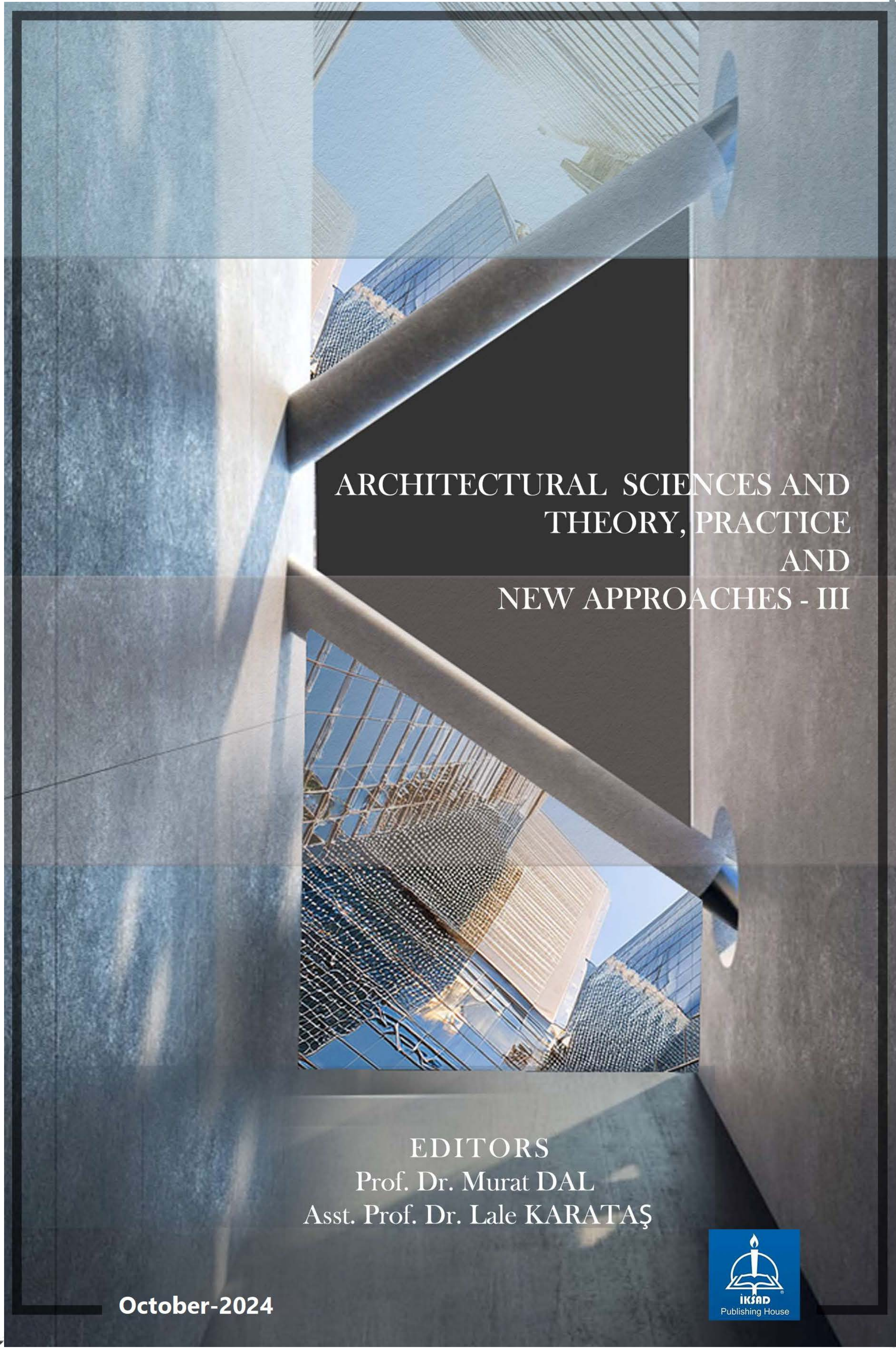

ARCHITECTURAL SCIENCES AND THEORY, PRACTICE AND NEW APPROACHES - III

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PREFACE

The editors of this book believe that a more livable world can be created by conducting interdisciplinary studies of spatial planning and design disciplines together under the umbrella of "Architectural Sciences". In this context, the "Journal of Architectural Sciences and Applications (JASA)," which is a pioneer in the collective studies of related disciplines was published for the first time in 2016. Afterward, JASA Editors make significant contributions to the creation of various books containing original works and to bring the latest developments in the field to the reader.

This book named "ARCHITECTURAL SCIENCES and THEORY, PRACTICE and NEW APPROACHES-III" consists of eleven chapters. In the book, the topics named "A Comparison of the Approach to the Concept of Design and The Methods Applied in Studio Courses in Interior Design Education in Turkey and Poland", "Exploring the Interplay of Architectural Design, Privacy Boundaries, and Cultural Values in Iranian Architecture: A Comprehensive Analysis of Entrance Areas and Circulation Hierarchies", "Determination of Design Criteria for Child-Friendly Indoor Playgrounds in Shopping Malls", "The Place of Biophilic Design Studies in the Literature Specific to the Discipline of Architecture", "Exploring Sustainable Architectural Practices: A Case Study of Design-centered Architectural Firms in Turkey"," Evaluation of the Use of 3D Printing Technology in Furniture Production in Terms of Sustainability"," The Transformation of

Private to Public Open- Green Space Use: The Case of Diyarbakır",“ A Mutualistic Relationship: Historical Buildings and Annex", “Architectural Analysis and Detection and Evaluation of Structural Problems of Diyarbakır Historical Mansions" , “The Use of Textile Recycling in Building Facades and Finishing Materials", “Structures, Usage Areas, Production and Case Studies of Mycelium-Based Bio-Composites" were discussed in detail. We would like to thank all those who contributed to the completion of the book, the authors, the referees of the chapters, IKSAD Publishing House, and Professor Atila GÜL, who is the General Coordinator of the Architectural Sciences book series.

We hope that our book “ARCHITECTURAL SCIENCES and THEORY, PRACTICE and NEW APPROACHES-III" will be useful to readers.

