education and experience (internships, etc.) affect their perspectives on conservation (Table 1).

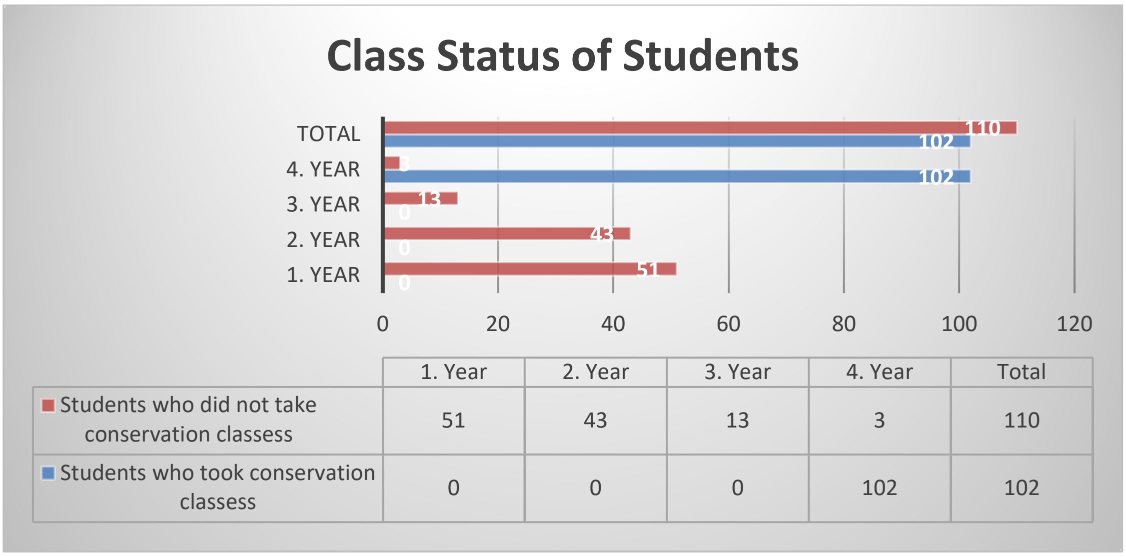
Table 1. Ages of students



	18	19	20	21	22	23	24	25	26	28	Total
Students who took conservation classess	0	0	0	16	36	34	9	4	2	1	102
Students who did not take conservation classess	5	21	45	22	14	1	2	0	0	0	110

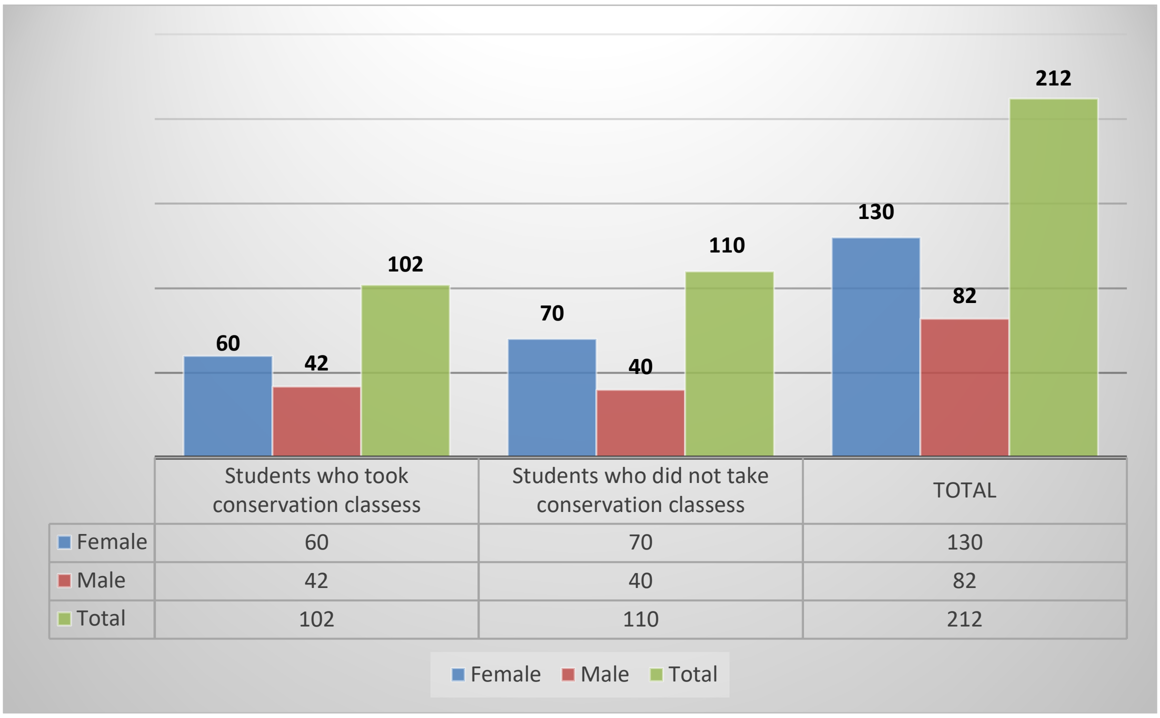
All of the students (102 people) who had taken a class on conservation were 4th-year students. The students who had not taken a class on conservation were 1st-year, 2nd-year, 3rd-year, and 4th-year students, and the majority of this group of students were in their 1st year (51 people) or 2nd year (43 people) of study. According to these findings, the students who had not taken conservation courses mostly took basic courses on topics such as technical drawing and building knowledge. These students were determined to have gaps in their exposure to courses on conservation awareness, traditional Turkish houses, and restoration, other than the basic required courses in architectural education (Table 2).

Table 2. The class status of students



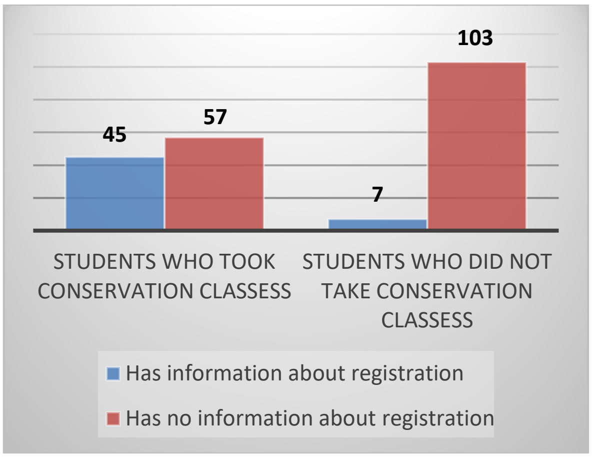
The majority of students who had taken conservation courses were female students and the majority of those who had not taken such courses were also female. The higher rate of female students in architectural education compared to male students is reflected in these findings. Specifically, 59% of the students who had taken conservation courses and 64% of those who had not were female students (Table 3).

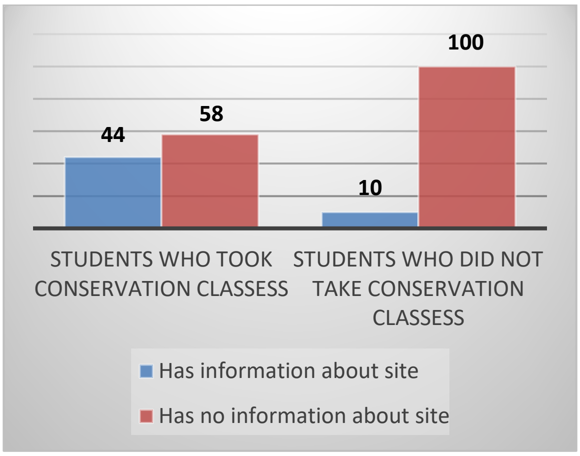
Table 3. Gender of students



According to data on whether the students knew the concepts of 'site' and 'registration', 44% (45 people) of the students who took conservation courses and 6% (7 people) of the students who did not take conservation courses knew about the concept of registration. On the other hand, 43% (44 people) of the students who took conservation courses and 9% (10 people) of the students who did not take conservation courses knew about the concept of conservation (Table 4).

Table 4. Registration and site knowledge of students





The answers to the subjective questions in the second part of the questionnaire were subsequently evaluated. In response to 'Have you seen a restoration work before?', 74% (75 people) of the students who had taken conservation courses, 47% (53 people) of those who had not taken conservation courses, and 60% (128 people) of all students answered 'yes'. In response to 'Have you ever seen street rehabilitation?, 36% (37 people) of those who had taken conservation courses, 74% (81 people) of those who had not taken conservation courses, and 56% (118 people) of all students answered 'yes'. In response to 'Do you enjoy visiting historical buildings?, 98% (100 people) of those who had taken conservation courses, 92% (101 people) of those who had not taken conservation courses, and 95% (201 people) of all students answered 'yes.' In response to 'Should historical buildings be restored?', 98% (100 people) of those who had taken conservation courses, 84% (92 people) of those who had not taken conservation courses, and 91% (192 people) of all students answered 'yes'. In response to 'Should historical buildings be demolished and replaced with modern ones?', 3% (3 people) of those who had taken conservation courses, 2% (2 people) of those who had not taken conservation courses, and 2.3% (5 people) of all students answered 'yes.' In response to 'I would like to see historical buildings in a city that I visit for the first time (yes/no)', 96% (98 people) of those who had taken conservation courses, 95% (104 people) of those who had not taken conservation courses, and 95% (202 people) of all students answered 'yes'. In response to 'I enjoy walking through historical streets and areas (yes/no)', 98% (100 people) of those who had taken conservation courses, 97% (107 people) of those who had not taken conservation courses, and 98% (207 people) of all students answered 'yes'. In response to 'I enjoy visiting archaeological sites (yes/no)', 89% (91 people) of those who had taken conservation courses, 85% (93 people) of those who had not taken conservation courses, and 87% (184 people) of all students answered 'yes'. In response to 'I like to go to museums where historical items and objects are exhibited (yes/no)', 89% (91 people) of those who had taken conservation courses, 91% (100 people) of those who had not taken conservation courses, and 90% (212 people) of all students answered 'yes'. In response to 'I have information about the cultural heritage of the city in which I live (yes/no)', 83% (85 people) of those who had taken conservation courses, 75% (82 people) of those who had not taken conservation courses, and 79% (167 people) of all students answered 'yes'. Finally, in response to 'I would like to help preserve old photographs related to the history of the city in which I live (yes/no)', 89% (91 people) of those who had taken conservation courses, 91% of those who had not taken conservation courses (100 people), and 90% (212 people) of all students answered 'yes' (Tables 5 and 6).

Table 5. Responses to subjective questions

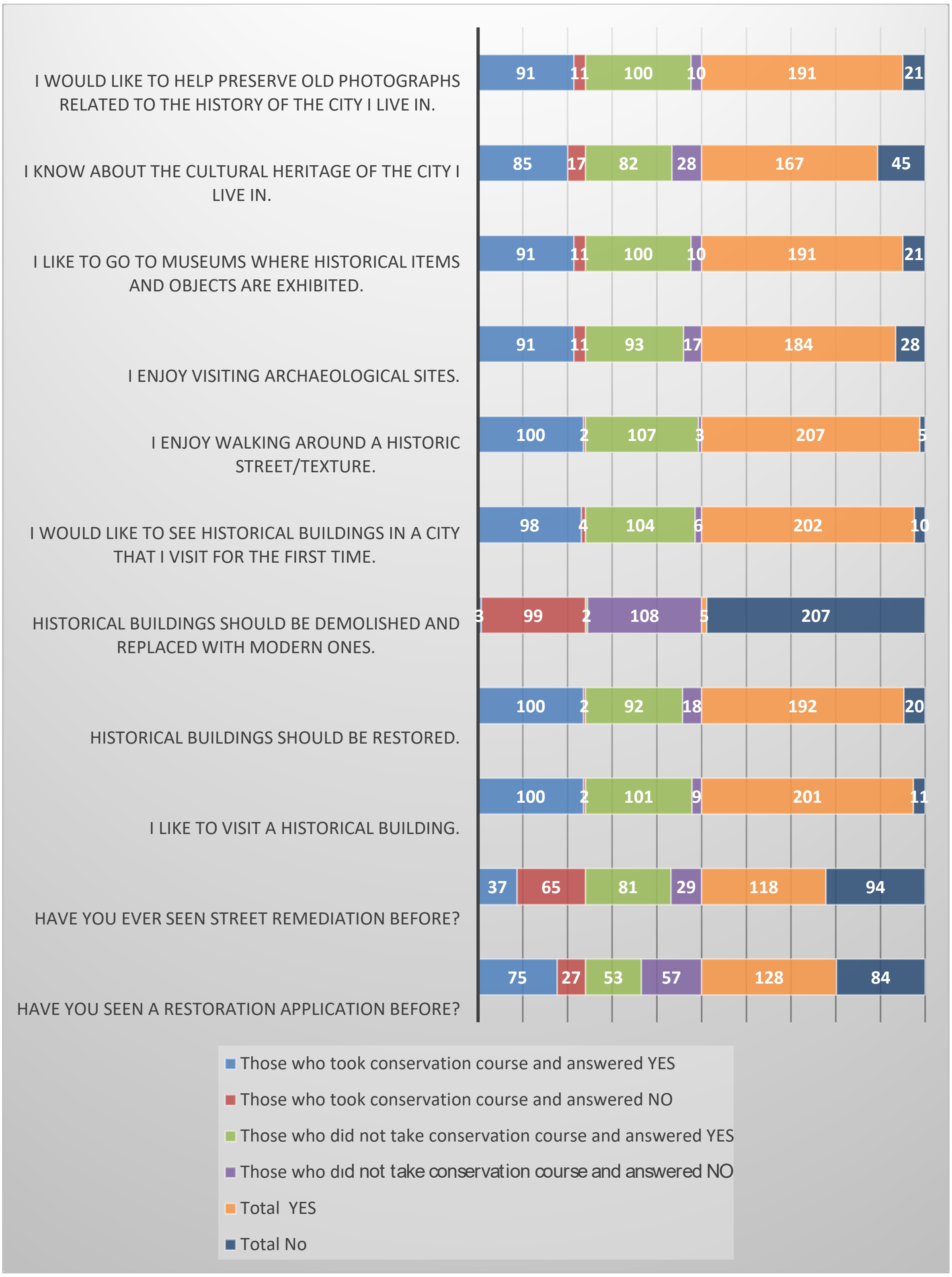


Table 6. Responses to subjective questions

	Answers of students who took conservation courses		Answers of students who did not take conservation courses		TOTAL	
	YES	NO	YES	YES	NO	YES
Have you seen restoration work before?	75	27	53	57	128	84
Have you ever seen street rehabilitation?	37	65	81	29	118	94
Do you enjoy visiting historical buildings?	100	2	101	9	201	11
Should historical buildings be restored?	100	2	92	18	192	20
Should historical buildings be demolished and replaced with modern ones?	3	99	2	108	5	207
I would like to see historical buildings in a city that I visit for the first time (yes/no).	98	4	104	6	202	10
I enjoy walking through historical streets and areas (yes/no).	100	2	107	3	207	5
I enjoy visiting archaeological sites (yes/no).	91	11	93	17	184	28
I like to go to museums where historical items and objects are exhibited (yes/no).	91	11	100	10	191	21
I have information about the cultural heritage of the city in which I live (yes/no).	85	17	82	28	167	45
I would like to help preserve old photographs related to the history of the city in which I live (yes/no).	91	11	100	10	191	21

Students were also asked an open-ended question: ‘What functions should be given to historical buildings?’ Two students replied that such buildings should be used as libraries, cafes, restaurants, or offices; 1 as public structures; 2 as workplaces; 2 as cultural centres; 47 as museums, galleries, or exhibition areas; 3 as hotels or other accommodations; 1 as schools; 2 as social facilities or social areas; 1 as centres for commercial functions; and 2 as buildings that maintain functions close to their original functions. The idea that the original functions of historical buildings should be preserved was stated by very few (less than 1%) students, and it was also seen that very few students knew about the concept of functionalization. Considering the overall responses of the students, 84% (48 people) of the majority of the students (57 people) who answered this question thought that historical buildings should take on public cultural-social functions. These beliefs that small-scale traditional buildings designed as houses should be given such heavy social functions reveal that the student’s knowledge of and perspectives on this subject are insufficient.

The accuracy of the answers given by the students who had taken conservation courses regarding the authenticity, value, and integrity of historical buildings was analyzed. When the average results of these data are considered, 75% of the students in this group provided correct answers for ‘integrity’, 65% for ‘historical value’, 64% for ‘local characteristics’, 58% for ‘aesthetic value’, 45% for ‘originality of design’, 39% for ‘originality of the material’, and 35% for ‘originality of the workmanship’. Considering all the answers given by these students, it can be concluded that they do not have the competence to evaluate originality in terms of originality of design, original workmanship, and original materials in spite of the fact that they took conservation courses (Table 7).

Table 7. Accuracy rates of the answers given by students who had taken conservation courses regarding different criteria of historical houses (Students who answered yes ÷ Students who took conservation courses)

	Originality of the Design		Originality of the Material		Originality of the Craftsmanship		Integrity		Historical Value		Aesthetic Value		Local Characteristics	
BUILDING NUMBER	Number of People	Percent	Number of People	Percent	Number of People	Percent	Number of People	Percent	Number of People	Percent	Number of People	Percent	Number of People	Percent
1	84	0,82	63	0,62	60	0,59	98	0,96	86	0,84	84	0,82	84	0,82
2	33	0,32	30	0,29	27	0,26	58	0,57	52	0,51	44	0,43	61	0,60
3	62	0,61	16	0,16	5	0,05	71	0,70	47	0,46	42	0,41	20	0,20
4	52	0,51	44	0,43	43	0,42	75	0,74	65	0,64	63	0,62	62	0,61
5	30	0,29	41	0,40	28	0,27	65	0,64	54	0,53	49	0,48	50	0,49
6	35	0,34	20	0,20	48	0,47	67	0,66	50	0,49	60	0,59	59	0,58
7	43	0,42	35	0,34	53	0,52	91	0,89	80	0,78	72	0,71	76	0,75
8	64	0,63	37	0,36	50	0,49	91	0,89	76	0,75	74	0,73	73	0,72
9	16	0,16	34	0,33	36	0,35	88	0,86	81	0,79	79	0,77	77	0,75
10	51	0,50	37	0,36	40	0,39	71	0,70	72	0,71	64	0,63	73	0,72
11	35	0,34	28	0,27	16	0,16	67	0,66	54	0,53	35	0,34	55	0,54
12	37	0,36	57	0,56	49	0,48	76	0,75	59	0,58	60	0,59	65	0,64
13	44	0,43	43	0,42	44	0,43	61	0,60	58	0,57	54	0,53	57	0,56
14	63	0,62	39	0,38	56	0,55	90	0,88	71	0,70	69	0,68	82	0,80
15	61	0,60	41	0,40	49	0,48	87	0,85	76	0,75	77	0,75	74	0,73
16	43	0,42	49	0,48	54	0,53	74	0,73	68	0,67	73	0,72	74	0,73
17	57	0,56	38	0,37	11	0,11	85	0,83	77	0,75	69	0,68	83	0,81
18	40	0,39	57	0,56	10	0,10	84	0,82	69	0,68	71	0,70	77	0,75
19	39	0,38	45	0,44	52	0,51	72	0,71	69	0,68	34	0,33	74	0,73
20	55	0,54	46	0,45	47	0,46	85	0,83	84	0,82	71	0,70	80	0,78
21	48	0,47	43	0,42	16	0,16	78	0,76	59	0,58	30	0,29	23	0,23
22	48	0,47	54	0,53	13	0,13	74	0,73	69	0,68	61	0,60	76	0,75
		0,45		0,39		0,35		0,75		0,65		0,58		0,64

The accuracy of the answers given by the students who had not taken conservation courses regarding the authenticity, value, and integrity of historical buildings was also analyzed. When the average results of these data are considered, 58% of the students in this group provided correct answers for ‘integrity’, 50% for ‘historical value’, 51% for ‘local characteristics’, 54% for ‘aesthetic value’, 34% for ‘originality of design’, 31% for ‘originality of the material’, and 30% for ‘originality of the workmanship’. Considering all the answers given by these students, it can be concluded that their knowledge of originality in terms of integrity, aesthetic value, local characteristics, and history is reasonably sufficient even though they did not take conservation courses (Table 8).

Table 8. Accuracy rates of the answers given by students who had not taken conservation courses regarding different criteria of historical houses (Students who answered yes ÷ Students who did not take conservation courses)

	Originality of the Design		Originality of the Material		Originality of the Craftsmanship		Integrity		Historical Value		Aesthetic Value		Local Characteristics	
BUILDING	Number of People	Percent	Number of People	Percent	Number of People	Percent	Number of People	Percent	Number of People	Percent	Number of People	Percent	Number of People	Percent
1	59	0,54	20	0,18	10	0,09	10	0,09	19	0,17	43	0,39	50	0,45
2	37	0,34	35	0,32	25	0,23	53	0,48	47	0,43	50	0,45	58	0,53
3	50	0,45	32	0,29	38	0,35	65	0,59	62	0,56	49	0,45	37	0,34
4	10	0,09	42	0,38	41	0,37	15	0,14	12	0,11	38	0,35	71	0,65
5	44	0,40	35	0,32	37	0,34	69	0,63	42	0,38	42	0,38	44	0,40
6	26	0,24	17	0,15	31	0,28	72	0,65	53	0,48	64	0,58	66	0,60
7	36	0,33	42	0,38	40	0,36	25	0,23	7	0,06	49	0,45	27	0,25
8	47	0,43	29	0,26	35	0,32	86	0,78	74	0,67	86	0,78	77	0,70
9	29	0,26	36	0,33	30	0,27	18	0,16	14	0,13	25	0,23	38	0,35
10	55	0,50	38	0,35	42	0,38	88	0,80	84	0,76	48	0,44	38	0,35
11	37	0,34	39	0,35	31	0,28	69	0,63	59	0,54	39	0,35	61	0,55
12	42	0,38	38	0,35	41	0,37	75	0,68	61	0,55	71	0,65	67	0,61
13	34	0,31	49	0,45	37	0,34	57	0,52	50	0,45	57	0,52	53	0,48
14	10	0,09	15	0,14	34	0,31	33	0,30	25	0,23	88	0,80	17	0,15
15	10	0,09	46	0,42	32	0,29	99	0,90	87	0,79	83	0,75	19	0,17
16	26	0,24	49	0,45	35	0,32	90	0,82	76	0,69	81	0,74	82	0,75
17	10	0,09	31	0,28	14	0,13	92	0,84	81	0,74	81	0,74	86	0,78
18	49	0,45	42	0,38	26	0,24	92	0,84	76	0,69	89	0,81	74	0,67
19	46	0,42	8	0,07	44	0,40	86	0,78	67	0,61	24	0,22	74	0,67
20	71	0,65	15	0,14	38	0,35	88	0,80	84	0,76	84	0,76	92	0,84
21	41	0,37	46	0,42	34	0,31	62	0,56	64	0,58	42	0,38	29	0,26
22	48	0,44	43	0,39	23	0,21	64	0,58	69	0,63	65	0,59	67	0,61
		0,34		0,31		0,30		0,58		0,50		0,54		0,51

3.1. Statistical Analysis with SPSS Software

The results of the data obtained from survey studies may be interpreted with different statistical methods, such as quartile analysis, depending on whether the values display normal distribution or not. SPSS software is used here for this analysis. In this study, the numbers and percentages of students who gave correct answers for the relevant criteria of each building (the originality of the design, the originality of the material, the originality of the workmanship, integrity, historical value, aesthetic value, and local characteristics) were tabulated and then the value ranges, minimum and maximum values, mode values, mean values, standard deviations, variance, and quartile analysis results were obtained. At the end of the analysis process, the average numbers of correct answers, quartile analysis results (25% slices), and standard deviations were evaluated, and overall accuracy rates were thus revealed. Comparisons of these results between students who had taken and had not taken conservation courses are presented in this subsection.

The average accuracy answers of the students who took the protection course about the originality of the design is 47.27; the standard deviation is 14.69; the variance value is 215,636; according to the quarterly analysis, the breaking points are 36.50 in the 25% slices; 46.00; is 58.00; the average of accuracy answers is 37.14; standard deviation 16,762; variance value 280,981; according to the quarterly analysis, the breaking points are 27.00 in the 25% slices; 39.67; It turned out to be 48.00. It was observed that the mean accuracy values of those who took conservation courses were similar according to quartile analysis, but the mean values obtained by quartile analysis for those who did not take conservation courses were higher than the normal mean values (Tables 9 and 10).

The average accuracy answers of the students who took the lesson about the originality of the material is 40.77; the standard deviation is 11.49; the variance value is 131,994; according to the quarterly analysis, the breaking points are 34.75 in the 25% slices; 41.00; is 46.75; the average of accuracy answers is 33.95; standard deviation 11.94; variance value is 142,617; according to the quarterly analysis, the breaking points are 29.00 in the 25% slices; 36.67; It turned out to be 42.50. It was observed that the mean accuracy values of those who took conservation courses were similar according to quartile analysis, but the mean values were higher than the quartile analysis results obtained for those who did not take conservation courses (Tables 9 and 10).

The average of the accurate answers of the students who took the protection course about the originality of workmanship is 36.68; the standard deviation is 17.60; the variance value is 309,465; according to the quarterly analysis, the breakpoints are 16.00 in the 25% slices; 43.50; is 50.50; the average of accuracy answers is 32.64; standard deviation 8.70; variance value is 75,671; according to the quarterly analysis, the breakpoints are 30,00b in 25% slices; 34.50; It turned out to be 38.67. It was observed that the mean accuracy values of those who took conservation courses and those who did not, as obtained by quartile analysis, were higher than the normal mean values (Tables 9 and 10).

The average of the accurate answers of the students who took the protection course about the integrity parameter is 77.64; the standard deviation is 10.86; the variance value is 117,766; according to the quarterly analysis, the breakpoints are 70.00 in 25% slices; 75.50; is 87.25; the average of accuracy answers is 64.00; standard deviation 27.53; variance value 757,810; according to the quarterly analysis, the breakpoints are 53.00b in 25% slices; 69.00; It turned out to be 87.50. The mean values of those who took conservation courses according to quartile analysis were lower than the normal mean values, while it was observed that the values for those who did not take such courses were higher (Tables 9 and 10).

The average of the accuracy answers of the students who took the conservation course about the historical value parameter is 67.09; the standard deviation 11.54; the variance value is 133,134; according to the quarterly analysis, the breakpoints are 57.00 in the 25% slices; 69.00; is 76.25; the average of accuracy answers is 55.14; standard deviation 25.30; variance value 639,933; according to the quarterly analysis, the breakpoints are 42.00b in 25% slices; 61.50; It turned out to be 75.33. It was observed that the mean values of those who took conservation courses and those who did not, as obtained by quartile analysis, were higher than the normal mean values (Tables 9 and 10).

The average accuracy answers of the students who took the protection course about the aesthetic value parameter are 60.68; the standard deviation is 15.57; the variance value is 242,513; according to the quarterly analysis, the breaking points are 47.75 in the 25% slices; 63.50; is 72.25; the average of accuracy answers is 59.00; standard deviation 21,051; variance value is 443,143; according to the quarterly analysis, the breakpoints are 42,33b in 25% slices; 53.50; It turned out to be 81.67. The mean values obtained by quartile analysis for those who took conservation courses were higher than the normal mean values, while for those who did not take such courses, the values were lower (Tables 9 and 10).

The average of the accurate answers of the students who took the protection course about the local value parameter is 66.14; the standard deviation is 17,335; the variance value is 300,504; according to the quarterly analysis, the breaking points are 58.50 in the 25% slices; 73.50; is 77.00; the average of accuracy answers is 55.77; standard deviation 22.06; variance value is 486,374; according to the quarterly analysis, the breakpoints are 37.67b in 25% slices; 59.50; It turned out to be 73.00. It was observed that the mean values of those who took conservation courses and those who did not, as revealed by quartile analysis, were higher than the normal mean values (Tables 9 and 10).

Table 9. Statistical analysis of answers of students who had taken conservation courses

	Range Statistic	Minimum Statistic	Maximum Statistic	Mode	Mean (Ort.)	Std. Deviation	Variance Statistic	Quartiles 25	50	75
Originality of Design - Number of Students	68	16	84	35[a]	47,27	14,685	215,636	36,50	46,00	58,00
Originality of Design - Percentage	,66	,16	,82	,34[a]	,4622	,14136	,020	,3550	,4500	,5700
Originality of Material - Number of Students	47	16	63	37[a]	40,77	11,489	131,994	34,75	41,00	46,75
Originality of Material - Percentage	,46	,16	,62	,36[a]	,3983	,11044	,012	,3375	,4000	,4575
Originality of Workmanship - Number of Students	55	5	60	16[a]	36,68	17,592	309,465	16,00	43,50	50,50
Originality of Workmanship - Percentage	,54	,05	,59	,16[a]	,3591	,16795	,028	,1600	,4250	,4950
Integrity - Number of Students	40	58	98	67[a]	77,64	10,852	117,766	70,00	75,50	87,25
Integrity - Percentage	,39	,57	,96	,66[a]	,7613	,10177	,010	,6900	,7450	,8525
Historical Value - Number of Students	39	47	86	69	67,09	11,538	133,134	57,00	69,00	76,25
Historical Value - Percentage	,38	,46	,84	,68[a]	,6583	,10986	,012	,5600	,6800	,7500
Aesthetic Value - Number of Students	54	30	84	60[a]	60,68	15,573	242,513	47,75	63,50	72,25
Aesthetic Value - Percentage	,53	,29	,82	,59[a]	,5948	,15048	,023	,4675	,6250	,7125
Local Value – Number of Students	64	20	84	74	66,14	17,335	300,504	58,50	73,50	77,00
Local Value - Percentage	,62	,20	,82	,75	,6491	,16470	,027	,5750	,7250	,7500

Table 10. Statistical analysis of the students who did not take the protection course

	Range Statistic	Minimum Statistic	Maximum Statistic	Mode	Mean (Ort.)	Std. Deviation	Variance Statistic	Quartiles 25	50	75
Originality of Design - Number of Students	61	10	71	10	37,14	16,762	280,981	27,00[b]	39,67	48,00
Originality of Design - Percentage	,56	,09	,65	,09	,3386	,15335	,024	,2467[b]	,3600	,4400
Originality of Material - Number of Students	41	8	49	42	33,95	11,942	142,617	29,00[b]	36,67	42,50
Originality of Material - Percentage	,38	,07	,45	,35[c]	,3091	,10945	,012	,2600[b]	,3350	,3850
Originality of Workmanship - Number of Students	34	10	44	31[c]	32,64	8,699	75,671	30,00[b]	34,50	38,67
Originality of Workmanship - Percentage	,31	,09	,40	,28[c]	,2973	,07875	,006	,2700[b]	,3150	,3533
Integrity - Number of Students	89	10	99	69[c]	64,00	27,528	757,810	53,00[b]	69,00	87,50
Integrity - Percentage	,81	,09	,90	,63[c]	,5818	,25042	,063	,4800[b]	,6300	,7950
Historical Value - Number of Students	80	7	87	76[c]	55,14	25,297	639,933	42,00[b]	61,50	75,33
Historical Value - Percentage	,73	,06	,79	,69[c]	,5005	,22967	,053	,3800[b]	,5550	,6833
Aesthetic Value - Number of Students	65	24	89	42[c]	59,00	21,051	443,143	42,33[b]	53,50	81,67
Aesthetic Value - Percentage	,59	,22	,81	,45	,5368	,19095	,036	,3833[b]	,5025	,7433
Local Value – Number of Students	75	17	92	38[c]	55,77	22,054	486,374	37,67[b]	59,50	73,00
Local Value - Percentage	,69	,15	,84	,35[c]	,5073	,20098	,040	,3467[b]	,5400	,6633

Considering the standard deviation values, it was seen that students who had taken conservation courses had standard deviations ranging between 10 and 17, while those who had not taken such courses had standard deviations ranging between 8 and 27 (Tables 9 and 10). As a result of quartile analysis and standard deviation values, it was concluded that average values alone do not provide a sufficiently clear understanding of the perspectives of students on the concept of conservation.

4. Conclusion

When the effects of conservation education given both theoretically and practically in architecture on the perception of conservation among students were examined, it was obvious that there was a significant difference in the levels of conservation awareness between students who had taken conservation courses and those who had not. Architecture education is related to the visual perception related to drawings, and models of the existing and non-existing structures (Yılmaz et al., 2022). It could be said that conservation education is also visual that consists of the reflection of several movements. Students determine the conservation principles and techniques both with the history and conservation courses. According to the results of the two-stage evaluation process applied in this study, the conservation awareness and knowledge of students who took conservation courses were prominent in both stages of the evaluation. The theoretical and practical experience gained from conservation courses, field studies, and internships included in the curriculum over a total of four semesters played an effective role in the development of students' perspectives on conservation. However, when the answers given to subjective questions by the students who had taken conservation courses were examined, it was observed that awareness of conservation should be encouraged from more basic educational levels.

The fact that the average age of those who had taken conservation courses was higher affected their perspectives on conservation as a result of their more extensive architectural education and experience (e.g., internships). On the other hand, students who had not taken conservation courses mostly took basic courses such as technical drawing and building knowledge. For this reason, it was found that these students had gaps regarding courses on topics such as Conservation Awareness, Traditional Turkish House, and Restoration, other than the basic required courses in architectural education. The majority of students who had taken conservation courses and those who had not were female students in both cases. The higher percentage of female students in architectural education compared to male students is thus reflected in the data of this survey. Furthermore, only 43% (44 people) of the students who had taken conservation courses and 9% (10 people) of those who had not reported knowing the concepts of registration and site. Thus, the effects of conservation courses on mastering technical terms related to this concept were also observed. However, in both groups, students had more correct answers regarding integrity and value and fewer correct answers regarding originality when comparing taking conservation courses. In addition to the international developments in today's world, it is necessary to take some steps at the national and local scale to improve the awareness and conservation culture for cultural assets.

It is obvious that every human is responsible to conserve and make the built environment sustainable in terms of heritage (Tuncer & Madran, 2012). When looking at the study even architecture students' conservation awareness needs to be increased with additional efforts. Students need to be thought to conserve the present to make it alive for the future (Madran, 2007). The accuracy rates of the answers given by students who had taken conservation courses regarding the authenticity, value, and integrity of historical buildings were also analyzed with SPSS and compared in terms of normal averages and quartile analysis. As a result, it was concluded that those who took conservation courses had more knowledge and competence regarding this information.

Acknowledgments and Information Note

The article complies with national and international research and publication ethics. Ethics committee approval was gained for the study. Ethics Committee approval in the study, Ethics Committee of the University of Mehmet Akif ERSOY, dated 07.09.2022, and decision no GO 2022/863.

Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

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Evaluation of Interior Architecture Education Research in the Web of Science Database: Bibliometric and Science Mapping Analysis

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Abstract

The aim of study is a bibliometric analysis of the publications in the Web of Science database related to interior design education. The research was carried out between 10 January and 12 February 2023. Searches in the TIT-ABS-KEY field of WOS search engine. "Interior architecture education" (Topic) OR "interior architecture education" (Topic) OR "interior design education" (Topic) OR "interior design education*" (Topic) generating 125 publications on the subject. Most of these were "Proceeding Paper" with 66 publications and in the top position of "Educational Research" with 65 publications; the "Architecture" category came in second with 26 publications. In addition, "Procedia Social and Behavioral Sciences" resulted in 25 publications and the "Journal of Interior Design" in 12 publications. Among the WOS indexes, "CPCI-SSH" contains 62 publications. The words most frequently used by authors are interior architecture education, interior architecture, design studio, education, sustainability, design, creativity, design thinking, design processes, and computer-aided design.*

***Keywords:** Interior design education, interior architecture education, bibliometric analysis, science mapping, web of science.*

Web of Science Veri Tabanındaki İç Mimarlık Eğitimi Araştırmalarının Değerlendirilmesi: Bibliyometrik ve Bilim Haritalama Analizi

Öz

Bu makalenin amacı iç mimarlık eğitimiyle ilgili Web of Science veri tabanındaki yayınların bibliyometrik analizini yapmaktır. Araştırma 10 Ocak-12 Şubat 2023 tarihleri arasında gerçekleştirilmiştir. Web of Science veri tabanında başlık-özet-anahtar kelimelerinde "iç mimarlık eğitimi" veya "iç mimarlık eğitimi" veya "iç mekân tasarım eğitimi" veya "iç mekân tasarım eğitimi*" kelimeleriyle araştırılmıştır. Buna göre konuyla ilgili 125 yayına erişilmiştir. Bu sonuçlara göre doküman türü olarak 66 yayın sayısıyla en fazla konferans bildirisi bulunmaktadır. "Eğitim Araştırmaları" kategorisinde 65 yayın bulunmaktadır. "Mimarlık" kategorisi 26 yayınla ikinci sırada gelmektedir. Ayrıca "Procedia Social and Behavioral Sciences" 25 yayın ve "Journal of Interior Design" dergisi12 yayına sahiptir. WoS indekslerinden "Conference Proceedings Citation Index - Social Science & Humanities (CPCI-SSH)" 62 yayını bulunmaktadır. Yazarların yayınlarında en çok kullandıkları kelimeler ise iç mimarlık eğitimi, iç mimarlık, tasarım stüdyosu, eğitim, sürdürülebilirlik, tasarım, yaratıcılık, tasarım düşüncesi, tasarım odaklı düşünme, tasarım süreçleri ve bilgisayar destekli tasarımdır.*

***Anahtar kelimeler:** İç mimarlık eğitimi, bibliyometrik analiz, bilim haritalama, web of science.*

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1. Introduction

Interior architecture: It is known as an organization of spaces such as living, working, and entertaining which includes art, science, and technology. It aims to transform the form, texture, color, and lighting in these spaces into a more qualified one for human life. Well-designed spaces not only provide shelter but also make people feel good, and have a positive effect on many aspects such as socialization and learning (IIDA, 2023). In interior architecture education, the goal is for students to gain the ability to produce creative designs that respond to social, cultural, and technological developments. Design education comprises the act of design and is shaped by applied methods. The process, not the result, is important in design education (Özkan et al., 2016). The process in question begins the moment one encounters the design problem. In other words, the real situational problem revolves around the learning experience in the design studio, which is the focus of all design-related programs (Schön, 1985). Interior architecture education questions the relationship between the building and the person and analyzes the building through its user; it is a discipline that forms the relationship between the structure and user through function, user, and aesthetics. Humans and space are the main fields of study in interior architecture, and it deals with space for people, contributing to the lives of individuals within that space.

According to Demirbas (2017), *"An interior architect, who researches and solves problems related to the level and functionality of interiors by adding creativity; designing space, making design analysis, providing information on-site inspection, building systems, aesthetics, interior construction information, fittings, materials, equipment; It is the person who has training and experience to prepare drawings and documents related to the interior."* (IFI-International Federation of Interior Architects/Designers, 2023).

When the publications on interior architecture education are examined, as a result of the literature review, research related to interior design education in the ProQuest Dissertations & Theses Global database is available (Sagun, 1999; Botti-Salitsky, 2005; Al-Salem, 2014; Liu, 2020). Furthermore, there are studies conducted with students in interior architecture studios (Demirbas & Demirkan, 2000; Tanrıover et al., 2015; Rauf et al., 2020; Kaya & Bilgiç, 2020). The Council of Higher Education Thesis Center Ph.D. theses on interior architecture education were also accessed. Other studies focused on the following: the relationship between learning styles and performance scores of students (Demirbaş, 2001); the effect of the parametric design approach (Şekerci, 2020); creative thinking in the process of basic design (Aşkın, 2020); and the use of virtual reality technology (Kılıç, 2020) (YÖKTEZ, 2023). Research on current and potential future trends and how they might affect the interior architecture profession and interior design education (Fowles, 1991), cirruculum development (Cordan et al., 2014), concept and scale (Hasırcı et al., 2022), virtual reality (Meggs et al., 2012) and augmented reality (Gürçınar & Esen, 2018).

In addition, The Chamber of Interior Architects, with the regulation published in the Official Gazette No. 26999 on September 16, 2008, legally determines the working areas and methods of interior architects working within the borders of Türkiye. "Regulation on Implementation, Registration and Professional Inspection of Freelance Interior Architecture Services" defines the design and service areas of Interior Architects under the title, "Design, implementation, consultancy and other services."

These areas can be briefly listed as follows:

1) Interior design, original movable-fixed furniture, and accessory design of these spaces,
2) Project design and implementation of interior equipment, equipment, and productions,
3) Development, renewal, and/or development with new design ideas according to the conditions of the old function. Production and arrangement of function modification projects to be envisaged in the interior spaces of the buildings that will gain a new function different from the old one,
4) Surveying and dimensioning for the interior,
5) Interior architecture project services,

6) Specifications for the interior, preparation of the tender dossier, and professional inspection and supervision services,
7) Interior decoration,
8) Producing proposals for multi-disciplinary fields in environmental design, interior projects, and application services,
9) Application of color, texture, and material selection in accordance with the designed interior,
10) Fair stands and exhibition organization and organization of exhibition areas, design applications with similar processes, and design and implementation of necessary accessories and environment requirements with installations,
11) Interior arrangements of land, sea, and aircraft vehicles,
12) Set and stage decoration,
13) Interior production and implementation of interior projects, together with relevant training for those involved in projects for space restoration, restitution, and conservation,
14) Continuous technical control and building sustainability projects,
15) Consultancy and consultancy services (Kaptan, 2016).

The focus of this article is on publications related to interior architecture and design education. First, interior architecture education was searched in Google Ngram to explore the literature. Related to this process, the e-book graphic about "Interior Design Education", published between 1900 and 2019, is shown in Figure 1. The greatest numbers of publications were produced in 1991.

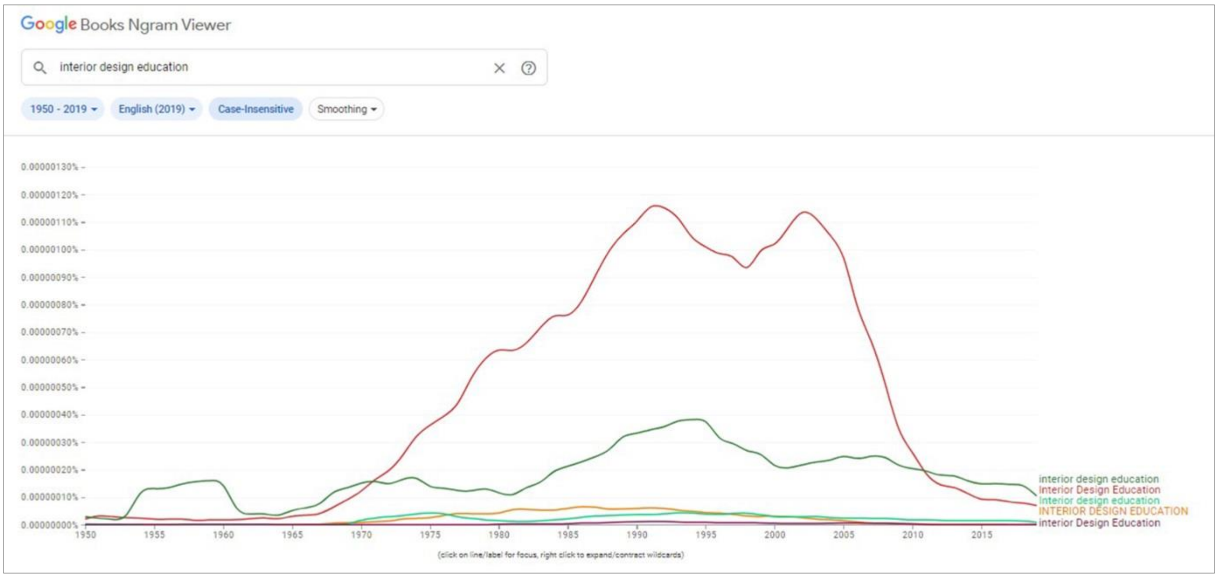

Figure 1. Google books ngram viewer (Google Books, 2023)

Mitton's *"Interior design visual presentation: A guide to graphics, models and presentation techniques"* describes quick sketches that help produce an entirely constructed model and as well as the capability to produce visual representations of designs, which is essential for any designer (Mitton, 2012). The book comprehensively describes interior design communications used throughout the design process and is complemented by many real-world examples.

Blossom & Thompson (2015) *"The Handbook of Interior Design"* examines the mental models that underlie the field of interior design. It asks readers to reflect on the relationships between theory, research, and practice, as well as the important principles that influence interior design.

Sully (2015) *"Interior Design: Conceptual Basis"* explains the conceptual process of interior design and the concepts making up the discipline. It also provides instructions to help the designer streamline the design process and sharpen the connections between the various skills bases required to do the job.

In addition, it allows designers to focus on each concept as independently as possible while accepting relative connections without undue influences that lead to conceptual bias.

The questions that this research focuses on are:

- Which publications are related to interior architecture/design education?
- Which publication is most cited in the Web of Science (WOS) database on interior architecture/design education?
- Which index contains the most publications in the WOS database on interior architecture/design education?
- In which categories are interior architecture/design education publications found in the WOS database?
- Which keywords did the authors use most in their publications on interior architecture/design education?