01.10.2024

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1. Introduction

Today, interior architecture education models are changing each day with the effect of innovative and different approaches to the concept of design and technology independent of various design education schools and universal criteria adopted by the universities providing the education. However, the fact that interior architecture departments are in faculties with different names such as architecture, fine arts and art and design causes the interior architecture department curriculum to change and differentiate with the various disciplines that are in the faculty. (Şekerci, 2017) As a result of these changes, differentiation is observed in the theoretical and applied courses of the interior architecture department, affecting content of the course, the approaches taken in the courses, outputs and achievements of the course. (Çelik, 2008) At this point, the necessity of preserving and controlling the education quality standards in the field manifests itself. Methods used to ensure quality assurance and control in education; accreditation, evaluation, supervision and comparison. (Gül, 2016) By using one or more of these methods, the institution or program can reach a certain standard by providing more qualified education. Quality assurance and control studies can be carried out on an institution, program or field. Accreditation studies in the field of interior architecture education are carried out by national and international organizations such as IFI, FIDER, CIDA, ECIA, NCIDQ in the world, especially in America and European countries. In Türkiye, the İMEPAK accreditation institution, which was established in 2018, continues to work and develop the name for TAPLAK in 2020. Since the organization is in the process of development, it has not yet actively carried out accreditation studies. For this reason, there is no regular and active accreditation study covering the education programs of the interior architecture departments of universities in Türkiye (Yıldız, 2019).

With the evidence obtained during the study, the thesis aims to reveal the advantages and disadvantages by comparing the differences of the approaches and applied methods in the interior architecture education studio courses in Türkiye and Poland.

2. Material and Method

Three different research and analysis methods are used in the study.

2.1. Literature Review (Establishing / Determining the Theoretical Framework of the Study)

*Interior architecture education and studio courses, notion of the design, design knowledge were carried out by examining the approaches to the design process and design activity within the scope of design research.

2.2.Creating / Editing a Thought Graph (Model)

*A thought graph (model) was designed in order to obtain more efficient and accessible information and evidence about the design process and design activity carried out in the studio courses, which are the learning environment in interior architecture education and the comparative analysis carried out in the field study and to make the comparative analysis on a single criterion. This model was developed and presented based on design education methods and approaches within the scope of design studies and studio courses practices. In the thought graph, notion of the design and design knowledge have been considered along with the design process.

2.3.Field Study

It was carried out in order to examine a comparative analysis of the studio courses within the scope of interior architecture education, which is the subject of the thesis, on design scale.

<u>Field Study Method,</u>

1. Participation in studio courses within the scope of comparative analysis,
2. Observing the tendency and behaviors of the studio master and studentsin the studio courses participated,
3. Making face to face interviews with the studio master and students, whoare the sides of the studio courses,
4. Preliminary knowledge about the design activity process and its elements was given by the thesis owner before asking the research questions in the interview with the students.
5. Research questions to students, was managed III. Phase of the design activity process.
6. While a face to face interview was held with the studio master of Academy of Art In Szczecin Department of Interior Architecture Studio 214, the interview with the studio master of Studio 213 was made in the form of an interview due to being part-time in the institution in question.
7. Face to face meetings could not be held with Afyon Kocatepe University Interior Architecture students due to distance education but the methods applied in the interviews with the students of Academy of Art in Szczecin. Afyon Kocatepe University Department of Interior Architecture and Environmental Design the studio master of Interior Architecture Project 2 was made in the form of an interview. Asking open ended

questions to the sides within the scope of the studiocourses during the interviews with the studio master and the students,

8. It consists of using the thought graph (model) constructed in the analysis of studio courses.

The scope and limitations of the methods followed in the fieldwork can be revealed with the following items: The study takes place in the studio courses of the interior architecture department.

At the center of comparative analysis are Afyon Kocatepe University from Türkiye and Academy of Art in Szczecin from Poland. The study area has been determined as Afyon Kocatepe University Fine Arts Faculty Department of Interior Architecture and Environmental Design Studio Course and Academy of Art in Szczecin Interior Architecture Faculty Department of Interior Architecture Studio Course.

Studio courses attended by the second year undergraduate students of the department of interior architecture are included in the scope of the study so that the comparative analysis between the two universities can be made in the same position and conditions.

Participation as a researcher and observer in the studio courses where the field study was carried out by the thesis owner. The realization of participation made it possible to observe the tendencies and behaviors of the studio master and the design student throughout the process, the communication between the sides and to conduct face-to-face meetings with the sides during the studio courses.

While a full-time physical participation was realized in Academy of Art in Szczecin Department of Interior Architecture studio courses, it was decided to conduct distance education in higher education institutions in the spring term of the 2022-2023 academic year due to the earthquake disaster that occurred in Türkiye. For this reason, Afyon Kocatepe University Faculty of Fine Arts, Department of Interior Architecture and Environmental Design attended the studio course full-time with an internet based distance education program.

The field study is about the studio courses, which are the main elements of interior architecture education. The design process that took place within the scope of the course, the design activity that created this process, the methods applied in the course, the studio course sides; it deals with the behaviors and actions of the studio master and the design student, and the student achievements at the end of the studio course.

The thought graph (model) constructed was developed in order to make the comparative analysis of the studio courses, which are the subject of the thesis, based on a single criterion and approach, since the design process experienced in the studio courses and the applied methods vary in approaches of design education. The analysis of the design processes of the studio courses included in the field study and all the elements of the studio courses within the scope of the study were made over this thought graph (model). In other words, the thought graph (model) was used as a guide in the comparative analysis of the studio courses.

3. Findings and Discussion

3.1. Studio Courses in Interior Architecture Education

Design has a dynamic structure both as a notion and in terms of its factual structure. In this variable structure, the fact that design can be defined differently according to the functions it contains and the characteristics of the fields of various disciplines in which it exists as a notion and takes place as an activity is the factor.

While making the necessary preparations and planning for an activity, creating drafts is expressed as design, it is also defined as the creative mental process itself. From this point of view, the design covers the creative process and activity and can be used instead of the expression design activity, which covers the design process. Design as a notion can be expressed as a mental state, a set of ideas, a synthesis that is visualized in the mind, and a process belonging to the formation of this synthesis. (Aşkın, 2020)

A design phenomenon is obtained by considering the cause and effect relationship from the ideas produced for solutions that can be brought to the all of a certain situation or a set of problems and the needs and questions related to these situations.