2. Research Methodology

This study makes use of the quantitative research method. The bibliometric analysis method was also used in the research. A quantitative analytic technique called bibliometrics uses mathematical and statistical techniques to quantify the interactions and impacts of publications in a certain field of study. This approach can offer a macroscopically summary of a sizable body of scholarly literature. Moreover, it can effectively pinpoint influential research, authors, journals, groups, and nations over time (Van Eck & Waltman, 2010). In this research, the VOSviewer program was used for the bibliometric analysis of publications (VOSviewer, 2023). Figure 2 presents the methodology of the research and workflow steps of this study. The research design was carried out in three main steps. These steps are the following:

- **Step 1: Idea and Data Preparation**

This step was initiated at the beginning of the research; it is important in determining the quantitative research criteria, in which the general lines of the study are established. In this step, the following measures were taken: Generating the Idea, Collecting Data: WOS, and Definition and Source Criteria.

- **Step 2: Data Collection**

In this step, a search was activated for publications between 1975–2023 in the WOS database using the keywords "interior design education*" (Topic) OR "interior design education" (Topic) OR "interior architecture education*" (Topic) OR "interior architecture education" (Topic).

- **Step 3: Data Analysis and Visualization**

Descriptive Bibliometric Analysis: Publications in the WOS database, including author, citation, document type, category, country, affiliations, publication titles, publishers index descriptive bibliometric analysis table count, and percentage were created.

VOSviewer Scientific Mapping: Visualizing scientific landscapes using network visualization, overly visualization, and density visualization.

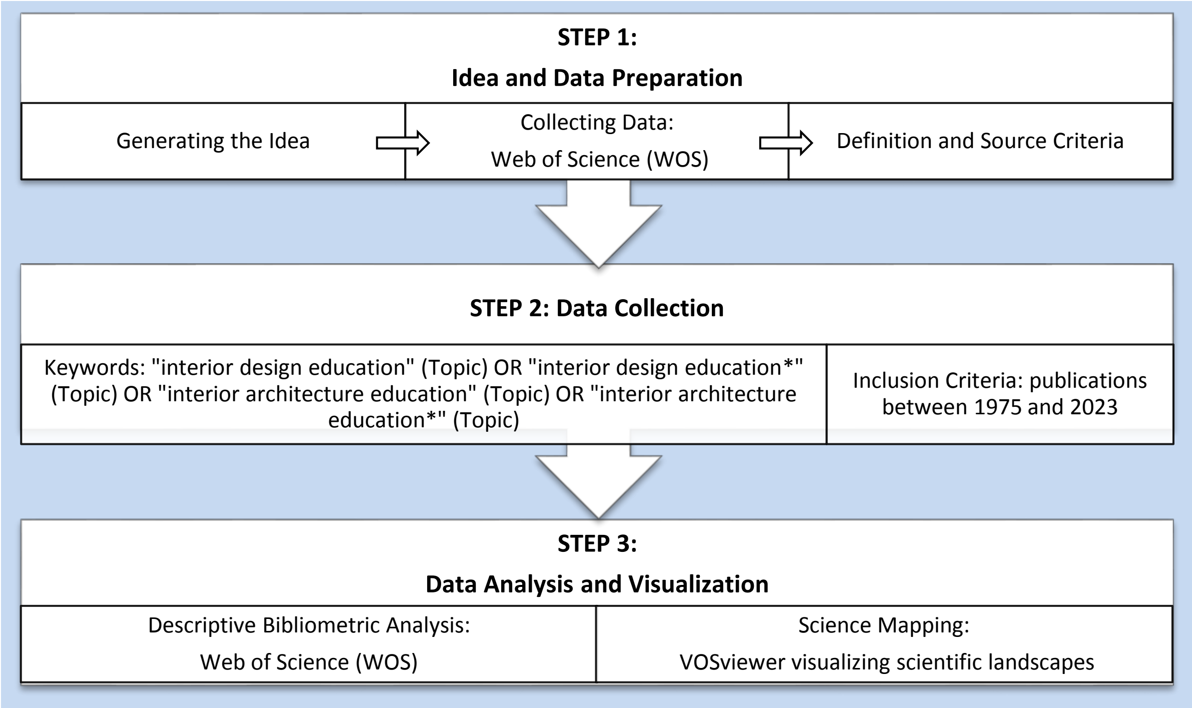

Figure 2. Research methodology and workflow steps

3. Results

3.1. Bibliometric Analysis

Studies examining publications in the field of architecture and interior architecture using the bibliometric analysis method exist in the literature (Chai & Xiao, 2012; Zhao et al., 2019; Yaşar, 2020; Park & Lee, 2022; Burkut & Koseoglu, 2022; Sauve et al., 2022). Bibliometric analyses were made using different databases on publications in architecture and interior architecture. The focuses of this study are publications on interior architecture/design education in the WOS database. Figure 3 shows the number of times these were cited, publications over time, and publications on interior architecture/design education (WOS, 2023).

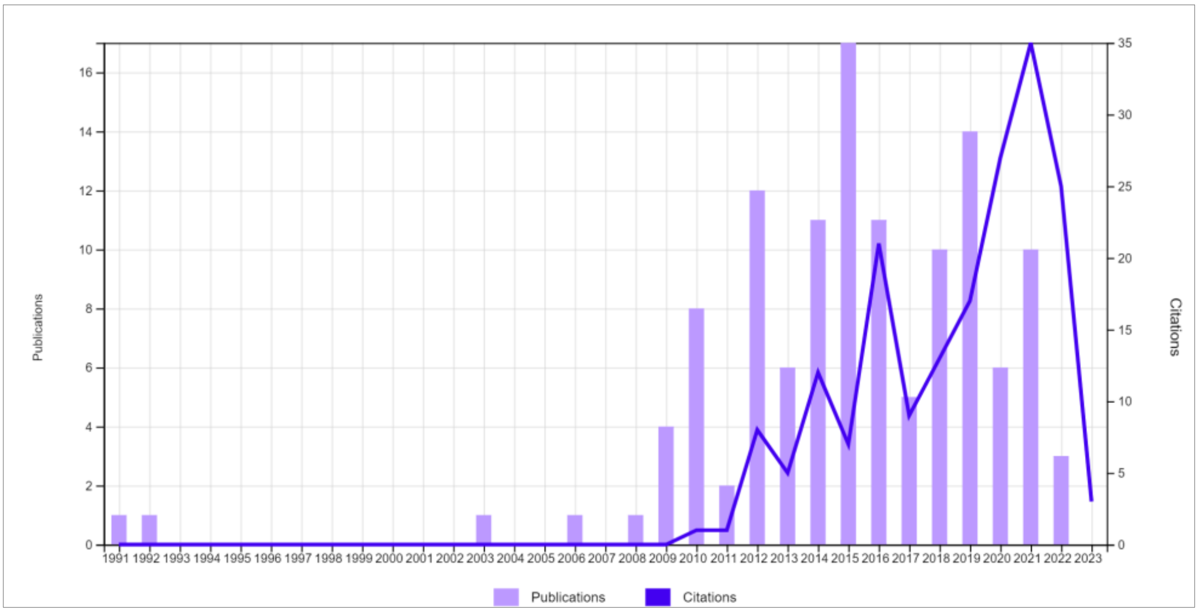

Figure 3. Times cited and publications over time (WOS, 2023)

A citation report of publications on interior architecture/design education can be seen in Figure 3 (WOS, 2023). According to the as seen in Figure 3, the year of citation and publication counts change. According to the WOS database, the most cited author is Zuo, whose citations peak in 2021. In other words, this author's numbers indicate a high increase over the years with 35 citations and ten publications, followed by Zuo et al., 2010; Demirkan & Demirbas, 2010; Olgunturk & Demirkan, 2009; Afacan, 2016; Cho & Suh, 2019; Dickinson et al., 2012; Islamoglu & Deger, 2015; Afacan, 2012; Stark & Park, 2016; Augustin, 2014. Authors, publication titles, source titles, and publication years can be seen in Table 1 in more detail.

In addition to the works mentioned above, notable research on interior architecture education includes the following topics with their corresponding authors: environmental approach in interior architecture education (Adıgüzel & Ciravoglu, 2013), design studio education (Özker & Makaklı, 2016), oral presentation competency (Hynes & Kwon, 2018), place, environmental embodiment, and architectural sustenance (Seamon, 2015), decolonizing (Hadjinani, 2020), the role of expression techniques (Özker, 2014), and interaction of fashion and interior design styles (Tavsan & Sönmez, 2013). Figure 4 below shows the results of the analysis of the publications in the Web of Science database on interior architecture education (WOS, 2023).

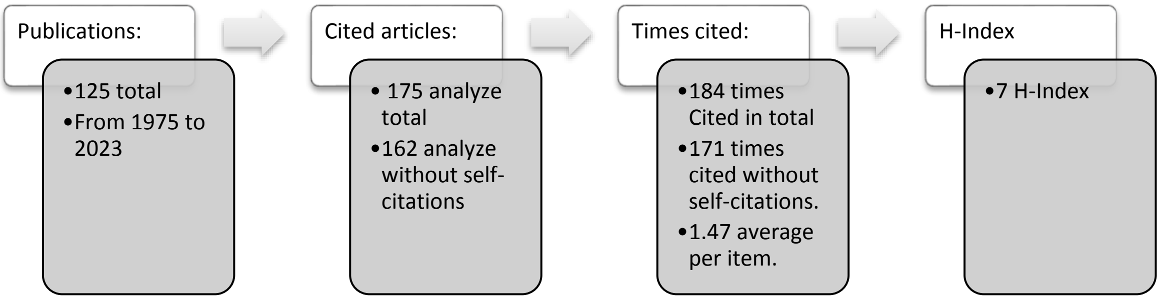

Figure 4. Citation report of publications on interior architecture/design education (WOS, 2023)

Also, the WOS database was searched using the keywords "Interior architecture education" (Topic) OR "interior architecture education*" (Topic) OR "interior design education" (Topic) OR "interior design education*" (Topic) and the results of the most cited publications (listed by number of citations) are shown in Table 1 (WOS, 2023).

Table 1. Most cited publications (listed by number of citations) (WOS, 2023)

Publication Title	**Author(s)**	**Source Title**	**Year**
1) "Integrating Performance-Based Design In Beginning **Interior Design Education**: An Interactive Dialog Between The Built Environment And Its Context"	Zuo et al., (2010)	"Design Studies"	2010
2) "The Effects Of Learning Styles And Gender On The Academic Performance Of Interior Architecture Students"	Demirkan & Demirbas (2010)	"Innovation And Creativity In Education"	2010
3) "Ergonomics And Universal Design In **Interior Architecture Education**"	Olgunturk & Demirkan (2009)	"Metu Journal Of The Faculty Of Architecture"	2009
4) "Exploring The Effectiveness Of Blended Learning In **Interior Design Education**"	Afacan (2016)	"Innovations in Education And Teaching International"	2016
5) "Understanding Spatial Ability İn **Interior Design Education**: 2D-To-3D Visualization Proficiency As A Predictor Of Design Performance"	Cho & Suh (2019)	"Journal Of Interior Design"	2019
6) "A Survey On Practitioner Attitudes Toward Research İn **Interior Design Education**"	Dickinson et al., (2012)	"Journal Of Interior Design"	2012
7) "The Location Of Computer Aided Drawing And Hand Drawing On Design And Presentation in The **Interior Design Education**"	Islamoglu & Deger (2015)	"4th World Conference On Educational Technology Researches (Wcetr-2014)"	2015
8)"Investigating The Effects Of Group Working In Studying **Interior Architecture**"	Afacan (2012)	"World Conference On Design, Arts And Education (Dae-2012)"	2012
9) "The Burnout Phenomenon: A Comparative Study Of Student Attitudes Toward Collaborative Learning And Sustainability"	Augustin (2014)	"Journal Of Interior Design"	2014

10) "**Interior Design** Students Perceptions Of Sustainability"	Stark & Park (2016)	"International Journal Of Sustainability In Higher Education"	2016
11) "Study On Instructional Methods Used in Cad Courses in **Interior Architecture Education**"	Gul (2015)	"International Conference On New Horizons In Education, (Inte 2014)"	2015
12) "Survey On The Use Of Lighting Design Software In Architecture And **Interior Design** Undergraduate **Education**"	Sarawgi (2006)	"International Journal Of Architectural Computing"	2006
13) "Impact Of Covid-19 Lockdown On Design Students' Performance Case Study In The UAE"	Amro (2022)	"International Journal Of Art & Design Education"	2022
14) "Experiential Learning Through Community Co-Design İn **Interior Design** Pedagogy"	Thamrin et al., (2019)	"International Journal Of Art & Design Education"	2019
15) "Comparison Of Conventional And Computer-Aided Drafting Methods From The View Of Time And Drafting Quality"	Ozkan &Yildirim (2016)	"Eurasian Journal Of Educational Research"	2016
16) "Factors İnfluencing Function And Form Decisions Of **İnterior Architectural Design** Studio Students"	Karsli (2015)	"International Conference On New Horizons In Education, (Inte 2014)"	2015
17) "Exploratory And Descriptive Aspects Of Environmental Psychology Course Within The **Interior Design Education**"	Yalcin (2015)	"International Conference On New Horizons In Education, (Inte 2014)"	2015
18) "Build-To-Learn: An Examination Of Pedagogical Practices In **Interior Design Education**"	Konkel (2014)	"Journal Of Interior Design"	2014
19) "Integrating Green Building Approaches To **Interior Architecture Education**: A Cross-Cultural Study"	Pektas et al., (2015)	"Open House International"	2015
20) "The contributions of workshops on formal **interior architecture education"**	Karsli & Ozker (2014)	"Erpa International Congress On Education (Erpa Congress 2014)"	2014

According to Table 1, the most cited publication on interior architecture education is Zuo et al., (2010). Then in order, the researches of Demirkan & Demirbas (2010), Olgunturk & Demirkan (2009), Afacan (2016), Cho & Suh (2019), Dickinson (2012), Islamoglu & Deger (2015) are the most cited publications.

The most recent publications published in the Web of Science database on interior architecture education are; the impact of the Covid-19 pandemic (Kamal Zaubi et. al., 2023), circular economy (Whiting et al., 2023), components of design thinking (Çavuş & Kaptan, 2022), inclusive group work (Fathallah, 2021).

Moreover, the WOS database was searched using the keywords "Interior architecture education" (Topic) OR "interior architecture education*" (Topic) OR "interior design education" (Topic) OR "interior design education*" (Topic) and the results of the document types are shown in Table 2. Accordingly, the most significant number of results was "Proceeding Paper" with 66 publications (52.8%) as a document type. Next, "Article" resulted in 54 publications (43.2%), and "Book Chapters" and "Editorial Material" had three publications (2.4%) each. "Note" and "Review Article" both resulted in one publication (0.8%) (Table 2).

Table 2. Document types (WOS, 2023)

Document types	Result Count	% of 125
Proceeding Paper	66	52.800
Article	54	43.200
Book Chapters	3	2.400
Editorial Material	3	2.400
Note	1	0.800
Review Article	1	0.800

As seen in Table 3, the greatest numbers of publications were published (52.0%) in the "Education Educational Research" category, according to the results linked to WOS category searches. Following this, "Architecture" resulted in 26 publications (20.8%), "Art" in 18 publications (14.4%), "Social Science Interdisciplinary" in 18 publications (14.4%), "Environmental Studies" in six publications (4.8%), and "Environmental Science" in five publications (4.0%). Finally, the "Green Sustainable Science

Technology", "Humanities Multidisciplinary", "Psychology Educational", and "Urban Studies" categories contained three publications each (2.4%) (Table 3).

Table 3. Web of Science categories (WOS, 2023)

Web of Science Categories	Result Count	% of 125
"Education Educational Research "	65	52.000
"Architecture"	26	20.800
"Art"	18	14.400
"Social Science Interdisciplinary"	18	14.400
"Environmental Studies"	6	4.800
"Environmental Science"	5	4.000
"Green Sustainable Science Technology"	3	2.400
"Humanities Multidisciplinary"	3	2.400
"Psychology Educational"	3	2.400
"Urban Studies"	3	2.400

The universities associated with the most publications on interior architecture/design education in the WOS database can be seen in Table 4 and are as follows: İzmir Economy University with nine publications (7.2%), İhsan Dogramacı Bilkent University with eight (6.4%), Karadeniz Technical University with eight (6.4%), and Dogus University and Istanbul Kultur University with five publications each (4.0%) (Table 4).

Table 4. University affiliations (WOS, 2023)

Affiliations	Result Count	% of 125
İzmir Economy University	9	7.200
İhsan Dogramacı Bilkent University	8	6.400
Karadeniz Technical University	8	6.400
Dogus University	5	4.000
Istanbul Kultur University	5	4.000

The journal "Procedia Social and Behavioral Sciences" has 25 publications (20.0%), the "Journal of Interior Design" has 12 (9.6%), "Inted Proceedings" has 10 (8.0%), "Iceri Proceedings" has five (4.0%), and the "International Conference on New Horizon in Education (INTE)-2014" and "Turkish Online Journal of Design Art and Communication" both have five each (4.0%) (Table 5).

Table 5. Publication titles (WOS, 2023)

Publication Titles	Result Count	% of 125
"Procedia Social and Behavioral Sciences"	25	20.000
"Journal of İnterior Design"	12	9.600
"Inted Proceedings"	10	8.000
"Iceri Proceedings"	5	4.000
"International Conference on New Horizon in Education (INTE)-2014"	5	4.000
"Turkish Online Journal of Design Art and Communication"	5	4.000

In terms of publishers, "Elsevier" resulted in 27 publications (21.6%), "Wiley" in 20 (16.0%), "(IATED)-Int Assoc. Technology in 16 (12.8%), and "Education & Development" in nine (7.2%) (Table 6).

Table 6. Publishers (WOS, 2023)

Publishers	Result Count	% of 125
"Elsevier"	27	21.600
"Wiley"	20	16.000
"(IATED)-Int Assoc. Technology, Education & Development"	16	12.800
"(IATED)-Int Assoc. Technology, Education A& Development"	9	7.200

For the countries/regions search, Türkiye resulted in 69 publications (55.2%), the USA in 25 (20.0%), China in seven (5.6%), and the United Arab Emirates in six (4.8%) (Table 7).

Table 7. Countries/regions (WOS, 2023)

Countries/Regions	Result Count	% of 125
Turkiye	69	55.200
USA	25	20.000
China	7	5.600
United Arab Emirates	6	4.800

The WOS Index contained the following: "Conference proceedings citation index-Social Science & Humanities (CPCI-SSH)" had 62 publications (49.6%), "Emerging Sources Citation Index (ESCI)" had 25 (20.0%), "Arts and Humanities Citation Index (A&HCI)" had 23 (18.4%), "Social Sciences Citation Index (SSCI)" had 12 (9.6%), "Conference Proceedings Citation Index-Science (CPCI-S)" had six (4.8%), "Science Citation Index Expanded (SCI-Expanded)" had five (4.0%), and the "Book Citation Index-Social Sciences & Humanities (BKCI-SSH)" had three (2.4%) (Table 8).

Table 8. Web of Science Index (WOS, 2023)

Web of Science Index	Result Count	% of 125
"Conference proceedings citation index-Social Science & Humanities (CPCI-SSH)"	62	49.600
"Emerging Sources Citation Index (ESCI)"	25	20.000
"Arts and Humanities Citation Index (A & HCI)"	23	18.400
"Social Sciences Citation Index (SSCI)"	12	9.600
"Conference Proceedings Citation Index-Science (CPCI-S)"	6	4.800
"Science Citation Index-Expanded (SCI-EXPANDED)"	5	4.000
"Book Citation Index-Social Sciences & Humanities (BKCI-SSH)"	3	2.400

3.2. Science Mapping Analysis

Bibliometric analysis is a practical technique for discovering and assessing literature research, as well as developing a system for examining it to uncover publication trends and patterns. Bibliometric reviews have become a popular field of study as many studies have been published in almost every area of knowledge (Chai & Xiao, 2012; Zhao et al., 2019; Yaşar, 2020; Park & Lee, 2022; Burkut & Koseoğlu, 2022; Sauve et al., 2022; Abd Aziz et al., 2022). Therefore, this review aims to contribute significantly to advancing science and the execution of interior architecture/design education. Bibliometric networks can be analyzed with VOSviewer software. There are several advanced features available for building bibliometric networks (e.g., co-authoring, bibliographic matching, and co-citation networks). Furthermore, by employing a fractional counting approach, the impact of multi-author, multi-citation, or multi-reference publications can be minimized. Thesaurus files can be used to tidy up data.

Science mapping of data obtained from databases such as WOS, Scopus, Dimensions, Lens, and PubMed is done with VOSviewer software programs. Co-authoring networks, citation-based networks, and co-occurrence networks can be created based on data downloaded from WOS, Scopus, Dimensions, LensCrossref, Europe PMC, and OpenAlex (Figure 5). Also, networks can be built based on data received via Crossref, Semantic Scholar, OpenCitations and WikiData, Europe PMC, and OpenAlex APIs. These APIs can be queried interactively in VOSviewer.

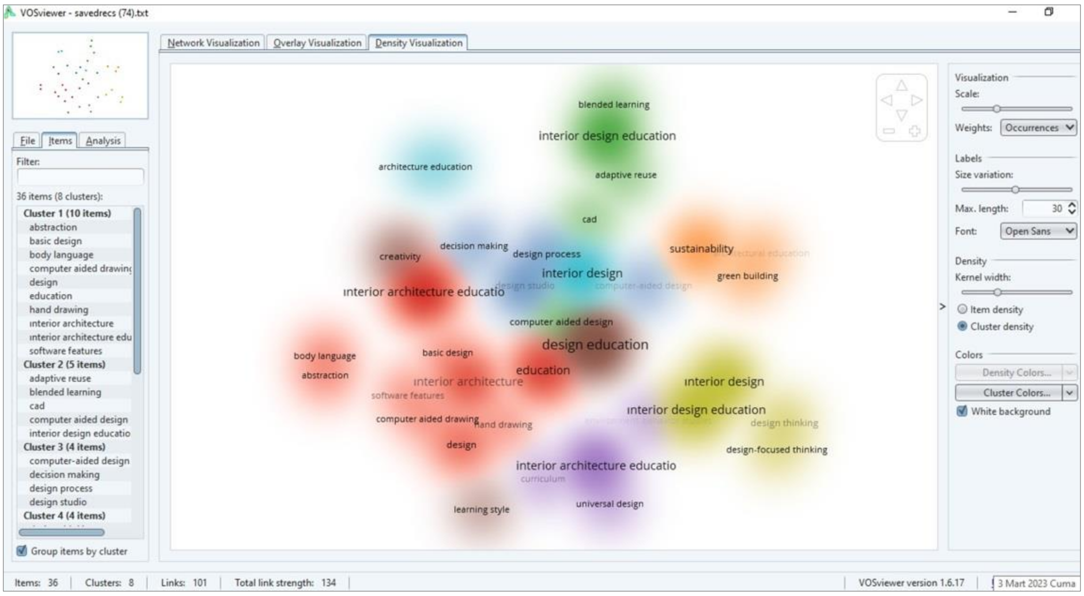

Figure 5. VOSviewer software interface

Network visualization analysis; is represented by a circle in which the elements appear with their names. The stronger the connection of this element with other elements, the larger the circle. The lines between the circles represent connections. In addition, the color of the items varies according to the subsets in which the items are located. Overlay visualization analysis creates the same visual as network visualization, except for its colors. The color of the items is determined by the scores of the items. The item with the lowest score is shown in blue and the item with the highest score is shown in yellow. Information about these colors is given in the lower right part of the analysis. Density visualization analysis can be analyzed in two different ways. The first of these is item density and the other is cluster density. Each dot in the element density visualization changes colors from blue to green to yellow, indicating the density of elements at that point.

The results of the analysis type titled co-occurrence, a unit of analysis: author keywords in the VOSviewer program are presented in Figure 6, the data of the most used words by authors in the publications on interior architecture education. Additionally, the network visualization category can be observed in the cluster (36 items) network visualization as seen in Figure 6, overly visualization between 2000 to 2020 as seen in Figure 7, and density visualization white background cluster density are also presented as seen as in Figure 8.

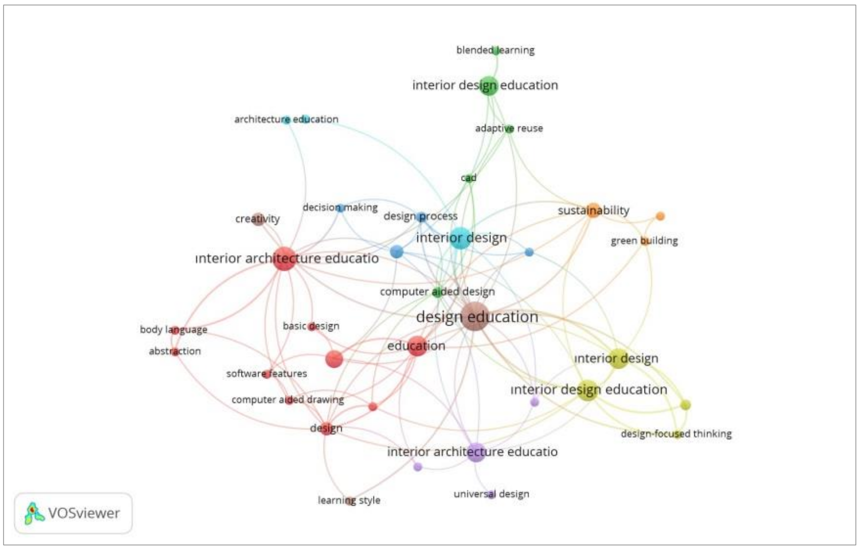

Figure 6. Type of analysis: co-occurrence, the unit of analysis: author keywords. Network visualization (min: 2)

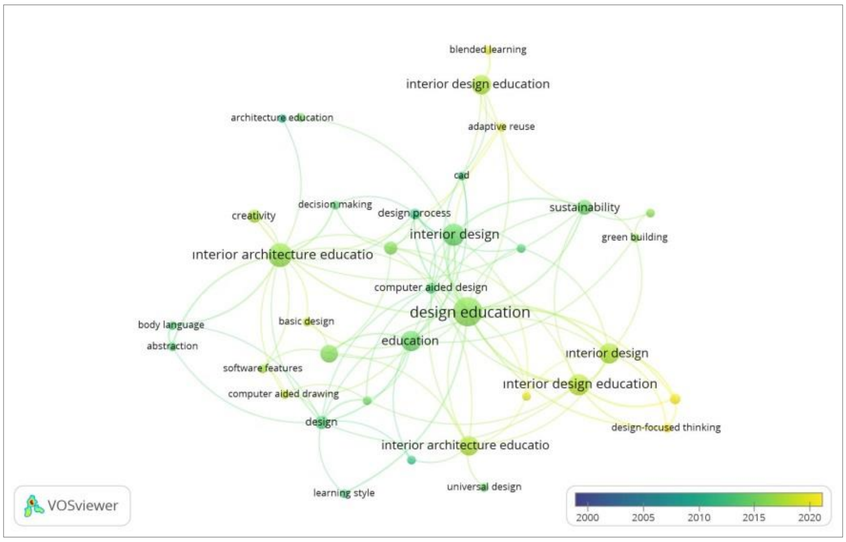

Figure 7. Type of analysis: co-occurrence, unit of analysis: author keywords. Overlay visualization 2000–2020 (min: 2)

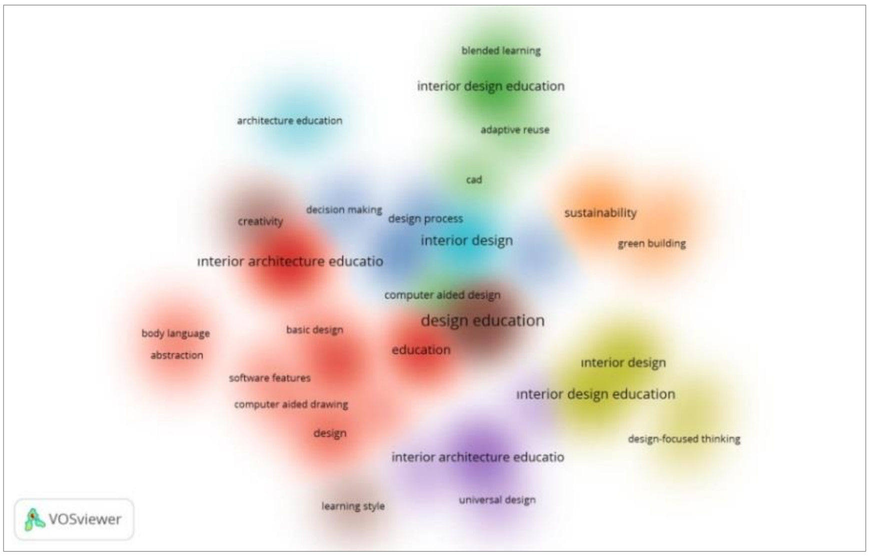

Figure 8. Type of analysis: co-occurrence, unit of analysis: author keywords. Density visualization (min: 2)

As seen as in Table 9 cluster and items of keywords that authors use most in their publications. According to the results of the Type of Analysis: Co-occurrence / Unit of Analysis: Author keywords in the VOSviewer software program, the sets of the most used words by the authors were created (Table 9).

Cluster 1: Abstraction, Basic design, Body language, Computer aided drawing, Design, Education, Hand drawing, Interior architecture, Interior architecture education, Software features.
Cluster 2: Adaptive reuse, Blended learning, Cad, Computer aided design, Interior design education.
Cluster 3: Computer aided-design, Decision making, Design process, Design studio.
Cluster 4: Design thinking, Design-focused thinking, Interior design, Interior design education.
Cluster 5: Curriculum, Environment-behavior studies, Interior architecture education, and Universal design.
Cluster 6: Architecture education, Interior design, Studio teaching
Cluster 7: Architectural education, Green building, Studio teaching.
Cluster 8: Creativity, Design education, and Learning style

Table 9. Clusters and items of keywords that authors use most in their publications

	Cluster 1 (red) (10 items)	**Cluster 2 (green) (5 items)**	**Cluster 3 (blue) (4 items)**	**Cluster 4 (yellow) (4 items)**
Keywords	Abstraction Basic design Body language Computer-aided drawing Design Education Hand drawing Interior architecture Interior architecture education Software features	Adaptive reuse Blended learning Cad Computer-aided design Interior design education	Computer aided-design Decision making Design process Design studio	Design thinking Design-focused thinking Interior design Interior design education
	Cluster 5 (purple) (4 items)	**Cluster 6 (turquoise) (3 items)**	**Cluster 7 (orange) (3 items)**	**Cluster 8 (brown) (3 items)**
Keywords	Curriculum Environment-behavior studies Interior architecture education Universal design	Architecture education Interior design Studio teaching	Architectural education Green building Studio teaching	Creativity Design education Learning style

Also, according to Figure 9, design education is at the center of the network map. Also, the relationship between design education and red, green, blue, yellow, purple, turquoise, orange, and brown clusters and keywords are shown in Figure 9.

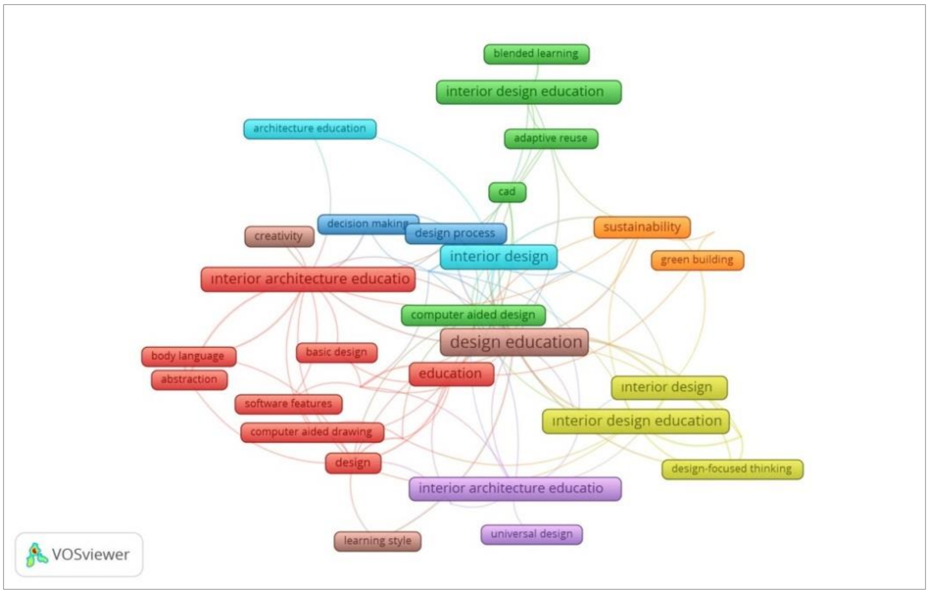

Figure 9. Type of analysis: co-occurrence, unit of analysis: author keywords

As seen in Figure 10, using VOSviewer program results of the type of analysis: bibliographic coupling, unit of analysis: sources (min: 1) and as seen as in Figure 11 (min:2) most effective sources in publications on interior architecture education; “Journal of Interior Design”, “Anadolu University Journal of Art and Design”, “Open House International”, “International Journal of Art & Design Education “, “ICONARP International Journal of Architecture and Planning”, “Turkish Online Journal of Design Art and Communication”, “Megaron” and “METU Journal of the Faculty of Architecture”.

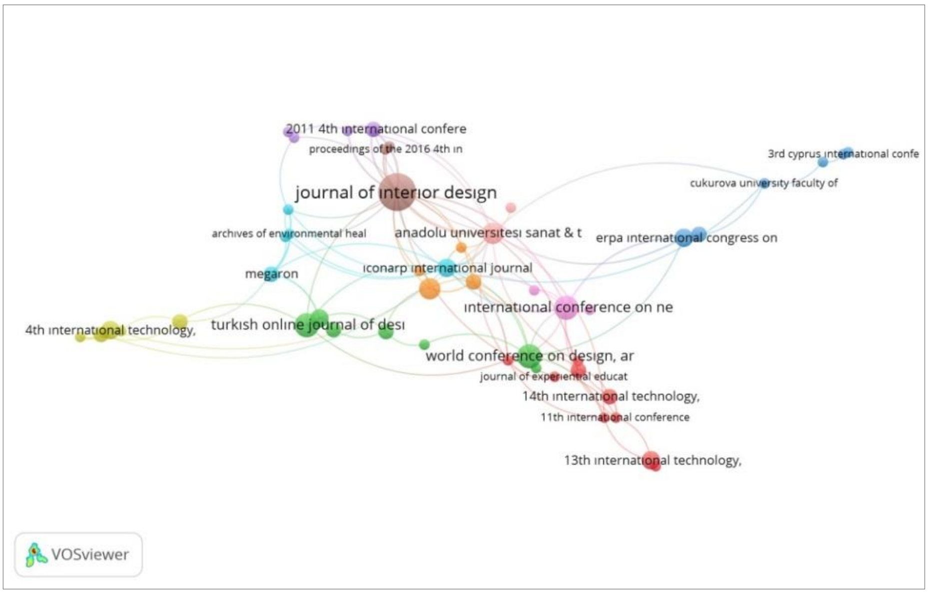

Figure 10. Type of analysis: bibliographic coupling, unit of analysis: sources (min: 1)

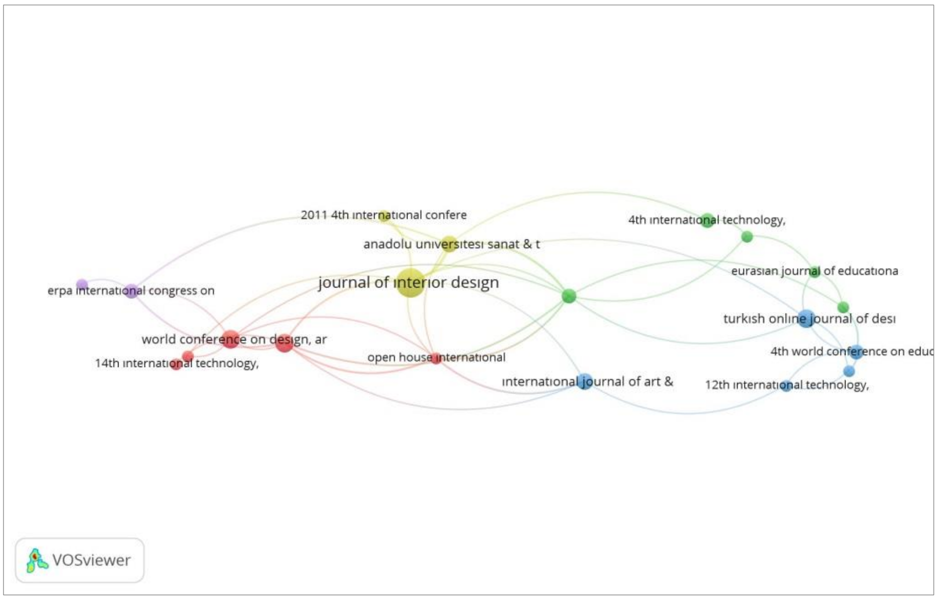

Figure 11. Type of analysis: bibliographic coupling, the unit of analysis: sources (min: 2)

To sum up, Buzan & Buzan (2002), Buzan (2006), and Edvards & Cooper (2010) asserts that mind mapping is a tool that provides us with the necessary knowledge to comprehend complex ideas simply. The mind is prepared by the mind mapping technique so that information may be used to create an image in the brain logically and imaginatively. With the mind mapping technique, the linear view is described first, followed by the core concept. It is helpful for oneself and groups as well, when it can be more effective than written reviews. As seen in Figure 12, the mind maps of publications on interior architecture education using data from the Web of Science database. It was created by the author according to the data of the documents published until 2023.

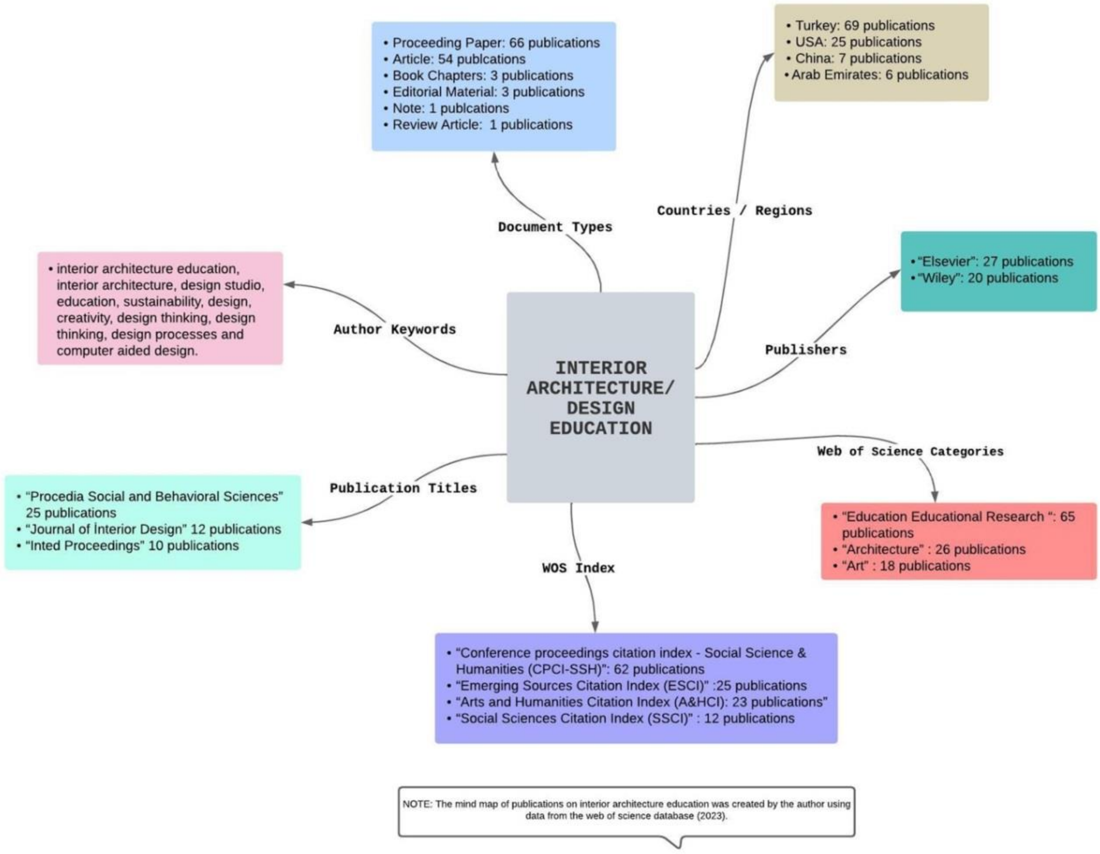

Figure 12. The mind map of publications on interior architecture education was created by the author using data from the Web of Science database (2023)

In Figure 13, a visual analysis of WordCloud (keywords plus used at the highest frequency) of the publications on interior architecture education published in web of science was made with the R Studio Biblioshiny software program. Accordingly, the most notable words are; education, design, studio, creativity, perception, communication, experience, model, impact, sustainability (Figure 13). Figure 14 is a visualization of the word cloud of the most used words by the authors. This word cloud was visualized by the author with Biblioshiny software (Figure 14).

Figure 13. The WordCloud of publications "keywords plus" on interior architecture education was created by the author using R Studio Biblioshiny software program (2023)

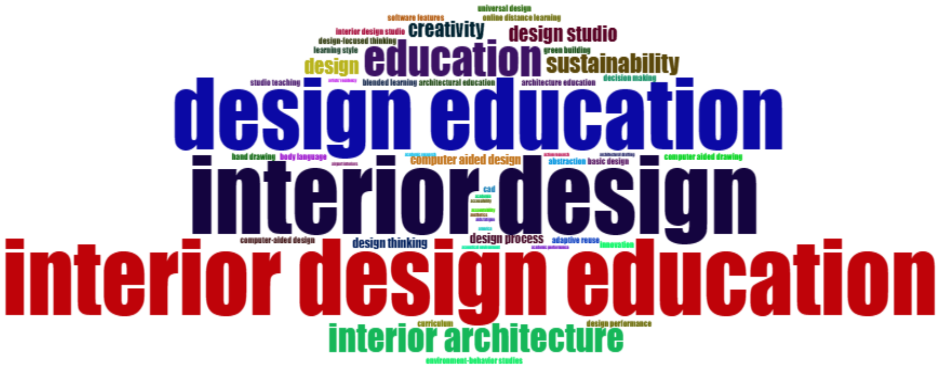

Figure 14. The WordCloud of publications "authors' keywords" on interior architecture education was created by the author using R Studio Biblioshiny software program (2023)

Figure 15 The Thematic Map of publications "authors' keywords" (density/centrality) on interior architecture education was created by the author using R Studio Biblioshiny software program. According to Figure 15 Development degree (Density) / Relevance degree (Centrality) is seen in Figure a) Motor themes; "interior architecture education", "education", "interior architecture", b) Basic themes; "interior design", "interior design education", "design education"; c) Emerging or Declining themes; "universal design", d) Niche themes; "blended learning", "design performance", "interior design studio". As seen in Table 10 the Thematic Map of publications "authors' keywords" clusters frequency analysis.

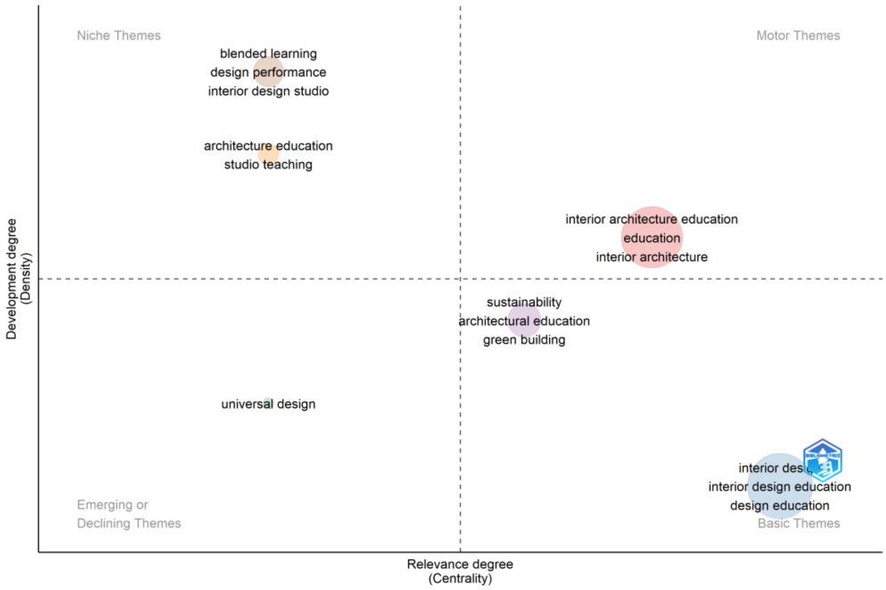

Figure 15. The Thematic Map of publications "authors' keywords" (density/centrality) on interior architecture education was created by the author using R Studio Biblioshiny software program (2023)

Table 10. The Thematic Map of publications "authors' keywords" clusters frequency analysis was created by the author using R Studio Biblioshiny software program (2023)

Cluster	Callon Centrality	Callon Density	Rank Centrality	Rank Density	Cluster Frequency
interior architecture education	0,4249091	57,25531506	5	4	71
interior design	0,7596728	41,51443363	6	1	97
universal design	0	50	2	2	2
sustainability	0,0833333	52,77777778	4	3	10
architecture education	0	62,5	2	5	4

Conclusion and Suggestions

Interior architecture/design education aims to develop and implement functional, aesthetic, sustainable, and original designs that will respond to the needs of users by evaluating the possibilities of developing technology with its human-oriented approach. In order to create healthy, comfortable, and sustainable living spaces, designing spatial elements and ensuring the unity of indoor and outdoor arrangements are also among the main topics of the department, not only limited to the interior space. This article examines searches in the WOS database related to interior architecture/design education. This research is important in evaluating the publications on interior architecture education and observing which publications exist. It also reveals deficiencies related to publications in the literature on interior architecture education. The research was solely conducted in the WOS database.

In summary, the most influential and most cited authors on interior architecture education are Zuo et al. (2010), the most frequent document type is the “proceeding paper”, and the "Education Educational Research" publication type is the most common category type. Influential journal titles include “Procedia Social and Behavioral Sciences”, the most influential publisher is “Elsevier”, the country with the most publications in the countries/regions category search is Türkiye, and the most significant number of publishers can be found in the WOS Index “Conference proceedings citation index-Social Science & Humanities (CPCI-SSH)”. In addition to these results, the words most frequently used by authors are “interior architecture education”, “interior architecture”, “design studio”, “education”, “sustainability”, “design”, “creativity”, “design thinking”, “design processes” and “computer-aided design”.

This study summarizes the findings of a bibliometric review of the literature on interior architecture education and presents a quantitative description of the dominant pattern in this field of study. However, there are limitations to the analysis technique and classification of records that must be considered. This study made use of WOS as a search tool. However, it is important to note that bibliometric reviews can also be performed using Google Scholar or various databases such as Scopus, PubMed, and ERIC. When specific keywords are searched in different databases using multiple combinations, additional or different detailed results can be accessed. Therefore, in the future, a more comprehensive study of interior architecture/design education can be performed using a separate database.

Acknowledgments and Information Note

The article complies with national and international research and publication ethics. Ethics committee permission was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

The article has a single author and there is no conflict of interest.

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Examining the Effect of Weather Conditions on On-Street Parking Variables

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Abstract

In this study, the effect of weather conditions on on-street parking variables is examined. In this context, data sets consist of 17 variables such as parking capacity, employee personnel, off-duty personnel, turn-over rate, first-hour parking price, daily parking price, number of transactions, number of cash transactions, average cash parking duration, 0-15 min parking duration, average parking duration, number of subscription, parking subscription price, daily transactions of subscription, subscription parking duration and income on the on-street parking spaces in the Anatolian Side of Istanbul for two years (2017-2018). In this study, turnover rate, parking duration, cash parking duration, and parking income variables are investigated by multiple regression analysis with dummy variables. Daily general weather data during this period are classified into 11 categories as sunny, cloudy, partly cloudy, light rain, rain, short-term heavy rainfall, heavy rainfall, light snow, light snowfall, snow, and a heavy snowstorm- as *dummy variables. Based on the estimation results, it is found that both sunny and light snow + light snowfall + snow + heavy snowstorm weather variables decrease parking duration by 0.528 and 1.293 min, respectively. Moreover, results also indicated that the same variables increase cash parking duration by 1.21 and 3.29 min, respectively. Both sunny and cloudy + partly cloudy weather variables increase parking income by 719 TL and 580 TL, respectively. Light snow + light snowfall + snow + heavy snowstorm weather variable decreases parking income by 1143 TL.*

Keywords: *ISPARK, parking variables, parking duration, weather conditions, multiple regression analysis.*

Hava Koşullarının Yol Kenarı Parklanma Değişkenleri Üzerindeki Etkisinin İncelenmesi

Öz

Bu çalışmada, hava koşullarının yol kenarı otopark değişkenleri üzerindeki etkisini incelemek için veri setleri iki yıl boyunca (2017-2018) İstanbul Anadolu Yakası'ndaki yol kenarı park yerlerinde park kapasitesi, çalışan personel, mesai dışı personel, devir hızı, ilk saat park fiyatı, günlük park fiyatı, işlem sayısı, nakit işlem sayısı, ortalama nakit park süresi, 0-15 dk park süresi, ortalama park süresi, abonelik sayısı, park abonelik fiyatı, abonelik günlük işlemleri, abonelik park süresi ve gelir gibi 17 değişkenden oluşmaktadır. Bu çalışmada, ciro oranı, park süresi, nakit park süresi ve park geliri değişkenleri kukla değişkenlerle çoklu regresyon analizi ile araştırılmıştır. Bu dönemdeki günlük genel hava durumu verileri kukla değişkenler olarak güneşli, bulutlu, parçalı bulutlu, hafif yağmurlu, yağmurlu, kısa süreli şiddetli yağış, şiddetli yağış, hafif kar, hafif kar yağışı, kar ve şiddetli kar fırtınası olmak üzere 11 kategoriye ayrılmıştır. Sonuçlara göre hem güneşli hem de hafif kar + hafif kar yağışı + kar + yoğun kar fırtınası hava değişkenlerinin park süresini sırasıyla 0,528 ve 1,293 dakika azalttığı bulunmuştur. Ayrıca, aynı değişkenlerin nakit park süresini sırasıyla 1,21 ve 3,29 dakika artırdığını da göstermiştir. Hem güneşli hem de bulutlu + parçalı bulutlu hava değişkenleri otopark gelirini sırasıyla 719 TL ve 580 TL artırmaktadır. Hafif kar + hafif kar yağışı + kar + yoğun tipi hava durumu değişkeni ise otopark gelirini 1143 TL azaltmaktadır.

Anahtar Kelimeler*: İSPARK, otopark değişkenleri, otopark süresi, hava koşulları, çoklu regresyon analizi.*

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1. Introduction

With the rapid increase in the world population after the industrial revolution, industrialization has accelerated to meet the increasing needs. Motor vehicles, which are a component of today's lifestyle, increase with the increase in population and per capita income, and their use of them is also widespread (Hajimohamadipour, 2016). Ground, air, and water are natural supplies which state is worse and worse because of civilization development. One of the factors exerting an important effect on that is road transportation. Transportation affects the natural environment through infrastructure elements, -roads, bridges, car-parking facilities-, as well as vehicles that are exhaust emission, noise, and vibrations. The natural environment, and especially the weather, experts on drivers. We can notice the growth of the intensity of vehicles together with the deterioration of the weather. Especially when the weather is rainy in Istanbul, traffic flow rates decrease and traffic density increases. This is caused by the comfort of drivers and expected shorter journey time by own passenger car than by public transportation. The increase in the number of trips affects cities' crowds, including. car-parking facilities (Parkitny, 2017a).

Transport and accessibility is one of the most important factors in achieving city image and spatial quality. Controlling and strategically managing automobile-based transport and its components is of great importance, especially for a sustainable environment and a livable city (Özkan, Öz, Demir, Gül & Gül, 2020). Today, with the development of the economy and the increase in user needs and demands, car ownership and use has become a vital necessity. However, this situation has brought along other multifaceted problems (Gül, Öz, Demir & Gül, 2019). As a result of the increasing number of vehicles with urbanisation trends in our country and in the world, the car parking problem has become a major problem in the transportation system infrastructure and superstructure inadequacy (Gül et al., 2019). In order to create a more livable and sustainable transport system in cities, the main approach will be to try to adapt cities to automobiles and to try to adapt automobiles to cities instead of building more roads and/or car parks (Özkan et al., 2020). Within the scope of the city's transportation system, the main objective of car park management planning should be to associate and prioritise the parking space needs and demands of different users, and to produce equitable and balanced solutions according to social, economic, technological, spatial, environmental and climatic conditions (Gül et al., 2019).

The literature suggests that on-street parking demand is negatively related to on-street parking prices, but its sensitivity depends on the user and trip characteristics (Gragera & Albalate, 2016). On-street parking demand depended upon the journey purpose (Kelly & Clinch, 2006; Simicevic et al., 2012) decreases with income (Gillen, 1977; Shoup & Wilson, 1992), increases with the duration of stay (Khodaii et al., 2010; Kobus et al., 2013), and increases with the level of alternative modes of transportation (Hess, 2001; Weis et al., 2012). Furthermore, hostile weather conditions or climates can impact walking (Barter, 2016). Conditions such as weather conditions, car-park capacities, occupancy rates, and prices can be effectively created for driver's behavior as finding alternative parking, traveling at a different time, choosing a different mode of transportation, changing the destination, and avoiding the whole trip (ICPMMP, 2016). A study conducted by Parkitny (2017a), undertakes a trial of researching the effect of weather on the occupation of parking spaces. The investigation aims to check the dependence between the chosen weather conditions, e.g., temperature, falling, clouding, and the utilization of parking spaces. Observations in the study also show that road vehicle traffic in a city increases when the weather gets worse (Parkitny, 2017a). In the master thesis by Harris (2004), current United States parking regulations determine if and how well design principles with climate have been incorporated. Rules are then given to help in the construction of a parking regulation that aims to improve the city's microclimate. A design is created that shows how these parking rules can be incorporated into functional, aesthetically pleasing parking (Harris, 2004).

On-street parking locations in the Anatolian Side of Istanbul are chosen as the research area. Istanbul, which is one of the largest cities in Türkiye, encompasses nearly 15.06 million people, along with a high rate of motorization lately. The dynamic increase in population and expanding its territory in Istanbul cause many problems. One of the most difficult problems to solve is the large parking problems in the megacity as well as the problem of the increasing number of vehicles, particularly passenger cars.

Since there are a few studies in the literature examining the relationship between weather conditions and street parking, the current study would make a significant contribution to the literature. In this context, some modeling approaches on car-parking spaces are shown in Table 1.

Table 1. Different models of car parks' functioning in literature

Models of car parks' functioning	***Researchers***
Checking dependence between the chosen weather conditions, e.g., temperature, falling, clouding, and the utilization of parking spaces.	Parkitny, 2017a
The thesis looks at current United States parking regulations to determine if and how well design principles with climate have been incorporated.	Harris, 2004
Analyzed the impact of garage fee and on-street parking regulation characteristics (price and type of dedicated spaces) on multi-story car-park demand (for both occasional parkers and subscribers).	Gillen, 1977; Shoup & Wilson, 1992; Khodaii et al., 2010; Kobus et al., 2013; Gragera, 2017; Demir, 2019.
Analyzed the specific behavior of garage users, and the interactions between on- and off-street parking regulation tools (i.e. fees, duration limits, parking permits, type of spaces, and the level of enforcement)	Tsamboulas, 2001; Khodaii et al., 2010; Simicevic et al., 2012, 2013; Kobus et al., 2013.
Taking advantage of parking transaction data	Kelly & Clinch, 2009; Pierce & Shoup, 2013; Kobus et al., 2013.
Both on-street parking and multi-story car-park demand are negatively related to parking price	Kobus et al., 2013; Simicevic et al., 2013.
The substitution effect between multi-story carpark and on-street parking was first empirically suggested. They estimated probit models on the choice between them, based on stay duration.	Kobus et al. (2013)
Empirical studies on parking demand have generally focused on the impact of on-street parking rules on commuters' travel choices using stated or revealed preference surveys	Concas & Nayak, 2012.
Model of setting parking prices	Nourinejad & Roorda, 2017.
About the Role of Drivers' psychological characteristics in the parking space selection process	Guo et al., 2013a.
Defining environmental costs associated with searching for parking spaces	Guo et al., 2013b; İnci & Robin, 2015; İnci et al., 2017.
Logit models to estimate the behavior of passenger car drivers concerning car parks choice	Parkitny, 2014.
Using game theory to describe the relationship between parking administrators and drivers	Zong et al., 2013.
Use the game theory in modeling equipment and parking fees. By modifying fees for parking as well as parking equipment, parking administrators can increase the attractiveness of car parking spaces and enlarge financial receipts from parking payments	Parkitny (2017-b)

Paid attention to data's credibility of information systems models about parking locations	Hoh et al., 2012.
Reviewing urban parking models	Young et al., 1991.
Effect of on-street parking locations on traffic flow speeds	Uzun, 2009; Praburam & Koorey, 2015; Uzun et al., 2021.
Other car parking models (game theory and et al.)	Goyal & Gomes, 1984; Hunt & Teply, 1993; Thompson & Richardson, 1998; Shoup, 2006; Arnott & İnci, 2010. Ayala et al., 2011; Ayala et al., 2012: Azari et al., 2013; Arnott et al., 2015; Mejri et al., 2016.

In this study, the effect of weather conditions on on-street parking variables is examined. For this purpose, data sets consist of 17 variables such as parking capacity, employee personnel, off-duty personnel, turn-over rate, first-hour parking price, daily parking price, number of transactions, number of cash transactions, average cash parking duration, 0-15 min parking duration, average parking duration, number of subscription, parking subscription price, daily transactions of subscription, subscription parking duration and income on the on-street parking spaces in the Anatolian Side of Istanbul for two years (2017-2018). Turn-over rate, parking duration, cash parking duration, and parking income variables are investigated by multiple regression analysis with daily general weather data as dummy variables classified in sunny, cloudy, partly cloudy, light rain, rain, short-term heavy rainfall, heavy rainfall, light snow, light snowfall, snow, heavy snowstorm. The weather data are used in regression analysis by firstly 6 and then 4 dummy variables, by combining both the correlation coefficients and frequency in general weather data. The study consists of five sections. In the first section: is the importance of the subject, in the second section: is a brief review of the literature, in the third section: is the creation of the data set related to the study areas, meteorological data and classification, dummy variable regression analysis, and information about the dependent and independent variables used in the analysis, in the fourth section: regression analyzes and other discussions on the subject, and the conclusion and suggestions are given in the last section.

2. Material and Methods

In this section, information on both Istanbul and especially car-parking operations on the Anatolian Side is given. The distribution of 2-year weather data recorded with daily observations in 11 categories is classified. In the next step, the dummy variable regression analysis is briefly introduced, and the dependent and independent variables used in the regression analysis (the values in the data sets used in the regression analysis are daily average values) are presented.

2.1. Study Area (Anatolian Side and Istanbul)

Istanbul which has 39 districts, 959 neighborhoods, approx. 3.9 million residential and a population of 15.067 million according to the address-based population registration system has a surface area of 5,461 km^2, a road network of 32,386 km, and 4,173,312 vehicles. In addition, approximately 465 new vehicles are registered daily, and 14.5 passengers are traveling by public transport (IETT, 2018; TUIK, 2017). As of the end of 2018, vehicle ownership is calculated as 276 vehicles / 1,000 people and car ownership is 193 cars / 1,000 people in Istanbul. Istanbul has 4.173 million road vehicles 2.887 million of which are passenger cars (IETT, 2018). These values tend to increase over time for Istanbul. When the values of the last 10 years are taken into consideration, an average of 355 new cars are registered every day in Istanbul. This value is equivalent to a large multi-story car park capacity. In other words, the construction of a large multi-story car park every day for vehicles participating in traffic in Istanbul will only be able to meet the need of vehicles registered newly. The mobility rate in Istanbul is approx. 2.07 (IETT, 2018).

Istanbul Parking Management Trade Inc (ISPARK Inc.), a semi-private establishment, was established in 2005 by Istanbul Metropolitan Municipality. The collections that continued with the counterfoil ticket up to 2008 were gradually replaced by handheld terminals. On-street parking with SMS was implemented on a local basis in 2009, but it has not been currently continued. Multifunctional handheld terminals are used with software in which parking declaration can be made both by mobile phone and parking attendant. After a vehicle enters the parking space, the vehicle's number plate manually is written in the system by the attendant according to the relevant platform number and it is logged into the system with the relevant options by asking for the planned parking duration (Gurbetci et al., 2007; Demir & Çavdar, 2008; Yardım & Demir, 2009; Gurbetci et al., 2014; Demir, 2019). ISPARK has operated approx. 95,000 paid parking spaces in both on-street (most of which are operated during day times, generally between 08:00 am - 6:00 pm) and off-street parking facilities.

All on-street parking locations in the Anatolian Side of Istanbul are chosen in the study. The parking capacity of the Anatolian Side, approximately 33% of the total parking capacity, is given in Table 2

Table 2. Parking inventory of ISPARK (ICPMMP, 2016; Demir, 2019)

	Anatolian Side	*Europan Side*	*Total*
Number of locations	186	456	642
Total parking capacities	30624	61051	91675
On-street parking capacities	4804	10081	14885
Multi-story car parking capacities	5543	16075	21628
Surface parking capacities	13703	27558	41261
P+R parking capacities	6574	7287	13861
Number of transactions per day	38896	63594	102490

2.2. Meteorology Data and Their Classifications

Daily general weather data for two years are classified into 11 categories as sunny, cloudy, partly cloudy, light rain, rain, short-term heavy rainfall, heavy rainfall, light snow, light snowfall, snow, and heavy snowstorm. In Table 3, the weather data are used in regression analysis by firstly 11, then 6, and finally 4 dummy variables, by combining both the correlation coefficients and frequency in general weather data. In addition, 2-year weather statistics are given in Table 4.

Table 3. General weather conditions as dummy variables

11 variables	*6 dummy variables*	*4 dummy variables*
1. Sunny (S) 2. Cloudy (C) 3. Partly cloudy (PC) 4. Light rain (LR) 5. Rain (R) 6. Short-term heavy rainfall (STHR) 7. Heavy rainfall (HR) 8. Light snow (LS) 9. Light snowfall (LSF) 10. Snow (SN) 11. Heavy snowstorm (HS)	1. Sunny 2. Cloudy + Partly cloudy 3. Light rain 4. Rain 5. Short-term heavy rainfall + Heavy rainfall 6. Light snow + Light snowfall + Snow + Heavy snowstorm	1. Sunny 2. Cloudy + Partly cloudy 3. Light rain + Rain + Short-term heavy rainfall + Heavy rainfall 4. Light snow + Light snowfall + Snow + Heavy snowstorm

Table 4. Two-year weather statistics (In the 2 years, on-street parking locations have been operated for 706 -days)

Weather conditions	***Number of working days***		
	On-street	***Surface***	***Multi-storey***
Sunny	226	237	237
Cloudy	63	64	64
Partly cloudy	271	277	277
Short-term heavy rainfall	4	4	4
Heavy rainfall	21	22	22
Light rain	58	58	58
Rain	54	57	57
Light snow	3	3	3
Light snowfall	3	3	3
Snow	3	3	3
Heavy snowstorm	-	2	2

2.3. Dummy Variable Multiple Regression Model

Whether or not there is a relationship between two variables, and if so, determining the extent of this relationship is a method often employed in statistical analyses. For this purpose, regression analysis is a widely used technique in examining the relationship between variables (Newbold et al., 2013). Regression analysis is the explanation of relations between dependent variables and independent or multiple independent variables through mathematical equations. Success in regression analysis depends on the availability of the appropriate and reliable dataset. In regression analysis, the relation between X_j independent variables and Y_j dependent variables is stated as a mathematical function. By plotting the scatter diagram between dependent and independent variables, it is determined whether a linkage between two variables can be correlated or not, and what kind of function will be considered if it can be correlated. For example, if a linear relationship is assumed between Y and X such as $Yj = \alpha + \beta X_j + \varepsilon_j$ (j= 1, 2, 3, ... n), then the first step is to estimate the unknown parameters (α and β) of the model. Once the unknown parameters of the model are estimated, estimating the value of the dependent variable for different values of the independent variables is another purpose of the regression (Newbold et al., 2013; Karaca & Karacan, 2016). In the multiple regression model, for p explanatory variables and n observations; it can be formulated as $Yj = \beta_0 + \beta_1 X_{1j} + \beta_2 X_{2j} + \ldots + \beta_p X_{pj} + \varepsilon_j$ (j = 1, 2, … n). It is necessary to provide some assumptions about the model for parameter estimates of the regression model, which are obtained by both simple and multiple regression analysis, to be reliable.

Dummy variables for regression models: Assuming the independent variables, xj, exist over a range and contain many different values. However, in the multiple regression assumptions, the only constraint on independent variables is that they are constant values. Thus, we can have an independent variable that takes on only two values: xj = 0 and xj = 1. This structure is commonly defined as a dummy variable, and we will see that it provides a valuable tool for applying multiple regression to the respective situations. An important example is a linear function that changes in response to some effects (Newbold et al., 2013).

In this study, dependent and independent variables in multiple regression models are given in Table 5. These parameters -turnover rate, average cash parking duration, average parking duration, and parking income- are variables that can be affected by weather conditions. Dummy variables used in the multiple regression model are given in Table 3.

Table 5. Dependent and independent variables in multiple regression model

Dependent variable	Independent variable(s)*	Number of the independent variable(s)	Observations
Turn-over rate	Capacity (C), employee personnel (EP), off-duty personnel (ODP), turn-over rate (TOR), first-hour parking price (FHPP), daily parking price (DPP), number of transactions (NoT), number of cash transactions (NoCT), average cash parking duration (ACPD), average parking duration (APD), number of subscription (NoS), parking subscription price (PSP), daily transactions of subscription (ToS), subscription parking duration (SPD), income (I), number of transactions - NoT (0-15 min), average parking duration - APD (0-15 min)	On-street: 16	706
Parking duration*, s			
Cash parking duration, s			
Parking income, TL			

***** Variable "parking duration" is the average of paid, free, and 0-15 min. parking duration

3. Results and Discussion

In this study, datasets in multiple regression analysis with dummy variables consist of 17 variables such as parking capacity, employee personnel, off-duty personnel, turn-over rate, first-hour parking price, daily parking price, number of transactions, number of cash transactions, average cash parking duration, 0-15 min parking duration, average parking duration, number of subscription, parking subscription price, daily transactions of subscription, subscription parking duration and income in the on-street parking spaces in the Anatolian side of Istanbul for two years (2017-2018). The effects of weather conditions on turn-over rate, parking duration, cash parking duration, and parking income variables are summarized as follows.

3.1. Effect of Weather Conditions On Turn-Over Rate

In the correlation analysis of the variables, it is determined that the first hour and daily parking price variables have the same correlation effect, and the first-hour parking price variable from these variables is included in the regression model (This is also applied to other regression analyzes). In the first regression analysis, off-duty personnel (ODP), number of transactions (NoT), average cash parking duration (ACPD), average parking duration (APD), and parking subscription price (PSP) that have P-values greater than 0.05 are also subtracted from the data set. The second regression analysis statistics with 706 observations are given in Table 6. The R square for the turnover rate is 99.6%. Ten of the coefficients in the regression statistics have P-values less than 5%. It is determined that the weather condition variables used as dummy variables do not affect the turnover rate. The first-hour parking price (FHPP) has also the biggest effect on it. For each unit (TL) increase in FHPP, the turnover rate increases by 0.446 units.

The estimated regression equation for turnover rate (1) is;

$$\boldsymbol{TOR} = -0.0013*C + 0.00503*EP + 0.446*FHPP + 0.00044*NoCT + 0.00013*NoT\ (0\text{-}15\ min) - 0.0081*APD\ (0\text{-}15\ min) + 0.00176*NoS + 0.00077*ToS + 0.00048*SPD + 0.000012*I \quad (1)$$

Table 6. The turnover rate in on-street parking spaces was analyzed using a dummy variable multiple regression model

Regression Statistics	
Multiple R	0.99798
R Square	0.99596
Adjustable R Square	0.99444
Standard Error	0.19953
Observation	706

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	14	6790.07	485.005	12182.6	0
Difference	692	27.5494	0.03981		
Total	706	6817.62			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Low 95%*	*High 95%*	*Low 95.0%*	*High 95.0%*
Intersection	0	-	-	-	-	-	-	-
C	-0.0013	4.5E-05	-28.894	5E-121	-0.0014	-0.0012	-0.0014	-0.0012
EP	0.00503	0.00096	5.26646	1.9E-07	0.00316	0.00691	0.00316	0.00691
FHPP, TL	0.44655	0.12876	3.46809	0.00056	0.19374	0.69935	0.19374	0.69935
NoCT	0.00044	4.5E-05	9.68566	6.8E-21	0.00035	0.00053	0.00035	0.00053
NoT (0-15 min)	0.00013	2.7E-05	4.725	2.8E-06	7.4E-05	0.00018	7.4E-05	0.00018
APD (0-15 min)	-0.0081	0.00112	-7.2	1.6E-12	-0.0103	-0.0059	-0.0103	-0.0059
NoS	0.00176	0.00034	5.15825	3.3E-07	0.00109	0.00244	0.00109	0.00244
ToS	0.00077	0.0003	2.54332	0.0112	0.00017	0.00136	0.00017	0.00136
SPD	0.00048	0.0002	2.47607	0.01352	0.0001	0.00087	0.0001	0.00087
I, TL	1.2E-05	4.9E-06	2.54363	0.01119	2.8E-06	2.2E-05	2.8E-06	2.2E-05
DV_{C+PC}	-0.191	1.04576	-0.1826	0.85516	-2.2442	1.86227	-2.2442	1.86227
DV_{S}	-0.1335	1.04311	-0.128	0.89822	-2.1815	1.91457	-2.1815	1.91457
$DV_{LS+S+HS}$	-0.1545	1.05251	-0.1468	0.88337	-2.2209	1.91203	-2.2209	1.91203
$DV_{LR+R+STHR+HR}$	-0.1487	1.0465	-0.1421	0.88703	-2.2034	1.90598	-2.2034	1.90598

3.2. Effect of Weather Conditions on Parking Duration

In the first regression analysis, TOR, EP, ODP, NoT, NoCT, and PSP variables that have P-values greater than 0.*05* are also subtracted from the dataset. The second regression analysis statistics with 706 observations are given in Table 7. The R square for parking duration is 97.3%. Nine of the coefficients in the regression statistics have P-values less than 5%. First-hour parking price (FHPP) has also the biggest effect on parking duration. For each TL increase in FHPP, parking duration decreases by 4.32 min. It is also determined that sunny (DV_S) and light snow + light snowfall + snow + heavy *snowstorm* ($DV_{LS+S+HS}$) weather variables used as dummy variables decrease parking duration by 0.528 and 1.293 min, respectively. None of the other weather condition variables in the model are significantly associated with parking duration.

The estimated regression equation for parking duration (2) is;

$$\mathbf{APD} = 45.61 + 0.00015*I + 0.00162*C - 4.322*FHPP - 0.0030*NoT\ (0\text{-}15\ min) + 0.491*ACPD + 0.405*APD\ (0\text{-}15\ min) + 0.024*ToS - 0.0099*NoS + 0.006*SPD - 0.528*DV_S - 1.293*DV_{LS+S+HS} \quad (2)$$

Table 7. Parking duration in on-street parking spaces was analyzed using a dummy variable multiple regression model

Regression Statistics	
Multiple R	0.986423
R Square	0.973031
Adjustable R Square	0.972604
Standard Error	1.519695
Observation	706

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	11	57827.6	5257.055	2276.301	0
Difference	694	1602.774	2.309473		
Total	705	59430.38			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Low 95%*	*High 95%*	*Low 95.0%*	*High 95.0%*
Intersection	45.61507	6.621681	6.888744	1.26E-11	32.61414	58.616	32.61414	58.616
I, TL	0.000148	1.95E-05	7.571008	1.18E-13	0.000109	0.000186	0.000109	0.000186
C	0.001621	0.000281	5.77702	1.15E-08	0.00107	0.002171	0.00107	0.002171
FHPP, TL	-4.321919	0.787366	-5.489085	5.67E-08	-5.867824	-2.776014	-5.867824	-2.776014
NoT (0-15 min)	-0.003064	0.000184	-16.6892	7.95E-53	-0.003424	-0.002703	-0.003424	-0.002703
ACPD, min	0.491828	0.008493	57.90787	6.1E-268	0.475153	0.508504	0.475153	0.508504
APD (0-15 min)	0.405724	0.008662	46.8399	4.6E-217	0.388717	0.422731	0.388717	0.422731
NoS	-0.009922	0.002402	-4.130865	4.05E-05	-0.014638	-0.005206	-0.014638	-0.005206
ToS	0.02444	0.001998	12.23228	2.7E-31	0.020517	0.028363	0.020517	0.028363
SPD	0.00605	0.0015	4.03296	6.12E-05	0.003105	0.008996	0.003105	0.008996
DV_S	-0.528763	0.133875	-3.949671	8.63E-05	-0.791611	-0.265914	-0.791611	-0.265914
$DV_{LS+S+HS}$	-1.293281	0.520509	-2.484646	0.013203	-2.315242	-0.271319	-2.315242	-0.271319

3.3. Effect of Weather Conditions on Cash Parking Duration

In the first regression analysis, TOR, EP, ODP, NoT, NoCT, and PSP variables that have P-values greater than 0.05 are also subtracted from the data set. The second regression analysis statistics with 706 observations are given in Table 8. The R square for cash parking duration is 88.8%. Nine of the coefficients in the regression statistics have P-values less than 5%. First-hour parking price (FHPP) has also the biggest effect on cash parking duration. For each TL increase in FHPP, cash parking duration increases by 9.36 min. It is also determined that both *sunny (DV_S) and light snow + light snowfall + snow + heavy snowstorm ($DV_{LS+S+HS}$)* weather variables used as dummy variables increase cash parking duration by *1.21 and 3.29 min*, respectively. None of the other weather condition variables in the model are significantly associated with cash parking duration.

The estimated regression equation for cash parking duration (3) is

$$\mathbf{ACPD} = -77.9 + 1.684*APD - 0.00026*I - 0.0037*C + 9.36*FHPP + 0.0058*NoT\ (0\text{-}15\ min) - 0.626*APD\ (0\text{-}15\ min) + 0.022*NoS - 0.0419*ToS - 0.0153*SPD + 1.21*DV_G + 3.29*DV_{LS+S+HS} \qquad (3)$$

Table 8. Cash parking duration in on-street parking spaces was analyzed using a dummy variable multiple regression model

Regression Statistics	
Multiple R	0.942328
R Square	0.887982
Adjustable R Square	0.885713
Standard Error	2.81611
Observation	706

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	14	43440.54	3102.895	391.2623	0
Difference	691	5479.958	7.930475		
Total	705	48920.49			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Low 95%*	*High 95%*	*Low 95.0%*	*High 95.0%*
Intersection	-77.9035	12.40699	-6.279	6.02E-10	-102.263	-53.5436	-102.263	-53.5436
APD, min	1.684183	0.029169	57.73896	1.3E-266	1.626912	1.741453	1.626912	1.741453
I, TL	-0.00026	3.87E-05	-6.77839	2.61E-11	-0.00034	-0.00019	-0.00034	-0.00019
C	-0.0037	0.000529	-6.99593	6.24E-12	-0.00474	-0.00266	-0.00474	-0.00266
FHPP, TL	9.361899	1.453591	6.440534	2.23E-10	6.507915	12.21588	6.507915	12.21588
NoT (0-15 min)	0.005853	0.000339	17.2504	1.01E-55	0.005187	0.006519	0.005187	0.006519
APD (0-15 min)	-0.62557	0.022496	-27.8076	8.7E-115	-0.66974	-0.5814	-0.66974	-0.5814
NoS	0.022188	0.004434	5.004033	7.13E-07	0.013482	0.030894	0.013482	0.030894
ToS	-0.04193	0.003771	-11.1192	1.55E-26	-0.04933	-0.03453	-0.04933	-0.03453
SPD	-0.01535	0.002764	-5.55568	3.95E-08	-0.02078	-0.00993	-0.02078	-0.00993
DV_{C+PC}	0.051368	0.40644	0.126386	0.899463	-0.74664	0.849374	-0.74664	0.849374
DV_{S}	1.213028	0.421449	2.878231	0.004123	0.385553	2.040503	0.385553	2.040503
$DV_{LS+S+HS}$	3.293337	1.019098	3.231621	0.001289	1.292438	5.294237	1.292438	5.294237
DV_{R}	0.040244	0.54095	0.074394	0.940718	-1.02186	1.102346	-1.02186	1.102346
$DV_{LR+STHR+HR}$	-0.62041	0.684982	-0.90573	0.365397	-1.9653	0.72449	-1.9653	0.72449

Table 9. Income in on-street parking spaces was analyzed using a dummy variable multiple regression model

Regression Statistics	
Multiple R	0.988828
R Square	0.977781
Adjustable R Square	0.977396
Standard Error	1715.023
Observation	706

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	12	8.97E+10	7.47E+09	2541.39	0
Difference	693	2.04E+09	2941303		
Total	705	9.17E+10			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Low 95%*	*High 95%*	*Low 95.0%*	*High 95.0%*
Intersection	-111344.8	9700.151	-11.47866	4.82E-28	-130390	-92299.57	-130390	-92299.57
TOR	2282.144	302.9572	7.532893	1.55E-13	1687.32	2876.968	1687.32	2876.968
C	5.746847	0.433791	13.24798	7.16E-36	4.895146	6.598548	4.895146	6.598548
FHPP, TL	15772.13	944.105	16.70591	6.68E-53	13918.48	17625.78	13918.48	17625.78
NoCT	6.928914	0.278429	24.88575	3.62E-98	6.382249	7.47558	6.382249	7.47558
APD (0-15 min)	-83.24899	13.19134	-6.310884	4.95E-10	-109.1488	-57.34921	-109.1488	-57.34921
APD, min	84.05163	17.67854	4.754444	2.42E-06	49.3417	118.7616	49.3417	118.7616
NoS	28.29809	2.625609	10.77772	3.8E-25	23.14299	33.45319	23.14299	33.45319
PSP	-92.34547	28.2074	-3.273803	0.001114	-147.7277	-36.96326	-147.7277	-36.96326
ToS	-14.02526	2.233158	-6.280461	5.96E-10	-18.40982	-9.640692	-18.40982	-9.640692
DV_{C+PC}	580.2192	184.5786	3.14348	0.001741	217.8189	942.6196	217.8189	942.6196
DV_S	719.2909	193.4212	3.718779	0.000216	339.529	1099.053	339.529	1099.053
$DV_{LS+S+HS}$	-1143.241	595.4968	-1.91981	0.055292	-2312.435	25.95347	-2312.435	25.95347

3.4. Effect of Weather Conditions on Parking Income

In the first regression analysis, NoT, EP, ODP, NoT (0-15 min), ACPD, and SPD variables that have P-values greater than 0.05 are also subtracted from the data set. The second regression analysis statistics with 706 observations are given in Table 9. The R square for parking income is 97.7%. Nine of the coefficients in the regression statistics have P-values less than 5%. First-hour parking price (FHPP) has also the biggest effect on parking income. For each TL increase in FHPP, parking income increases by 15,772 TL. It is also determined that both *sunny (DV_S) and cloudy + partly cloudy (DV_{C+PC})* weather variables used as dummy variables increase *parking income by 719 TL and 580 TL*, respectively. (*Cloudy + partly cloudy (DVC+PC) weather conditions have had an increasing effect on the turnover rate. The average general turnover rate is 3.07; in cloudy + partly cloudy weather, it increases to 3.14 and the average cash parking time is reduced to a small extent).*

Light snow + light snowfall + snow + snow + heavy snowstorm ($DV_{LS+S+HS}$) weather variable, used as a dummy variable *decreases parking income by 1143 TL.* None of the other weather condition variables in the model are significantly associated with parking income.

The estimated regression equation for income (4) is

$$I = -111344.8 + 2282*TOR + 5.75*C + 15772*FHPP + 6.93*NoT - 83.24*APD\ (0\text{-}15\ min) + 84.05*APD + 28.30*NoS - 92.34*PSP - 14.02*ToS + 580.22*DV_{C+PC} + 719.30*DV_S - 1143.24*DV_{LS+S+HS} \quad (4)$$

4. Conclusions

As a result of the increasing number of vehicles with urbanisation trends in our country and in the world, car parking has become a major problem due to the inadequacies of transportation infrastructure and superstructure. These problems cannot be solved due to traditional transport policies and planning. The appropriate positioning of open and closed car parks and the provision of holistic car park management and control is one of the most important factors that positively affect urban life and quality (Gül et al., 2019; Özkan et al., 2020).

The car parking problem should be addressed within the framework of the city's holistic transport planning and policy. According to the existing conditions (spatial, environmental, social and economic conditions) in public spaces, a balance should be achieved between the long and short-term parking needs of different user demands, pricing, duration of use and roadside and off-road car parking supply, and a consistent car parking policy and management should be established in line with the objectives (Gül et al., 2019).

In this study, the effect of weather conditions on on-street parking variables is examined. And to that end data sets are consisted of 17 variables such as parking capacity, employee personnel, off-duty personnel, turn-over rate, first-hour parking price, daily parking price, number of transactions, number of cash transactions, average cash parking duration, 0-15 min. parking duration, average parking duration, number of subscriptions, parking subscription price, daily transactions of subscription, subscription parking duration, and income in the on-street parking spaces in the Anatolian side of Istanbul for two years. Dependent variables (turn-over rate, parking duration, cash parking duration, and parking income) are investigated by multiple regression analysis with weather condition variables as dummy variables. Daily general weather data during this period are classified into 11 categories (sunny, cloudy, partly cloudy, light rain, rain, short-term heavy rainfall, heavy rainfall, light snow, light snowfall, snow, and heavy snowstorm). Obtained results from multiple regression analysis with dummy variables are summarized as follows:

- It is determined that the weather condition variables used as dummy variables do not affect the turnover rate.
- The first-hour parking price (FHPP) also has the biggest effect on it. For each unit (TL) increase in FHPP, the turnover rate increases by 0.446 units.
- It is determined that sunny (DV_S) and light snow + light snowfall + snow + heavy *snowstorm* ($DV_{LS+S+HS}$) weather variables used as dummy variables decrease parking duration by 0.528 and 1.293 min, respectively. None of the other weather condition variables in the model are significantly associated with parking duration.
- First-hour parking price (FHPP) has also the biggest effect on parking duration. For each TL increase in FHPP, parking duration decreases by 4.32 min.
- First-hour parking price (FHPP) has also the biggest effect on cash parking duration. For each TL increase in FHPP, cash parking duration increases by 9.36 min.
- It is determined that both sunny (DV_S) and light snow + light snowfall + snow + heavy snowstorm ($DV_{LS+S+HS}$) weather variables used as dummy variables increase cash parking duration by 1.21 and 3.29 min, respectively. None of the other weather condition variables in the model are significantly associated with cash parking duration.
- First-hour parking price (FHPP) also has the biggest effect on parking income. For each TL increase in FHPP, parking income increases by 15,772 TL.
- It is determined that both sunny (D_{VS}) and cloudy + partly cloudy (DV_{C+PC}) weather variables used as dummy variables increase parking income by 719 TL and 580 TL, respectively. Light snow + light snowfall + snow + snow + heavy snowstorm ($DV_{LS+S+HS}$) weather variable, used as a dummy variable decreases parking income by 1143 TL. None of the other weather condition variables in the model are significantly associated with parking income.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article.

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Harvesting the Hidden Value of Vacant Lands: A GIS-Based Approach to Urban Agriculture

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Abstract

The study aims to determine the urban agriculture potential of vacant lands in the city center of Usak, Turkey, and to create a GIS-based urban agriculture inventory. Our analysis focuses on available vacant lands of the municipally-owned lands, foundation lands, public properties, forest lands, and pasture lands within the boundaries of the implementary development plan of the city center of Usak. The optimal urban agriculture map was created using GIS and considered different categories of urban agriculture, including small-scale agriculture, large-scale agriculture, community gardens, and impervious surface or poor soil urban agriculture. The study results showed a significant amount of vacant lands in Usak suitable for urban agriculture, with 7.32 ha being highly suitable, 80.58 ha moderately suitable, and 110.94 ha marginally suitable. Results indicate that vacant lands in the city can be utilized for urban agriculture, which can provide numerous benefits to the local food system.

Keywords: *Urban agriculture potential, urban agriculture, vacant lands, geographic information system, land use.*

Boş Arazilerin Kentsel Tarım için Kullanılması: Kentsel Tarıma CBS Tabanlı Bir Yaklaşım

Öz

Bu çalışma, Türkiye'nin Uşak ili merkezindeki boş arazilerin kentsel tarım potansiyelini belirlemeyi ve kentsel tarım envanterini belirlemek için CBS tabanlı bir metodoloji oluşturmayı amaçlamaktadır. Analiz, Uşak il merkezi uygulama imar planı sınırları içerisinde bulunan belediyeye ait araziler, vakıf arazileri, kamu taşınmazları, orman arazileri ve mera arazilerinin mevcut boş arazilerine odaklanmaktadır. Çalışma sonucunda küçük ölçekli tarım, büyük ölçekli tarım, topluluk bahçeleri ve geçirimsiz yüzey veya zayıf toprak kentsel tarım dahil olmak üzere farklı kentsel tarım kategorileri dikkate alınarak CBS tabanlı optimal kentsel tarım haritası oluşturulmuştur. Çalışma sonuçları, Uşak'ta önemli miktarda boş arazinin kentsel tarıma uygun olduğunu, 7.32 ha yüksek derecede uygun, 80.58 ha orta derecede uygun ve 110.94 ha marjinal olarak uygun olduğunu göstermiştir. Sonuçlar, şehirdeki boş arazilerin önemli derecede kentsel tarım potansiyeli olduğunu ve yerel gıda sistemine çok sayıda fayda sağlayabileceğini göstermektedir.

Anahtar kelimeler: *Kentsel tarım potansiyeli, kentsel tarım, coğrafi bilgi sistemi, arazi kullanımı.*

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1. Introduction

The growth of the urban population has caused a range of ecological, economic, and social challenges for cities. The United Nations (2019), reported that the global population reached about 7.7 billion in 2019 and is expected to reach 8.5 billion in 2030, 9.7 billion in 2050, and 10.9 billion in 2100. In 2018, about 55.3% of the global population lived in cities, which is expected to reach 60% by 2030. Cities such as Delhi, Tokyo, and Shanghai are expected to have populations exceeding 30 million (United Nations, 2018). Today, with the rapid population growth of cities and settlement areas with high attraction power and the multifaceted demands of many sectors and related actors such as housing, service, commercial, education, industry, etc., the tendency to obtain effortless economic benefits, etc. factors have created and are creating unhealthy and irregular cities and urbanisation (Gezer & Gül, 2009).

This rapid population growth has implications for urban areas and requires careful planning and management to address the challenges. Rapid urbanization brings local policies and approaches toward the urban food system to the fore, the built environment, consumption, and nature. Cities provide an opportunity to rethink the management of food systems (Gül, 2022).

One way to address these challenges is through urban agriculture (UA), which has recently gained popularity. Urban agriculture solves many problems in cities and helps to create more sustainable cities. Urban agriculture is the cultivation of food products and all related activities in urban and around the cities (Van Veenhuizen & Danso, 2007). Urban agriculture is an alternative food system, and it is always interacting and cooperating with the city's food systems and rural agriculture. Therefore, the food system in the city can offer an important solution tool for the food supply problem caused by climate change (Türker et al., 2021). It is a sector that covers all activities (production, marketing, etc.) of food and related non-food products to meet the daily needs of city dwellers by using urban waste and natural resources and recycling in urban and periurban areas (Smit et al., 1996).

Urban agriculture is an alternative food system and an integral element of rural agriculture. It has many benefits for cities and their residents. Urban agriculture has a positive impact on urban biodiversity (Doherty, 2015; Lin et al., 2015; Deelstra & Girardet, 2000; Matteson et al., 2008), rainwater management (Hankard et al. 2016; Deelstra & Girardet, 2000), air quality (Deelstra & Girardet, 2000), waste management (Amirtahmasebi, 2008), food security (Mougeot, 2000; Smit et al. 2001; Armar Klemesu, 2000), rehabilitation (Hynes, 1996), household income (Bryld, 2003; Ackerman et al. 2014) and real estate value (Voicu & Been, 2008). There are many different types of urban agriculture, and Table 1 provides information on the production scales, types of activities, objectives, products, and distribution targets for these different typologies.