The act of design was considered to be an intuitive activity. Since the middle of the 20th century, new researches and studies on the design process have handled. In 1960, a group of researchers, who called themselves the first generation within the scope of design methods, tried to explain the design process in a systematic way. The majority of the design process researches are trying to express the design activity and the design process with a rational and scientific approach. The researches state that the design activity is an analytical process that takes place in the mind. The design can be defined as the designed thing itself, as well as to express the design activity carried out to reach the designed product and the design process in which the design activity begins and ends with a final product. (Aşkın, 2020)

Due to the flexibility and different approaches in the meaning of the design within the scope of the thesis, a language has been created based on the design process approaches in order to ensure that the field study and the thought graph (model) created reach its goal.

The design is considered as the final product reached at the end of a design problem solving process. The term 'design activity' is used to describe the state of designing and the design action. The creative mental process that starts with the design action and ends with a output of the design study, in which a designed product is obtained, is stated as the 'design activity process'. The design activity process consists of three phases as analysis - synthesis - evaluation. These three phases are used when obtaining a design (design product) or evaluating alternatives for a possible solution to a design problem. The design activity process is basically, deals with transferring / acquiring / learning all the theoretical knowledge about design knowledge. In a education of design in the studio course, there is a transfer of knowledge from the studio master to the student. The student develops design activity by learning individually and using design knowledge during education of design. In the design activity process of the analysis, synthesis and evaluation phases, are cyclical and can not separated from each other in terms of activity and situation. Figure 1 has been developed in order to make the comparative analysis of interior architecture education, which is the thesis subject, on a single scale. In this model, the design activity process of the studio course, in other words, the process of solving a design problem is conveyed.

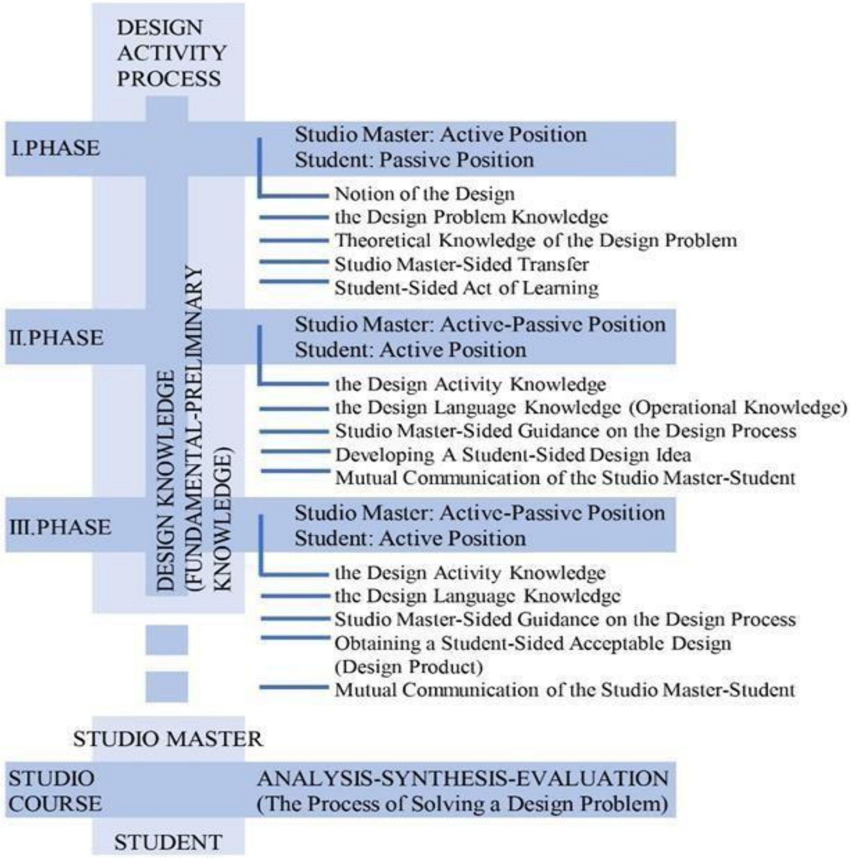

Figure 1. A Thought Graph (Model) Developed for the Field Study, Design Activity Process (Türcan, 2023)

The design activity process consists of three phases covered by the stages of analysis - synthesis - evaluation. This process takes place in the studio classes, which are the learning environment where interior architecture students learn to design and experience being a designer and interior architect. The studio course is at the core of the education program in disciplines such as architecture, interior architecture, landscape architecture and industrial product design, especially in design education.

There are different definitions and processes for the course in question due to the structural diversity of the faculties and the differences in the curriculum in the institutions where interior architecture education is given. The studio course provides the design student with the ability to design, understanding and formation about the interior architecture profession. Since the lecturer is a designer / interior architect as a professional as well as being an studio master, she / he plays a guide role for the student in the design process within the scope of the course. For this reason, preparation for the interior architecture profession is in question. In other words, courses are simulations of the interior architecture profession, being an interior designer and the working environment related to the profession. The master - apprentice relationship, which exists in the traditional architectural education approach, is also in the studio course (Ciravoğlu, 2001) Studio course is a lecture in which the design process and design activity take place and teaching and learning activities related to design are experienced. In line with a basic approach, the thought system of these courses is 'What is design?. How is the design done?'. With these approaches, the design process mechanism that forms the structure of studio courses emerges. (Günday, 2015)

Studio courses provide a study area where the theoretical knowledge gained from the theoretical courses in the interior architecture education curriculum and the design knowledge gained during the course in question are analyzed, internalized and synthesized. This course turns into an experience area with the design process. The design process takes place as a result of the design activity being experienced through the analysis -

synthesis - evaluation cycle. For this reason, studio courses can be thought of as a laboratory if we make an analogy. The purpose of the studio course is to strengthen the relationship of the design student with the social environment, namely the outside world, while learning to design, without being in a frame. It is aimed that the student, who is expected to fulfill the interior architecture profession with the design education she / he receives, is aware of the situations related to the structure, space, part of a whole in which human beings, who are users in the social order and other things have the close link with life are in close contact and to behave sensitively to needs and problems. The design student, who gains the ability to analyze with her / his experience in the design process in the studio, learns to identify a problem and to produce alternatives for an acceptable optimum solution to this problem (Gülel, 2018) There is a mental activity based on mutual interaction that is efficient for each other in the design activity process between the studio master and the design student, who are the sides of the studio course. In this communication, besides mutual learning and knowledge transfer, the sides also perform individual learning (Demirbaş, 2001).

According to Schön, the studio master of the studio course can transfer the knowledge to the student in two different ways. The first is to express what the lecturer wants to convey through drawing and the other is to present general design principles, to display a critical attitude and to offer solutions. In the first of methods of these knowledges transfer, the role of the trainer is active, while in the second, being a guide is at the forefront (Türkyılmaz, 2010) The success and efficiency of the studio course are dependent on the interaction between the studio master and the student, the analysis of the student's personal learning methods, and the determination of adequate strategies that improve the creativity of the students (Tarakci Eren & Yılmaz, 2022).

*Design Activity Process:

- I. Phase

The design activity process consists of three phases. The design activity starts in the first phase. The studio master, who is one of the sides of the studio course, plays an active role in the first phase. The lecturer begins to transfer the students design knowledge (fundamental - preliminary knowledge).

- II. Phase

In the second phase, while the student is in an active position, the studio master moves to the active - passive position by being in the background compared to the student. The student analyzes the design knowledge transferred to him / her in the first phase and which he / she learns individually, with notion of the design or design problem given by the studio master to reach a design (design product). Communication between the studio master and the student is not restricted to transferring and acquiring knowledge. There is a mutual mental interaction, exchange of ideas and learning. The design student, then tries to create her / his own design language throughout the process. In addition, the studio master evaluates the student's design activity process and preliminary design products and performances in line with her / his professional knowledge and experience.

- III. Phase

In the third phase of the design process, while the studio master is in the active -passive position, the student actively continues the design activity and the act of learning about the design knowledge. The students express the design phenomenon she / he created with a preliminary design idea in the second phase, using her / his knowledge of design language during the previous phase, with a design language through technical drawings, sketches and computer aided programs from various architectural representation tools. At the end of the design activity process, she / he conveys the design (design product) that she / he obtains with the design language she / he has created and developed.

After the research and analysis phase, the design activity process is completed with successive periods such as the concept, predesign, alternatives of solution, and final design product (Tarakci Eren & Var, 2017).

The Design Knowledge (Fundamental - Preliminary Knowledge): The thought graph (model) developed within the scope of the thesis and the design knowledge (fundamental - preliminary knowledge) is divided into two categories as descriptive and operative knowledge (Uluoğlu, 1990). Descriptive knowledge: In the first phase of the design activity process that takes place in the studio course, it is the type of knowledge that the student mostly tries to convey and that the student is exposed to, acquired, passively assimilated or performs individual learning. Descriptive knowledge is handled in three categories.

- Object Knowledge
- The Design Problem Knowledge
- Realization Knowledge

Operative Knowledge: It is the type of knowledge that is actively used in the second and third phases of the design activity process. The studio master conveys this type of knowledge not only by direct transfer but also by conducting mutual communication with the student through her / his professional knowledge and experiences throughout the process of designing. With this knowledge, the student acquires the methods of design activity by finding an answer to the question 'How to design?' and learns to express design ideas, activities and the design (design product) in the design activity process.

- Process Knowledge
- The Design Activity Knowledge
- The Design Language Knowledge (Operational Knowledge)

3.1.1. Studio courses in interior architecture education in Türkiye-Poland and the approach to notion of the design

Afyon Kocatepe University was established in 1992 and the Faculty of Fine Arts became operational in 2001. Within the Faculty of Fine Arts, there are Traditional Turkish Arts Department, Painting Department, Ceramics Department, Cinema and Television and Basic Education Department. The Department of Basic Education has not actively started education in the current situation. The education given in the discipline of interior architecture started in the academic year of 2012-2013 under the name of Interior Architecture and Environmental Design. The undergraduate education period of the Department of Interior Architecture and Environmental Design is four years.

Academy of Art in Szczecin is a public university founded in 2010. The school, which provides education in the discipline of art and design, consists of four faculties that provide education in the field of visual arts and music. Faculty of Interior Architecture is one of these faculties. The department providing interior architecture education operates under the name of Interior Architecture. The undergraduate education period of the Interior Architecture department is three years.

3.1.2. Design problem and solution process in interior architecture education studio courses in Türkiye and Poland

Theoretical Framework

Design education has its own characteristics and processes in disciplines and in the geography and cultures in which these disciplines emerge. At the time when the design existed as a phenomenon and started to be applied as a form of education and today, various ideas have been analysed by researchers and methods and practices have been developed and implemented. When design education researches are examined, these problems that are how these methods and applications should be given an especially efficient design education? What should be the elements and models that constitutes the structure of design education? are handled in the design studies. While the comparative analysis of the studio courses, which is the subject of the thesis, is carried out on the design scale, a thought graph (model) has been put forward to serve as a guide for both the existence of method and approach diversity and for the comparative analysis to be made more effective and to examine evidence of the analysis on a common criterion.