Table 1. Proposal for production scales, types of activities, objectives, products, and distribution targets for potential urban agriculture categories

Category	Scale	Type of Activity	Model	Products	Distribution
Small-scale urban agriculture	Micro	Farmer's markets, educational agricultural programs, permaculture, beekeeping, flower growing, commercial food production, and vegetable growing (Balmer et al. 2005)	Commercial and Non-Commercial	Vegetables, fruits, compost, medicinal and aromatic plants, etc.) poultry products, beekeeping products, ornamental plants	Direct sales, farmer's stands, markets
Large-Scale Urban Agriculture	Macro	Community-supported agriculture (CSA), urban farms, orchards, animal husbandry, immigrant programs, nurseries, beekeeping, and horticulture. (Balmer et al. 2005) rehabilitation programs	Commercial and Non-Commercial	Vegetables, fruits, compost, medicinal and aromatic plants, etc.) and animal products (milk, eggs, meat, fertilizer, leather, hides, etc.) forestry products (firewood, etc.) nuts, forage plants, ornamental plants, beekeeping products	Restaurants, retailers, markets, hotels, cafes
Community Garden	Micro	Allotment gardens, organization gardens, demonstration gardens, immigrant programs/	Non-Commercial	Vegetables, fruits, compost, medicinal and aromatic plants, etc.) poultry products, beekeeping products, ornamental plants	Food aid to those in need, personal consumption

Impervious/poor soil urban agriculture	Micro-Macro	Vertical gardens, indoor gardens, greenhouses, farmer's markets, container farms, hydroponics (Balmer et al. 2005)	Commercial	Vegetable, fruit, compost, medicinal and aromatic plants, etc.), forage plants, ornamental plants, aquaculture, mushroom, and yeast production	Restaurants, retailers, markets, hotels, cafeterias

1.1. Urban Agriculture in Türkiye

Intense urban growth is occupying agricultural lands day by day. Air pollution, global warming, and ecological destruction significantly impact agriculture. Agricultural lands are being destroyed worldwide and in Türkiye for various reasons. Over the past few decades, the amount of agricultural land per person has decreased significantly globally and in Türkiye. According to the Tema Foundation (2018), the global average fell by 1.8 hectares between 1961 and 2015, while Türkiye decreased by 5.6 hectares over the same period. This trend is concerning because it can lead to reduced food production and negative environmental impacts. The Metropolitan Municipality Act No. 5216 and the Metropolitan Law No. 6360 put agricultural lands in Türkiye at risk of urbanization (Yenigül, 2016). There are currently a limited number of urban agriculture areas in Türkiye. This is due to deficiencies in legislation and insufficient incentives.

1.2. GIS and Urban Agriculture Potential

Benefits of urban agriculture and its potential provide an essential tool for policy-makers. GIS has been widely used in literature to explore the vacant land potential for urban agriculture. Balmer et al. (2005) identified the urban agriculture potential of public vacant lots in Portland using GIS. Kaethler (2006) aimed to identify the potential of public vacant spaces in Vancouver for urban agriculture using VanMap software. Balmer et al., (2005) and Kaetler (2006) classified urban agriculture areas into two main categories (large-scale and small-scale urban agriculture) and two sub-categories (community garden and impervious surface agriculture) in their studies. Horst (2008) used GIS to analyze the potential of public vacant spaces for community gardens in Seattle, Washington. McClintock et al., (2013) assessed the potential for urban agriculture of Oakland's public and private vacant lands and presented a GIS-based inventory. MacRae et al., (2010) investigated whether Toronto can produce 10% of its vegetables and analyzed land inventory using GIS. In this study, zoning plans and aerial photography were used, and it was aimed to determine the potential urban agriculture areas and food production potential in the city. Eanes & Ventura (2015) assessed the suitability of community gardens in Madison using GIS methodology. Using GIS, they created an urban agriculture inventory for community gardens by analyzing public and some private land. This study used size, surface, slope, water access, solar access, area, land-use conflicts, size, vehicle access, and proximity criteria. Using the GIS method, Allen (2015) determined the urban agriculture potential of vacant or underutilized land. They identified essential criteria for urban agriculture; land use slope, sunlight, access to water, soil, ownership, accessibility, neighborhood income, neighborhood population density, proximity to other community facilities, community support, percentage of people living in apartments, neighborhood crime rates, aesthetics, and visibility criteria were used. Dumitrescu (2013) aimed to map the physical, economic, and social criteria for urban agriculture in Rotterdam and identify potential areas suitable for urban agriculture. As a result of the analysis, a suitability map has been revealed for four different scenarios with different physical, economic, and social characteristics for Rotterdam. Taylor & Lovell (2012) analyzed and mapped urban agriculture practiced in public and private spaces using ArcGIS and Google Earth in Chicago, USA. McClintock &Cooper (2010) aimed to determine the food production potential of public spaces belonging to Federal, State, Municipal, and Regional institutions in line with the criteria using GIS. The study determined the potential of vacant lands for urban agriculture in Oakland, California. In some studies, GIS was combined with multi-criteria decision methods. Thapa & Murayama (2008) investigated suitable areas for urban agriculture in the peri-urban area of Hanoi, Vietnam, using GIS and the Analytical Hierarch Process (AHP).

All of these studies have been conducted at ground level. However, Saha & Eckelman (2017) examined the urban agricultural potential of ground level and rooftops in Boston. They used remote sensing and GIS to determine the urban agriculture potential of Boston. This study used ownership, slope, soil quality, and adequate light availability criteria. Previous studies on urban agriculture have limited the use of GIS methods, and the potential for urban agriculture in Türkiye has not been studied. This study aims to fill this gap in the literature and provide decision-makers and planners with a helpful tool for integrating urban agriculture into the city and developing strategies to address existing urban problems. The study aims to determine the urban agriculture potential of vacant lands in the city center of Usak, Türkiye

2. Material and Method

The study area for this research is the boundary of the complementary development plan (2019) of the city center of Usak. Usak Province is located in the Central Anatolia region of the Aegean in Türkiye between 38°13′ to 38°56′E and 28°48′, 29°57′S (Figure 1). It has a long history dating back to 4000 BC. It has been home to many civilizations over the years. In the 19th century, it saw significant commercial development (Usak Municipality, 2020), and today, it is an industrial center known for its textile, leather, and ceramic industries. Usak has a rural character (Sarp, 1994) and most of the population living in the city center are from village origins. The population of the city center is 228,328 (TURKSTAT, 2020), and Usak has a semi-arid climate with hot, dry summers and cold winters. The annual average temperature is 12.8°C, with daily maximum temperatures averaging 19.1°C and daily minimum temperatures averaging 7.2°C. The highest recorded temperature is 40.2°C, and the lowest is -15.4°C (Turkish State Meteorological Service, 2020).

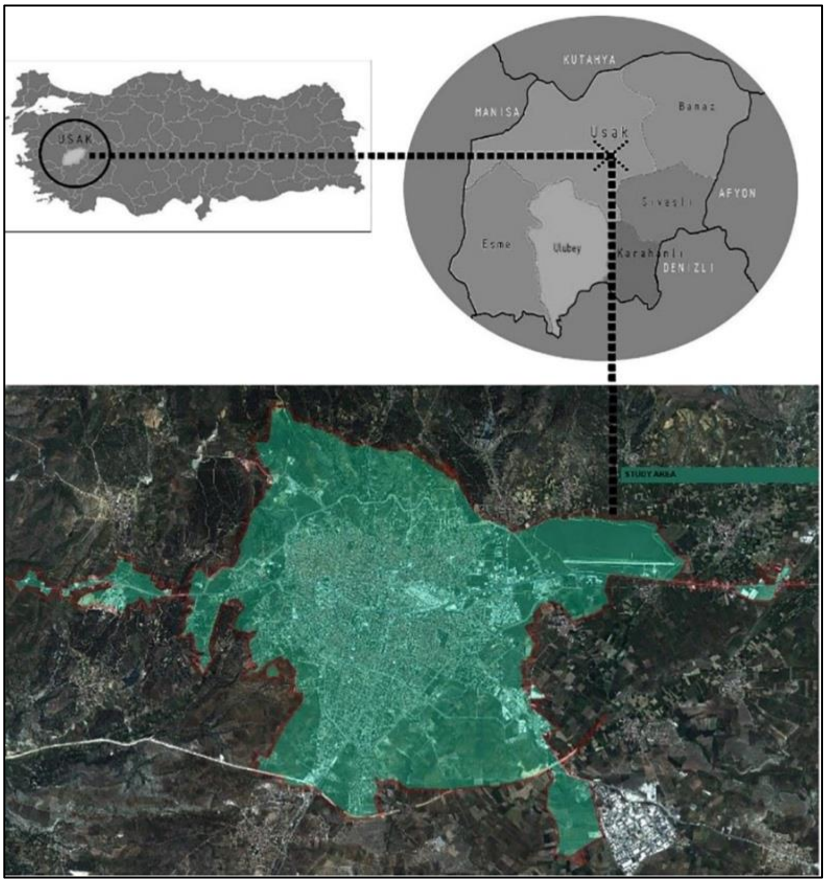


Figure 1. The geographical location of the research area

2.1. Data sources

The primary material of the study is a total of 2821 public parcels (municipally-owned lands, foundation lands, public properties, forest lands, and pasture lands) belonging to 19 neighborhoods in the city center of Usak. Data used in this study were assembled from various sources (Table 2).

Table 2. List of data and sources

Data	Scale	Source
Implementary development plan 2019	1:1000	Department of Urban Planning, Usak
Excel file of 2821 parcels of information	-	Department of Land Office, Usak
Base map of Usak (2007)	1:1000	Department of Urban Planning, Usak
Satellite Pictures (2018 and 2019)	-	Department of Urban Planning, Usak
True Ortofoto WMS (Web Map Service) (2014)	-	Ministry Of Environment And Urbanisation, Turkey
Road Map		Open Street Maps
Mains Water Map (2019)		Department of Urban Planning, Usak
DEM (30 x 30 m) (View-shed Map)		USGS Web Site
Soil map		The Ministry Of Agriculture And Rural Affairs, Turkey

2.2. Methodology

The study aims to determine the potential for urban agriculture of public vacant lands in Usak and presents a GISbased inventory. There were six significant steps to produce an optimal urban agriculture map and these are: (1) Identify available vacant lands by aerial photo analysis (2), Determination of urban agriculture categories (3), Determination of factors and classification of criteria (4), Criteria maps generation (5), Calculation of degree of influence for each criterion for categories by expert score (6), Suitability analysis. The flowchart in Figure 2 summarizes the steps involved in the GIS methodology of the study.

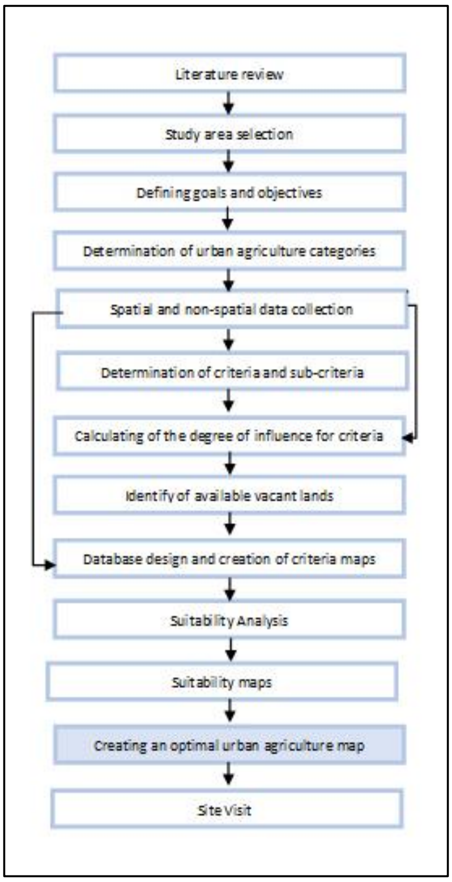


Figure 2. Schematic overview of the research

2.2.1. Determination of urban agriculture categories

There are many different typologies for categorizing urban agriculture (Table 1), and the specific categories and sizes used in this study varied depending on this research's specific focus and goals. Balmer et al., (2005) and Kaethler (2006) divided urban agriculture categories into two main categories (small-scale urban agriculture and large-scale urban agriculture), and two sub-categories (community garden and impervious surface / poor soil) in their studies. The four categories and category sizes of urban agriculture used in this study were based on the typologies defined by Balmer et al., (2005) and Kaethler (2006). The categories are divided into two main categories: previous urban agriculture and impervious urban agriculture. Previous urban agriculture refers to agricultural activities on land that are not covered by pavement or other hard surfaces. This category includes three sub-categories: small-scale urban agriculture, large-scale urban agriculture, and community garden. Small-scale urban agriculture refers to agricultural activities on parcels of land smaller than 1000 m^2, while large-scale urban agriculture refers to agricultural activities on land larger than 1000 m^2. Community gardens are typically between 700 and 2100 m^2 in size. Impervious urban agriculture refers to agricultural activities on land covered by pavement or other hard surfaces or on land with poor soil quality and unsuitable for traditional agriculture. This category includes a sub-category called impervious surface / poor soil urban agriculture, which does not have a specific size requirement. It may include activities such as hydroponics or aeroponics etc., which do not require soil to grow plants. Detailed information about these categories is provided in Table 1.

2.2.2. Identify available vacant lands

In this study, parcel data in Excel was digitized into a Shapefile format using the General Directorate of Land Registry Cadastre Parcel Search Application. In total, 2810 parcels were downloaded in Shapefile file format, and added ArcGIS 10.6.1 software. The parcels were overlapped with satellite photos and True Orthophoto and made ready to identify available vacant lands in ArcGIS. Based on the typologies of urban agriculture defined by Balmer et al., (2005) and expert opinions, a minimum size criterion of 82 square meters was set for urban agriculture areas. Any parcels smaller than 82 square meters were excluded from the analysis. Next, an aerial photo analysis of the study area was conducted to identify available vacant lands suitable for urban agriculture. This involved visually examining each parcel and deleting those that were deemed unsuitable. Adjacent parcels were also merged to create larger contiguous areas. In the end, 603 study sites were determined to be suitable for urban agriculture, along with ten active and passive green areas. This gave a total of 613 study sites ready for suitability analysis.

2.2.3. Determination of factors and classification of criteria

Determining the suitability of urban agriculture requires an assessment of various factors. This study used specific criteria, selected based on a literature review and expert opinions, and divided into natural and urban factors. Natural factors considered in the study include slope, with flatter lands being more favorable and accessible, and aspect, which refers to the direction the land faces, affecting factors such as sunlight, temperature, and wind that can impact crop productivity. Other natural factors considered include LUCC, erosion, soil depth, drainage problems, and LUCS. The urban factors considered in the study include environmental sensitivity, proximity to industrial or waste sites, spatial location, area size, proximity to roads, access to water, and vehicle access. The criteria were standardized using a four-level scale (4 = highly suitable; 3 =moderately suitable, 2 = marginally suitable, 1 = not suitable (Table 3). This allows for consistent and systematic evaluation of the suitability of different lands for urban agriculture.

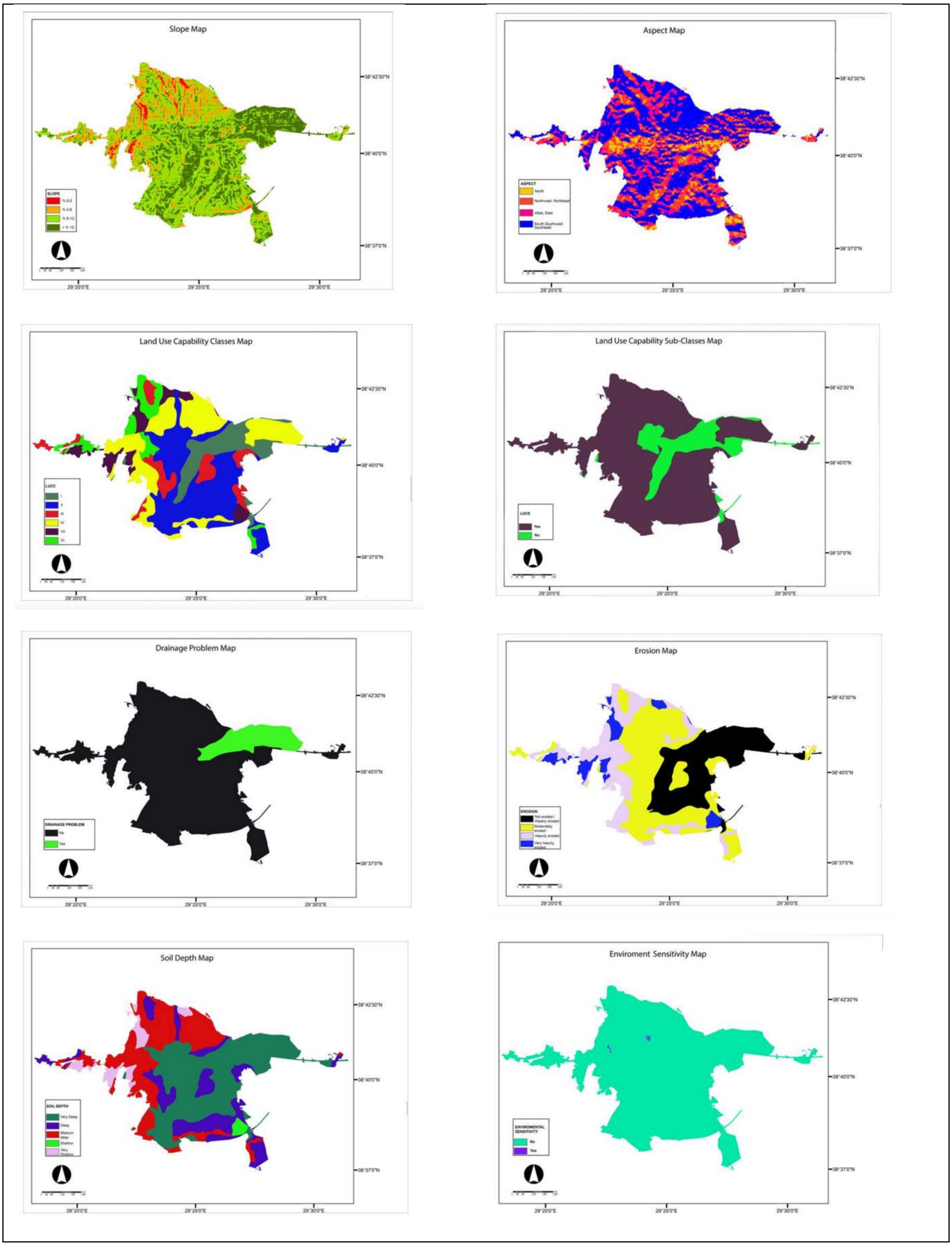
Table 3. Criteria in suitability analysis for urban agriculture categories

Criteria	Sub-Criteria	Small Scale	Large Scale	Community	Impervious surface	Reference
Slope	0-2	4	4	4	4	Balmer et al., (2005) and Allen (2015) set the slope threshold upper limit of 10%, Horst (2008) set the slope threshold upper limit of 40%, McClintock & Cooper (2010) and McClintock et al., (2013) set the slope threshold upper limit as 30%, and Eanes & Ventura (2015) set this limit as 20%.
	2-6	3	3	3	3	
	6-12	2	2	2	2	
	>12	1	1	1	1	
Aspect	South, Southwest, South East	4	4	4	4	McClintock et al., (2013) stated in their study that optimal aspects for urban agriculture are western, south or east, and north. North-west and northeast aspects are less preferred for urban agriculture
	West and East	3	3	3	3	
	Northwest, Northeast	2	2	2	2	
	North	1	1	1	1	
Land use capability sub-class (LUCC)	I	4	4	4	1	TRGM (2008) Class I, II, and III lands are suitable for agriculture, and Class IV lands are classified as partly suitable for agriculture. Class V, VI, VII. VII lands are not suitable for agriculture.
	II	3	3	3	2	
	III.	2	2	2	3	
	IV	1	1	1	4	
	VI	1	1	1	4	
	VII	1	1	1	4	
Erosion	Not eroded or little eroded	4	4	4	4	
	Weakly eroded	2	2	2	2	
	Moderate eroded	1	1	1	1	
	Heavily eroded	1	1	1	1	
Soil depth	Very deep	4	4	4	1	Deep and medium-depth soils are the best soil type for agriculture. Soils with shallow depths are partially favorable. The soil structure with a very shallow depth is not suitable for cultivated soil (Akten, 2008; Akten et al., 2009).
	Deep	3	3	3	1	
	Medium	2	2	2	1	
	Shallow	1	2	2	4	
	Very Shallow	1	1	1	4	
Drainage problem	No	4	4	4	1	
	Yes	2	2	1	4	
Land use capability sub-class (LUCS)	No	4	4	4	1	
	Yes	1	1	1	4	

Environmental sensitivity	No	4	4	4	4	
	Yes	1	1	1	1	
Spatial location	Urban area	-	-	4	-	
	Peri-urban area	-	-	1	-	
Proximity to industrial and solid waste storage site	> 3	4	4	4	4	TRGM (2002), "Organic farming cannot be carried out in agricultural lands within 3 km of heavy industrial facilities, reactors, hydraulic and thermal power plants, …."
	< 3	1	1	1	1	
Proximity to dense traffic roads	> 10	4	4	4	4	Saumel et al., (2012) found intense trace elements in vegetables grown at a distance of 10 m. In Allen (2015), Samuel et al., (2012) based on the findings, the distance to the main roads accepted the threshold limit as> 10 m. MacRae et al., (2010) used a distance of> 10 m from all roads in their study.
	<10	1	1	1	1	
Land use	Vacant lands	4	4	4	4	
	Green areas	4	4	4	1	
	> 15% impervious surface / poor soil	1	1	1	1	
Access to water	0-10	4	4	4	4	Dumitrescu (2013) examined the water access criteria in 3 sub-criteria: Easy access < 5 m, difficult access, 5-100 m, and problematic access > 100 m. In this study, the same parameters were used.
	10-100	3	3	2	3	
	>100	2	3	1	3	
Vehicle access	Yes	4	4	4	4	
	No	1	1	1	1	

2.2.4. Criteria maps generation

A database was designed, and criteria maps were created for suitability analysis (Figure 3). The maps were created using a variety of data sources. The slope and aspect maps were created by classifying DEM data, while the land use capability class (LUCC), erosion soil depth, drainage problem, and land use capability sub-class (LUCS) maps were derived from the soil map. The environment sensitivity map was generated by marking geologically sensitive areas in the zoning plan. The spatial location map was created using aerial photo analysis to identify the settlement pattern of the city. The industrial site and solid waste storage site maps were created by creating a 3 km buffer zone around these sites using ArcMap's buffer zone tool. The dense traffic road map was created by first identifying roads with dense traffic in the city and adding them to the database, then creating a 10 m buffer zone around these roads using ArcMap's buffer zone tool. The access to water map was created using the mains water map, and the vehicle access map was generated using aerial photo analysis in ArcMap. These criteria maps were then used in the suitability analysis to evaluate the potential for urban agriculture on the vacant public lands in Usak.


Slope Map
Aspect Map
Land Use Capability Classes Map
Land Use Capability Sub-Classes Map
Drainage Problem Map
Erosion Map
Soil Depth Map
Enviroment Sensitivity Map

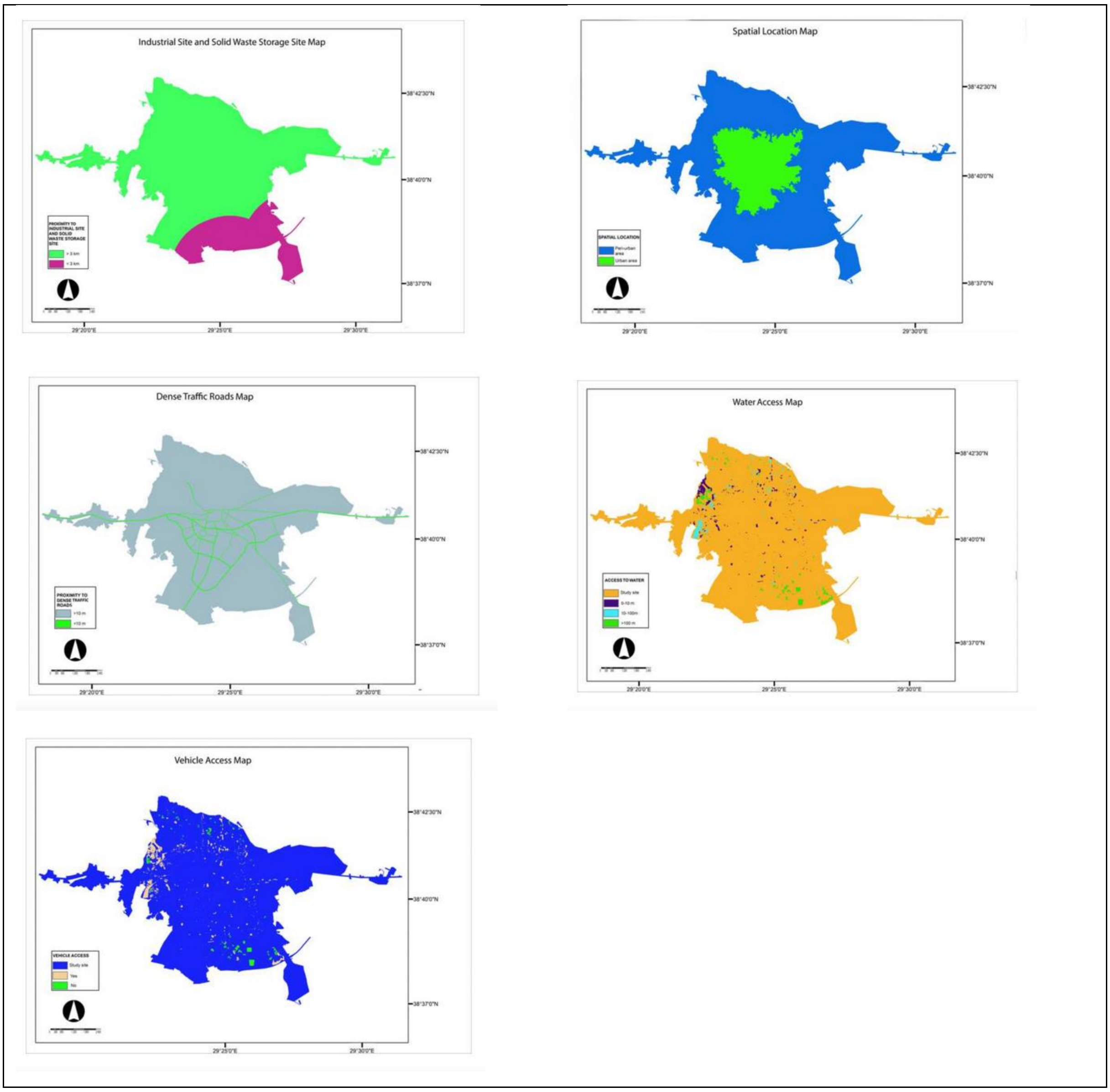


Figure 3. Criteria maps for urban agriculture analysis

2.2.5. Calculation of degree of influence for each criterion

The calculation method used in this study is a way to determine the relative importance or influence of each criterion in the evaluation of urban agriculture. The degree of influence of each criterion was calculated by expert score. Fifteen experts from different disciplines related to urban agriculture, including Landscape Architecture, Field crops, Garden plants, Plant protection, and Urban and Regional planning scored each criterion on a scale from 1 to 10. (1 = Highly Important; …….; 10 = Not important). The calculating approach described by Akpınar (1994), Karaelmas (2003), and Zengin (2017) was used to determine the degree of influence of each criterion. The formula is given below:

$DT= \sum Dfu$ $Af= DT / \sum DT$ DT= Sum of the values given to the f evaluation factor by experts
u= Number of experts from 1 to n
f= Number of factors from 1 to m
Dfu= Values given by the experts to the f evaluation factor
Af = Weight of the f evaluation factor

2.2.6. Suitability analysis

Suitability techniques are an approach that enables planners and local administrators to analyse multiple aspects of the decision-making process (Gül et al., 2006). The suitability maps were generated for each urban agriculture category by utilizing ArcMap. The standardized criteria and the degree of influence of each criterion were taken into account during the analysis (Figure 4, Figure 5, Figure 6, Figure 7). These suitability maps were divided into three classes: highly suitable, marginally suitable, and not suitable. The suitability maps for small and large-scale urban agriculture and community gardens were then overlaid to create an optimal urban agriculture map (Figure 8). The results of the suitability analysis were then validated through a site visit phase.

3. Findings

Suitability analysis results are given in Table 4. Based on the suitability maps for the different urban agriculture categories, it was found that there was a total of 1.04 hectares of highly suitable area, 9.72 hectares of moderately suitable area, and 0.62 hectares of not suitable area for small-scale urban agriculture. For large-scale urban agriculture, there was a total of 12.20 hectares of highly suitable area, 175.80 hectares of moderately suitable area, and 30.86 hectares of unsuitable area. For community gardens, there was a total of 0.89 hectares of highly suitable area, 8.18 hectares of moderately suitable area, and 3.82 hectares of unsuitable area. For impervious surface/poor soil urban agriculture, there was a total of 153.2 hectares of highly suitable area and 93.98 hectares of moderately suitable area. By overlaying the suitability maps for small and large-scale urban agriculture and community gardens, an optimal urban agriculture map was created for these categories (Figure 8). Based on this map, it was determined that there was a total of 7.32 hectares of highly suitable area, 80.58 hectares of moderately suitable area, 110.94 hectares of marginally suitable area, and 31.42 hectares of a not suitable area in the study area (Table 5).

Table 4. The distribution of urban agriculture suitability analysis results

Suitability degree	**Category**			
	Small-scale urban agriculture	**Large-scale urban agriculture**	**Community Garden**	**Impervious surface / poor soil urban agriculture**
Highly Suitable	1.04 ha	12.20 ha	0.89 ha	153.2 ha
Moderately suitable	9.72 ha	175.80 ha	8.18 ha	93.98 ha
Not suitable	0.62 ha	30.86 ha	3.82 ha	-

Table 5. The distribution of optimal urban agriculture analysis results

Suitability degree	**Area**
Highly Suitable	7.32 ha
Moderately suitable	80.58 ha
Marginally suitable	110.94 ha
Not suitable	31.42 ha

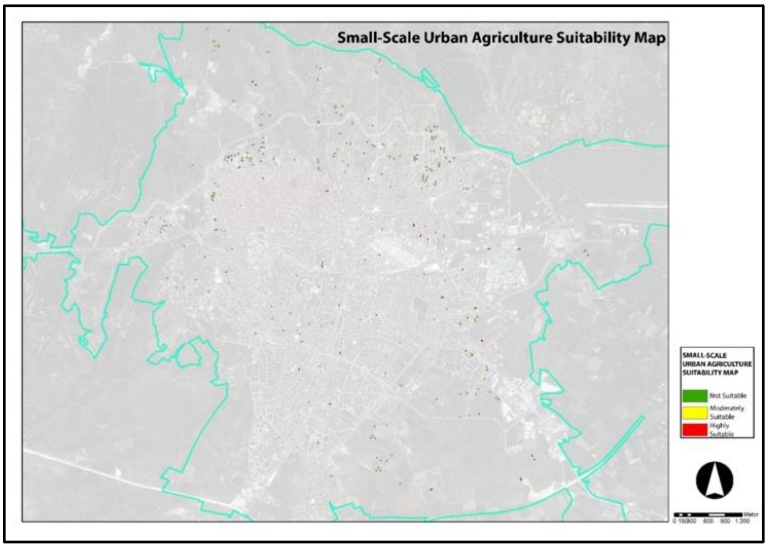


Figure 4. Small-scale urban agriculture suitability map

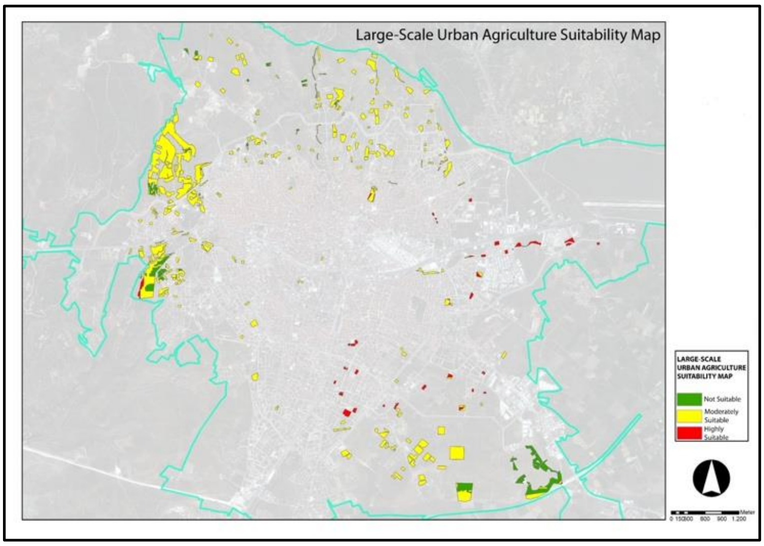


Figure 5. Large-scale urban agriculture suitability map

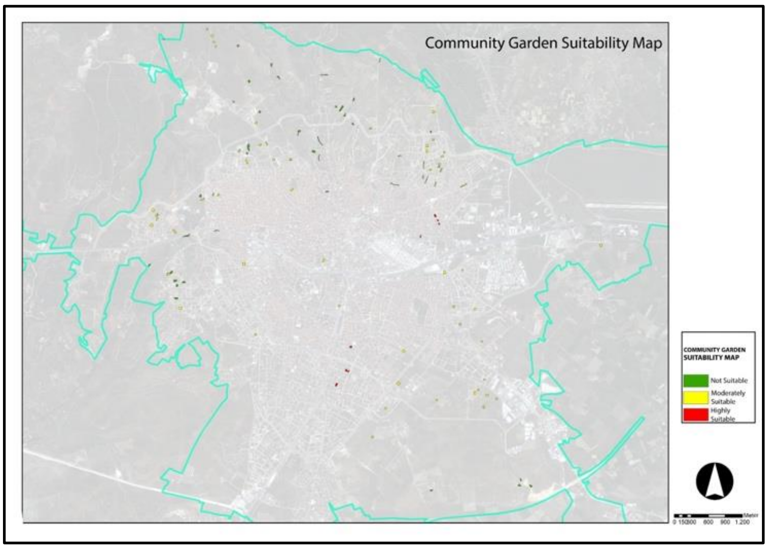


Figure 6. Community garden suitability map

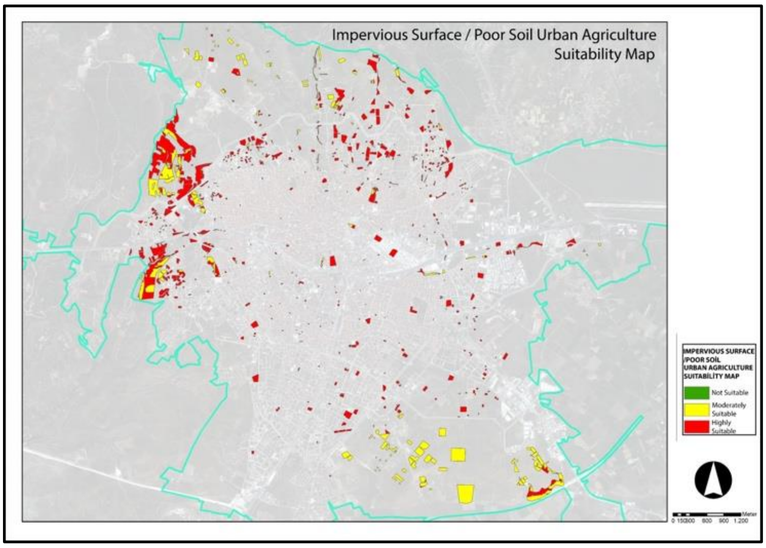


Figure 7. Impervious surface/poor soil urban agriculture suitability map

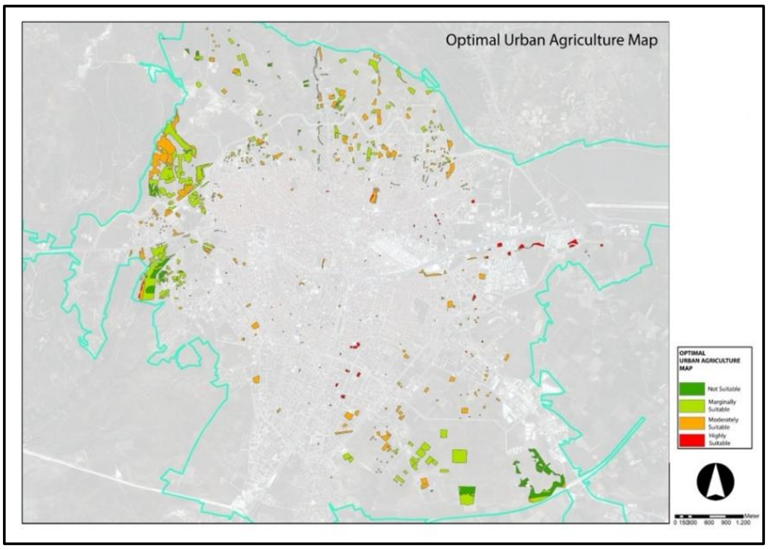


Figure 8. Optimal urban agriculture map

4. Conclusion and Suggestions

This study aimed to evaluate the urban agriculture potential on vacant lands in the city center of Usak using GIS. The study identified potential urban agriculture sites for four categories in Usak based on 15 criteria. By combining these categories, GIS-based optimal urban agriculture maps were created. The results showed 7.32 hectares of highly suitable, 80.58 hectares of moderately suitable, and 110.94 hectares of marginally suitable areas for urban agriculture. According to these findings that highly suitable areas are generally located in intra-urban areas, while moderately suitable and marginally suitable areas are located in peri-urban areas. The highly suitable, moderately suitable, and marginally suitable for urban agriculture identified in the study should be allocated for developing urban agriculture projects on these lands. This could involve working with urban agriculture organizations and other stakeholders to identify and prioritize projects that align with the potential and suitability of these lands. The study's findings reveal promising opportunities for utilizing vacant land in Usak for urban agriculture. By identifying areas of high, moderate, and marginal suitability, decision-makers can prioritize areas that are most conducive to high productivity and yield. Areas with high and moderate suitability may also be useful for a range of urban agriculture projects, while marginally suitable areas could be used for less intensive projects that still contribute to the city's food system and sustainability.

Incorporating the identified suitable areas into urban planning and development processes is another way to leverage their potential. By working with decision-makers to integrate urban agriculture into the city's planning strategies, we can create more sustainable and resilient cities. Similar studies in the literature have also shown that vacant lands have significant potential for urban agriculture, further underscoring the importance of utilizing these spaces to their fullest potential (Balmer et al., 2005; Eanes & Ventura, 2015; Allen, 2015; Horst, 2008; McClintock et al., 2013; MacRae et al., 2010; McClintock & Cooper, 2010; Taylor & Lovell, 2012; Kaethler, 2006; Dumitrescu, 2013). While the study presents exciting possibilities for utilizing vacant lands for urban agriculture in Usak, it also has some limitations. Gathering data proved challenging, and some institutions did not make their information available in digital formats. Despite these challenges, the study offers valuable insights into how urban agriculture can provide alternative and sustainable food systems for the city's residents. By identifying potential sites for urban agriculture, this study may pave the way for a more sustainable food system in and around Usak. Furthermore, the GIS-based methodology used in the study can be applied in other cities to identify potential urban agriculture sites. Decision-makers and researchers can use the study's findings to inform the development of urban agriculture policies and strategies. By utilizing vacant lands in the city for urban agriculture, cities can support local food production, reduce the environmental impacts of food miles, and create opportunities for economic development. In this research, the urban agriculture potential of a city was determined for the first time in Türkiye using GIS.

For this reason, the study has original value. In addition, in this study, the subject is discussed much more comprehensively than the related studies in the literature. Overall, the study provides valuable insights into the potential for urban agriculture on vacant lands in Usak and demonstrates the potential benefits of utilizing these lands for this purpose. The GIS-based methodology used in the study can be replicated in other cities to identify potential urban agriculture sites. The study results can be used to inform the development of urban agriculture policies and strategies.

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Author Contribution and Conflict of Interest Declaration Information

1st author 60%, 2nd author 40% contributed. There is no conflict of interest.

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Analysis of Kinetic Disaster Relief Shelters and a Novel Adaptive Shelter Proposal

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Abstract

Natural disasters such as earthquakes, wildfires, landslides, and floods displace millions of people worldwide every year. Therefore, temporary shelters should be provided to the people affected by disasters. Generally, conventional shelters such as tents, container-type shelters, and prefabricated structures are used after disasters. However, they do not provide spatial flexibility and adaptability to changing circumstances. Although using kinetic structures in temporary shelter design allows the creation of adaptive systems, the majority of temporary shelters are limited to certain types. This study aims to develop an adaptive disaster relief shelter that can deploy from a compact state to an expanded one to provide not only formal flexibility but also ease of transport and storage. First, it investigates spatial and structural solutions developed for temporary shelters and analyzes to what extent kinetic structural systems provide solutions regarding adaptation to changing circumstances. Based on the findings obtained from the analysis, a novel adaptive shelter composed of scissor linkages and plates has been proposed. The proposed Shelter Module X is adaptive enough, functioning not only as an accommodation unit during distinct sheltering periods but also serving different functions by unit combinations.

Keywords: *Temporary shelters, disaster relief shelters, adaptability, natural disasters, kinetic structures.*

Kinetik Afet Yardım Barınaklarının Analizi ve Yeni Bir Adaptif Barınak Önerisi

Öz

Deprem, orman yangını, toprak kayması ve sel gibi doğal afetler her yıl dünya çapında milyonlarca insanı yerinden etmektedir. Bu nedenle, afetlerden etkilenen insanlara geçici barınaklar sağlanmalıdır. Afetlerden sonra genellikle çadır, konteyner tipi barınaklar ve prefabrik yapılar gibi konvansiyonel barınaklar kullanılmaktadır. Ancak, bunlar mekânsal esneklik ve değişen koşullara uyum sağlayamazlar. Geçici barınak tasarımında kinetik strüktürlerin kullanılması, adaptif sistemlerin oluşturulmasına izin verse de geçici barınakların çoğu belirli tiplerle sınırlıdır. Bu çalışma, kompakt bir konfigürasyondan genişletilmiş bir yapıya geçerek sadece biçimsel esneklik sağlamakla kalmayıp aynı zamanda taşıma ve depolama kolaylığı sunabilen adaptif bir afet yardım barınağı geliştirmeyi amaçlamaktadır. İlk olarak, geçici barınaklar için geliştirilen mekânsal ve yapısal çözümler araştırılmakta ve kinetik yapı sistemlerinin değişen koşullara uyum konusunda ne ölçüde çözüm sağladığı analiz edilmektedir. Analizinden elde edilen bulgulara dayanarak, makaslı bağlantılar ve plak elemanlardan oluşan yeni bir adaptif barınak önerilmiştir. Önerilen Barınak Modülü X, yeterince uyarlanabilir olup küçük değişikliklerle farklı barınma dönemlerinde konaklama birimi olarak kullanılabilir ve aynı zamanda birim kombinasyonlarıyla farklı işlevlere de hizmet edebilir.

Anahtar kelimeler: *Geçici barınaklar, afet yardım barınakları, adaptasyon, doğal afetler, kinetik strüktürler.*

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1. Introduction

Every year, millions of people worldwide are directly affected by disasters, resulting in the loss of their homes, loved ones, and personal belongings. The damage caused by disasters somehow depends on the vulnerability of buildings and the risk reduction policies implemented by governments and organizations. The first 72 hours following a disaster are significant for providing shelter and meeting the immediate needs of the affected individuals. Effective management during this period is essential to prevent secondary disasters in affected areas, safeguard lives, ensure safety, and minimize risks for disaster victims (AFAD, 2011).

Humanitarian organizations and governments strive to provide shelters for immediate use after disasters occur. Due to their affordability, ease of transportation, and quick installation, tent-type shelters are often preferred by organizations, as they can fulfill the immediate demand for thousands of shelters. However, such shelters are convenient for short-term usage. The need for more durable shelter solutions arises because tent-type shelters fail to address the evolving needs of disaster victims who have to reside in temporary shelters for months and even years. Considering the disaster type, location, climate, and the changing user needs over time, the "one size fits all" approach to shelter becomes inadequate and impractical in the subsequent stages of the sheltering process.

The duration of sheltering begins from the moment a disaster occurs and continues until affected individuals are provided with livable, durable, and permanent housing options (Shelter Centre, 2012). The process of disaster response involves a comprehensive recovery approach spanning three inter-connected periods: immediate relief, rehabilitation, and reconstruction (Corsellis & Vitale, 2005).

The immediate relief period entails precautionary measures and actions that are implemented before and after a disaster, intending to minimize the vulnerability of individuals and mitigate potential damages caused by the disaster. Once the immediate needs of the disaster victims have been addressed, the rehabilitation period commences. Its primary goal is to fulfill the needs of the affected people by providing them with temporary shelters and enabling them to continue their daily routines and regain a reasonable standard of living.

In contrast to the temporary solutions provided during the immediate relief and rehabilitation periods, the reconstruction period aims to establish a permanent, robust, and secure living environment for individuals affected by disasters. The process of reconstructing damaged buildings is often lengthy, further prolonged by the requirement of obtaining permits and contracts from municipalities and government authorities (Sey & Tapan, 1987). Therefore, the duration of sheltering can be longer than initially anticipated. As the duration of sheltering extends, there arises a need for diverse types of shelters that encompass varying spatial and technical characteristics to meet the evolving needs of shelter users (Sphere Association, 2018). Emergency shelters are typically employed immediately after disasters, with their usage ideally limited to a few days. On the other hand, temporary shelters should not be occupied for more than six months. Pre-planned vacant sites are generally designated for temporary shelter settlements.