Within the scope of the study, this model is developed. The thought graph (model), in other words, is created according to the theoretical structure obtained from the design researches, the studies carried out in the discipline of interior architecture and the studio course practices in the institutions and organizations that provide education. The model which serves as a road map in the comparative analysis process of the thesis, deals with the design process, which is the main element of studio courses, as a notion, phenomenon and action. The design process, as a design activity, is revealed as the structure in which the action that results in the evolution of a notion into a phenomenon and the production of a design (design product) that is the design activity takes place during the studio course. Moreover, the developed model is concerned with what kind of design activity is the act of the design and what kind of mental activity is involved in the design action. In the 1960s, there are approaches that try to explain the design process in a systematic way and define the design activity as a problem solving. Simon was one of the first theorists to come up with this definition and approach. Rowe (1987), Hamel (1990) and Lawson (1990), who are among the researchers examine the architectural design process in the design discipline, also define the design process as a problem solving process. The design process is not just a sensory process guided by inspiration, it is a mental process in which certain information is used interactively and alternately while performing the design activity. Lawson (1980) states that design is an advanced mental process that uses certain information about the design process and design activity as a set of situations, ideas and results in the realization of ideas and reveals that design is an activity that requires mental synthesis. At the same time, Lawson (1990) states that in the act of design, the phenomenon of mental synthesis consists of a close relationship with notion of creativity. (Türkyılmaz, 2010) Notion of creativity is a fundamental phenomenon in design disciplines. Creativity plays an active role in the design process. At the end of the mental synthesis process that creativity is effective, the designer reached the design (design product). Aslan (2001) stated that creativity is a cognitive state that a designer uses her / his reasoning ability and mental performance in order to present a design product, which has a unique problem-solving process in the design process, or a new product. (Aşkın, 2020). According to Hamel (1990), a problem-solving action should cover the phases of analysis, synthesis and evaluation as a structure. In addition to this, he states that architectural design activity is a problem-solving process and the final design (design product) should be evaluated with both qualitative and quantitative criteria. Lawson (1990), who positions the mindset formed during the design process as rational and intuitive thinking, considers using these ways of thinking interactively and directing these in line with the design activity as a priority design capability. The model designed for the thesis study was structured based on the approaches and design researches. The focus of the studied model is on the design process and the act of designing, covering the discipline of interior architecture. In the model, the process of design activity: the process of solving a design problem is discussed within the framework of the studio courses, which are at the center of the interior architecture education curriculum. Within the scope of interior architecture education, the design action process takes place between the studio master and the student in studio courses, which are a learning environment. This process consists of three phases. In the first phase, the student acquires theoretical knowledge about notion of the design, design knowledge (fundamental - preliminary knowledge) and design problem (subject of the project). In the second phase, the student starts the act of designing by acquiring the knowledge of design activity. In the third phase, the student develops the design idea and presents a design (design product). The product that the student reaches by studying on it is considered as an acceptable design subject for measurement and evaluation and then the design activity process ends. The student uses the knowledge of the design language she/ he learned while expressing her / his design (design product). Figure 1 indicates the design activity process in the studio courses. In the model used in the comparative analysis of interior architecture education studio courses, the design activity process, analysis - synthesis - evaluation actions are formed as three phases based on the knowledge related to the design methods. The design activity process, which is divided into these three phases, takes place in the studio, which is the learning environment, between the studio master and the student.

In line with the design researches, design activity is considered as a process that requires mental synthesis and an idea / a problem evolves into a design / a solution. Design activity process consists of a series of sequential cognitive activities such as learning, transforming knowledge into an idea, interpreting / internalizing / assimilating and expressing / revealing. Design knowledge (fundamental - preliminary knowledge) is the main element of all phases of the design activity process. It is the field of knowledge that the basic concepts of formal design education, subject (human / user), knowledge of the object in design and its relations with properties are defined. Notion of the design includes theoretical knowledge about the design activity and process. In research on notion of knowledge, design knowledge is basically divided into two groups. According to the studies of Akın (1986) and Uluoğlu (1990), this two basic knowledge are descriptive and operative knowledge.

3.2. Analysis of Studio Courses in Interior Architecture Education in Türkiye for the Case of Afyon Kocatepe University

In Interior Architecture Project 2, which is the studio course of the second year students participating in the field study within the scope of Afyon Kocatepe University, Faculty of Fine Arts, Department of Interior Architecture and Environmental Design, the design process and the methods applied in the process examined through the thought graph (model) constructed for the thesis study. In addition, the analysis the interviews conducted with the students who are the side of the studio course were made. A group of sixty students including second year undergraduate students in the academic year of 2022-2023 attend the Interior Architecture Project 2 course. Due to the large number of students, this studio course is divided into three student groups. Each student group and a studio master carry out the design activity process within the scope of the course. Thus, there are three separate groups of studio masters and students in the same studio course. In the scope and limitations of Interior Architecture Project 2, a single design problem is handled in the studio courses complied with equal conditions with these three different student groups and the design action process is carried out with the application of the same methods. For this reason, one studio master and one student group from these three separate student groups were included in the field study. The studio course group analyzed consists of twenty students. Seven students from a group of twenty students participated in the interviews held with the students within the scope of the field study.

3.2.1. Design process and the methods applied in studio courses

Phase 1:

The studio master and the student can be in active, passive or active - passive positions according to the requirements of notion of the design and problem studied in the studio course. While the student is in a passive position during the first weeks during which design problem knowledge is transferred to her / him in this phase, the studio master takes an active position. In the context of approach to notion of the design, the design problem was presented to the student in the form of a design subject. The design subject studied in Interior Architecture Project 2 is a development of rural project for settlement of Afyonkarahisar, İhsaniye / Ayazini / Fatih village. The design problem knowledge was given by three studio masters in the first weeks of the studio course in the same distance education course attended by all student groups. This knowledge transfer has been made as theoretical knowledge about rural development, the historical and cultural identity of the project area. In addition, the studio masters analyzed the sample projects within the scope of rural development implemented in the settlement of Ayazini. While giving the design problem knowledge, the students were asked to study in the same residential area and a 150 square meter restriction that was determined for the indoor space the students would design was shared. The fact that the determined site is under protection due to its historical and cultural identity limits the design decisions and applications to be made for the project to be studied. At this phase, students are expected to create a design problem that they can study on during the design activity process within the given design subject and limitations. The analysis boards prepared by the student groups were evaluated by the studio masters in the same distance education course and feed back was provided. During these evaluations, each student continues the learning activity by reaching the analysis knowledge of another student. After the collective learning, which is realized with the analysis of student boards, the studio course continues with each studio master's own student group. In this phase of the design activity process, the student performs passive assimilation and individual learning activity. On the studio master’s side, there is evaluation and guidance in the direction of transferring knowledge to the student and creating a design problem.

Phase 2:

In the second phase, while the studio master is on the active - passive side as she / he conveys the knowledge of design activity and design language (operational knowledge) and directs the student's design activity with a critical approach, the student begins the design activity by putting forward a design idea and takes an active position. The student obtains a notion of the design by synthesizing the pieces of knowledge she / he has reached by analyzing the design knowledge (fundamental - preliminary knowledge) that acquired during the creative mental process. Notion of the design is the starting point for the student to come up with a design idea. At this phase, the student expresses his / her design idea with various architectural representation tools such as sketches, plan diagrams and graphics. Moreover, the student uses the design language knowledge acquired from the studio master. With the design idea that is the design decision, the student actively begins the design activity, while the studio master maintains her / his active - passive position and conducts the design activity with the knowledge of design activity and design language (operational knowledge) transferred to the student. At the end of the second phase, the student created notion of the design by developing the design idea with the communication that she / he established with the studio master in the studio courses and the lecturer's directing the design activity process. A midterm exam is applied to the students in line with the measurement and evaluation methods in the studio course. This midterm exam is conducted by the jury system in the field study of Interior Architecture Project 2.

Phase 3:

The studio master is in the role of guide and directing the design activity, like the second phase of the design activity process. In the studio courses, the student's collective learning with the other students in the same group and individual learning through face-to-face communication with the studio master take place to a great extent in the third phase. The group of the studio master in Interior Architecture Project 2 plays an effective role in the retrospective analysis and development of the design decisions of the student that constitutes the preliminary design. Moreover, the studio masters guide the design that presented by the students and did not satisfy optimum solution in the midterm exam. While reviewing the design decisions, the student performs the analysis, synthesis and evaluation activities that are in the design activity process retrospectively and the final product. The final phase of the design activity process concludes with the final exam that is a final assessment by the group of the studio masters. In the final exam, the design (design product) presented by the student is assessed to measurement and evaluation within the scope of an acceptable optimum design.

<u>The Methods Applied in Studio Courses</u>

1. In determining the design problem, students were asked to create a design problem by giving a design subject and a study area where the design would be made.

2. During the design activity process, the student acquires the design knowledge (fundamental - preliminary knowledge) both by direct transfer of the studio master and performing individual learning.

3. In the design problem studied within the scope of Interior Architecture Project 2, notion of the design, which constitutes the design idea of the student in the second phase, in other words, the starting point is an important factor in evaluation of the midterm because this affects the preliminary design decisions and shapes the design activity.

4. In the studio course, assessment and evaluation are carried out by the studio masters of the student groups with a midterm and a final exam, as well as the evaluation of student performances throughout the whole design activity process. The open jury system was applied in the midterm exam. In this examination system, the students present their preliminary design studies through face-to-face communication with the group of the studio masters. The group of the studio masters critically evaluated the preliminary design studies after the student's presentation. The midterm exam success scores of the students were formed by the average of the

evaluation scores determined for each student in the same methods by each lecturer from the group of the studio masters.

5. The final exam was applied as a closed jury system at the end of the design activity process. In the midterm exam, the students submitted their designs (design product) they obtained at the end of the design activity process. In the closed jury system, there is no presentation made by the student. The group of the studio masters evaluates the final designs in a closed condition to the students. The decision to apply the closed jury system instead of the open jury in the final exam of the scope of Interior Architecture Project 2 was taken because the student's preliminary designs in the midterm exam developed and shaped the final designs (design product). Each studio master determined the final exam success score for the student design (design product). The final success score of the student is obtained by taking the average of the determined success scores.

6. The measurement and evaluation of the design (design product) presented by the student is carried out in line with the technical parameters that should be in an architectural design and the final product can be a solution to the design requirements within the scope of the design problem that each student is studying on.

7. Performances of the students in the design activity process are effective in the evaluation of the midterm and the final design studies of the students. In the evaluation of the student’s performance, full-time participation in the studio course and achievement of duties and responsibilities in line with the project studied for each success course during the design activity are taken into consideration.

3.3. Analysis of Studio Courses in Interior Architecture Education in Poland for The Case of Academy of Art in Szczecin

Studio 213 and Studio 214, which are studio courses attended by second year undergraduate students, the design process and applied methods in Academy of Art in Szczecin, Department of Interior Architecture studio courses was scrutinized through the thought graph (model) developed for the thesis. In the context of the field study, the analysis of the interviews with the studio master and the design student were included during the participation in the studio courses.

3.3.1. Design process and the methods applied in studio courses

Phase 1:

The studio master and the student can be in active, passive or active - passive positions according to the requirements of notion of the design and problem discussed in the studio course. The design problem determined in Studio 213 is the project of the house as a living space. In the first phase of the design activity process, theoretical knowledge about living spaces was transferred by the studio master. In addition, the design problem knowledge about the project of the house to be studied within the scope of the course was given to the students. Within the framework of this design problem knowledge, the location of the project of the house and an apartment plan were shared with the student as a draft and also the profiles of different user were given to each of the students as a design problem. In Studio 214, the design problem was determined as project of a public space. The framework of the design problem was drawn by the studio master and the student was asked to design a public space. In the first phase, the studio master and the student are in the same position as active

- passive. In Studio 213, while the transfer of the design knowledge (fundamental - preliminary knowledge) by the studio master was available, passive assimilation and internalization of the knowledge were carried out through performing learning activity of the students. In Studio 214, the design problem knowledge regarding the design knowledge (fundamental - preliminary knowledge) is conveyed and theoretical knowledge is given to the student by the communication of the studio master that each student establishes with the studio master throughout the design activity process in line with the project decision.

Phase 2:

While the studio master was active - passive in Studio 213 and Studio 214, the student was in the active side. The studio master conveys the knowledge of design activity and the design language knowledge (operational knowledge) to the students. The students of Studio 213 determined the pieces of the design knowledge they would use in order to create their designs (design product) by analyzing the design knowledge (fundamental - preliminary knowledge) that the students acquired within the scope of the project of living space given as the problem knowledge in accordance with the design requirements. On the other hand, the students of Studio 214 were not given directly a design problem in the first phase and also the design problem were asked the students to create their own problems in line with the subject of the design and the design problem knowledge conveyed by the studio master. The studio masters convey the design activity and the design language knowledge (operational knowledge) so that the students express the preliminary design ideas in line with their purpose and develop these ideas throughout the design activity process through face-to-face or group interviews.

While some of the students try to present their preliminary design ideas with sketches and plan diagrams, the other students prefer computer aided programs. They try to create their own design language to express their design activities and the designs (design product) with the different types of representation.

Phase 3:

The student is active when the studio master is in the active - passive position. The design activity process concludes with a final evaluation at this phase. The students express their designs (design product) in their own design language, which created at the end of the design activity process, in accordance with the assessment and evaluation conditions of the studio course.

<u>The Methods Applied in Studio Courses</u>

1. In determining the design problem, according to the information obtained within the scope of the field study, a design problem was determined and transferred to the student in Studio 213 to satisfy total needs, while the subject of the design was determined in Studio 214 and the students of the course were expected to create a problem within the scope of the subject.

2. In the studio courses involved in the field study, the studio master is the side that transfers the knowledge to the student with the role of the lecturer, and this transfer is made with the analysis of the applied sample projects and studies within the scope of the design problem, as well as his own knowledge, including the student.