Temporary accommodation refers to a period of extended stay that encompasses emergency, temporary and transitional shelters (Johnson, 2002). Depending on the duration of shelter settlements, temporary shelters can also serve as transitional shelters. In permanent settlements, progressive and core shelters can be used for several months or even years until permanent housing is constructed. Despite being mere rooms rather than fully functional houses, these shelters aim to meet the basic needs of their occupants, enabling them to maintain their everyday lives. In cases where disaster policies and structural systems permit, shelters can be moved to permanent sites. Moreover, they can be upgraded or combined to accommodate larger families.

Temporary shelters used until the construction of permanent dwellings are often unsuitable for long-term usage due to their limited adaptability to different types of disasters, locations, climates, and changing functions. These shelters are generally not upgradeable or reusable, necessitating the use of new shelters after each disaster. For instance, tent-type shelters lack durability against wind loads, fail to provide sufficient thermal insulation and ventilation, and lack privacy, security, and on-site sanitary facilities. The production of tents that can only be used for a few weeks during the sheltering period presents a significant challenge regarding resource consumption and sustainability.

On the other hand, container-type shelters and prefabricated temporary houses offer greater durability compared to tent-type shelters. However, they often lack spatial flexibility for users. Since constructing a large number of container-type shelters or prefabricated houses is time-consuming, manufacturers must carefully plan to produce an adequate supply of shelters. Considering the difficulties experienced after catastrophic disasters and the occurrence of secondary disasters, there is often a need to relocate shelters. This relocation is also necessary for storage or utilization in future disasters. However, it poses logistical challenges as container-type shelters and prefabricated houses are not easily transformable in shape. Transporting only one shelter at a time on a truck increases transportation costs and implementation time accordingly. The use of conventional temporary disaster shelters of this nature can lead to numerous long-term problems for humanitarian organizations and governments, including high costs, storage challenges, transportation limitations, and a lack of adaptability.

Although various types of temporary shelters exist, most of them fail to meet the universal design standards and technical requirements determined by humanitarian organizations (Sphere Association, 2018; IFRC, 2013). Therefore, adaptive design solutions should be developed in response to changing environmental conditions and user needs. To address this, designers have explored innovative structural systems in recent decades, incorporating kinetic structural systems into their shelter designs. Kinetic structures consist of moving elements that can change their geometric configurations without altering the overall structural integrity of the system. Notably, they offer the distinct advantage of easy assembly and disassembly. They can be relocated to any location in their compact states and may become self-supporting structures when fully deployed or unfolded. These structures have primarily been employed in architecture as temporary structures, retractable roofs, movable bridges, and responsive facades, allowing them to adapt to changing environmental conditions, meet user requirements, and enhance building performance.

Even though kinetic structures provide many advantages, the studies exploring their potential in temporary shelter design are limited (Asefi & Sirus, 2012; TMMOB, 2012; Lee et al., 2013; Extremis Technology, 2014; Mira et al., 2014; Quaglia et al., 2014; Thrall & Quaglia, 2014; Seikaly, 2015; Kawuwa, 2017; TenFold Engineering, 2017; Gomez-Jauregui et al., 2018; Larsen et al., 2018; Alharthi, 2020; Arslan et al., 2021; Pérez-Valcárcel et al., 2021; Lee et al., 2022; Verzoni & Rais-Rohani, 2022). Those studies generally focus on developing new types of shelters. However, there is no systematic study in the literature examining those proposals regarding their kinetic structural systems. In the first stage, this study systematically analyzes kinetic disaster relief shelters based on their structural properties, spatial characteristics, and transportability features. This analysis provides insights into the state-of-the-art in this field and highlights their potential to offer adaptable and flexible solutions. The findings obtained in this stage serve as a comprehensive guide for individuals or organizations interested in developing alternative temporary shelters. Building upon the knowledge gained from the first stage, the second stage of this study introduces a novel adaptive design for disaster relief shelters. This design is specifically developed to overcome the existing problems associated with sheltering. By proposing this adaptive design alternative, this study makes a valuable contribution to the literature. It not only offers a systematic analysis of disaster shelters utilizing kinetic systems but also presents a practical solution that meets the necessary design requirements.

2. Methodology

The methodology employed in this study encompasses a qualitative research approach that combines a critical review of literature on disaster relief shelters with simulation and modeling techniques to develop a kinetic disaster relief shelter (Figure 1).

The initial stage of the study involved a comprehensive review of relevant literature, utilizing bibliographic research to identify design standards and technical requirements for disaster relief shelters. This review also involved the classification of kinetic structural systems based on their kinematic properties and the identification of specific parameters necessary for evaluating the selected shelters. To collect relevant data, a wide range of sources were consulted, including journal and conference papers, books, reports, and websites, accessed through platforms such as Web of Science, Scopus, Google Scholar, and ResearchGate. The study proceeded by examining the characteristics of temporary shelters, living space standards, technical requirements, and design criteria in accordance with temporary shelter standards (Corsellis & Vitale, 2005; Shelter Centre, 2012; AFAD, 2015; Sphere Association, 2018, UNHCR, 2021). Notably, the Sphere Handbook (2018) acknowledged as the preeminent international design standard offering comprehensive and detailed guidelines, played a significant role in formulating the tables and evaluating the shelters. Furthermore, kinetic structural systems used in architecture were classified into two categories regarding their kinematic properties: structures with variable mobility and structures with variable geometry. Each category includes sub-groups with distinct movement and transformation capabilities. The aforementioned characteristics, standards, requirements, and classifications were employed to determine the parameters for selecting and analyzing the kinetic disaster relief shelters. The selected shelters have been analyzed regarding three main categories that are structural properties, spatial characteristics, and transportability features. The analysis findings were presented in Tables to facilitate comparison among the disaster relief shelters employing different types of kinetic structural systems.

The second stage of the methodology focused on 3D modeling techniques to develop a kinetic disaster relief shelter, which enabled the exploration of various configurations and functionalities of the shelter, facilitating an in-depth understanding of its potential adaptability and flexibility. Through this process, the findings from the literature review were utilized to inform the design and implementation of the shelter prototype. An adaptive disaster relief shelter, called *Shelter Module X*, was developed considering the aforementioned design criteria, requirements, and characteristics.

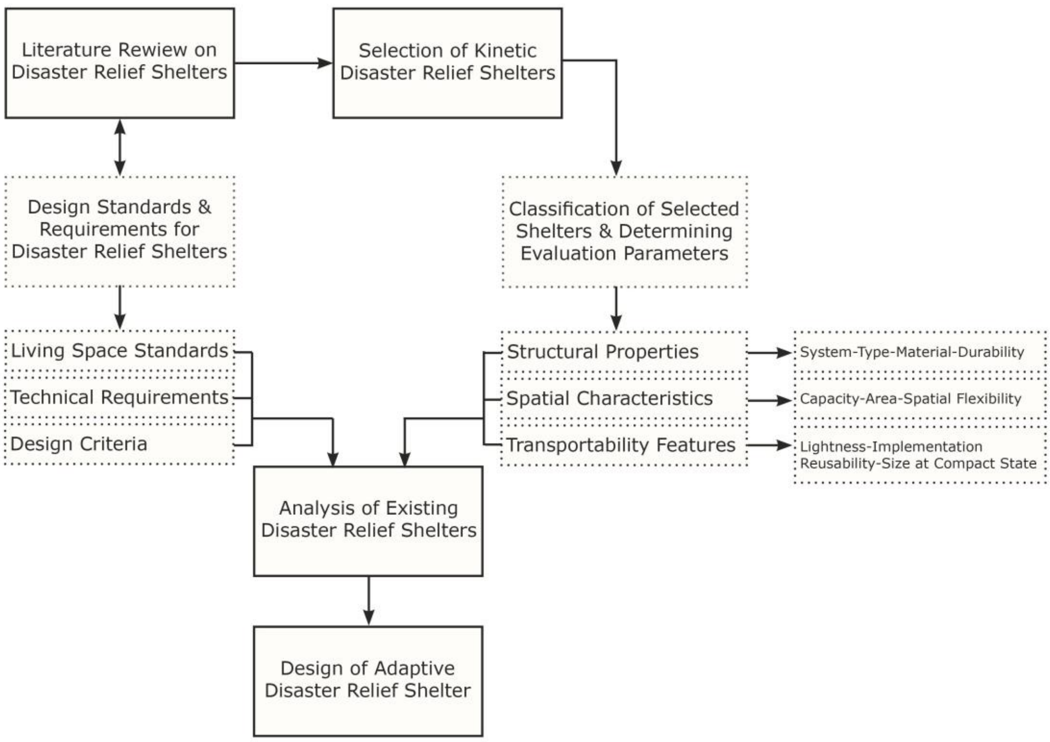


Figure 1. Steps of the research methodology

3. Research Findings, Design Proposal and Discussion

3.1. Characteristics of Temporary Shelters

Temporary shelters can cover the stages in which emergency and transitional shelters are used due to the extended sheltering periods if they meet spatial needs and technical requirements. Unlike emergency shelters, temporary shelters are designed to be used for up to six months and provide essential amenities such as sleeping, bathing, and cooking facilities. In cases where transitional shelters cannot be utilized due to settlement policies, they are referred to as temporary shelters, highlighting the overlapping terminologies used in the context of shelters. However, employing various types of shelters throughout the sheltering process presents more drawbacks than benefits. Each type of shelter possesses distinct spatial and technical characteristics to fulfill specific needs, resulting in increased overall costs. Temporary shelters are expected to be cost-effective, easily constructible, relocatable, and reusable, while transitional shelters should offer rapid upgradeability.

Once temporary shelters have been used for six months, they can undergo various actions to prolong their life cycle, including repairs, relocation to permanent settlements, or expansion to meet additional needs until permanent dwellings are constructed. The literature emphasizes the importance of extending the life cycle of these shelters through measures such as space additions, repairs, reuse in subsequent stages, and relocation to permanent or safer shelter settlements (Arslan, 2007; Askar et al., 2019). Even if temporary shelters are not intended to become permanent houses, they can be upgraded to accommodate different stages of the sheltering period. The incremental transition approach suggests using the same shelter and making minor modifications to meet the evolving needs of shelter users (Wagemann & Moris, 2018). This approach allows for the continued use of the shelter in the same location and habitat, thereby protecting the mental health and comfort of disaster victims (Choi et al, 2020). Furthermore, adopting this approach can lead to reduced costs during the sheltering period compared to the conventional three-phase reconstruction approach, where temporary shelters are used after emergency response until permanent houses are built.

To address the need for adaptability and relocatability, designers and researchers have explored new design solutions for temporary shelters. They have started using kinetic structural systems in temporary shelter designs since they offer formal transformability, spatial flexibility, rapid assembly and disassembly, adaptability to changing conditions, and ease of transportability.

3.2. Analysis of Temporary Shelters

Universal standards, technical requirements, and structural capabilities are prioritized in the selection and evaluation of temporary shelters.

3.2.1. Design standards and technical requirements for temporary shelters

Temporary shelters should be designed considering many parameters to provide habitable living spaces for the people affected by disasters. The living space standards, technical requirements, and design criteria for temporary shelter design are given in Table 1 (Corsellis & Vitale, 2005; Shelter Centre, 2012; AFAD, 2015; Sphere Association, 2018, UNHCR, 2021).

As indicated by the Sphere Association (2018) and UNHCR (2021), the minimum area required for a living space per person in a temporary shelter should be $3.5m^2$, excluding dedicated spaces for cooking and bathroom facilities. However, the living space per person should be increased to a range of $4.5m^2$ - $5.5m^2$ in cold climates, which includes the spaces for cooking, bathing, and sanitation facilities. Temporary shelters should protect the users from extreme weather conditions while providing user comfort through natural ventilation and daylighting the indoor areas. The minimum internal floor-to-ceiling height should be 2m in temporary shelters. However, in hot climates, it should be 2.6m for air circulation. Temporary shelters should also provide privacy, safety, and security, which are essential requirements to maintain daily life for shelter users as much as possible. Moreover, complementary facilities should be considered in and around the shelter because providing designated spaces for cooking, bathing, and sanitary allows people to undertake daily activities. Technical requirements should also be provided, which include fire safety, technical performance, and supplying basic infrastructures and needs. The parameters such as durability, optimal thermal comfort, fire resistance, water resistance, natural ventilation, accessibility, and selection of appropriate materials positively affect the performance of shelters. On the other hand, design criteria include reusability, ease of storage, lightness, cost-effectiveness, rapid erection and dismantling, transportability as well as spatial integrations through spatial flexibility or modularity constitute the principles of designing an adequate temporary shelter.

Table 1. Design standards and technical requirements for temporary disaster shelters

Living Space Standards	***Minimum living space per person***				**$3.5m^2$ in a hot climate excluding space for cooking, bathing, and sanitary**		**$4.5m^2$ - $5.5m^2$ in cold climates including space for cooking, bathing and sanitary**	
	Minimum internal floor-to-ceiling height				2m		2.6m in hot climates	
	Shelter habitability	covered living area	privacy	safety	security	natural lighting	artificial lighting	complementary facilities
Technical Requirements	***Fire safety***	30m firebreaks per built-up 300m in shelter settlements						
	Technical performance	durability	thermal comfort	fire resistance	water resistance	natural ventilation	accessibility	appropriate material selection
	Supplying basic infrastructures and needs	water tanks	sanitary	electricity	bathroom	food supplies	healthcare supplies	
Design Criteria	reusability	flexibility	ease of storage	modularity	lightness	cost-effective	rapid erection & dismantling	transportability

3.2.2. Classification of kinetic structural systems

Kinetic structures can be classified under two main categories as shown in Table 2: structures with variable mobility and structures with variable geometry (Zuk & Clark, 1970; Kronenburg, 2003; Maden, 2019). The first type is divided into three main categories such as demountable, relocatable, and portable. Demountable structures consist of pre-fabricated elements that can be stored in parts, transported as a complete package, and quickly assembled or demounted at the site (Figure 2a). Relocatable structures are composed of transportable modular parts that are generally dry-assembled at the site, whereas portable ones are transported in one piece for instant use (Kronenburg, 2003) (Figures 2b and 2c).

Table 2. Types of kinetic structural systems

Kinetic Structures				
Structures with variable mobility	Demountable Structures	Relocatable Structures	Portable Structures	
Structures with variable geometry	Scissors & Bars Structures	Foldable Plate Structures	Tensegrity Structures	Deformable Structures

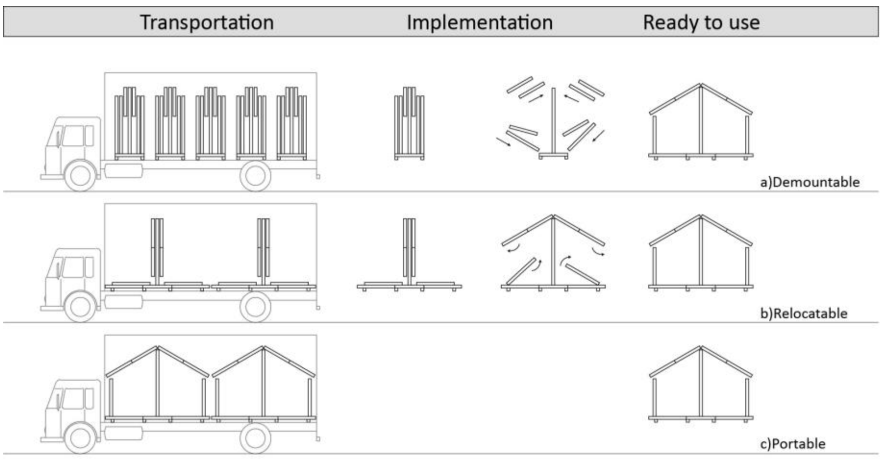


Figure 2. Types of kinetic structures with variable mobility

On the other hand, the second type can be reviewed under four main categories. The first category contains scissors and bar structures. Scissor structures are composed of primary scissor units or loops

(Sarısayın et al., 2022), whereas bar structures can be built using any element. Both types provide advantages regarding transformation, transportation, and storage, but their systems may become complex if they consist of numerous elements and joints. The second category is foldable plate structures composed of plate elements rotating relative to their adjacent plates. The third category covers tensegrity structures composed of bar elements and cables, which are rarely used in kinetic architecture. The fourth category includes deformable structures (e.g., membrane and pneumatic systems) mostly used to cover large spans.

3.2.3. Analysis of selected temporary shelters

Based on the aforementioned design standards, criteria, technical requirements, and classifications, the selected temporary shelters have been analyzed in three main categories, which are as follows:

- *Structural properties*: system, mobility/movement, material, and durability
- *Spatial characteristics*: capacity, area, and spatial flexibility
- *Transportability features*: lightness, implementation, reusability, and storage

Having mobility in terms of changing location or movement in terms of formal change in the structural systems of temporary shelters is essential since it allows adapting to the evolving conditions and user needs during the sheltering process. Therefore, mobility and movement have been determined as the selection criteria for temporary shelters to be used in the evaluation. The existing literature on the topic has been reviewed, and shelter examples having variable mobility and variable geometry have been chosen, which are proposed by researchers, designers, humanitarian organizations, and engineering companies. Those examples have been analyzed and compared regarding their structural properties, spatial characteristics, and transportability features.

First, temporary shelters having variable mobility have been examined (Table 3). Demountable shelters occupy less space for storage as they can be dismantled into smaller parts and transported by packing those small parts. However, small structural elements increase the implementation time, labor requirement, and complexity of the structure. In addition, reusing such shelters may cause deformation or damage in structural components and joints; thus, requiring renewal and repair. Because the disadvantages of the conventional type of demountable shelters (e.g., tents, container-type shelters, and prefabricated structures) outweigh their advantages, they have not been included in this evaluation. Two relocatable shelters and two portable shelters have been selected for the analysis. These are the *Shelter Proposal* by Beyatlı (2010), the *Disaster and Emergency Living Facility* by AFAD (2015), the *Portable Shelter Proposal* by Uçar (2015), and the *Portable Post-disaster Home Proposal* by Dialameh (2017), accordingly.

Table 3. Temporary shelters have variable mobility

PROJECTS		STRUCTURAL PROPERTIES				SPATIAL CHARACTERISTICS			TRANSPORTABILITY FEATURES			
NAME	EXTERNAL VIEW	SYSTEM	TYPE	MATERIAL	DURABILITY	CAPACITY	AREA	SPATIAL FLEXIBILITY	LIGHTNESS	IMPLEMENTATION	REUSABILITY	SIZE AT COMPACT STATE
Beyatlı - Shelter Proposal 2010		Container structure w/ steel expansion solution	RELOCATABLE	Steel, PVC panels, textile	Materials are durable but cannot be assured time	2 people	10sqm	YES: Units can be combined	Heavy	< 1 hour by 1 person	YES	One unit package = 280x233x240cm
AFAD - Disaster and Emergency Living Facility 2015		Modular system with insulated plates and tensioning belt	RELOCATABLE	Polyurethane plates in walls and roof, fiberglass and polyester in pallet floor w/ adjustable legs and covering plates	> 1 year	1 person	3.5sqm	YES: Modules can be combined	Lightweight	20 mins by 3 people	YES	As one module package Not specified size 12 modules can be carried in one truck
Uçar - Portable Shelter Proposal 2015		Container structure w/ steel expansion solution	PORTABLE	Steel, PVC panels	Materials are durable but cannot be assured time	4 people	18sqm	YES: Expands by changing dimensions of scissors & panels	Heavy	2 mins by 2 people	YES	One unit package = 120x650x270cm
Dialameh - Portable Post-disaster Home Proposal 2017		Steel frames, wooden beams, plywood panels	PORTABLE	Steel, wood, plywood	Materials are durable but cannot be assured time	4 people	20sqm	YES: Expandable units	Heavy	2 mins by 1-2 people	YES	One unit package = 215x350x280cm

The *Shelter Proposal* is a relocatable container structure designed which reuse waste materials as components and use new materials only for the scissor-like elements (Beyatlı, 2010). Unlike conventional container-type disaster shelters, it occupies less space in its compact configuration than a container since it is expandable. The shelter is composed of scissor-like elements and panels, and it can be stored in parts and assembled at the site. Therefore, it is easier to transport and store the shelter than the other conventional container-type shelters. In this shelter, PVC panels and accordion textile material are used for walls and roofs, and steel is used for structural elements and adjustable legs. Using the waste container structure makes it cost-effective and provides material savings. Having a 10m2 living area for two people, the *Shelter Proposal* is spatially flexible since it allows combining two units from the sides of the shelter.

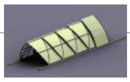
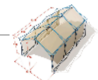
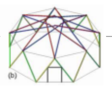
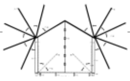
The *Disaster and Emergency Living Facility* has a modular system consisting of polyurethane plates used for walls and roof, fiberglass and polyester for the slab, and it has a tension belt to increase structural durability. Its adjustable legs allow the shelter to keep flat and to be used even on sloping terrain. The wheels under its adjustable legs make it easier to move for implementation, which can be locked via latches on its wheels to keep the shelter in place. One of the modules of the shelter is 3.5m^2, which equals the minimum area for the living space standard per person. However, it can be expanded by module additions because its slab is designed like a pallet.

Both of the examined relocatable shelters are durable enough to be used for more than one year and meet the technical requirements of fire and water resistance, thermal comfort, daylighting, and natural ventilation. They can be implemented rapidly. The *Shelter Proposal* can be implemented in less than one hour by one person, whereas the *Disaster and Emergency Living Facility* can be assembled in 20 minutes by three people. Multiple shelters can be transported on trucks. Considering their sizes, it can be said that they may provide habitable living environments for users for long-term use.

The *Portable Shelter Proposal* developed by Uçar is a container-type structure composed of scissor-like elements and PVC panels as in the relocatable shelter designed by Beyatlı. This shelter has more expansion capability, and it can be transported in one piece in its compact state. It occupies less space for storage. In the *Portable Post-Disaster Home*, steel and wooden frames are used for the structural components, and plywood panels are used for the walls. Wooden beams are preferred on the slab and walls to reduce the shelter cost, whereas steel frames are used for the shelter skeleton. Both selected portable shelters are durable enough to be used for more than one year. The *Portable Shelter Proposal* meets all technical requirements, while the *Portable Post-Disaster Home* meets the requirements except fire resistance. When the living areas are compared, it is seen that the *Portable Shelter Proposal* provides 18m^2 for four people while the *Portable Post-Disaster Home* has 20m^2. Although these portable shelters are heavy, their implementation takes 2 minutes by one or two people since they can be expanded by just pulling one side of the shelter to make it ready for use.

After examining the shelter examples having variable mobility, the temporary shelters having the capability of changing their geometries have been analyzed (Table 4). The search for adaptive structural solutions to store, assemble, and transport shelters has led designers to develop temporary shelters that can transform their shapes from compact shapes to expanded forms. Features such as lightness, flexibility, rapid erection and dismantling, reusability, ease of storage, and transportability can be accomplished using kinetic systems in shelter design. For the evaluation, six deployable temporary shelters have been selected, which are the *Weaving Home Shelter* by Seikaly (2015), the *Transformable Shelter* by Asefi & Sirus (2012), the *Gable Roof,* and the *Deployable Yurt* by Pérez-Valcárcel et al. (2021), the *Deployable Scissor Arch* by Mira et al. (2014), the *TF-64* by TenFold Engineering (2017). Also, foldable examples such as the *Hush Shelter-2* by Extremis Technology (2014) and the *Disaster Shelter* by TMMOB Ankara (Union of Chambers of Turkish Engineers and Architects, Ankara Branch; 2012) have been examined.

Table 4. Temporary shelters having variable geometry

PROJECTS		STRUCTURAL PROPERTIES				SPATIAL CHARACTERISTICS			TRANSPORTABILITY FEATURES			
NAME		SYSTEM	TYPE	MATERIAL	DURABILITY	CAPACITY	AREA	SPATIAL FLEXIBILITY	LIGHTNESS	IMPLEMENTATION	REUSABILITY	SIZE AT COMPACT STATE
Seikaly Weaving a Home Shelter 2015		Deformable self-deploying system	DEFORMABLE	Fabric & plastic members	-	3 people	20sqm	YES: Modules can be combined	Lightweight	Easy to assemble, no time specified	YES	Fully folded unit No size specified
Asefi & Sirus Transformable Shelter Proposal 2012		Steel frame w/ sliding mechanism	SCISSOR & FOLDABLE PLATE	Steel frames & curved plates	-	-	50sqm	YES: Modular and can be combined	Lightweight	< 1 hour by 2 people	YES	Compact modular units No size specified
Valcárcel et al. Gable Roof Proposal 2021		Deployable cylindrical vaults with reciprocal scissor linkages	SCISSOR	Aluminum tubes, fabric	-	-	73sqm	YES: Units can be combined and deploy together	Lightweight	Easy to assemble, no time specified	YES	As kit of parts or modules No size specified
Valcárcel et al. Deployable Yurt Proposal 2021		Reciprocal structures w/ triangular frames	BAR	Aluminum tubes, sloping pillars	-	-	76sqm	YES: Modules can be combined	Lightweight	Easy to assemble, no time specified	YES	As one compact module - No size specified 24-30 modules can be carried in one truck
Mira et al. Deployable Scissor Arch Proposal 2014		Scissor arch	SCISSOR	Aluminum, membrane	-	4 people	14sqm	YES: Units can be expanded & transformed	Lightweight	2 hours by 3 people	YES	Fully folded unit No size specified
TenFold Engineering TF64 2017		Modular, self-deploying system	SCISSOR & FOLDABLE PLATE	Steel, insulated panels	> 1 year	6 people	68sqm	YES: Units can be combined, expandable units	Heavy	In minutes by one person	YES	10.4sqm compact unit
Extremis Technology Hush Shelter-2 2014		Foldable plates w/ hinges	FOLDABLE PLATE	Wooden insulated walls	> 1 year	-	19sqm	YES: Units can be combined	Heavy	2 hours by one person	YES	Compact folded unit No size specified
TMMOB Disaster Shelter 2012		Foldable plates & panels w/ hinges	FOLDABLE PLATE	MDF plates, panels & L-shaped water-protective components w/ white lacquer coating	> 1 year	2 people	~9sqm	YES: Panels can be removed & another unit can be combined w/ hinges	Lightweight & has wheels to carry	< 1 hour by one person	YES	As one compact module = 30x300x260cm 45 modules can be carried in one truck

The *Weaving Home Shelter* has a deformable structure and is composed of structural fabric with plastic members. Being capable of folding itself across a central axis, the shelter has operable windows that can control air circulation. There is a space for the water collector that supplies electrical energy for the waving action of the shelter. The shelter has a 20m^2 living space for three people, but it can be expanded by combining units. It is lightweight due to its materiality, easy to assemble, and can be stored as folded. Also, this shelter meets all technical requirements.

The *Transformable Shelter* has scissor and foldable plate structures composed of steel-framed modules with a sliding mechanism. The shelter is easy to assemble, store, and transport due to its lightweight structural system. It can be assembled by two people in less than an hour. Having a sliding mechanism, the shelter provides variable geometries changing the configurations only along the horizontal direction. The shelter can cover 50m^2 by expanding, which allows it to be used for various functions.

The *Gable Roof* is composed of reciprocal scissor linkages, whereas the *Deployable Yurt* has reciprocal bar structures. The *Deployable Scissor Arch* is comprised of polar scissor units, and the shelter is covered by a fabric membrane. These three examples demonstrate the structural investigations and possible applications of scissor linkages and bar structures in shelter design proposals. The designers of these structures explored the structural limits of the proposed mechanisms and conducted several analyses for durability. Because such structures are durable and provide ease of storage, transportation, and implementation, they are promising for further applications even if technical requirements have not been accomplished yet. Since these shelters can cover large spaces, they are adequate even for larger families, although the designers did not mention the number of occupants. The *Gable Roof* covers 73m^2, which can be expanded on both horizontal sides of the shelter. Likewise, the *Deployable Yurt* encloses 76m^2 thanks to its reciprocal scissor structures. Compared to these shelters, the *Deployable Scissor Arch* is smaller since it covers only 14m^2 and serves four people. However, larger spaces can be covered with module combinations. These three structures provide various geometric configurations and can be used as temporary shelters in the long term. Even though these examples are composed of scissor mechanisms or bar structures, they do not require professional assistance to assemble the structures. The *Deployable Scissor Arch* can be assembled in 2 hours by three people.

The *TF-64* is another deployable example composed of a steel structure and insulated foldable plates that are used for walls, roofs, and slabs. Its height can be changed thanks to its adjustable steel legs. The *TF-64* needs electrical power for deployment, which is provided by solar panels and batteries attached to the system. The deployment of the whole structure takes minutes. Covering an area of $68m^2$, this shelter provides living space for six people. It covers 10.4 m^2 in its compact state. Thanks to its expandable feature, the units can be combined for space additions to meet the spatial needs of shelter users.

The *Hush Shelter-2* and the *Disaster Shelter* have foldable wooden plates that are connected by rotating hinges. The *Hush Shelter-2* may require fieldwork and cannot be fully folded. It can be unfolded in 2 hours by one person if the foundation is ready for the shelter. Otherwise, it may take more than 2 hours. On the other hand, the *Disaster Shelter* does not require fieldwork thanks to its adjustable legs, which allow the shelter to be used even on sloping terrain. Although the shelter is heavy, the adjustable legs make the shelter easy to move and relocate. Since the shelter has wheels, they can be locked when placed. The slab and roof of the *Disaster Shelter* are also foldable, which makes the shelter more compact. The shelter has L-shaped elements placed above the roof and wall intersection to prevent water leaks. Both examined foldable shelters are durable and easy to store and transport because they can remain in their compact foldable states while transporting. These shelters are spatially flexible, but they can be extended only if new units are added by removing the side panels from the shelter.

3.3. Design Proposal: Shelter Module X

Providing lightness, protection from changing environmental conditions, ease of transport and storage, and quick installation by users have been aimed while designing *Shelter Module X*. The proposed shelter has a deployable system consisting of scissor linkages and insulated foldable plates, which covers 17.88 m^2 when unfolded from the compact state to expanded form (Figure 3).

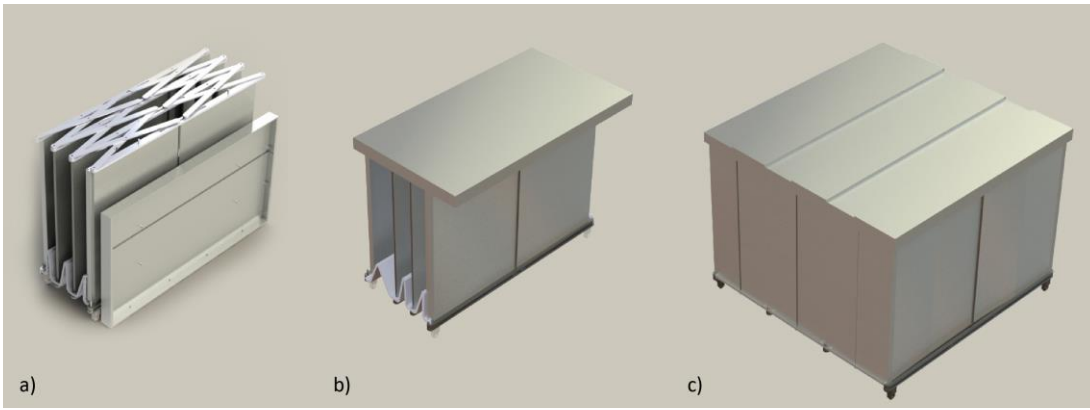


Figure 3. Deployment stages of the *Shelter Module X*: a) compact state; b) half deployed state; c) expanded form

The *Shelter Module X* is composed of twelve translational scissor units that are connected with revolute joints. Six are positioned at the bottom (Figure 4a), while the remaining ones are located at the top (Figure 4b). The scissor elements play a crucial role in controlling the movement of the plates as they are connected to the side plates. By sliding the scissor-like elements along the slots on the side plates, the deployable system starts moving and expanding. Simultaneous deployment occurs for the plates positioned on the sides, top and bottom, excluding those aligned with the *y*-direction (the longer sides of the unit) (Figures 4a and 4c). These plates are temporarily fixed to the scissor elements, but they are designed to be bifold for storage (Figure 4b). The side plates lying on the *x*-direction fold into the shelter, optimizing space utilization. The side plates along both *x*- and *y*-directions are connected at the corner by concealed cross hinges that enable rotation of the plates (Figures 4b and 4d). These hinges remain completely invisible when the plates are unfolded. The slab folds vertically within the shelter and is supported by horizontal rods and vertical pins (Figures 3b and 4b), which engage with stationary plates located between the scissor elements. The roof encloses the shelter structure, featuring eaves and a sliding mechanism that enables its width to be reduced by half (Figure 4c).

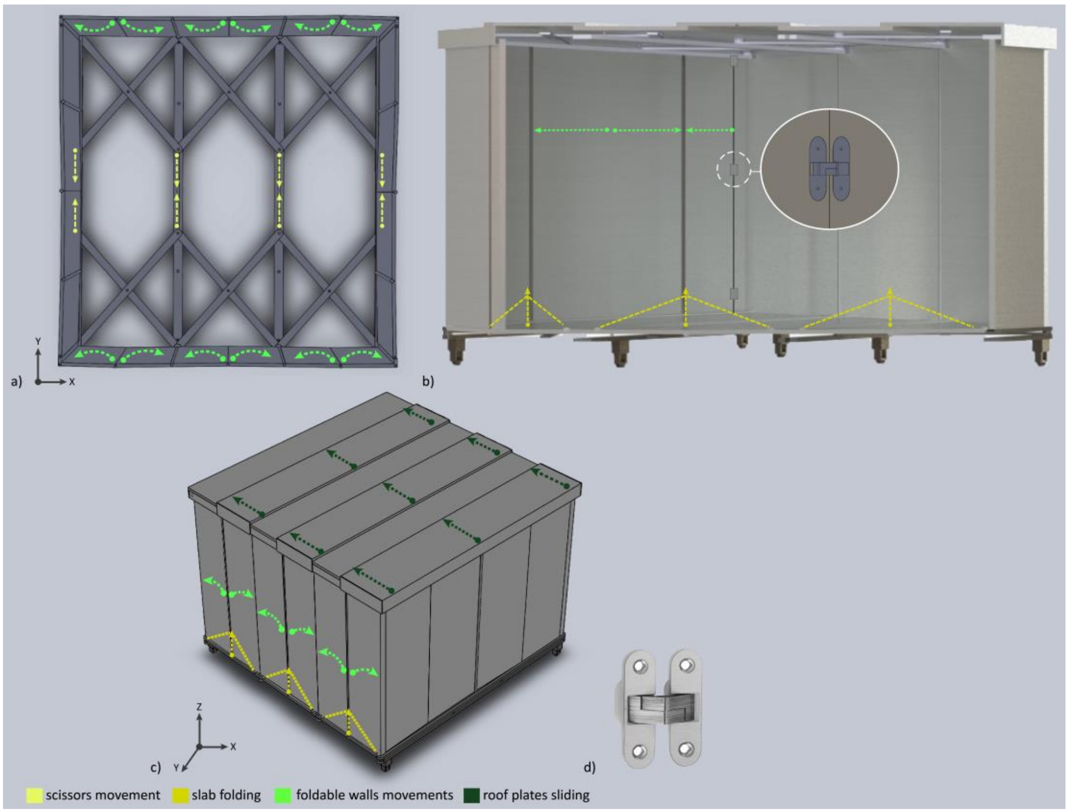


Figure 4. Movement diagram of the shelter components

The system's deployability enables the unit to be folded into a compact bundle, offering ease of transport and storage. The *Shelter Module X* can be transported on a truck either in a fully folded state by detaching the roof plates and wheels or in a demounted state. Three shelters can be transported on a truck in their fully folded configurations as shown in Figure 5a. The size of the shelter reduces by almost one-third, and it occupies an area of 6.44 m^2 (1.52m x 4.24m). On the other hand, each component of the shelter can be packed with its corresponding carrier rods, allowing for easy storage. Dismantling the components offers a relocatable option that enables the transportation of up to six shelters on a truck at once (Figure 5b). The dimensions of the shelter package measure 230x450x140cm. To facilitate relocation and adaptability to uneven terrain, the shelter is equipped with wheels and adjustable legs (Figure 6). These wheels can be attached to the shelter before movement or during the placement of the shelter on the ground. With a height adjustment range between 24cm and 32cm, it is preferable to select a relatively smooth terrain, although the wheels can accommodate variations in ground elevation. Moreover, the wheels can be locked to securely position the shelter and provide protection against flood. Thanks to these wheels, users can swiftly open the shelter and commence usage. Otherwise, the process may take longer due to the physical effort and weight of the components.

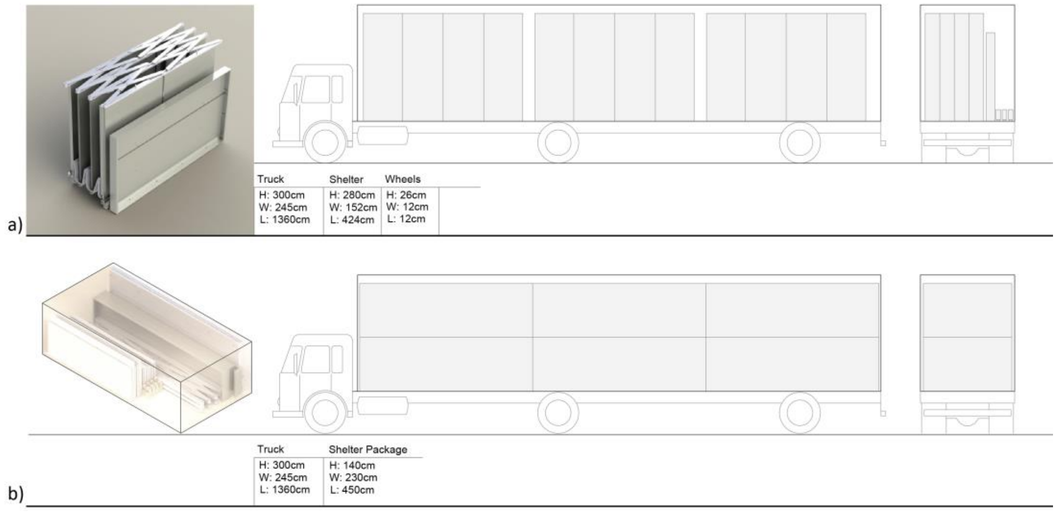


Figure 5. Transportation of the *Shelter Module X*: a) fully folded state; b) demounted state

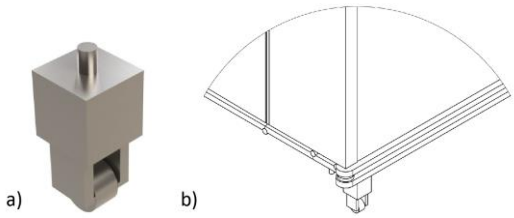


Figure 6. Wheel and connection detail

Disaster relief shelters should provide a minimum of 4.5 m^2 of living space according to universal design requirements and guidelines for temporary disaster shelters, including the bathroom and kitchen. The *Shelter Module X* encompasses a bathroom, a kitchen equipped with essential amenities, foldable tables, and chairs, a living room that includes functional work areas with foldable furniture, and a bedroom suitable for two occupants (Figure 7a). Because it covers an area of 17.88 m^2, the proposed shelter can meet users' basic needs for longer use and accommodate up to four individuals when the living room doubles as a sleeping area (Figure 7b). The *Shelter Module X* has slim windows positioned to not only provide cross ventilation and privacy but also allow in natural light (Figure 8a). The design of the shelter takes into consideration changing conditions to ensure habitable and sustainable spaces (Figure 8b). To enhance user comfort and adaptability within these compact environments, foldable furniture and doors are used. Sliding doors are employed to optimize space utilization, while the exterior door is designed as a double-leaf door for practicality.

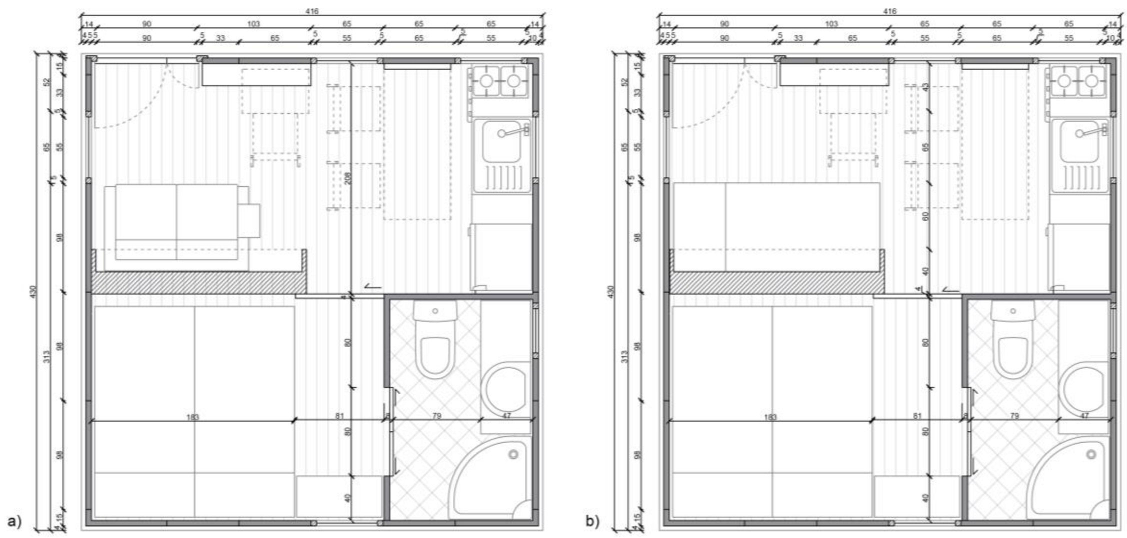


Figure 7. Plan layout of the *Shelter Module X*: a) two-person living space; b) four-person living space

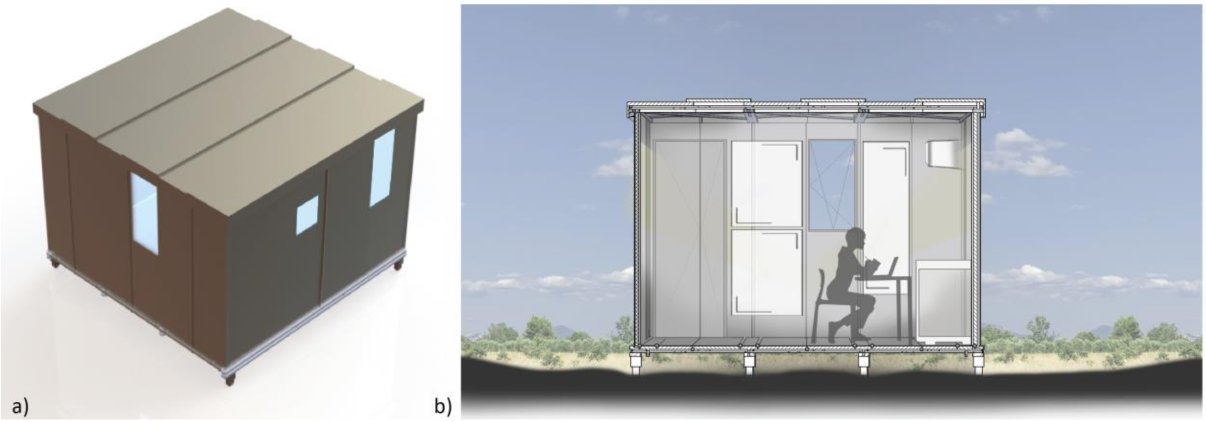


Figure 8. a) 3D view; b) sectional perspective view

Even though the proposed *Shelter Module X* is designed to serve as a temporary shelter that is suitable for long-term use since it features a kitchen and bathroom area, it can also be used as an emergency shelter by excluding the service unit (kitchen and bathroom). Because the system is adaptive, the number of scissor linkages in the system can be changed. Rather than using three scissor units in each row (i.e., a 3x2 type module), two scissor units can be used to generate a smaller module (2x2 type module) that covers an area of 12m^2, which can accommodate two people during emergency periods (Figure 9a). The proposed *Shelter Module X* is adaptive enough to develop alternative solutions by offering module combinations to accommodate larger families or diverse functions (Figures 9c-9g). Those solutions incorporate the creation of common open areas to enhance the overall habitability of the sheltering area.