3. She / He conveys this knowledge in face-to-face or group interviews to the student, during the evaluation for the performance of the student's design activity process and the design (design product) or the student's in class presentations.

4. The measurement and evaluation of the students' design activity process and the design (design product) were conducted with a final exam. There is no midterm evaluation and exam. The student's attendance to the studio course and her / his performance during the course affect the evaluation of the final exam.

5. In the design activity process, the evaluation of the final exam was conducted by only one studio master. The approach to the design activity process and the final product were assessed at technical parameters and notion of the design rather than artistic and aesthetic concerns. The studio course, the applied methods and directing the design activity also proceeds according to an engineering approach.

<u>Analysis of Student Interwievs</u>

*The students of studio course stated that if the design problem knowledge is not directly given to them, they can research and discuss their interest and the subjects that they want to study on and exchange of ideas with the studio master within the scope of the determined the subject of the design and concept.

*They said that in the case of the subject of the project to be studied in a broad scope, the studio master guides and does not intervene directly in the decision of the design problem of the students.

*They stated that they take into consideration needs for optimum solution and the alternatives that is related to notion of the design in order to improve the current situation in creating the design problem of the project in question.

*They drew attention to the fact that in the case of giving the design problem knowledge directly, they begin the study by researching and examining the problem according to cause and effect related to the design problem.

*The students emphasized that the act of designing and their knowledge obtain their personal experience or initially from the studio masters. They also stated that making inferences about the social life, namely the environmental context, provides them with developing their design activity.

*In the second phase of the design activity process, the students said that they get inspiration from sources such as social media and architectural design blog via the internet while creating a design idea and making preliminary design decisions.

*The design students drew attention to the fact that they reach their preliminary design decisions with sketches, graphics they use while expressing the designs apart from the computer-aided programs at the end of the design process.

*The architectural models are effective in studying the design ideas in a concrete form and determining whether the optimum solutions are working on the problem.

*The students stated that the participation in the studio course contributes significantly to the development of their designs.

*While some of the students stated that they obtained all their design knowledge (fundamental - preliminary knowledge) from the studio master, the other students drew attention to the fact that they obtained this knowledge both by performing individual learning and is transferred by the studio master.

*Within the scope of the design activity process, a few of the students stated that the studio masters are positively effective and efficient in guiding the design activities and transferring the knowledge, while the other students said that they are able to intervene more than necessary the decisions of the design. The students generally stated that while trying to express their own design activity process, they do not have a specific technique of the study and reach a design either randomly or as a result of applied methods, depending on the subject of the design problem.

3.4. Comparison of The Approach to Notion of The Design and The Methods Applied in Interior Architecture Education Studio Courses in Türkiye and Poland

While making the comparative analysis, using the thought graph (model) developed,

1. Approaches and applied methods to the design activity process (a design problem solving process)

*The design knowledge transfer and acquisition

*Formation of the design language

2. Approaches to notion of the design in the design process and the formation of a design problem phenomenon

3. Reaching an acceptable design (design product)

*Notion of the design and transformation of the design knowledge

4. The structure and system of the studio courses

*Measurement and evaluation throughout the design process

*Measurement and evaluation of the acceptable design (design product) at the end of the design process

*Behaviours and tendencies of the student and the studio master who are participating in the studio course. After the studio course, the student achievements were examined.

3.4.1. Comparison of the studio courses: studio 213-214 / interior architecture project 2

<u>Similar Methods</u>

* In line with the thought graph (model) created for the field study, the structure and system of the phases that are in the design activity process and the elements that constitute the studio courses are similar in the context of a basic approach, although these differ.

*The transfer of the design knowledge (fundamental - preliminary knowledge) is carried out by the studio master in Interior Architecture Project 2, Studio 213 and Studio 214.

*The student’s design language is formed as a result of the direct acquisition of the descriptive and operative knowledge constituting the design knowledge (fundamental - preliminary knowledge) by the studio master and / or the individual learning activity and passive assimilation of these types of knowledge and then using these in the design activity.

*In Interior Architecture Project 2 and Studio 213 and 214, the sample architectural project analysis was carried out directly by the studio masters and transferred to the student with the approach gained through professional experience and knowledge.

*The studio master acts as an instructor and guide during the course. She / he has a critical approach while evaluating the student's design activity process, performance and final product.

*In the first phase of the design activity process, the same methods are applied in the three studios involved in the field study in the approach to notion of the design, in other words, the design problem.

*The design problem is determined by the lecturer of the studio course to transfer the student directly in an existing design problem in line with the whole situation or as a notion, concept and subject. And the student is asked to create a design problem in this context.

*In the student interviews for the field study, the students tried to explain their design activity processes and the methods they used and applied while performing the design activities in the process with similar expressions.

*During the studio course, the behaviours and tendency of the studio master is to transfer design knowledge (fundamental - preliminary knowledge) to the student and to direct the design activity through professional experiences in mutual interaction with the student.

*In addition, all three studio students generally prefer computer-aided programs instead of sketches, plan diagrams or preliminary design graphics while expressing their study and preliminary design to express a design idea in the second phase of the design activity process.

*In order to learn the design activity and reach a design (design product) accepted by the studio master at the end of the process, design students are responsible for fulfilling the assignments and tasks for each successive course according to the requirements of the design problem studied in the studio course.

*In all three studio courses, the student is given the right to a second exam in case of failure because the design (design product) presented by the student in the final exam does not fulfill the final exam criteria or is not an acceptable optimum solution according to the design problem.

*In the process of design activity, the student acquires the ability to design and design activity of solving a design problem. Moreover, with this education, the student gains tendencies of individual and collective learning.

Different Methods

*In the context of Academy of Art in Szczecin Department of Interior Architecture curriculum, at the beginning of each semester, the studio courses that deal with various design problems, which are different from each other, are offered to the second-year students.

*For 213-214, there are different student groups and the studio masters at the 2nd year undergraduate level in each studio. The student group, which determines the studio course, experiences the design activity process independently from other studios and the student group by studying on the design problem discussed in the lecture with the studio master of the relevant studio.

*In the context of Afyon Kocatepe University Department of Interior Architecture and Environmental Design undergraduate 2-level course curriculum, there is one studio course each in the fall and spring semesters of the academic year. Design students are responsible for a single studio course for each semester.