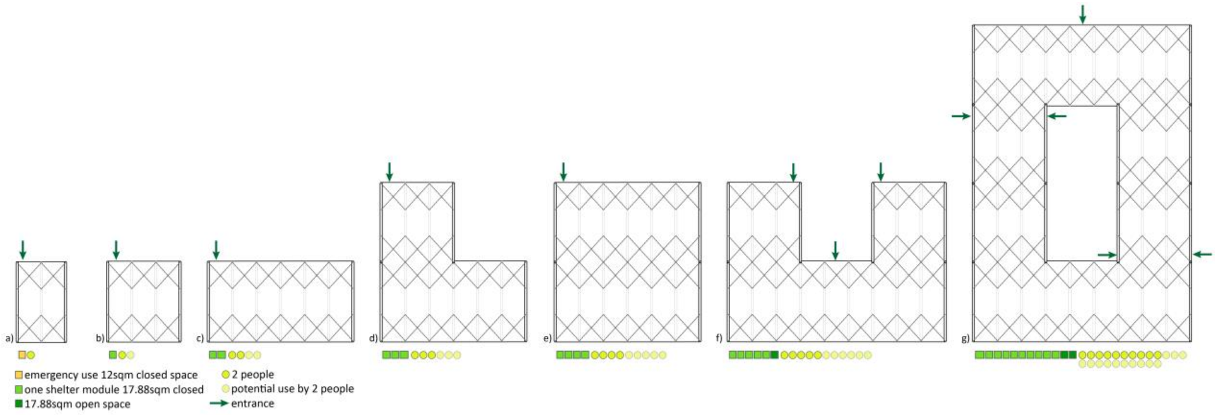


Figure 9. Alternative module combination diagrams

3.4. Discussion

It is crucial for temporary shelters to adhere to universal standards and possess adaptability and flexibility, as they may be deployed in diverse locations, climates, and cultural contexts as well as in response to various types of disasters. However, conventional-type temporary shelters often lack reusability and adaptability. Most of them cannot be rapidly assembled and necessitate the involvement of skilled professionals for construction. Moreover, they have disadvantages regarding storage and transportation, as they cannot be easily folded into compact states and occupy a significant amount of space.

The examined disaster relief shelters in this study have various structural systems providing advantages in terms of adaptation to spatial, functional, or environmental changes. The analysis shows that the selected temporary shelters having variable mobility provide significant advantages since they can be relocated when needed. This mobility enables shelters to be moved within the shelter settlement or to safer and permanent zones during the sheltering period. Using relocatable and portable shelters brings multiple advantages, including cost reduction, ease of transportation and storage, and the elimination of the need for extensive workforce or fieldwork during implementation.

The examples given in Table 3 are adaptive and flexible enough to meet the changing needs of the users. Moreover, these shelters demonstrate durability in withstanding changing weather conditions and can be implemented easily in less than one hour by one or two people. Furthermore, they occupy less space compared to conventional-type shelters when in their compact configurations.

On the other hand, temporary shelters having variable geometry are more flexible in shape control and can be compacted when relocation is necessary. That means more shelters can be transported on a truck at once. Compact shelters can rapidly be expanded in minutes by the users without the need for professional assistance or extensive fieldwork. Their structural systems, including adjustable legs, enable placement on various terrain and slopes without requiring significant land improvement. Among the examples of temporary shelters, scissors, and foldable ones are promising in terms of the advantages they provide. It is crucial to keep the mechanisms used in such shelters as simple as possible while also ensuring that the components are lightweight for ease of transportation. Nevertheless, durable materials should be chosen, considering the potential for extended usage beyond the initially intended timeframe. The majority of the temporary shelters in Table 4 are lightweight and can be rapidly erected or dismantled within minutes when needed, whereas the relocatable shelters in Table 3 may require more time for assembly. However, their compact design allows for multiple units to be transported on a truck, maximizing efficiency in large-scale implementations. This advantage enables the rapid deployment of thousands of shelters within a short timeframe, addressing the urgent shelter needs of disaster-affected populations.

The lightweight and compact nature of temporary shelters necessitates the careful integration of insulation solutions with structural systems without significantly increasing the weight or implementation time. Deployable temporary shelters composed of scissor-like and bar elements require using flexible or rigid covering materials to create enclosed living spaces. Designers of such structures generally focus on mechanism design and disregard the covering material, but it should be integrated with the system. Because the covering material is not the primary issue, insulation may become a challenge in these shelters. On the other hand, foldable structures are more advantageous since insulated panels can be used as part of the foldable system. This integration ensures that the insulation is incorporated seamlessly without compromising functionality or adding excessive weight to the shelter.

In the case of the proposed *Shelter Module X*, careful attention has been given to several features. The scissor linkages and insulated folding panels have been designed in a way that they do not block each other during the opening and closing processes. This consideration ensures smooth operation while maintaining insulation properties. Furthermore, the design takes into account the importance of minimizing additional weight, ensuring that the shelter remains lightweight and portable without compromising on insulation capabilities.

The multi-phased sheltering process, which covers emergency shelters, transitional shelters, and permanent reconstruction, requires the use of different shelter types until permanent dwellings are built. Tents are mostly employed during the immediate relief period, whereas container-type shelters are used during the rehabilitation period. Despite their cost-effectiveness, they have many deficiencies such as poor thermal insulation, limited privacy, inflexibility, and instability. Thus, they are not convenient for long-term usage. Despite their durability, container-type shelters are not cost-effective, and only one shelter can be transported on a truck due to its size. Moreover, they are heavy and not adaptive enough to respond to changing user needs and conditions.

On the other hand, temporary shelters having mobility and movement provide many advantages compared to those conventional types, encompassing not only adaptability to changing circumstances but also reduced implementation time and overall cost. Using multiple shelter types in the periods of immediate relief and rehabilitation such as tents and containers increases the overall cost spent for sheltering. However, with the development of efficient design solutions, kinetic disaster relief shelters have the potential to fulfill the criteria, standards, and requirements of both periods. They can even serve as permanent shelters due to their inherent ability to be relocated, upgraded, and reused. At this point, a question arises: can temporary kinetic disaster shelters evolve into long-lasting solutions? The answer lies in their inherent flexibility and adaptability.

Because the energy crisis and limited resources led designers to develop sustainable and energy-efficient design solutions, more adaptive and flexible alternatives have been proposed in recent years not only in building and façade designs but also in the realm of temporary shelters. Kinetic disaster relief shelters can offer many benefits, from ease of storage, transportation, and implementation to spatial flexibility and adaptability. One notable benefit of kinetic shelters is their potential for multiple uses in various disaster scenarios, mitigating the need for continuous shelter production. Kinetic shelters might be more economical than three-stage sheltering which requires using different types of shelters. In addition, they can yield time and energy savings since their ease of assembly, disassembly, and transportation significantly reduces the time and effort required for implementation. Another advantage lies in the potential transformation of kinetic disaster shelters into permanent dwellings. By repurposing these shelters as long-term housing solutions, they can help prevent land waste and urban sprawl, while also reducing construction costs.

Taking the aforementioned factors into consideration, the development of a modular shelter can offer a viable solution for disaster relief shelters. Because the *Shelter Module X* is designed to be both easily transportable and expandable, it allows for adaptability to varying shelter durations and changing conditions. Implementing the *Shelter Module* X does not require extensive fieldwork or professional assistance. However, in cases where a combination of diverse modules is needed, professionals may need to assemble them on-site or prior to their arrival at the shelter settlement to ensure a smooth deployment process. For long-term usage, the proposed design can be converted into a permanent dwelling by enclosing the entire structure, reinforcing the insulated panels, and securely attaching them to the scissor elements. This transformation would necessitate the creation of a foundation, which could be achieved by improving the shelter's land, increasing its elevation, and removing the wheels. By following these steps and making the appropriate modifications, the *Shelter Module X* can transition from a temporary shelter to a durable and functional permanent dwelling. This adaptation allows for the longevity of the shelter, ensuring its suitability for long-term usage and providing a sustainable solution for displaced individuals or communities.

4. Conclusion and Suggestions

The need for shelters persists as long as the displacement resulting from disasters continues. The duration of sheltering depends on many factors such as the type of disaster, the extent of damage to the built environment, and the number of people affected. Even though sheltering is commonly perceived as a temporary solution, its duration is not always limited to a specific timeframe, as indicated in the existing literature. In fact, the construction of permanent housing can be delayed, leading to sheltering periods that can extend for years. During this extended period, the inadequacy of disaster shelters becomes apparent, and the living conditions can become unbearable for occupants. These shelters are designed with a temporary mindset, meaning to serve for no more than six months. As a result, they often fail to address the changing needs, locations, climates, and diverse user requirements, thus exacerbating the universal challenge of sheltering.

Acknowledging the potential changes in user types and needs over the extended sheltering period is crucial (e.g. children may enroll in school, and the number of patients or newborns may increase). Therefore, it becomes much more important to adapt to evolving circumstances and user needs. Designers must prioritize the quality of life within shelters, aiming to support the mental and physical well-being of the people affected by disasters and enable them to continue their daily routines such as work, study, rest, and recreation. In shelter settlements where people must live in temporary shelters until permanent dwellings are built, it is essential to incorporate common areas that foster social interaction. Moreover, there is also a need to provide service units, administrative facilities, and healthcare centers within the shelter settlements. Therefore, design solutions should cover creating large communal areas for such needs by either proposing large-scale units or combining small units to form larger spaces.

Because finding adaptive and flexible shelter solutions remains a priority, humanitarian organizations, engineering companies, researchers, and designers continue developing alternative design solutions. To respond to the changing needs and spatial requirements over time, interdisciplinary studies can be conducted. As new structural solutions are developed, the deficiencies in the existing design solutions of the temporary shelters can be solved. Kinetic structural systems can be a good solution in temporary shelter design since they offer not only structural and spatial improvement but also more adaptive and habitable living environments. Among the examples of disaster relief shelters, those having deployable and foldable systems are promising regarding adaptability and flexibility since they may provide alternative spatial arrangements for larger units and settlements.

The *Shelter Module X* offers a range of benefits, including spatial flexibility, modularity, adaptability to changing needs, and the creation of a habitable living environment throughout the sheltering period. However, most of the studies in the literature dealing with temporary shelters primarily focus on system development. Many studies highlight demountable or complex systems that are typically not user-friendly when it comes to installation. Emphasizing ease of assembly can be a key consideration for facilitating quick installations during the immediate relief period. In addition to system development, temporary shelter design should also concentrate on spatial arrangements and enhancing user comfort within and around the shelter. Further research is needed to develop more adaptive solutions for both individual shelter units and entire settlement settlements. In particular, the design proposal can be further enhanced by considering the implementation time and required workforce for both relocatable and demountable options. In the case of the relocatable option, the connection of plates and scissor linkages need to be explored to enable installation by non-professionals. Likewise, demountable options need to be designed and evaluated, taking into account the necessary workforce and time required for both professional and non-professional assemblies.

As the existing studies on kinetic disaster relief shelters are limited in scope, there is a significant gap in the literature regarding their potential for further development. Therefore, conducting a systematic review of such shelters to reveal their potential for further development and presenting a design proposal in this study will not only fill the gap but also contribute valuable insights to the field. This study can serve as a guide for further studies in this field.

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All authors contributed equally to the article. There is no conflict of interest.

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Defining the Adaptive Reuse of Traditional Houses for Tourism Purposes through Multi-Choice Process: Türkiye-Konya/Sille Example

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Abstract

"Architecture" is one of the tools that define sustainable cultural tourism. The sustainability of architecture which is an important source of culture is possible by conversation and restoration studies. It is observed that the most worn-out building group is residential buildings due to the lack of strict rules for historical settlements with this potential. A process based on the existence of traditional houses in historical settlements with their current function has been defined to be a tool, not a goal; particularly in cases where this becomes difficult. The Sille quarter which contains various cultural richness of Turkey and provides an adequate touristic axis for the province of Konya has been discussed. Fundamental decisions have been made to determine new functions that will define the model where functions other than residences will not cause transport capacity problems, social and cultural pressures; and prevent protected areas to become the decor of commercial activities.

Keywords: Housing, adaptive reuse, cultural tourism, multiple choice method, interior.

Geleneksel Konutların Turizm Amaçlı Yeniden İşlevlendirilmesinin Çok Seçenekli Süreçle Tanımlanması: Türkiye-Konya/Sille Örneği

Öz

Sürdürebilir kültür turizmini ifade eden araçlardan biri de "mimari" dir. Önemli bir kültür kaynağı olan mimarinin sürdürülebilirliği, koruma ve restorasyon çalışmalarının yapılması ile mümkündür. Bu potansiyele sahip tarihi yerleşimler için katı kuralların bulunmaması nedeniyle en çok yıpranan yapı grubunun konut yapıları olduğu görülmektedir.Çalışma tarihi yerleşmelerde bulunan geleneksel konutların mevcut işlevi ile varlığını sürdürmesinin esas alınarak; özellikle restorasyon sonrası turizm gibi tetikleyici nedenlerle bunun zorlaştığı durumlarda gündeme gelen yeniden işlevlendirmenin bir amaç değil, araçolması gerekliliğine yönelik bir model ortaya konmuştur. Türkiye'de farklı kültürel zenginlikleri barındıran; Konya ili için alternatif bir turizm aksı oluşturarak yeterli bir turizm arzına sahip Sille mahallesi ele alınmıştır. Konut dışı fonksiyonların ulaşım kapasitesi sorunlarına, sosyal ve kültürel baskılara yol açmayacağı ve korunan alanların ticari faaliyetlerin dekoru haline gelmesine engel olmayacağı modeli tanımlayacak yeni fonksiyonların belirlenmesi için temel kararlar alındı.

Anahtar kelimeler: *Konut, yeniden işlevlendirme, kültür turizmi, çoktan seçmeli yöntem, iç mekan.*

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1. Introduction

Cultural tourism is defined as a type of trip that aims to share and recognize all products of tangible and intangible cultural heritage covering natural areas, monumental or civil architectural structures, art products, collections, cultural identities, traditions, and languages (ÇEKÜL, 2012). According to the UNWTO, cultural tourism which accounts for more than 39% of tourism revenues recently stands out as an important element of international tourism consumption (Richards, 2018). Cultural tourism is a development tool that provides economic growth for a community by attracting visitors from outside the host community with its cultural heritage, which means the history, art, science, or lifestyle of the region (Silberberg, 1995). In this context, it can be stated that cultural heritage contributes to the growth of tourism and tourism generates financial resources for cultural heritage conservation.

Majority of the historical structures in the world are regarded as necessary assets for the development of local tourism owing to their heritage and socio-cultural values (Aigwi, et al., 2020). These structures play a significant role in the socioeconomic and cultural development of society (CPWD, 2013) by providing a physical connection and progression of cultural evidence to the past (Aigwi, et al., 2020). Acknowledging old buildings as reusable resources preserves their historical characteristics while adapting them to new uses increases the attractiveness of the city and neighborhood (Adiwibowo, et al., 2015). The re-functioning of historic buildings has become an essential part of regeneration programs in many countries (Ball, 1999).

The conservation of historical environments which are an important component of identity elements, the re-evaluation of these environments while they are protected and transforming them into "re-living spaces" is a universal acceptance for the occurrence of the conservation action. The goal of reuse is to keep cultural existence alive without losing its values such as history, aesthetics, and uniqueness (Ahunbay, 2013). Consequently, the most important goal of conservation is to keep the building alive by using a new function with its new values and environment (Yaldız & Asatekin, 2016; 163). This relationship brings new investment and job opportunities, economic development, and options that increase competitiveness to preserve and sustain cultural heritage, particularly for small-scale historical cities (ÇEKÜL, 2012). Especially, the necessity of determining the limits of building intervention has been emphasized to qualify re-functioned buildings triggered by tourism activities (Caterina et al., 2004).

According to protection guidelines, the limitations are mostly for facades and there are not enough limitations on interior designs (Kim, et al., 2008). Since lifestyle changes have an impact on the house in a changing and developing world, it is becoming increasingly difficult to preserve the traditional features of the house (Yürekli & Yürekli, 2007). These difficulties also accelerated the abandonment of traditional houses which reflect the original identities of the cities.

It is a known fact that traditional houses with historical, cultural, and structural value gradually wear out and eventually disappear because of uncontrolled tourism activities. However, traditional structures that have survived to the present day and constitute our architectural heritage should be preserved as best as possible and passed on to the future. The first step of protection is to identify and reveal the causes of wear. Various field studies, including many academic studies from the past to the present, have revealed that there are some problems in the interaction of the physical arrangements with the original structure and material which will enable traditional houses to respond to the current needs and demands that arise as a result of cultural and vital changes (Perker & Akıncıtürk, 2011).

In this context, this study focuses on the stages of the settlement process, user, and adaptive reuse decisions in residential buildings with particular emphasis on the Sille settlement of the province of Konya where activities for cultural tourism have increased rapidly since 2010. Accordingly, traditional houses are an important cultural indicator in a historical texture; the stages through which they should experience the functionalization; process , and the necessity of protecting it as a whole from the inside out in accordance with scientific, technical, legal, and ethical rules and principles have been brought up for discussion. Focusing on identifying and investigating key factors that may influence the adaptive reuse process of residential buildings because of tourism; a model proposal which is defined as a multiple-choice method has been developed to avoid an uncontrolled change process.

2. Cultural Tourism and Adaptive Re-Use

"Re-functioning" which is one of the popular methods today, provides the use of historical buildings that have lost their original function by equipping them with new functions. Hence, the buildings saved from abandonment become a part of cultural and architectural sustainability. Adaptive reuse involves converting a building to accommodate a use change required by new or existing owners (Latham, 2000; Wilkinson, et al., 2009). The change of use may require refurbishing and/or complete refurbishing of existing buildings or structures. Thus, semantic, and cultural elements of the structure can also be preserved. However, various elements of structures that had lost their unique structural properties in time are vanished and forgotten in time as well. Despite these negative circumstances, protection methods have been developed. Among these, the practical implications of adaptive reuse and conservation conceptual values support the reuse of heritage buildings as a sustainable strategy. Adaptive reusing transforms heritage buildings into accessible and usable locations through the sustainable rebuilding of an area. Latham (2000) stated that adaptive reuse protects architectural, social, cultural, and historical values. Historical settlements and local architecture connect people to their roots, emplace their collective memories and reflect both their cultural and personal identities (Bentley & Butina-Watson, 2007). In this way, an essential part of our cultural heritage and identity can be preserved.

Historical buildings are historical documents with their architectural, technical, and artistic values. Therefore, only keeping its shell and emptying it will harm that historical document. The goal of re-functioning is not to make a profit or to create new designs; rather, it is a method developed to preserve historical buildings. Keeping historical buildings alive involves many aspects such as architecture, technique, art, landscape, close environment, place spirit, memory - symbolic value. In other words, the goal of introducing a new function is not to completely transform the historical structure but to preserve the historical structure with all its original values.

2.1. Features of Historic Settlements in Adaptive Re-Use

There is a current growing trend toward economic activities based on tourism. However, particularly in underdeveloped countries, the impact of tourism can be extremely destructive for the environment which is also an attraction point for tourists. It is broadly acknowledged that tourists prefer to experience the natural environment, social and cultural life, and historical heritage of the region they visit. As a result, it is critical to respond to these needs through a responsive tourism development process. While sustainable tourism provides economic benefits, it also includes the protection of the natural and architectural environment as well as cultural identity. In this regard, the sustainability of these specific natural, cultural, and architectural environments is a critical issue. Another important factor in successful planning is the integration of tourism with the local environment and community (Türker & Dinçyürek, 2007).

Functionally, the transformation of old heritage buildings into contemporary functions has an important role to play in the rehabilitation and improvement of historical settlements. Thus, the re-functionalized building adds value to the living environment in which it is located. Historical environments define as the totality of economic, educational, health, and cultural activities which not only attract tourists but also work as a catalyst for the development of society (Rodwell, 2007; Shehata, et al., 2015). As part of a broader revitalization strategy to promote sustainability in the built environment, many buildings that have cultural and historical importance are adapted and reused rather than being demolished (Ball, 1999; DEH, 2004; Wilkinson & Reed, 2008; Wilkinson et al., 2009; Bullen & Love, 2009; Shehata, et al., 2015).

Adaptive re-use of heritage buildings contributes to improving the physical characteristics of the surrounding areas, both directly by the impact of the project on the environmental quality of the area and indirectly by assuring it as a catalyst for settlement (Atash, 1993; Jonas, 2006; Yung & Chan, 2012; Shehata, et al., 2015).

The relationship of re-functional areas with the environment should be well defined. The exterior appearance of the new function should be carried out without damaging the historical image of the space. Therefore, the location of historic buildings has a significant role and importance in determining the new function to be assigned to the historical structures.

2.2. Features of Traditional Housing in Adaptive Re-Use

Traditional housing is a cultural heritage owned by a nation that is known for its identity, history, and culture. With the development in this modern era, these local values may be forced to change in terms of function and usage (Chadijah & Fajarwati, 2020). According to Langston (2008), historic buildings contribute significantly to the historical and cultural aspects of the countries in which they are located, and thus adaptive reuse of buildings (ARB) will play an important role in renewing the built environment while preserving the hidden prestige of historic buildings. In this context, the functions and dimensions of the houses have changed in recent years (Sipahi & Kulözü, 2021). Traditions that have evolved through collective memory and their related traditional forms can and must be widely used and re-used in contemporary architectural and urban design projects, with proper community involvement. Hence, re-functioning or conversion of traditional buildings to contemporary uses is a tool for carrying the traditional environments into the future, both physically and socially (Fakhouri & Haddad, 2017:191). Before giving new functions to the residences, usage should be envisaged according to the criteria suitable for the qualities of the structure that will not disrupt the original perception of the structure (Gazi & Boduroğlu, 2015:68).

Traditional residences reflecting the identity, culture, and lifestyle of the user are not able to provide current comfort conditions which affect the usability of the houses. Particularly, adapting to current conditions and re-functioning as well as protections by providing maintenance and repairs may enable these buildings to sustain without losing values such as history, aesthetics, and uniqueness (Ahunbay, 2013).

In the protection of historical monuments in Turkey, the government is meticulously trying to protect large-scale public structures that are within the definition of "Group I Structures" under its ownership while most civil architectural which are mostly privately owned and are within "Group II Structures" cannot be adequately protected due to deficiencies in legal infrastructure (Regulation, Official Gazette, 2005).

The inadequacy of conservation awareness and protection policies in this sense makes it difficult to protect and maintain traditional houses that constitute cultural heritage and witness our past with their original functions, therefore these unused structures face the danger of extinction in the process (Dikmen, 2017).

According to 2019 year-end data, there are 113, 137 registered immovable cultural assets in Turkey; 71,414 of them constitute examples of civil architecture (Kültür Varlıkları ve Müzeler Genel Müdürlüğü, 2020). The conservation of traditional houses, which have a prominent place among examples of civil architecture and account for 63 % of all immovable cultural heritages, has been identified as a significant issue (Ertaş Beşir & Bekar, 2020).

Currently, it is clear that registering traditional houses only as immovable cultural assets and leaving them to their fate is ineffective in terms of protection and survival (Muşkara, 2017:445).

2.3. Features of User in Adaptive Re-Use

A historic building is thoughtfully planned with the appropriate resources for adaptive reuse, it can benefit the public, local governments, settlements, and the country. In a broad sense, functional change may result from the creation of new usage opportunities by preserving the architectural, aesthetic, social, and cultural values of historic buildings, while also including interventions to meet spatial requirements in a way that responds to the user's needs (Gazi & Boduroğlu, 2015:58). The suitability of the recommended function for the structure and the adopting of this function by users contribute to the service of the structure in a healthy way as well as in the context of sustainability and liveability. It is possible to keep the protected buildings to serve the community and to survive with their original structures by the right function and particularly maintaining the technical, functional, and aesthetic requirements (Urak 2002; Dikmen, 2017; Güremen & Dede, 2010).

Given that the new function assigned to the structure may change over time as a result of the changing social process, changes in the social texture and cultural structure should be planned beforehand. Therefore, the family structures, beliefs, and political values of those who live in the vicinity of the structure should be carefully evaluated together with their socio-economic status situation status. Historic buildings and neighborhoods connect the users to their roots, embed their collective memories, and reflect their identities as well as their cultural identities (Bentley & Butina-Watson, 2007).

Adaptive reuse is one of the practices for conserving historic buildings that are becoming increasingly popular with local governments around the world (Hanafi et al., 2018; Mısırlısoy & Günçe, 2016; Rodrigues & Freire, 2017; Tan et al., 2018; Wong, 2016; Ariffin, et al., 2020). Heritage conservation effort for historic buildings has been undertaken only by the governments in most developing countries (Abdullah et al., 2017; Harun, 2011; Tan et al., 2018; Ariffin, et al., 2020). Stakeholders are the investors, regulators, developers, house owners, and local people (Kincaid, 2002). The decisions taken in the early stages of the process affect the whole project. Consequently, all stakeholders should be examined in detail. Correspondingly, users can be represented as residents, property residents, local government, or public units.

2. Material and Method

2.1. Method

The problem addressed in the study is how to determine the functions other than housing that will contribute to the conservation of traditional textures in a way that does not cause carrying capacity problems, does not create social and cultural pressure, and prevent the protected areas from becoming the decoration of commercial activities. In this framework, the "multiple choice" model proposal defines the re-functioning process with the development of different scenarios created. The model proposal consists of the preparation stage where determination of the cultural and historical resource values of the settlement with the opinions of the actors responsible for the change of the settlement and the option stage where the answers to the function suggestions are produced. In the model; the preparation stage is the part where the determined data of the settlement are analyzed and evaluated. The option stage shows the process in which functions are determined according to the revealed results (Figure 1). As a result of these stages, under the supervision of seven expert groups consisting of architects, interior architects, restoration experts, and art historians; 3 basic data belonging to the settlement, the traditional houses in Hacı Ali Ağa Street, and the users were obtained by considering field studies, interviews and various information sources (literature, tourism master plan, strategic plan, development agency regional plan and various official indicators).

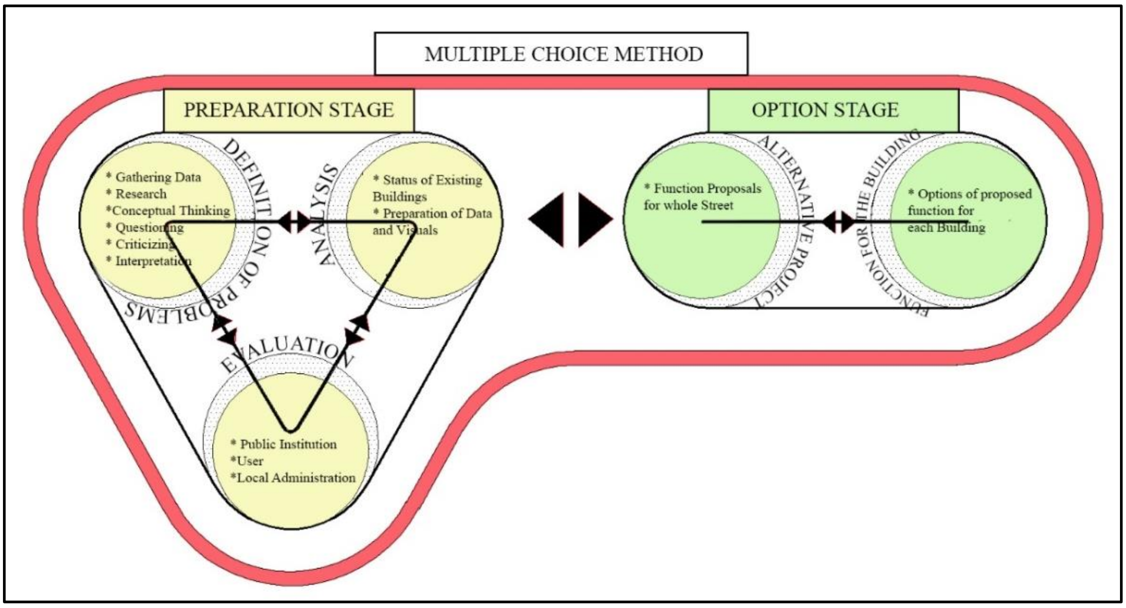

Figure 1. Multiple choice method scheme

Information about the settlement, residences and users was gathered during the preparation phase. In this context, data on settlements and residences were gathered during the visits to the area in 2016. In this process, the map depicting the general situation of the settlement was examined on the spot and the usage conditions of the buildings were determined in conjunction with tourism. Furthermore, it has been determined in which functions they are currently used by conducting the surveys of the residential buildings.

A face-to-face survey was conducted with locals, domestic and foreign visitors in 2015 to determine the attitudes of the users towards tourism between June and July in the summer of 2015 and October and November in the winter of 2015.

The sample size formula was used to determine the number of local people and visitors (Kalıpsız, 1981). Furthermore, Kiper's (2006) research was used in the preparation of the surveys. Survey questions were asked to 75 people selected by incidental sampling method from 3,780 people identified as the approximate population of the region when determining the sample of locals the visitor number of Konya is 2.313.293 while the number of visitors to Sille is 91.264 according to the Selçuklu municipality's official museum visitor records. Foreign visitors account for 38% of these visitors. The survey was conducted with a total of 125 people of whom 75 were local and 50 were foreign visitors selected through incidental sampling method. All data were analyzed with the SPSS V.22 statistical program. During the option stage, tourism alternatives were developed, and function suggestions were compared. In this direction, the analysis in which the current situation is read and the evaluated function suggestions on all the data are determined and answers to the function recommendations are produced with the proposed method.

2.2. Material

Sille is located between Takkeli and Karabuğa Mountains in the form of a valley to the north of Sille Stream which is 8 kilometers from Konya's city center and located in central Anatolia region of Turkey (Figure 2).

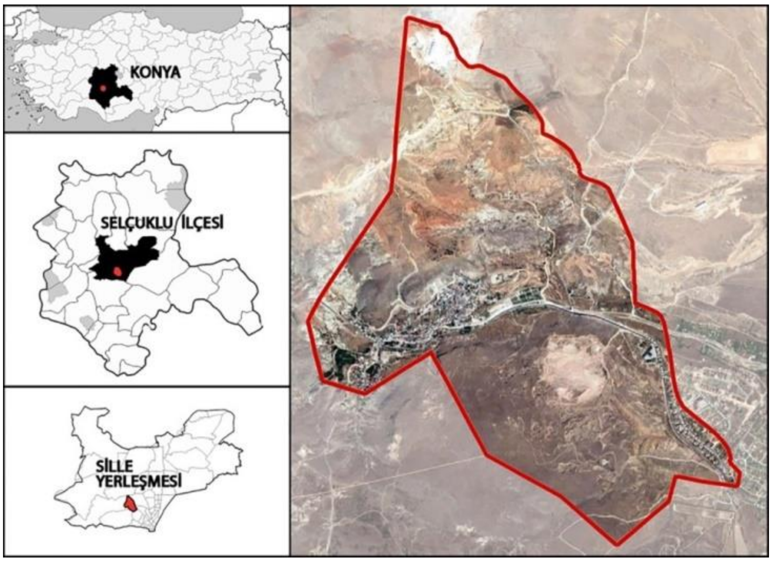

Figure 2. Sille’s location (Sönmez et al., 2017)

Sille which was an advanced socio-economic settlement until the pre-Republican era is one of the oldest centers known in Anatolia since the first periods of Christianity and is a center where cultures from different ethnic (Turkish and Greek) and religious origins (Christian and Muslim) coexisted in both the Seljuk and Ottoman periods.

The location of the buildings creates the settled texture of the city with a perspective perception because of the shape of the land. The Konya Selçuklu Municipality accelerated restoration work in 2010 and most of the buildings on it such as Hürriyet Street, Hacı Ali Ağa Street were restored at the façade level until

2016. Ten unique residences on Hacı Ali Ağa Street, where the housing structure is most concentrated in Sille settlement, were examined in the study (Figure 3).

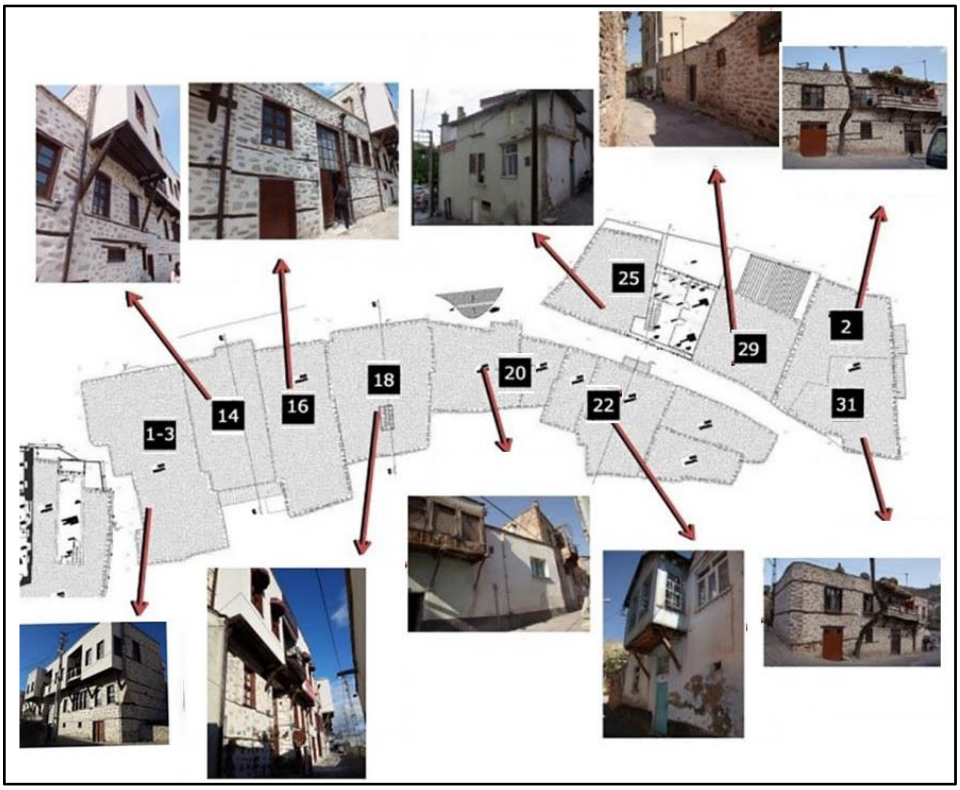

Figure 3. Hacı Ali Ağa Street and row of 10 residences with unique qualities

3. Findings and Discussion

3.1. Determinations of Sille

Existing literature, on-site observation, interviews, collaborative studies, and social research results reveal the data on cultural and historical resource values in terms of tourism. In this regard, the cultural assets revealed in Sille settlement were identified and divided into five groups. These are sorted as follows and visualized on the map (Tomar, 2015), (Figure 4).

(1) Religious Structures

(2) Water Structures

(3) Public Buildings

(4) Civil Architectural Buildings

(5) Cemeteries

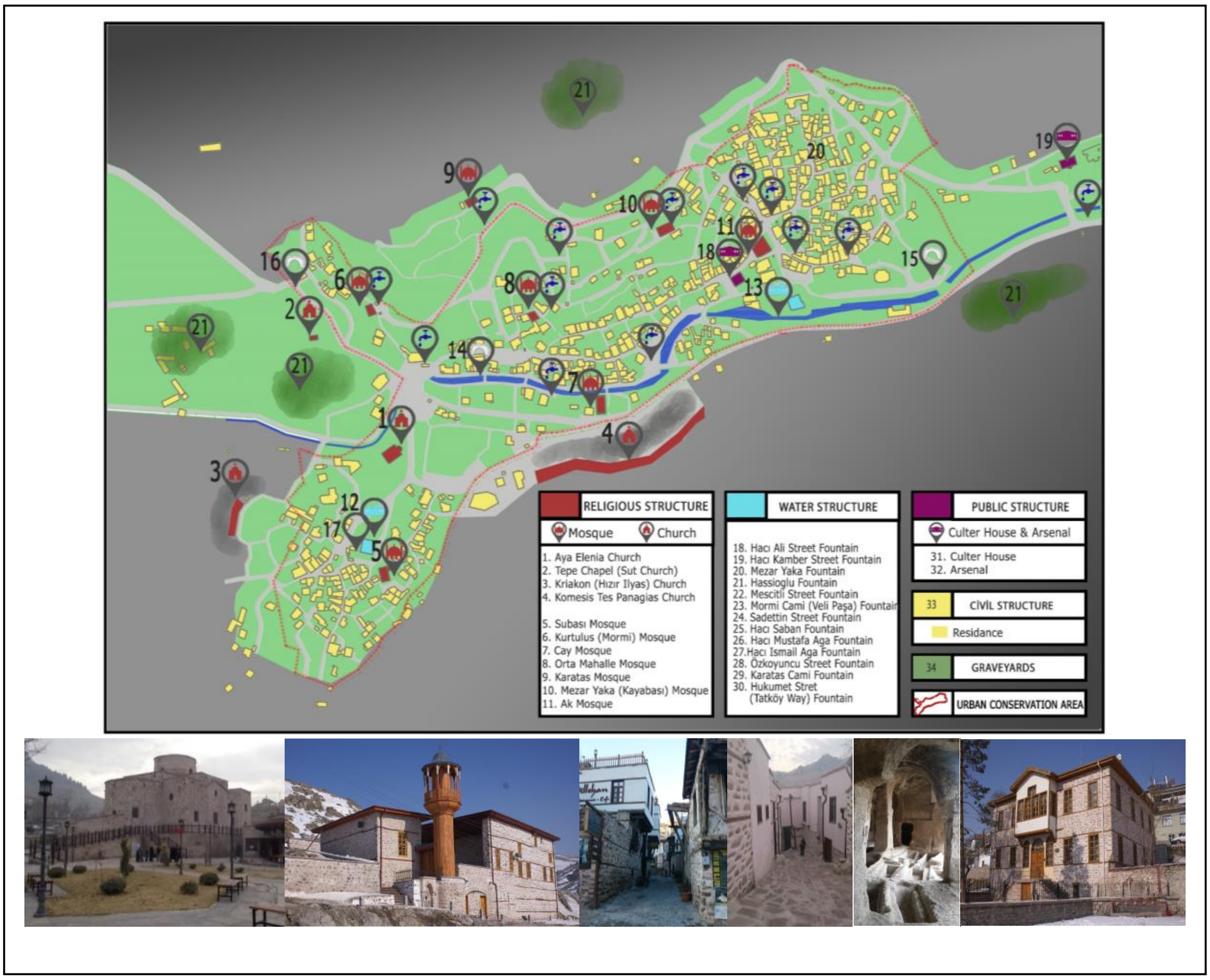

Figure 4. Layout and cultural assets of Sille, Aya Elenia Museum (Hagios Mikhael Church), Karataş Mosque (Ertaş et al., 2016), exterior and interior view of the residences (Taş, 2015)

Religious structures in Sille are examined in two groups: churches and mosques. Churches in Sille which have a rich history are referred to in the historical sources where there are many churches and monasteries from the Byzantine period to the present (Mimiroğlu, 2012). The Ak Monastery, Aya Elenia Museum (Hagios Mikhael Church), Komesis Tes Panagias Church, Kriakon (Hızır Ilyas) Church, the Monastery and Tepe Chapel in the Salasorma District are some of the artifacts that have preserved up to the present (Tomar, 2015:50). On the other hand, mosques have all features of Turkish wood art, although they have been changed numerous times up until now. Kurtuluş (Mormi) Mosque, Subaşı Mosque, Mezar Yaka (Kayabaşı) Mosque, Orta Mahalle Mosque, Ak Mosque, Karataş Mosque, and Çay Mosque can be traced back to late Ottoman architectural features (Tomar, 2015), and have been restored by the Selçuklu municipality (Figure, 4).

Sille has rich water architecture thanks to its geological and geographical structure. The settlement currently has baths, fountains, bridges, and aqueducts. There are many fountains with Ak (Hacı Ali Ağa) Hammam, Subasi Hammam, Sille Laundry, and Great Aqueduct, both adjacent to and independent of the houses. There are plenty of fountains with Ak (Hacı Ali Ağa) Hammam, Subasi Hammam, Sille Laundry, and Great Aqueduct both adjacent to and independent of the residences.

Two of the public buildings in Sille dated back between the 19th and 20th centuries have survived until today. The first of these was Sille Primary School which was built in 1941 and was later restored as Sille Culture House by the Selçuklu Municipality before becoming Sille Museum in 2018. The other one is the arsenal at the entrance to Sille's east. This structure has been restored currently and is used as a cultural and social affairs service building.

Civil architecture examples in the Sille area are generally dated to the late 19th century and the first quarter of the 20th century. The large number of residential buildings that have not yet been demolished has played a role in shaping the overall character of the settlement. The houses with a cubic exterior form have flat roofs and the ones that have roofs are almost non-existent. The residences were designed on a small scale and functionality was prioritized according to the lifestyle. The number of floors in the residences is directly affected by the location of the building on the sloping land and its relationship with the street (Figure 4).

The character of the facade is formed in Sille residences by the exterior extension of the hall, or the balcony-shaped cantilevers based on the terrain slope (Taş, 2015). The residence is composed of living and service areas. Living places consist of a hall, and grand hall whereas the service areas are the kitchen, stairs, firehouse, yard, bievi-büevi, storage room, bathroom (güsulhane), and toilet places (Taş, 2015). Sille stone, which is unique to Sille region is extracted from quarries nearby commonly (Sönmez, 2014) used as a building material; besides this, soil (adobe), wood, and ironwork are also used prominently.

When the cultural assets of this settlement, which is near the province of Konya, are examined, it is discovered that it has very rich touristic resource values and a different style from Konya in terms of the general character of the residential buildings. In this sense, it is obvious that it can serve as a tourism corridor as an alternative route with both monumental and civil architectural structures.

3.2. Determinations of Traditional Houses located on Hacı Ali Ağa Street

Hacı Ali Street distinguishes itself with its unique residential texture, which is among the important architectural structures such as baths, mosques, and museums in its immediate vicinity; hence its residential and architectural features are significant as a cultural element. In this study, the street type, location, current function, plan scheme, and registration status of the determined ten buildings have been indicated and schematized to obtain data on what kind of decisions can be made in the case of re-functioning. (Figure 5), (Taş, 2015; TUBITAK, 2016).

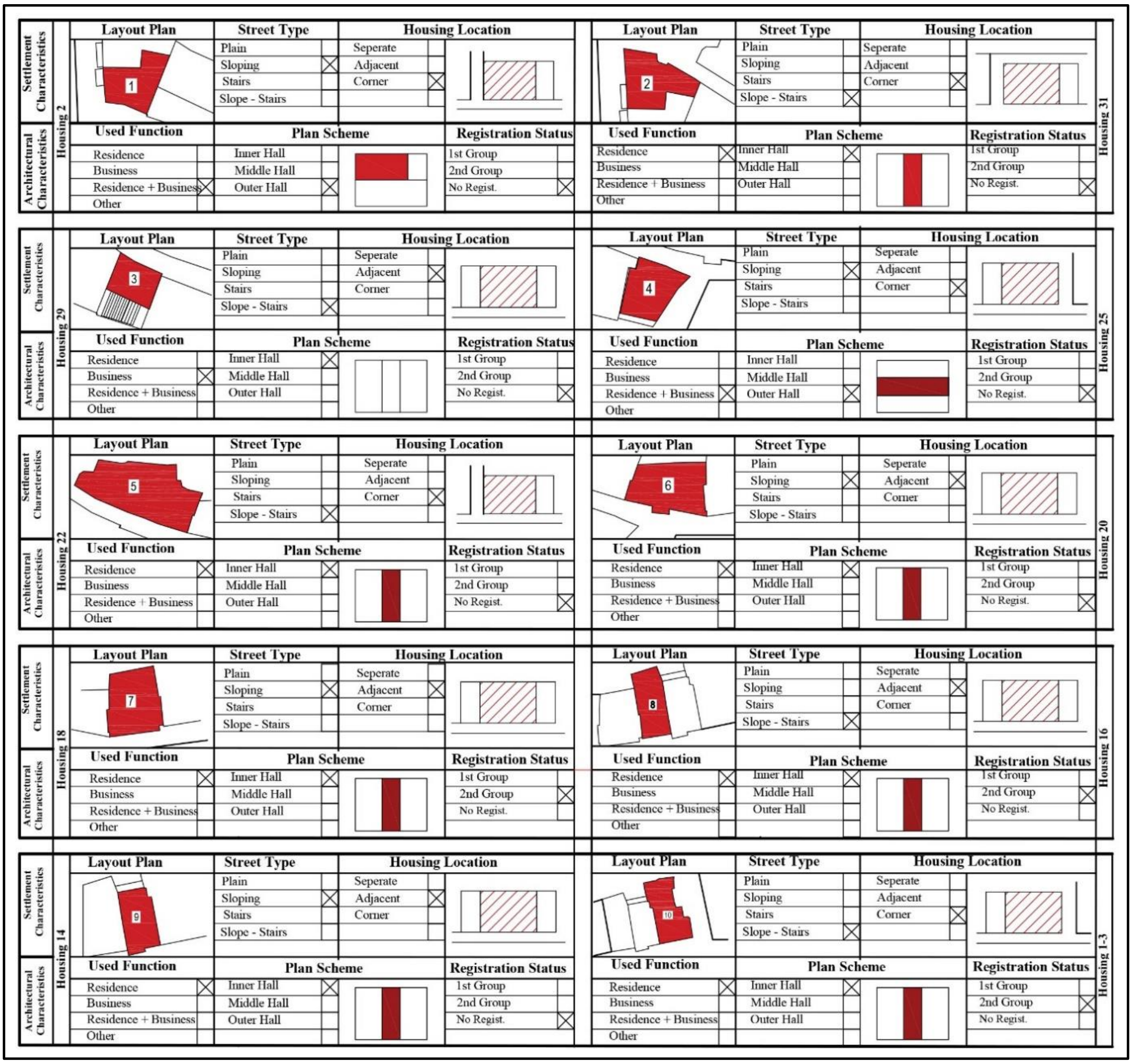

Figure 5. Current status of a row of 10 residences

The residential buildings under consideration as a result of the examination include both registered and unregistered structures on a sloping street. It is observed that the majority of these houses have two and three stories and appear as a variation of a plan scheme with an inner sofa. The sofa is completed with a front roof, balcony, or terrace. Outbuildings and service areas on the ground floors include a barn, haystack, breeding roof, and kitchen, and some have a middle space called taşlık. The guest room and bedrooms are located upstairs. Separate entrance doors were made for this floor in some residences. This is due to the sloping nature of the land. There is a kitchen, toilet, and bathroom on the stairwell, which is usually made of wood. There are also gusülhanes in some rooms of the residence (TUBITAK, 2016) (Figure 6).

Figure 6. Photographs of residences on the Hacı Ali Ağa Street

Aside from these, 3 periods that determined the settlement character of Sille were revealed by detecting the functional changes of the selected houses in the historical process (Taş, 2015). Thereby, the kind of additions has been made to the structures or the features that have deteriorated in the process have been identified by examining the changes in the houses from the past to the present.

- The Seljuk and Ottoman periods that followed the early Christian periods and the Republican period preceded the Treaty of Lausanne in 1923,
- The period between the population exchange in 1923 and local people's emigration from the settlement in 1980,
- 1980-2010,
- Post 2010.

While the residential buildings were used for their original purposes before 1923, it was discovered that following the population exchange in 1923, particularly after the 1950s, some parts of the houses numbered 2, 29, and 25 were used as commercial sales spaces. Between the two periods, various additions were made especially to the residences due to both its original function and its changing function. Sille was affected by economic conditions between 1980 and 2010, and the population decreased significantly in comparison to other periods. There was no functional change in the housing structures during this process. However, the number of unused houses has started to increase particularly in recent years with the triggering of migrations. Tourism activities in the settlement accelerated in 2010, with the start of restoration works. On the other hand, residential buildings started to be restored after 2014. Especially with these works, Sille which has a dense housing structure can be considered as a period of change and activities after 2016 due to tourism. Residences numbered 20 and 22 were not restored during this period because the house owners did not want them to be restored. The function of residence numbered 2 has not changed and some of it has continued to be used as a sales area; residences numbered 29 and 25 have been converted from a sales area into a dining area. Additionally, residence numbered 18 has also changed its function and turned into a place for eating and drinking; residences numbered 2,4,14 and 1-3 are empty and unoccupied. The functional change of residences in the study area is shown below by the years. To show the function change; light brown was used for the original functions, red was used for selling, green was used for eating and drinking functions, and colorless parts were used for unoccupied residences (Figure 7).

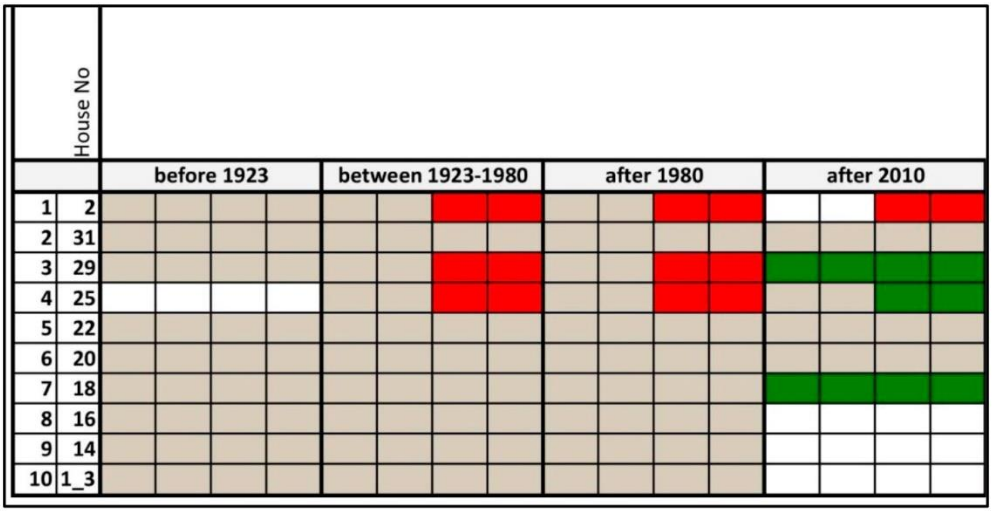

Figure 7. Functional change of residences in the study area by years

The original plan schemes of the houses, their facade characteristics, registration status, and their current usage purposes were determined for the adaptive reuse scenario of the 10 house-selected houses to develop options where alternative projects are discussed. Subsequently, the functional change over the years was determined. Building parameters are critical when deciding to adapt residences for reuse. For this reason, the expert group's evaluations should be considered as they have complete knowledge of the parameters and qualifications. The expert group developed 12 function proposals to provide a correct direction for future changes by considering the m^2 of the buildings, their original functions, and their re-functioning status (Figure 8).

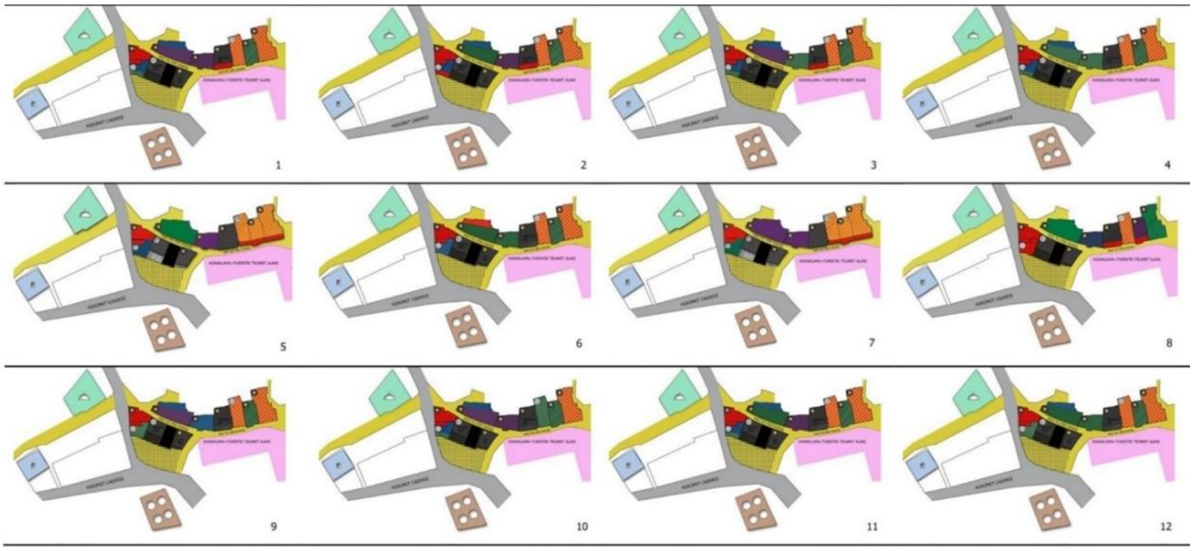

Figure 8. 12 function proposals created by the expert group for Hacı Ali Ağa Street

Among these suggestions, the residences numbered 31, 25, 22, and 20, according to the most recommended functions for the same residence, are used as commercial houses together with their residential function; acknowledging the changed function of residences numbered 18 and 29 after 2010 due to tourism; the opinion that residences numbered 2, 16, 14 and 1-3 may be used as business premises because of their long vacancy; specified below with various functional options (Figure 9).

	House No	Options Created Based on Experts' Opinions																											
		Food & Beverage Spaces							Sales Spaces							Workshops/ Exhibition Spaces					Cultural Spaces					Accomodation			Current Function
		Local Cuisine Restaurant	Winehouse	Tea House	Sherbet House	Breakfast House	Greek Restaurant	Cafe-Souvenirs	Carpet Sale Space	Food-Beverage Sale Space	Souvenirs Sale Space	Candle Sale Space	Herbalist	Grape Molasse Production and Sales House	Terra Cotta Sales	Stone Workshop-Exhibition+Sales	Wood Workshop+Sales+Cafe	Carpet Workshop+Exhibition	Terra Cotta Workshop+Sales	Art Education Workshop	Clothing Museum	Kitchen Museum	Folklor (Cultural) Museum	Examplary Local Sille House	Carpet Museum	Boutique Hotel	Boutique Hotel+Restaurant	Hostel	House
1	2							●																●					
2	31													●															●
3	29	●																											
4	25			●																									●
5	22							●										●	●										●
6	20																	●	●	●									●
7	18	●																											
8	16																											●	
9	14	●																											
10	1_3																											●	

Figure 9. Options created based on expert opinions

Many functions can thus be assigned to houses that have not been used for a long time to prevent them from collapsing or wearing out; however, the most appropriate one among these functions should be assigned by revealing the expectations and needs of all users because of participatory consultation. The sustainability of the housing structure, which is one of the most important elements that describe the culture in historical settlements, can therefore be ensured without the need for unnecessary functional changes.

3.3. User Reviews

According to the International Cultural Tourism Charter (1999); one important goal in cultural heritage management is to explain the importance of cultural heritage and why it should be preserved for the host community and visitors. Therefore, all actors in the settlement were determined, and their perspectives on cultural tourism were considered. In this context, the Konya Cultural Heritage Preservation Regional Board, Selçuklu Municipality, householders, domestic and foreign visitors, and local people were identified as important users.

Information about the New Conservation Development Plan was obtained through face-to-face meetings with the Konya Cultural Heritage Preservation Regional Board about the regulations applicable to the Konya/Sille region. Similar meetings have been held with the Selçuklu Municipality, to which Sille is affiliated since the changes in the zoning plan went into effect in 2017 will affect the re-functioning process.

Another actor in the settlement is the house owners. The desire to use the residences by changing all the functions or a portion of them has been revealed because of the tourism developments in Sille, considering the meetings that took place regularly from 2013 to 2016. In this respect; aside from the restoration project, additions or removals made by the user in both registered and unregistered buildings were evaluated based on the functions provided; strategies were determined based on their property status and location.

Other important actors are local people and domestic and foreign visitors. In this regard, when the distribution of original features for Sille was examined in the survey conducted with local people, it is thought that traditional architectural and rural texture and historical and cultural values are among the characteristics of the village. These are followed by regional dishes, traditional handicrafts, agricultural structure and regional products, vegetation, and winemaking respectively (Figure 10), (Ertaş et al., 2017).

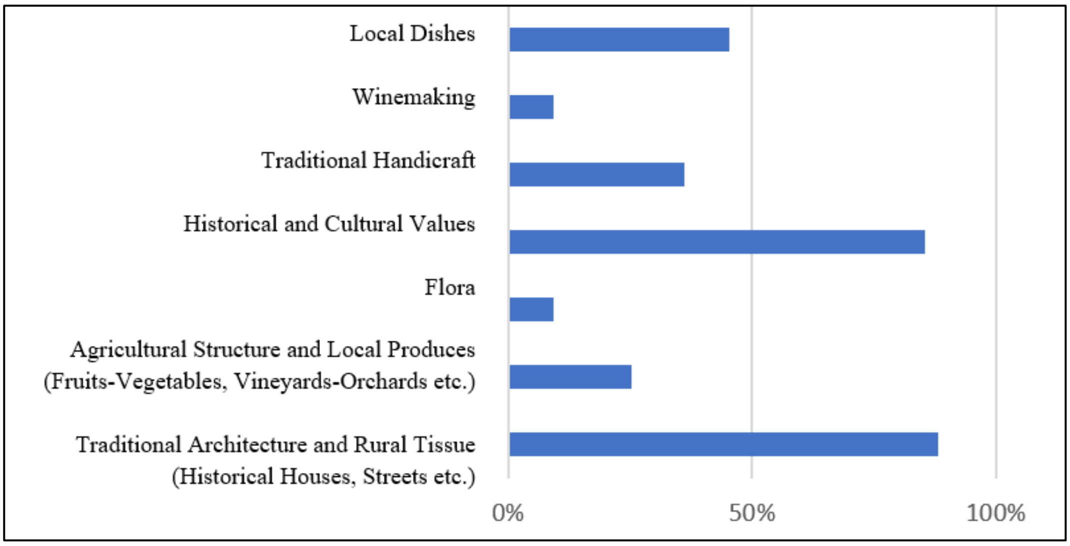

Figure 10. Features that locals find unique to Sille (Ertaş et al., 2017)

Respondents emphasized that festivals can be organized and that touristic activities should be arranged in their responses about the activities that can be done for tourism in Sille. On the other hand, the development of visitor and accommodation facilities in houses with traditional architecture has been identified as an important activity. In their answers to the surveys regarding the activities that can be done for tourism in Sille, respondents emphasized that festivals can be organized first and that tourist activities should be arranged. On the other hand, the creation of visits and accommodations in houses with traditional architecture has been shown as an important activity (Figure 11), (Ertaş et al., 2017).

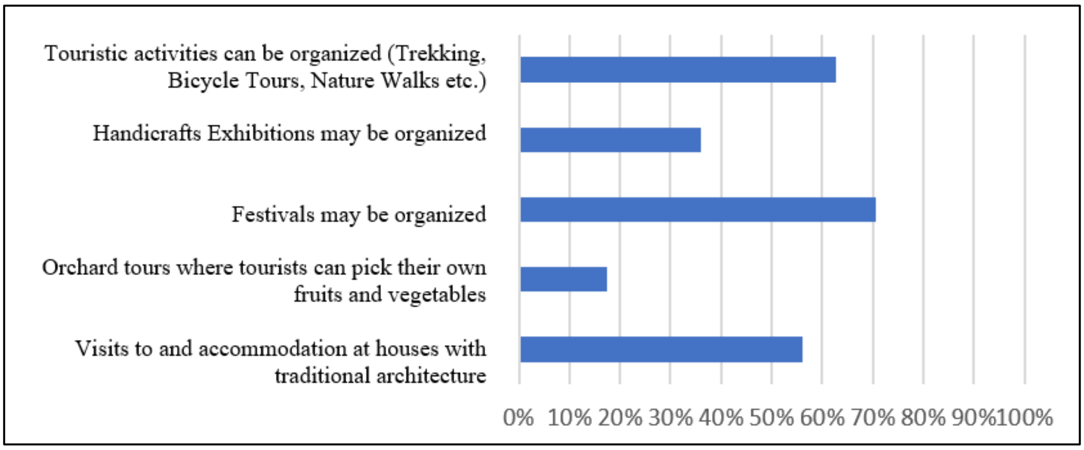

Figure 11. Evaluations of the types of activities that local people can engage in for tourism in Sille (Ertaş et al., 2017)

Residents have indicated that they can support the studies on tourism by providing service and guidance services to domestic and foreign visitors. They also stated that by making handicrafts, visitors can be drawn in and different services can be provided by using traditional houses for accommodation (Figure 12), (Ertaş et al., 2017).

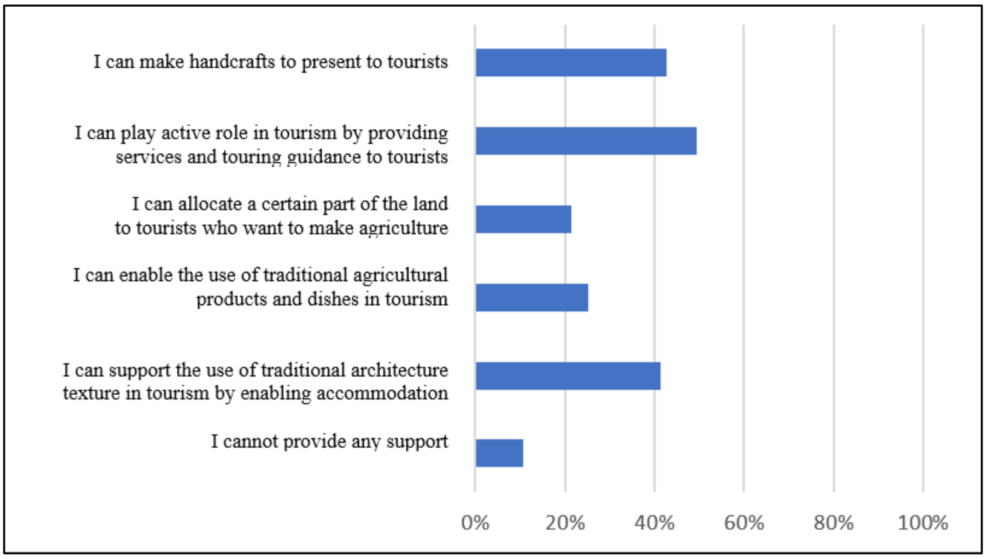

Figure 12. Evaluations of local people's services that can provide support for tourism studies (Ertaş et al., 2017)

According to the revealed data, tourism activities for local people will stimulate the regional economy, reduce out-migration, and prevent unemployment. Besides, it has been stated that traditional architectural structures support tourism and can be used specifically for accommodation purposes.

When survey studies of domestic and foreign tourists are examined, the traditional architectural structure comes first with 66.4% of the respondents' answers about what first drew their attention in Sille. Then, there are historical charms with 23.2% and original nature and scenery with 7.2%. The rich architectural examples in Sille are the factors that attract the most attention from visitors so that the traditional architectural structure can be said to be one of the most important factors in the development of cultural tourism in the region (Figure 13).

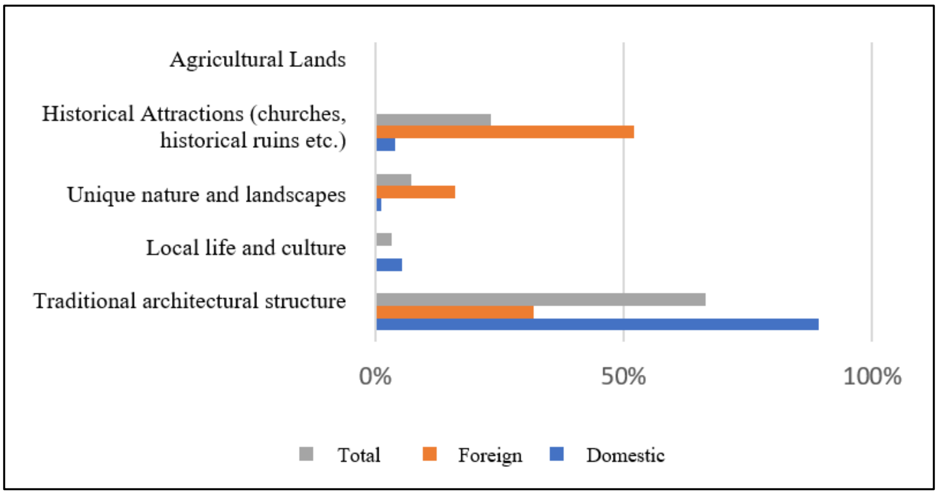

Figure 13. Features that attract the first attention of domestic and foreign tourists in Sille

According to the responses to the question about what kind of activities can be done for tourism in Sille, 66.4% think that it can be organized to visit and accommodate in houses with traditional architecture, 63.2% think that festivals can be organized, and 53.6% think that touristic activities (nature walks, bicycle tours, etc.) can be arranged. Following there are handicraft exhibitions with 32.8% and garden trips with 24.8% which allow tourists to pick their vegetables and fruits. In this sense, it can be argued that among the activities to be carried out in the region, accommodation and touristic activities should be prioritized (Figure 14).

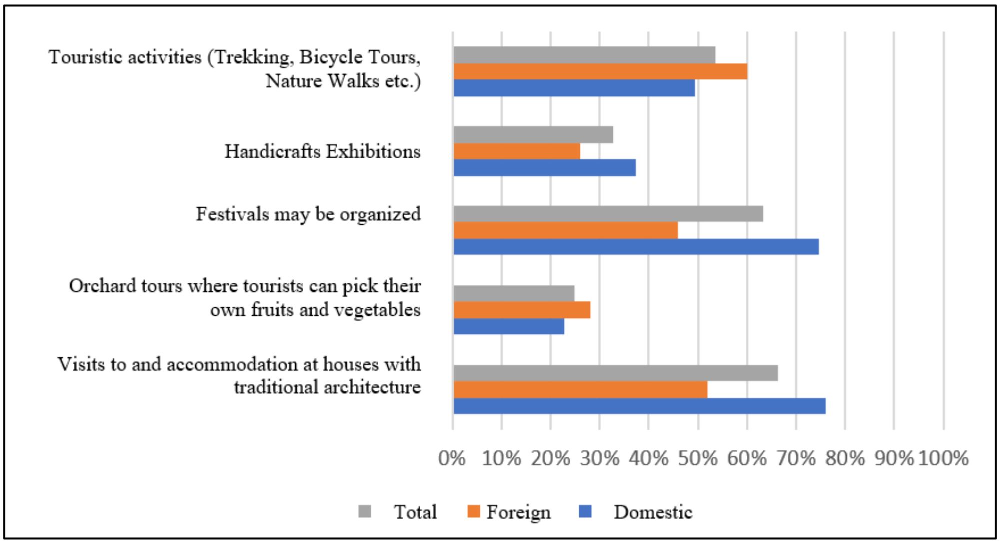

Figure 14. Evaluations of activities that can be done by domestic and foreign tourists in Sille

According to the revealed data, from domestic and foreign visitors' perspectives, the development of cultural tourism in Sille is possible with the preservation and evaluation of historical and cultural assets through restoration works, the development of handicrafts, and the completion of tourism infrastructures such as accommodation, food and beverage, etc. Thus, in historical settlements undergoing rapid change because of tourism, the activities within the settlement can be controlled by periodically observing the visitors, while the functional transformation process can be avoided wearing down the settlement and structures.

4. Conclusion

The project work titled "Physical Renewal of Traditional Texture in Konya-Sille within a Method for Touristic Purposes" is based on testing the applicability of the "Multiple Choice Method" based on physical renewal projects consisting of different scenarios. Accurate planning has been made about the correct definition of the privileges with the proposed method design process that distinguish one region from another, and which of these can be used for tourism purposes. Thus, it is underlined that the options are presented afterward by emphasizing the necessity of reading the current situation.

As a result of all the examinations, the following two main points should be considered to avoid an uncontrolled change process for settlements such as Sille, where the increase in tourism activities triggered by the restoration works and the resulting accelerated re-functioning proposals are concentrated in the residences. Consequently, houses can be prevented from becoming the most worn-out type of building due to tourism.

- The balance of protection and use should be taken under control with a multi-choice process by considering the evaluations of public institutions, local administrations, experts, housing owners, local people, and domestic and foreign visitors.
    - The expectations and needs of all users of the settlement should be determined.
    - In terms of residential structures, the practices of local and private institutions and house owners should be investigated.
    - The opinions of the public and visitors on tourism and the basic data should be repeated frequently for the solution of the problems that may arise in the future.
- Reconstruction, renewal, and other changes occurring on the facade character and interior spaces of residential buildings with the shift in business type in the tourism sector are affecting the overall appearance of the historical settlement. In this regard, more proper precautions for house interior restoration are required.
    - All cultural assets belonging to the settlement should be examined and archived by making relevant determinations, the potential of the historical area in terms of tourism should be ascertained, and the areas with dense residences should be determined.
    - In order not to demolish or wear out the residences that are not used for an extended period of time, the use potential should be examined, and the option of re-functioning should be considered or if the residences are suitable, function proposals should not be created unnecessarily, and residences should continue in their function.
    - The functional performance of these structures for their sustainability should be revealed by examining the new functions of houses that have undergone a functional change.

Consequently, a visual and social archive emphasizing the continuity of time and space has been created by defining key decisions on how to identify new functions that define the model in a way that will not cause carrying capacity problems due to the functions imposed on the residence, will not create social and cultural pressure, and will prevent the protected areas from becoming the decoration of commercial activities in historical settlements that have changed due to tourism.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article.

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Re-discussing Architectural Contextualism Through the Competition Project: The Case of Dominique Perrault and Wang Jianguo

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Abstract

Intentionally or unintentionally, architecture affects the world with its physical and cultural values and represents its judgments with the outcome product. Modern architecture and its influences should be considered to define those judgments in the contemporary architectural environment. The city-in-park model, among the most substantial influences of contemporary architecture, introduces serious challenges. While certain ideas emerge regarding the fundamental issue addressed as exclusivism, criticisms, and suggestions are also available with respect to this subject. This study discusses the concept of contextualism, coined by Stuart Cohen to produce suggestions and criticisms for the problems caused by modern architecture. Also, within the framework of this concept, a critique is presented of the Transformation and Revival of Industrial Heritages Competition. In this critique, while comparing two projects, a general discussion is carried out on the purpose of the projects, the parameters they affect, and the problems they deal with, as well as their form and context. The study aims to reevaluate architectural contextualism with two different projects designed within the framework of the same problems and to present a definitive study based on the idea of renewing in its context, brought by contextualism.

Keywords: *Contextualism, inclusivism, exclusivism, urban models, Cohen.*

Mimari Bağlamsalcılığın Yarışma Projesi Üzerinden Yeniden Tartışılması: Dominique Perrault ve Wang Jianguo Örneği

Öz

Mimarlık, bilinçli ya da bilinçsiz olarak, yaşanılan dünyayı fiziksel ve kültürel değerleriyle etkilemekte ve ortaya çıkardığı ürünlerle kendi yargılarını temsil etmektedir. Güncel mimarlıktaki bu yargıları tanımlamak için modern mimarlığı ve etkileri ele alınmalıdır. Modern mimarinin en önemli etkilerinden olan park içinde kent modeli beraberinde ciddi problemlerden olan dışlayıcılık problemi için belli fikirler ortaya çıkarken, konu hakkında eleştiriler ve öneriler de bulunmaktadır. Yapılan bu çalışmada, modern mimarlığın ortaya çıkardığı söz konusu problemlere karşı Stuart Cohen'in bağlamsalcılık kavramı ele alınmakta ve bu kavram çerçevesinde The Transformation and Revival of Industrial Heritages yarışma projesi üzerinden bir eleştiri yazısı sunulmaktadır. Yapılan karşılaştırmada, projelerin amacı, etkilendikleri parametreler ve ele aldıkları problemlerle birlikte biçim ve bağlamları üzerinden genel bir tartışma yürütülmektedir. Mimari bağlamsalcılığı, aynı sorunlar çerçevesinde tasarlanan iki ayrı proje ile yeniden değerlendirmek ve bağlamsalcılığın getirdiği kendi bağlamında eleştirilme fikrinden yola çıkarak, örnek bir çalışma ortaya koymak hedeflenmektedir.

Anahtar kelimeler: *Bağlamsalcılık, kapsayıcılık, dışlayıcılık, kent modelleri, Cohen.*

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1. Introduction

Architecture is among the most important elements embodying and reflecting the city's values and culture. For this reason, the buildings constructed bear certain values and judgments and represent these judgments. The exterior approaches of the building, its scale, and the form or colors used leave an impact on the city hosting the structure. On the other hand, the architect represents his/her judgments within the emerging values of the buildings designed. In contemporary architectural criticism, these judgments are evaluated and discussed. However, to define and make sense of the criticisms made, it is required to understand the nature of judgments modern architecture includes and its place in architectural criticism.

Cohen (1974), in his article Physical Context / Cultural Context: Including it, all, states that modern architecture fails to fulfill its utopias and the success of its ideas fails to be demonstrated in practice. The city-in-park model, in which modernist cities offer utopian approaches, introduces certain problems, which are ignored by modern architecture. In the criticism of modern architecture, the exclusion of modern architecture, which is defined as isolated structures, is at the root of these problems. In this article, which Cohen (1974) wrote after Colin Rowe's work, it is seen that he criticizes the problem and offers contextualism (Özten & Anay, 2020, p. 15-17; Bingöl, 2020). The study aims to present the concept of contextualism through selected competition projects and criticize contextualism through these projects.

This study, addressing architectural contextualism, re-evaluates urban design by considering the exclusionary state of modern architecture. Since contextualism is a critical suggestion, it can be handled and evaluated with different data and results in each design (Karayama & Hekimoğlu, 2022). Therefore, the two projects most suitable for the data to be provided are selected through a current competition, and discussions are carried out with these projects. An up-to-date competition is selected based on the idea that contextualism should renew itself with up-to-date data. While performing the evaluation, the cultural context, physical context, and inclusivity factors are taken into consideration as well as what is required in the project. Moreover, while the study is being completed, a case study is conducted on the projects selected recently, as it is aimed to re-discuss architectural contextualism, and a critique is presented with comparisons done following the evaluation.

2. Material and Method

Focusing on architectural contextualism and aiming to discuss a recent competition project, features a qualitative case study. First, the foundations and purpose of architectural contextualism are explained, and then architectural contextualism is discussed on projects made in the same field, for the same purpose, and within the scope of the same competition. The discussion in question is based on the primary sources that define and discuss architectural contextualism and official information about the competition project. In this study, while starting with the argument that architectural contextualism is not periodic and can present a discussion on today's architectural works since its first emergence it is also defended that several answers are available for the emerging problems.

3. Findings and Discussion

This study reconsiders the concept of architectural contextualism through a current competition. First, the concept of architectural contextualism is explained and the concept of ecology is examined in this context. In the competition discussed, the concepts specified over the two selected projects are evaluated. These evaluations are carried out as similar aspects and comparisons. It is aimed to examine the extent to which architectural contextualism, which is an important factor in today's architecture, is among the expectations and outputs in contemporary architectural competitions.

3.1. Architectural Contextualism

Contextualism, derived from Colin Rowe's urban theories, emerges as a product of his master's program (Cohen, 1974; Özten & Anay, 2017a). The approach defines itself by the necessity of a comprehensive perspective rather than putting forward a uniform problem area. Considering the diversity it embodies, it is revealed that contextualism takes a critical approach toward the issue it addresses.

According to Fox (2014), contextualism is the inability of any situation or event to break away from its historical context. On the other hand, the contextualist approach is possible by criticizing the criticized subject by considering its entire conditions. It is more appropriate to review the whole context and to perform evaluations within this framework.

Although the book Collage City, written by Rowe & Koetter (1978), does not address the issue of contextualism as a word or even does not mention the practice of contextualism, the book presents the problems that contextualism deals with and includes analytical strategies. Following Cohen (1974) evaluates contextualism within the framework of inclusiveness by considering the cultural dimension beyond the concept referring to the immediate environment and physical parameters of the building. However, he defines modern architecture as exclusionary with its isolated structure. While Cohen (1974) approaches contextualism in terms of modern architectural criticism, he further states that modern architecture is far from a contextualist approach by ignoring the facts of life. Against this problem, he advocates proposing the physical and cultural context (Cohen, 1974). For this reason, while expressing modern architecture as exclusionary, it offers inclusiveness as a suggestion.

Cohen (1974) finds too superficial the criticism of modern architecture made in the book Learning From Las Vegas (Venturi, Brown & Izenour; 2017), another example of the inclusivity proposal. Stating that the criticism of modern architecture as ducks or decorated huts remains a criticism based on symbolism, Cohen claims that in this study that the approach of inclusiveness has been moved away.

In this study, while architectural contextualism is discussed, Cohen's contextualism ideas are taken as a basis, and the evaluation of the projects is carried out not only on the design of the building but also within the framework of the context as a whole. In addition, the subject is examined with the issues of inclusivity, physical context, and cultural context because they deal with overlapping problem areas in their three approaches.

3.2. Re-Discussing Architectural Contextualism Through Ecology and the City

Although contextualism appears as a monotonous and restricted concept that represents a restricted problem area in itself, it presents comprehensive and multiple problems. Modernist cities neither care about the internal context when creating their design nor do they care about the external context to be a part of a larger context in which they can exist. Contextualism described in Collage City (1978) focuses on these issues and acts to reverse this situation. In addition, urban design is not defined as merely functionalist and mechanical process in this book (Özten & Anay, 2017b). It starts with the concept of inclusiveness, which includes the physical and cultural context and stays away from the idea of ignoring the external effects implied by modern architecture. It can be stated that a design on its Architectural contextualism aims to address both the internal and external context and does not break away from these contexts in matters in terms of material, scale, form, and function. While it criticizes the problems of modern architecture with its approach, it also offers suggestions for this situation.

Following the emergence of the concepts of context and architectural contextualism, there are different interpretations of this subject. Alexander (1973) states that every design problem arises with an effort to capture the harmony between form and context and argues that form is not the subject of design alone, but it should include context. Lynch (2019), on the other hand, defines the factors related to the physical or cultural city with images that are perceived cognitively and formed in the mind. For this reason, context is defined as the unity between images. Even if they are handled with different names or concepts, a holistic and versatile approach is recommended in forming the city model. Although this proposal, described by Rowe as contextualism, seems like a single proposal that contains many elements and factors.

Allen (1997), while defining urban models, deals with the forms that reveal the urban fabric and the holistic effect they create. Stating that the overlapping of two regular fields forms the narrative in Figure 1, Allen (1997) further says that this effect is not random but contains complex mathematical rules. In contemporary architectural examples, besides the buildings rising in the void in modern cities, it is possible to come across types in which the mass-space relationship is intertwined and the types mentioned by Allen in his examples (Bingöl, 2020).

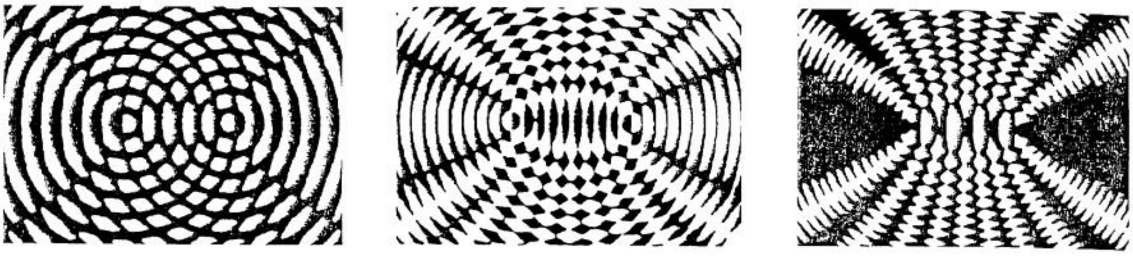

Figure 1. Moiré figures by Allen (1973)

Combining the different parameters covering the relationship between architecture and the environment, the concept of ecology, which deals with living life, can also be included in the contextualism approach. However, the concept of ecology is handled from different perspectives within architecture. Papanek (1972), in his article titled Environmental Design: Pollution, Crowding, Ecology, mentions the destruction of nature and the acceleration of this destruction by the processes in design while addressing the issue of ecology. In addition to the damage caused by the application and production of materials in architectural design, he also criticizes the emergence of design products not compatible with the human scale and rejects the use of urban planning that focuses on the use of automobiles. Although he does not entirely reject technology and approaches called development, he argues that they should be more compatible with nature. In this approach of him, it is revealed that the main focus is nature and the life of living things. Although Banham (1971) discussed ecology in his book Los Angeles: The Architecture of Four Ecologies that he wrote within the same years, it is observed that the main issue emphasized in this study is the technology and the state of development in the city According to Banham (2017), the entire civilizations built immense structures to improve themselves and continued this development with the help of technology.

Therefore, in his book regarding Los Angeles, he goes beyond the accepted architectural principles and describes it as a city with ideal features. Unlike Papanek, he defines huge buildings as striking and city-specific and positively evaluates the prevalence of automobile use. Defining this type of city model as a megastructure, Banham (2020) argues that gigantic structures are indispensable for such a model. In Cohen's contextualism, these types of structures that can be defined as exclusionary, contain vital discourses such as rebellion and opposition for Rooyen (2018).

3.3. Transformation and Revitalization of Industrial Heritage

The current urbanization process in China raises questions about how the process should be managed and in which direction the decisions will be shaped. Industrial heritages are an essential part of urban transformation, and they contain social, scientific, and cultural values. A similar initiative is taking place in China, following previous revitalization in the Ruhr Area in Germany, the SOHO Region in New York, and the Iwami Ginzan Silver Mine in Japan. UED, one of China's influential research and application institutions in urban-rural innovation and development, aims to see idea projects by organizing the International Professional Invited Competition to help urban transformation innovatively. "The Transformation and Revival of Industrial Heritage-Hansteel District Urban Design Master Competition" is co-hosted by the Hebei Provincial Department of Housing and Urban-Rural Development, Department of Natural Resources of Hebei Province, Handan Municipal People's Government, Handan Natural Resources and Planning Bureau and Urban Environment Design (UED) Magazine. The organizing committee of the competition has invited Dominque Perrault Architects, Coop Himmelb(l)au, UNStudio, Academician CHENG Training Team, Academician WANG Jianguo Team, Academician Zhuang Weimin Team to participate in the master competition and envisioning the future planning of Handan (The Architect's Newspaper, 2020). The competition was launched in Handan, Hebei Province, China, in January 2020. This was the third part of the annual competition, which has been organized since 2018, and it was held and ended in 2021. The city of Handan was chosen since it contains the remains of the Zhaowang Heritage Site as well as various cultural and historical heritages of ancient times, such as the Guangfu Ancient City, and it has a significant position in the emergence of Chinese civilization. The city's rapid growth led the Iron and Steel factory, which was previously far away, to remain in the living spaces as the development progressed, causing significant damage to the air quality.

Therefore, both protecting the industrial infrastructure and heritage and prioritizing the quality of human life are among the objectives of the competition. In addition, the head of the jury, Song Chunhua, states that the competition is examined in four dimensions. These criteria, referred to as historical and industrial heritage, ecological reasons, meaningful public spaces, and plans for the near future, aim to develop basic plans defined as a "strategy of smart renewal".

Dominique Perrault won the first prize in the competition held in China, and the second prize was shared between Wang Jianguo and Zhuang Weimin. In this study, evaluation and comparison are made between Dominique Perrault and Wang Jianguo. While the case study is being discussed, the competition projects are evaluated within the architectural contextualism framework mentioned at the beginning of the study. In addition, discussions on this topic are also included, as the aims of the competition include stimulating the industry and addressing problems in ecology. First, the projects discussed are explained within themselves with their purposes and discourses, and the discussion continues with the project visuals they share. Afterward, the evaluation is completed with the comparisons made.

Winning first place in Transformation and Revival of Industrial Heritage 2021, the Dominique Perrault Architecture team aims to build the Green Handan Manifesto for Handan City in Hangang District. There are four themes in Perrault's project. While the themes of water features, green production, and preserving the heritage are defined as themes directly related to the place, the last theme that defines usage and economy is called the hotel metropole. According to the jury's comments, the latest theme is a concept that considers urban life and aims to shape the project accordingly. In addition, the four identified themes affect every level of the design strategy. In addition, the jury considers it as a project that has a global vision and presents new strategies with international standards (Figure 2).

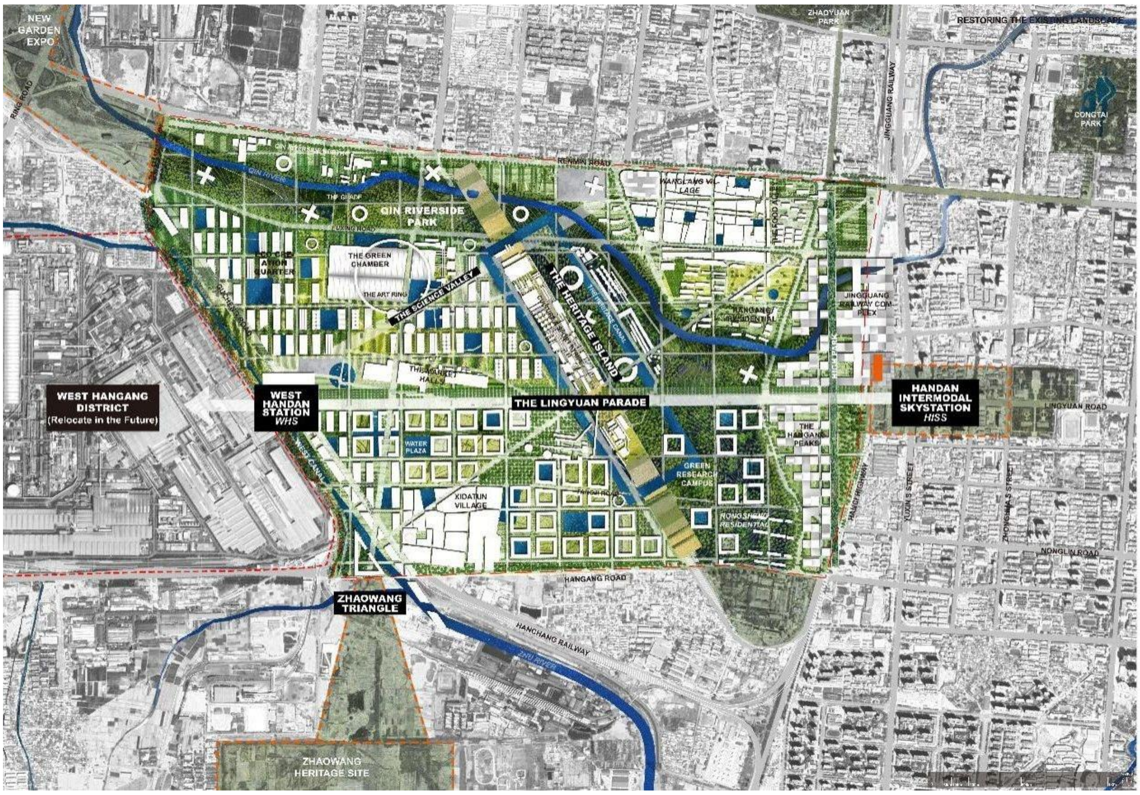

Figure 2. “The City of Tomorrow” by Dominique Perrault (Competitions, 2021)

Wang Jianguo, who won the second prize in the competition, is also an academician. Using the themes, he refers to transition, memory, and rebirth, he aimed that this proposal would increase the function of the region and provide a new model among urban models. The project aimed to promote the developing industry, revitalize the industrial heritage to renew the region and protect the urban memory, build a healthy society, activate the driving areas, and establish an integrated transportation network for fast and slow travel based on the blue-green system to purify the ecological zone. For those purposes project used six development strategies, including designing a living space (Figure 3).

Figure 3. “Transition memory renascence” by Wang Jianguo (Competitions, 2021)

When the projects of Perrault and Jianguo were examined, it has been observed that they focused on the water element, ecological balance, green space capacity, and industrial development. In addition, both projects were designed with the effects of modern architecture and the desire for innovation. While Perrault's project emerges on clean grids with precise axes that follow each other, in Jianguo's project, the forms are shaped by partitioned plots (Figure 4 and Figure 5). Although the structures consist of inwardly designed squares, dominated by inner courtyards, which are regularly seen at first glance at Perrault's project, it can be seen that the structures that look exactly like each other in the comparative lead to indefiniteness. The forms here refer only to each other physically, and it is seen that the differentiated structures do not overlap with each other in terms of Context (Figure 4). Jianguo's project, which has more self-organized areas compared to Perrault's project, tries to provide context between all building models. However, the circle and semi-circle models that appear next to the rectangular form do not coincide with the primary idea of modern architecture, eliminating ornamentation (Figure 5).

Figure 4. “The City of Tomorrow” by Dominique Perrault (Competitions, 2021)

Figure 5. “Transition · Memory · Renascence” by Wang Jianguo (Competitions, 2021)

When the projects are examined, environmental relations cannot be observed. Therefore, it is an unattainable goal to fully evaluate the extent to which the projects, represented only within the restricted area, meet the physical and cultural context. However, this non-representation can be interpreted as the context should have been considered. When evaluated internally, it is seen that they do not use the gigantic structures of the megastructure. Still, even if they use green areas, they do not prioritize ecology because production and living spaces are common, and its subject is industry. It is noteworthy that it does not contain a judgment about the cultural and physical context or the inclusiveness they deal with but includes the ideas that modern architecture opposes. Since they contain the desired scopes, these projects are considered successful. At this point, the main issue criticized is the idea that the expectations and evaluation forms of the competition should renew themselves in parallel with the principles of architectural contextualism.

4. Conclusion and Suggestions

Serious problems are observed in the city-in-park models that emerged after modern architecture. Together with Colin Rowe, it was aimed to solve this problem with contextualism. Contextualism should not be perceived as just a single proposal but should be considered both as a criticism of modern architecture and as a collection of proposals with complex components. One of these suggestions is the concept of inclusivity, which refers to both the physical and cultural context, and it also proposes a critique of the exclusionary state of modern architecture. While Cohen describes the inclusiveness proposal, ecology can also be included in the areas it covers, although he did not directly note the concept of ecology. When we examine the concept of ecology in architecture, it is seen that both the destruction of living nature and the use of technology required for development are included in this concept. For this reason, nature-sensitive city model proposals and megastructure city models are indeed encountered. The study re-examined contextualism through a competition project and reconsidered its expanded framework.

The competition named "The Transformation and Revival of Industrial Heritages", which was concluded in 2021 in China focuses on both ecology and industrialization. Therefore, urban models sensitive to living life and megastructure models are discussed, and the projects selected in the competition are evaluated. The project of Perrault, ranked first in the competition, and of Jianguo, ranked second, were chosen since they started from similar focuses and created different design proposals as well as different forms within the same space. It is observed that both projects do not comprehensively address the physical and cultural context and act with the principles of modern architecture. However, it is seen that modern architecture has moved away from the idea of eliminating decoration and creating the design of the building itself. Although these projects have the ideal of constructing structures in which nature-conservation-oriented green areas are dominant, and technology is not abandoned, their departure from the context is among the main issues of the project that are open to criticism and are ignored in the competition. In this study, it is thought that architectural contextualism is ignored in competition projects. The case study, which emerged with this idea, supports this idea. It would be helpful to look at different examples and expand the scope of the study so that the thought can be based on more solid foundations.

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Author Contribution and Conflict of Interest Declaration Information

The article has a single author and there is no conflict of interest.

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Wooden-Pillared Sille Çay Mosque and Its Wooden Elements

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Abstract

The use of wood, a traditional building material, in historical mosques dates back to ancient times. The use of wood, which has a wide range of applications in mosques, in the load-bearing system of the building is seen as a distinctive feature of the building. The reason for this situation is that the number of mosques in which wood is used in the load-bearing system is low today. Wooden-pillared mosques, which belong to different periods and have different plan types, can be found in different regions and cities. One of these types of structures, which are frequently encountered especially in Central and Inner Western Anatolia, is the Sille Çay Mosque in Konya. The goal of this study is to document the Sille Çay Mosque as an example of a mosque with wooden columns and to reveal its original aspect. In this context, a sketch of the current state of the building was prepared by examining the building; the architectural elements in the building were photographed, and their ornaments were analyzed. As a result, it was observed that woodworking was used extensively in the mosque, which has a basilical plan typology among the 19th-century wooden-pillared mosques, especially in the pulpit, mihrab, and lectern, and suggestions were made for the restoration of the structure.

Keywords: *Wooden-pillared mosque, Sille Çay Mosque, wood, woodworking.*

Ahşap Direkli Sille Çay Cami ve Ahşap Elemanları

Öz

Geleneksel bir yapı malzemesi olan ahşabın tarihi camilerde kullanılması çok eskilere dayanmaktadır. Camiler içerisinde çok geniş bir kullanım alanına sahip ahşabın yapının taşıyıcı sisteminde kullanılması yapı için ayırt edici bir özellik olarak görülmektedir. Bu durumun temelinde taşıyıcı sisteminde ahşap kullanılan cami sayısının günümüzde az olması yatmaktadır. Farklı dönem ve farklı plan tiplerine sahip olan ahşap direkli camilere farklı bölge ve şehirlerde rastlanabilmektedir. Özellikle orta ve iç batı Anadolu'da sıklıkla rastlanan bu tip yapılardan bir tanesi de Konya'da bulunan Sille Çay Camisidir. Çalışmanın amacı ahşap sütunlu cami örneği olarak Sille Çay Camii'ni belgelemek ve özgün halini ortaya koymaktır. Bu bağlamda yapıya temas edilerek yapının mevcut durumunun krokisi hazırlanmış, yapıdaki mimari elemanlar fotoğraflanmış ve süslemeleri incelenmiştir. Sonuç olarak 19. yüzyıl ahşap direkli camiler arasında bazilika plan tipolojisine sahip camide ahşap işçiliğinin özellikle de minber, mihrap ve kürsüde yoğun olarak kullanıldığı görülmüş ve yapının restorasyonuna yönelik önerilerde bulunulmuştur.

Anahtar kelimeler: *Ahşap direkli cami, Sille Çay Cami, ahşap, ahşap işçiliği.*

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1. Introduction

Wood, which is a material frequently used by human beings since prehistoric times, can be found in many areas, from its use as a material for daily articles to its use as an ornamental material. One of the many usages of wood is as a building material. The use of wood as a building material dates back to ancient times compared to concrete and steel, which are other building materials used today (Çalışkan et al., 2019). The fact that wood is abundant in nature, easily obtained, easy to apply, and easy to process has contributed to the usage of wood as a building material and the development of its usage.

Wooden material has been widely used in different parts of the building in different building types. It is seen that wood is used in civil and religious architecture, especially in residences. The existence of wooden buildings such as libraries, bridges, orphanages, sports buildings, educational buildings, mosques, churches, etc. is known (Kartal, 2015). Although the use of wooden material in mosques dates back to ancient times in the historical process, the use of wood as the load-bearing system of the building is based on the Masjid an-Nabawi. It is known that the canopy inside the house of the Prophet Muhammad in Medina was supported by palm trees (Arseven, 1954). This building, as the first masjid, was a model for the religious buildings to be built later. The masjids built in the early periods of Islam were plain, simple, open, with mudbrick walls, and shaded by palm branches. In the following period, different architectural styles emerged according to the conditions in the regions where Islam spread (Akın, 2016). Arık (1973) states that the Turkish people used wooden pillars and wooden ceilings in their mosques after their conversion to Islam. Aslanapa (2007) and Karakuş (2021) state that the mosque type with wooden pillars dates back to the Karakhanid and Ghaznavid periods. Although it is known that the tradition of mosques with wooden pillars continued in the Anatolian Seljuk, Principalities, and Ottoman periods, it is believed that this tradition was brought to Anatolia by the Turkish people (Kuran, 1972; Uysal, 2014).

The most important examples of the 13th-century timber-pillared mosque architecture of the Anatolian Seljuk Period and the Principalities Period were built with a masonry system, and masonry stone and cut stone were used as the main materials (Karakuş, 2021). A group of wooden pole mosques in the villages of Bozkır district of Konya, which were found to have been built between the second half of the 18th century and the beginning of the 19th century, were analyzed, and it was determined that they were built with masonry materials. In the repairs made in later periods, the facade surfaces were plastered, and it was observed that spolia was used in some mosques (Tekin, 2021). In the center of Kemaliye district, eight mosques with wooden poles were examined. 6 of the mosques were built with a masonry system and rubble stone was used as material; 1 of them was built with a masonry system but rubble stone was used as material, and the construction technique and material of 1 of them could not be determined because plaster and paint were used on the wall surfaces, but it was stated that it was estimated that the mosque was built with a masonry system and rubble stone was used as material concerning the retaining wall (Orhan, 2022).

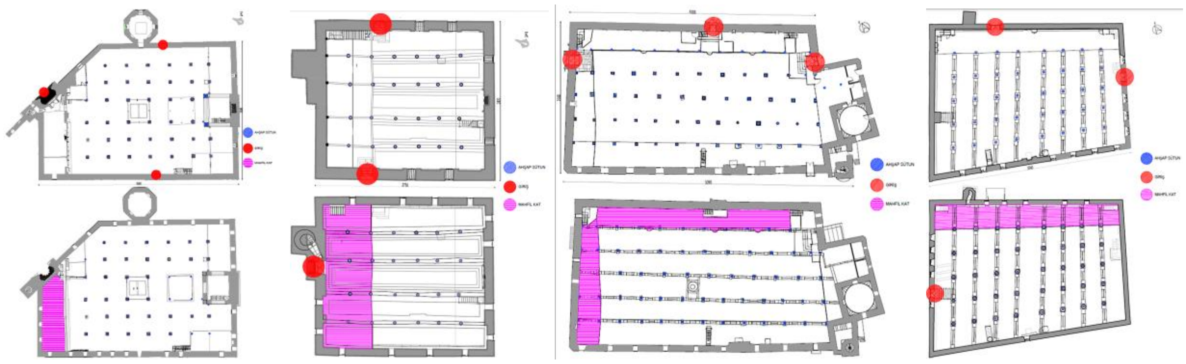
While the roof system of the wooden pole mosques had an earthen roof when they were first built, the earthen roof was removed, a hipped wooden roof was made, and the upper covers were covered with copper or lead (Karakuş, 2021). It is reported that a group of wooden pole mosques in the villages of Bozkır district in Konya have flat ceilings internally and hipped roofs externally (Tekin, 2021). It is reported that eight wooden pole mosques in the Kemaliye district center have hipped roofs (Orhan, 2022).

While it is known that the first examples of wooden-pillared mosques in Anatolia back to the Seljuk period in the 13th century, it is also known that these types of structures were built in a smaller and simpler form during the Principalities and Ottoman periods. Afyon Ulu Mosque (1273), Sivrihisar Ulu Mosque (1231-32), Beyşehir Eşrefoğlu Mosque (1297-99), Kastamonu/Kasabaköy Mahmut Bey Mosque (1366), Ankara Arslanhane (Ahi Şerafettin) Mosque (1290) are monumental examples of this mosque type. (Yaşayacak, 2018).

It is observed that wood is used not only in pillars but also in pillar heads, consoles, and beams in wooden-pillared mosques. In the early periods of the mosques with wooden pillars, it was observed that the column heads were adorned with muqarnas and profiled pillows were used, while in the

Ottoman period, it is noted that the muqarnas headboards and profiled pillows were replaced by simpler headboards and pillows (Yaşayacak, 2018). In addition to being used as a wooden material carrier system in mosques, it is used as a door, window, railing, pulpit, mihrab, lectern, sarcophagus, faldstool, etc., and has Found a variety of applications areas. The broad range of applications for wood has enabled societies to develop in woodworking. Since the Seljuk period, woodworking has played an important role in architectural works. This tradition, which gained importance in the Seljuk period, also manifested itself in the Principalities and Ottoman periods (Öney, 1989).

"Basilical plan" type or "Kufe plan" type can be seen in wooden-pillared mosques and masjids dating to the Seljuk period and the 14th–15th century Principalities period (Öney, 1990). Sivrihisar Ulu Mosque and Afyon Ulu Mosque have kufe plans. On the other hand, Ankara Arslanhane Mosque and Konya Beyşehir Eşrefoğlu Mosque have a basilical plan. Basilikal plan type is more comman than küfe plan type (Figure 1) (Yaşayacak, 2018).



a b c d

Bazilikal Plan Type Kufe Plan Type

Figure 1. a – The plan of Beyşehir Eşrefoglu Mosque, b–The plan of Ankara Arslanhane Mosque, c – The plan of Sivrihisar Ulu Mosque, d–The plan of Afyon Ulu Mosque (Yaşayacak, 2018)

Different examples of basilical-planned mosques are more common in 14th–15th-century buildings. In these buildings, the system that carries the wooden ceiling and roof are the wooden poles in the harem. These poles divide the harim into naves. Beyşehir Eşrefoğlu Mosque has 41 wooden poles, and these poles are positioned perpendicular to the mihrab wall and divide the harim into 7 naves. In Ankara Arslanhane Mosque, there are 24 wooden poles, and these poles divide the harim into 5 naves perpendicular to the mihrab Wall (Yaşayacak, 2018). Apart from these structures, there are various studies in the literature that examine different mosques with wooden poles (Table 1).

Table 1. Sources related to mosques with wooden poles (Orhan, 2022)

	NAME	AIM	METHOD	RESULT
THESIS	THE WOODEN HYPOSTYLE MOSQUES OF ANATOLIA MOSQUE-AND STATE-BUILDING UNDER MONGOL SUZERAINTY	It aimed to analyse five wooden pillared mosques built in Anatolia in the second half of the seventh/thirteenth centuries.	The study was prepared by using the documents obtained from the archive study and the data obtained from the field study.	The study concludes that the Mongol rule after the invasion in 641/1243 led to the emergence and spread of a new type of wooden building and that the cultural parameters of Seljuk patronage and the characteristic features of Mongol rule were emphasised to reveal the conditions that led to the emergence of this type.
ARTICLE	WOODEN POLE MOSQUES IN PINARBASI - UZUNYAYLA	This study, it is aimed to analyse the plans, materials, and ornaments of the mosques in Methiye, Hilmiye, and Altıkesek villages of Kayseri/Pınarbaşı district in all detail and to reveal their place and importance both in their own and Anatolian Turkish Art.	A comparison study was carried out by investigating the common and different features of the mosque with the documents obtained from the archive study.	In conclusion, the tradition of building mosques with wooden poles in Anatolia began in the 13th century and continued until the early 20th century. All three mosques that we have tried to introduce are examples that continue the tradition of wooden pole mosques built in cities such as Niğde, Ankara, Konya, Yozgat, Aydın, and Denizli in Kayseri, and they are also important because there are no other examples with pencil ornaments around Kayseri.
	EVALUATION STUDY ON WOODEN PILLAR MOSQUES BUILT IN ANATOLIA IN THE 13TH CENTURY	This study aims to make a general conclusion on the wooden pole mosques built in Anatolia in the 13th century in line with the data obtained in the studies and to determine the common aspects of the wooden pole mosques built in four different parts of Anatolia.	After the archive and literature research about the buildings in question, a catalog study of the buildings was carried out.	In the light of the information obtained as a result of the catalog studies and archive searches, it has been determined that the buildings have similar characteristics, especially in terms of the materials used and construction techniques; however, some of their features have been differentiated and shaped in line with the construction traditions of the places where they are located.
	A GROUP OF MOSQUES WITH WOODEN PILLARS AROUND BOZKIR DISTRICT OF KONYA	This study; It is aimed to examine a group of wooden pole mosques built in the villages of Bozkır district and to reveal their position in Turkish architecture with a general evaluation.	As a result of the data obtained during the field studies carried out in the region in 2014-2015, the mosques were analysed in terms of architectural features, ornamental features, materials, and construction techniques.	As a result; it was concluded that most of the artifacts in this district located in the Çarşamba Valley belong to the Late Ottoman Period and reflect the plan, architecture, and ornamentation features of this period in the provinces.
CONGRESS	CULTURAL ASSETS PLACED IN BAŞPINAR, DOLUNAY AND YEŞİLYURT VILLAGES OF KEMALİYE, ERZİNCAN	In this study, 3 mosques in Başpınar Village in Kemaliye District of Erzincan, 1 mosque and fountain in Dolunay Village, 1 mosque and 1 fountain in Yeşilyurt Village are among the cultural assets identified in the field study. These artefacts belong to the Ottoman period and it is aimed to evaluate them within their periods.	It was prepared by using the documents obtained from the archive study and the data obtained from the field study.	The data obtained were evaluated and the building elements and materials that make up the mosque were explained together with their justifications. Differentiated features are also indicated.

In wooden-pillared mosques, the pulpit, mihrab, and lectern stand out as elements that differ from other architectural elements of the building. Although wooden materials are generally used in these elements, various ornaments are observed. The diversity of the ornaments is evident both in the construction technique and in the motifs (Yaşayacak, 2018).

Sille Çay Mosque, located in Sille Historical City of Konya, has historical importance as it is a 19th-century building. Çay Mosque is in the 19th-century wooden column mosque typology. In addition to being used as a carrier system, wood is also used in different elements such as the pulpit, lectern, and mihrab. It is important to analyze historical buildings and document them in detail in this way. In this context, this study aims to document the Sille Çay Mosque as an example of a mosque with wooden poles. In the study, Sille Çay Mosque was examined in terms of plan, material, and construction technique, and information about the pulpit, mihrab, and lectern that preserved their original state was given.

2. Material and Method

In Sille, which has hosted many civilizations throughout the historical process, there are many cultural heritages, from mosques to churches, from traditional houses to historical fountains and bridges. Sille, located 8 km northwest of Konya, has differences in terms of geographical structure, social life, and cultural heritage (Figure 2).

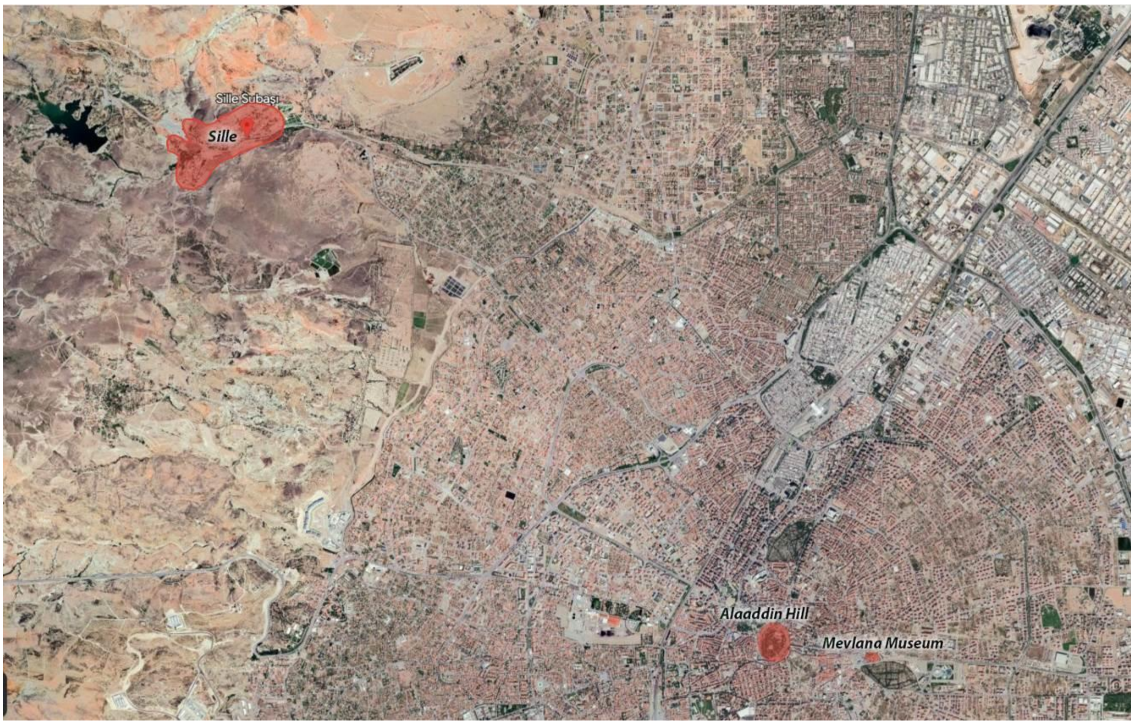


Figure 2. Location of Sille ancient city

There are many cultural heritages such as mosques, churches, cemeteries, bridges, fountains, Turkish baths, traditional houses, etc. from the Seljuk and Ottoman periods in Sille (Aklanoğlu, 2009; Tomar, 2015). One of the cultural heritage sites within the Sille Urban Protected Area is the Sille Çay Mosque. Sille Çay Mosque constitutes the scope of this study. Sille Çay Mosque is located in Sille Subaşı District, between Baraj Street and Hükumet Street (Figure 3).

Figure 3. Location of the Sille Çay Mosque

Sille Stream and then Hükumet Street are located to the north of the building, which is located on a sloping land in the north-south direction, while there is Baraj Street at a higher level than the mosque to the south. The building is connected to Government Street through two bridges, one of which is stone and the other is wooden, on Sille Stream (Figure 4a). The connection to Baraj Street in the south is provided by the staircase located in the east of the building (Figure 4b).

a

b

Figure 4a-b. Connections of Sille Çay Mosque with the streets

The mosque, which is still in use today, derives its name from the stream that passes in front of it. The mosque is also known as the Çarşı Mosque due to its location in the bazaar (Mimiroğlu, 2012). In addition to the use of wooden pillars in the building, which is thought to have been built in the 19th century, rich woodwork is seen on the mihrab, pulpit, and lectern (Selçuklu Municipality, 2016). Çay Mosque has been included in the class of registered buildings with the decision of the High Council of Real Estate, Antiquities, and Monuments, numbered 10.10.1991-1148 (Konya Metropolitan Municipality, 2010). The building was restored in 2013 by the Selçuklu Municipality (Ertaş Beşir et al., 2022).

A qualitative research method was used in the research. In the study, firstly, a literature review was conducted on Sille Çay Mosque and mosques with wooden poles. In the literature review, no specific study on Sille Çay Mosque was encountered. As a result, Sille Çay Mosque was analyzed in terms of plan, material, construction technique, and wooden ornamentation. During the examination phase, the building was visited, and determinations were made about the building. During the determinations, the building was photographed and its current condition was documented. At the same time, the construction materials of the building elements were determined. The ornaments on the historical building elements were analyzed and interpreted.

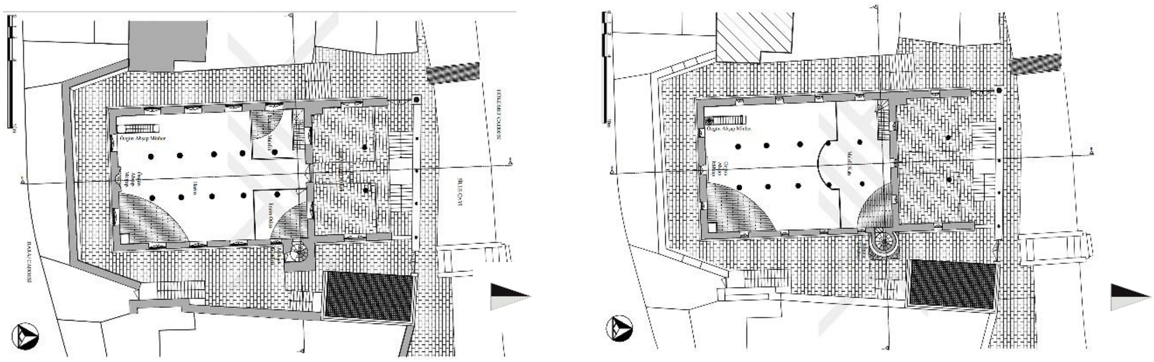
Since the building has a wooden carrier system and wood workmanship is seen intensively in the building, the wooden parts of the building were focused on. In addition to the wooden carrier system that makes the building important, detailed information was given about the pulpit, mihrab, and pulpit, which have historical value. The decorations on these architectural elements are explained.

The data obtained in the field study were compared with similar structures in the literature. As a result of this comparison, the importance of the building in the literature was emphasized.

3. Findings and Discussion

3.1. Plan Type of the Building

Sille Çay Mosque, which is an example of a 19th-century wooden-pillared mosque, is a rectangular basilica-planned structure. The building originally consisted of the sanctuary, the narthex, and the minaret. There is a sanctuary in the southern part of the mosque, which is placed in a north-south direction. The floor of the sanctuary part of the mosque is covered with wood, and it is divided into 3 naves using wooden carrier pillars placed perpendicular to the mihrab. Wooden carrier pillars are placed within sets of five each on the east and west sides of the door-mihrab direction (Figure 5).



a. The ground floor plan sketch **b.** The upper floor plan sketch

Figure 5a-b. The plan sketch of the Sille Çay Mosque (Özyurt, 2019)

The entrance to the mosque is provided by two doors in the north and a single door in the southwest, opening to the garden of the building. After the doors in the north, the narthex is reached via two stairs from both directions. The staircase in the northeast consists of 8 steps (Figure 6a), while the staircase in the northwest consists of 10 steps (Figure 6b), including 1 intermediate landing. The connection of the building with Baraj Street is provided by the door located on the middle landing of the staircase with 3 landings and a total of 40 steps (Figure 6c).

a **b** **c** **d**

Figure 6a-b-c-d. The approach to the courtyard of Sille Çay Mosque

The passage from the narthex to the sanctuary is provided by two winged doors in the middle of the wall. The door used today is not original and has been changed during the restoration (Figure 7).

a **b**

Figure 7a-b. The view of the entrance to the sanctuary

The western side of the entrance door is separated with the help of wood, and the eastern side is separated with the help of wood and glass. Among these places, the section to the northwest of the sanctuary is used as a women's place, while the section to the northeast is used as an imam's room. To the north of the women's place is a staircase leading to the upper floor. Through this staircase, the upper floor is also used as a women's place. Although the upper floor has wooden flooring, it has been renovated (Figure 8).

Figure 8. The view of the northern part of the sanctuary

The sanctuary is illuminated by a total of 10 windows, two large and three small, on the northern and southern walls, and a total of 16 windows, four large and four small, on the east and west walls. Wooden beams are also seen on the facades (Figure 9). In addition, there is a lectern in the southeast corner of the sanctuary, a mihrab in the middle of the south wall, and a pulpit on the west side of the south wall. The pulpit is not adjacent to the east wall.

a b c d

Figure 9a-b-c-d. The view of the facade views of Sille Çay Mosque

In the northern part of the building, there is the narthex. A total of two stairs were built, one for each of the two bridges that provide passage to the mosque over the stream. These stairs are between the carrier wall and the narthex. There are five wooden carrier pillars on the carrier wall in the narthex. In addition, there are walls on the east and west of the narthex, and there are four windows on these walls, large at the bottom and small at the top (Figure 10).

Figure 10. The view of the narthex

There is a minaret in the northeast of the sanctuary. The base of the minaret is square, and its body is circular (Figure 11a). However, a spiral staircase was used in the minaret. There are two doors in the minaret, one of which opens to the courtyard from the south of the minaret (Figure 11b) and the other one that opens to the woman's place which is the upper floor of the sanctuary from the east of the minaret (Figure 11c).

a b c

Figure 11a-b-c. The views of the minaret

3.2. Construction Technique and Material Use

In this part of the study, the construction technique of the building and the materials used in the building are mentioned, and the wooden pole system is explained. In the section, firstly the building material is mentioned, then the interior space, which is the harem section, then the exterior space, which is the last congregation place, then the minaret, and finally the sections added later to the building are explained. The wooden poles in the building are explained in the section in which they are located (Table 2).

Table 2. The content flow diagram in construction technique and material use section

- CONSTRUCTION TECHNIQUE AND MATERIAL USAGE
- INTERIOR
    - HAREM
        - WOODEN SUPPORTING SYSTEM
        - WOODEN ELEMENTS
- EXTERIOR
    - LAST CONGREGATION PLACE
        - WOODEN SUPPORTING SYSTEM
    - MINARET
- ADDITIONAL SPACE
    - FUNERAL WASHING ROOM
    - ABLUTION AREA
    - TOILET AND WASHBASIN

The historical Çay Mosque was built with the use of traditional Sille stone and wood materials, which are widely used in the region. The most distinctive feature of the building is that it has a wooden carrier system. This carrier system is seen both in the sanctuary part of the building and in the narthex. The main walls and garden walls of the building were built using rubble stone material in the form of masonry walls. Both the interior and exterior walls of the building were plastered (Figure 12a). The roof of the building is covered with lead material (Figure 12b).


a **b**

Figure 12. Walls and roof of Sille Çay Mosque

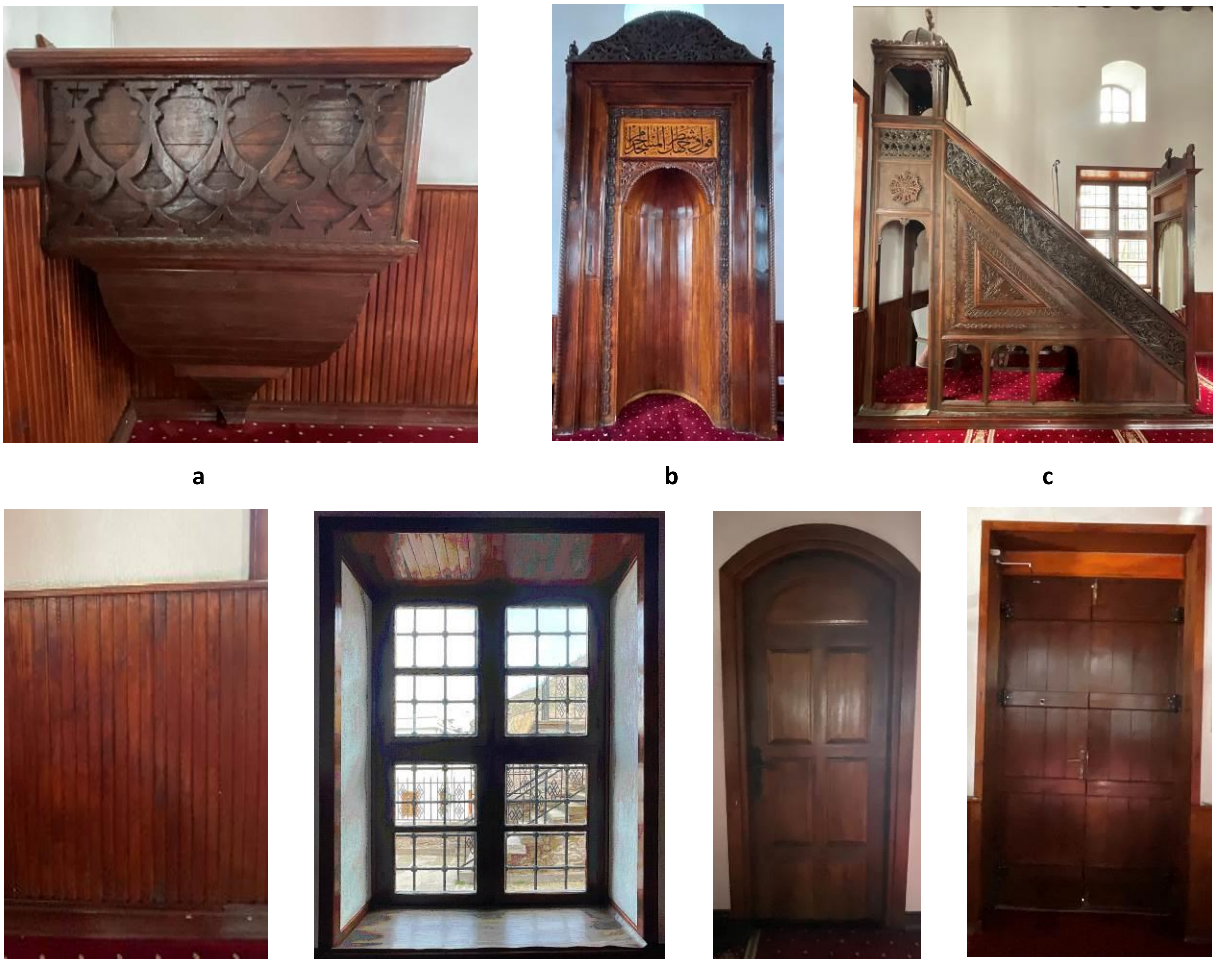
It is seen that wood is used extensively in the interior of the mosque. There are 10 wooden carrier pillars with a circular cross-section in the sanctuary part of the building (Figure 13a). These pillars are covered with wood paneling up to a certain height from the ground (Figure 13b). There are profiled wooden pillows on the pillars, rectangular wooden bond beams extending perpendicular to the mihrab on these pillows, and circular cross-section wooden ceiling beams extending parallel to the mihrab on the beams. A wooden ceiling covering is seen above the beams (Figure 13c).


a **b**

c

Figure 13a-b-c. Wooden carrier details of Sille Çay Mosque

Apart from the wooden carrier system in the building, the other points where the wood draws attention are the lectern (Figure 14a), the mihrab (Figure 14b), and the pulpit (Figure 14c). These three items have survived to the present day with some deterioration and repairs. In addition, there is wooden paneling made later for interior walls (Figure 14d), carrier pillars, window joinery (Figure 14e), the door (Figure 14f, Figure 14g).



a b c

d e f g

Figure 14a-b-c-d-e-f-g. Examples of places where wood is used in Sille Çay Mosque

Wooden elements are also seen in the narthex of the building. The front portico of the place has five wooden load-bearing pillars and rests on the carrier wall built as masonry using rubble stone material. Wooden material was also used in bursa arches in the section between the wooden load-bearing pillars.

There are two wooden pillars in the middle of the place; there are pillows with profiles and wooden bond beams parallel to the mihrab on the wooden pillars; and wooden ceiling beams placed in the north-south direction on the bond beams, perpendicular to the mihrab (Figure 15).

Figure 15. Wooden carrier system detail at the narthex of Sille Çay Mosque

Brick is used in the body, balcony, and stair steps of the mosque minaret, which sits on a pedestal built with rough-hewn stone material. There is a blue tile border surrounding the minaret just below the balcony and cone of the minaret. The cone of the minaret is covered with lead material. There are six rows of hedgehog fringes under the balcony of the minaret, which was built as a single balcony (Figure 16).

Figure 16. The view of the Sille Çay Mosque's minaret

The structure, consisting of a funeral washing room, ablution area, toilet, and washbasin, was added to the mosque, which consists of the sanctuary, the narthex, and the minaret sections. The facades on the north and east of this building were built by raising the garden walls, and brick material was used on the other walls. The roof is covered with Turkish-style tiles (Figure 17).

Figure 17. The view of the structure consisting of a funeral washing room, ablution area, toilet, and washbasin

3.3. Wooden Ornaments

There are three wooden architectural elements with historical value and ornaments adjacent to the south wall of the sanctuary. On the east of the wall, there is a lectern, in the middle, there is the mihrab and on the west, there is the pulpit (Figure 18).

Figure 18. The view of the southern part of the sanctuary

There is a wooden mihrab in the middle of the south wall of the sanctuary (Figure 19a). The niche in the mihrab is 40 cm deep. In the crown part of the mihrab, some branches and leaves interlace (Figure 19b). On the pediment of the mihrab, the verse "Turn your face toward al-Masjid al-Haram", which is the 144th verse of Surat Al-Baqara, is written in calligraphy (Figure 19c). The upper part of the niche is in the form of a half dome. Its corners are vegetally ornamented (Figure 19d). There is a cannabis leaf and a flowered border surrounding the niche and a verse in the mihrab (Figure 19e).

a d e

Figure 19a-b-c-d-e. The views of the Mihrab

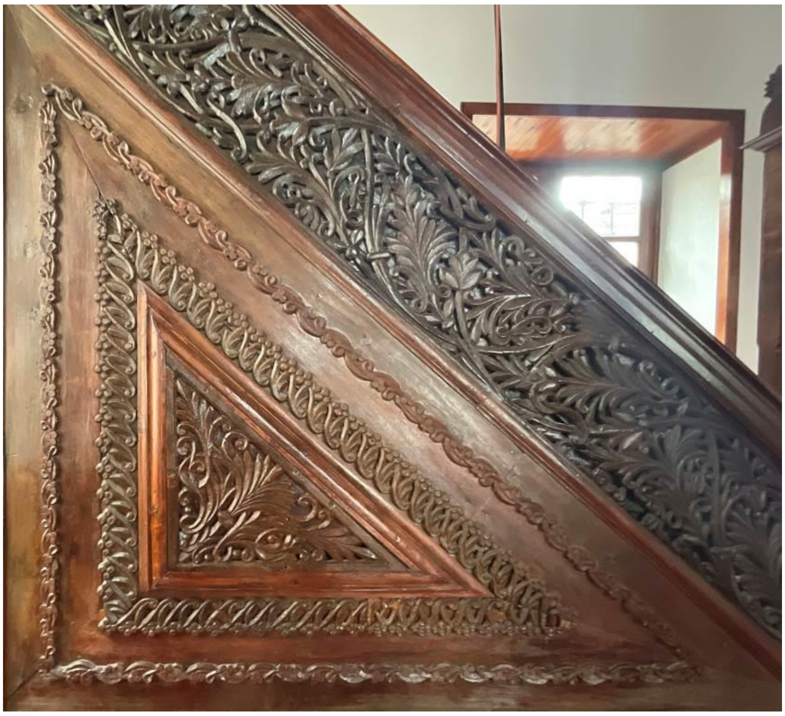
There are 12 steps on the pulpit to the east of the mihrab. There are three plinth sections under the side mirror. A large walkway section is located below the handrails. It is seen that two round pieces join together in both the walkway and the plinth arches. The ornaments on both sides of the pulpit are different from each other (Figure 20).

Figure 20. The view of the pulpit

There is an octagonal leaf motif above the walkway on the eastern edge of the pulpit (Figure 21a). The interlocking branch motif is seen on the banister of the pulpit. In the middle of the side mirror, there is a plant ornament in the form of a right triangle with cannabis leaves on it (Figure 21b). A relatively thick border is seen surrounding it, and there is another border with a relatively thin floral motif that includes this border as well (Figure 21c).

a

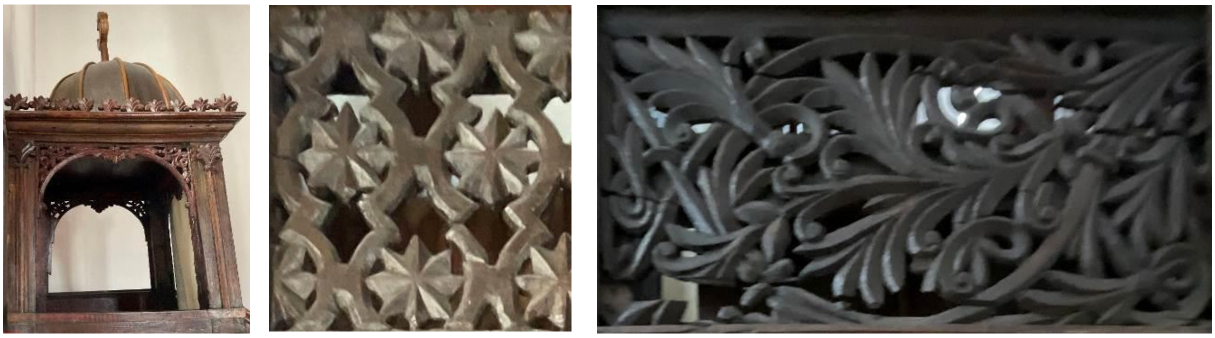
c



b

Figure 21a-b-c. The view of the east side of the pulpit

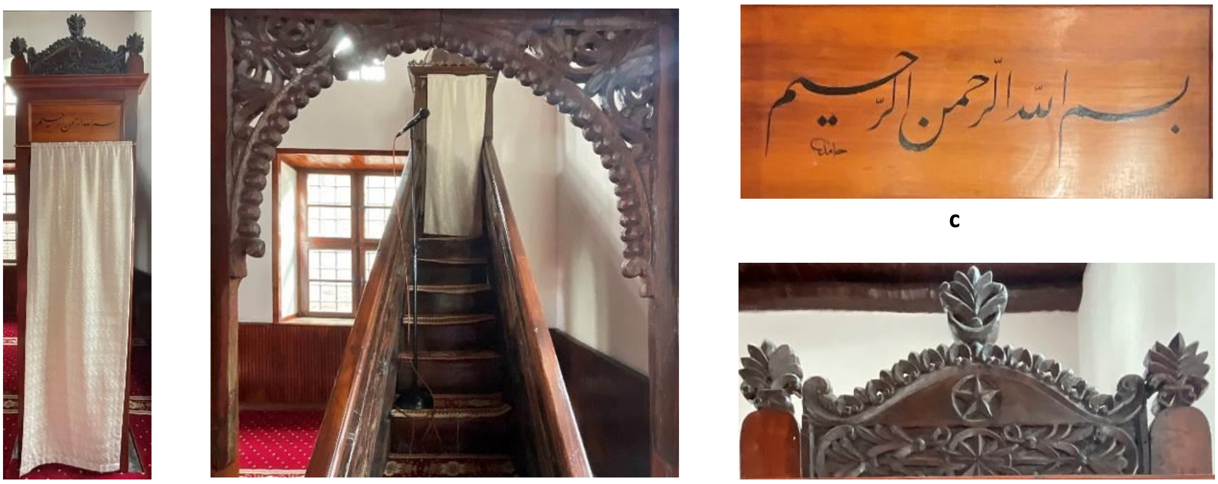
The pavilion section in the pulpit was covered with a sliced dome, and a wooden realm was placed on top of the dome. The cheering arch also has the shape found in the walkway section. On the arch corner of the pavilion section, there is a floral motif. On the carrier of the pavilion section, there are leaf motifs on both sides of the hill, and three wooden strips go down to the railing level. On the moldings on the arch, a leaf motif is also seen throughout the molding (Figure 22a). While there are octagonal stylized flower motifs on the eastern railing of the pavilion section (Figure 22b), there are intertwined branch motifs on the western railing (Figure 22c).



a b c

Figure 22a-b-c. The view of the pulpit pavilion section

There is a pointed arch over the doorway in the front of the pulpit, and the arch corners have the same floral motif as those on the pavilion section arch corners (Figure 23b). The basmala is written on the pediment above the arch. There is molding on the pediment and a crown over it (Figure 23c). There is a star motif in the middle of the crown and plant motifs surrounding the star (Figure 23d).



c

a b d

Figure 23a-b-c. The view of the pulpit's entrance

On the eastern edge of the pulpit, under the pavilion section, 34 linear rays emerge from the eight-petaled flower in a square form (Figure 24b). The interlocking branch motif is seen on the railing of the pulpit (Figure 24c). In the middle of the side mirror, there is a plant ornament in the form of a right triangle with cannabis leaves on it (Figure 24d). There is a relatively thick border surrounding it, and there is another border with a relatively thin floral motif that includes this border.

b

a c d

Figure 24a-b-c. The view of the east side of the pulpit

The wooden lectern in the southeast corner of the sanctuary also has historical value. The upper part of the historical wooden lectern has a square plan, and the lower part has a curved form. There are ornaments on the railings of the lectern (Figure 25).

a

b

Figure 25a-b. The views of the lectern

There are wooden bursa arches between the wooden pillars of the front portico resting on the carrier wall in the narthex. There are tulip and flower motifs in the middle of these arches. These motifs were made by cutting the inside of the wood (Figure 26).

Figure 26. The views of the ornaments in the middle of the arches

4. Conclusion and Suggestions

Sille Çay Mosque, located in the Historical City of Sille in Konya, has historical importance in terms of being a 19th-century structure. In addition to its historical importance, this building is also important because it is a wooden pole building and has historical wooden elements and ornaments. Çay Mosque is in the 19th century wooden-pillared mosque typology. This mosque contributes to the thesis expressed by Kuran (1972), Eskici (1998), Erdemir (1999), Çal (2000), and Uysal (2001), that wooden pillared mosques are abundant in central and western Anatolia. The building is of a three-nave basilical plan type divided by wooden pillars. The Çay Mosque is a plain structure with a rectangular plan consisting of a sanctuary and a narthex. The simple plan type of the building confirms the thesis of Yaşayacak (2018) that the wooden-pillared mosques of the Ottoman period were built smaller and simpler. In addition, while Yaşayacak (2018) states that the basilical plan type wooden-pillared mosques mostly belong to the 14th and 15th centuries, Sille Çay Mosque reflects the 19th-century structural features despite its basilical plan type.

The mosque is important in terms of being a wooden-pillared mosque as well as its historical importance. These wooden pillars attract attention with their aesthetic and structural features. The ceiling and roof of the harem and the last congregation place are carried by wooden pillars. The interior of the building is spacious and bright. The light coming into the mosque filters through the poles. The shadows and patterns created by the poles give depth to the interior. The poles made of natural wood material attract attention with their natural beauty and add warmth and naturalness to the architectural texture of the mosque.

The mosque has a total of 17 wooden carriers, 10 in the sanctuary area, 2 in the narthex, and 5 in the front portico of the narthex. On the wooden pillars in the sanctuary and narthex, there are profiled pillows extending in the east-west direction, bond beams extending in the same direction as the pillows on pillows, and beams extending in the north-south direction sitting on the bond beams. The wooden pillars in the front portico of the narthex sit on the carrier wall and are connected by bursa arches.

While Yaşayacak (2018) states that there were plain profiled pillows in the Ottoman period, only the profiled pillows in Sille Çay Mosque support this statement.

Wood was also used in architectural elements in the mosque. The door, window joinery, interior walls, lower parts of the carrier pillars, the women's room, and the imam's room were all made of wood. In addition to these items, it is known that the pulpit, lectern, and mihrab are entirely made of wood and that they have historical value and are actively used.

Woodwork is prominent in the building. Wooden ornaments were used extensively in the mihrab, pulpit, lectern, and bursa arches. It is seen that the features of the 19th century are reflected in the building through the ornaments. Floral motifs, which are characteristic of 19th-century ornament art, were frequently used in the building. While Öney (1989) states that woodworking, which started in the Seljuk period, continued in the Principalities and Ottoman periods, the woodworking seen in this structure shows parallelism with these expressions.

In the mihrab, there are cannabis leaves and a flowered border surrounding the niche, and on the crown of the mihrab, there are branches and leaves that pass through each other. While branches and leaves passing through each other are seen on the side mirrors of the pulpit, branches on the corners of the pavilion section arches, flower motifs under the pavilion section, branches on the arch corners of the pulpit entrance, branches, and stars on the crown. There are also wooden ornaments on the edges of the lectern. In addition, tulip and flower motifs can be seen in the cores of bursa arches in the front porches of the narthex.

The building is important both in terms of history and in terms of construction technique and materials. The durability of the building, which has been standing for many years, against environmental effects should be checked and transferred to the future with necessary protection works. In this context, the condition of the wooden pillars of the structure needs to be checked frequently. However, it is necessary to control the conditions of the beams under the plaster on the walls, to stop deterioration if possible, and to replace the unsound parts if it is not possible to strengthen the material. However, the fact that the building is located on the edge of the stream and therefore in a humid environment can cause dampness, moss, and vegetation on the walls of the building. For this reason, it is important to clean the plants on both the retaining and the outer walls of the building and to take measures to prevent the building from getting damp.

A restitution proposal for the building needs to be developed. In light of the information coming from the restitution proposal, it may be necessary to scrape the plaster off the inner and outer walls of the building and highlight the stone material. At the same time, the women's place and the imam's room in the sanctuary section of the building prevent the perception of the interior of the building and the integrity of the sanctuary. In this context, taking both sections to the upper floor of the building will be beneficial in terms of perceiving the sanctuary as a whole. Removing the wooden paneling on the inner walls of the building and the lower parts of the wooden pillars, which are thought to have been added later, will be beneficial both in terms of reflecting the origins of the building and in terms of detecting deterioration in those sections quickly and early.

In summary, in addition to its historical value, Sille Çay Mosque is important because it has wooden poles and intensive woodwork. These features of the building are significant for the preservation and transfer of the building to the future.

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The article complies with national and international research and publication ethics. Ethics Committee approval was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

The article has a single author and there is no conflict of interest.

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