*The projects studied within the scope of the design problem discussed in the Academy of Art in Szczecin Department of Interior Architecture and Environmental Design studio courses are small-scale.

*Interior design projects within the scope of design problems studied in Afyon Kocatepe University Department of Interior Architecture and Environmental Design studio courses are mostly large-scale projects that the environmental context is taken into account.

*There is an engineering approach in the development and transformation of the design problem studied in the first phase of the design activity process, which is discussed in Studio 213 and 214 that the second-year undergraduate students participate and the evaluation of the design by the studio master.

*In Interior Architecture Project 2, these two approaches, that the design scale and technical parameters are taken into account, like in the other studio courses of the relevant department, are of equal importance in the design activity process. In the measurement and evaluation system, the preliminary design and the final product are handled in line with these two approaches.

*In Academy of Art in Szczecin Department of Interior Architecture studio courses, the study of design students at the development stage is not evaluated with a midterm exam.

*A midterm exam is applied in the second phase of the design activity process in order to evaluate the preliminary design of the design student in the studio courses of Afyon Kocatepe University, Department of Interior Architecture and Environmental Design.

*After the presentation, the final evaluation of the student's design (design product) and the determination of the success score are conducted only by the studio's master. There is no jury system and a group of the studio master evaluates the student's study simultaneously.

3.4.2. Advantages / disadvantages of studio courses in the context of methods applied: studio 213-214 / interior architecture project 2

Advantages Methods

*In Interior Architecture Project 2, the environmental context in the interior architectural projects studied is a factor that plays an important role in the evaluation of the product as an acceptable optimum design.

*The student develops his / her design ability by an interdisciplinary and analytical process with the projects that require such environmental context that he / she performs the design activity.

*Studying on large scale design problems, the design student both performs an interdisciplinary design activity and gains the ability to simultaneously solve many various problems of a large-scale design problem.

*As a result of the observation and analysis conducted within the scope of the field research, it was found that the interaction between the student and the studio master and the student experiences the design activity process more efficiently in the studio courses with a small number of students.

*Evaluation of student preliminary designs with a midterm exam in the second phase of the design activity process in Interior Architecture Project 2 studio education is an important factor in reaching an acceptable optimum solution at the end of the design process.

*In Interior Architecture Project 2, the jury system is applied in the second phase of the design activity process and the midterm and final exams are held in line with measurement and evaluation at the end of the process. With this jury system, the design activity process and the design (design product) that students obtain at the end of the process are evaluated simultaneously by more than one studio master.

*In this way, it can be accepted as an objective evaluation criterion in determining how close the student's design (design product) is to an acceptable optimum solution, which is the purpose of the design process.

*In addition, having a large number of students in a single learning environment and studying on the same design problem improves collective learning.

*In Studio 214, Studio 213 and Interior Architecture Project 2, there is a mutual communication between the student and the studio master at all stages of the design activity process. The presence of other student groups in the studio course learning environment and the student's communication with the studio master creates more than one interaction.

*The student experiences both individual and collective learning.

*In Studio 213 and 214, in the first phase of the design activity process, the students have access to the design knowledge (fundamental -- preliminary knowledge) is directly transferred by the studio master. After the student reaches the design problem knowledge, she / he performs an individual learning activity.

Disadvantages Methods

*The environmental context is not taken into account in the design problems of Studios 214 and 213.

*In Studio 213 and 214, small scale interior design projects are studied, while Interior Architecture Project 2 deals with large scale interior design projects with an environmental context.

*In Studio 213 and 214 design education, it is seen that an engineering and quantitative evaluation, which is not dominated by a design scale approach, is significantly effective in the design process and the measurement and evaluation of student studies. This can be explained by the fact that the resulting design is an acceptable optimum solution although the measurement and evaluation is conducted by a single studio master.

*While the number of students in Academy of Art in Szczecin Department of Interior Architecture studio courses varies between 5 and 7 in each studio, Afyon Kocatepe University Department Interior Architecture and Environmental Design studio courses are divided into three different student groups due to the large number of students. In Interior Architecture Project 2, the number varies between 15 and 20 in each student group.

*Afyon Kocatepe University Department of Interior Architecture and Environmental Design studio courses, in the first phase of the design activity process, the student's access to the design knowledge is realized both directly by the studio master and individually.

*In the case of Interior Architecture Project 2, like the approach applied in Studio 213 and 214, in the first phase, the transfer of design knowledge (fundamental - preliminary knowledge) was made primarily through the studio master and the student took an active position by beginning the individual learning activity in the second phase after the theoretical knowledge about the design problem.

4. Conclusion and Suggestions

The study aims to analyze the studio courses that enable interior architecture education to evolve an idea / problem into a design / solution in the light of the objective information conveyed to the student during the education, and to reveal the acquisition of making this transformation tangible with various means of representation. In addition, studio courses, which form the basis and essence of the interior architecture education curriculum, are included in the scope of the study, as these courses play a guide role in the professional field after the training. This analysis will be carried out through the comparison of departments of interior architecture of the state universities from Türkiye and Academy of Art in Szczecin Department of Interior Architecture from Poland the approach to the studio courses and the methods applied in these courses on notion of the design scale. In the study, the subject of interior architecture education to be studied is limited to the studio courses included in the curriculum of interior architecture departments, since it constitutes the essence of the education in terms of the acquisition of design knowledge and skills. Afyon Kocatepe University Department of Interior Architecture and Environmental Design and Academy of Art in Szczecin Department of Interior Architecture studio courses, its elements and the design process are at the focus of the comparative analysis of the studio courses on design scale. The study deals with the comparative analysis of studio courses of undergraduate second year. According to the evidence obtained as a result of the comparative analysis, while similar methods were applied on design scale in Studio 213, Studio 214 and Interior Architecture Project 2 participated in the field study, there are differences in the evaluation of the design (design product) reached after the design process by the design students. Moreover, three different research and analysis methods are used in the study. These are literature review, creating / editing a thought graph (model) and field study which is participation in studio courses within the scope of comparative analysis. Studio courses' approach to the design notion is expressed by performing the comparative analysis on design scale.

The aim of the study is to make a comparative analysis of the design education approaches in the studio courses, which form the basis of interior architecture education, through the example of Afyon Kocatepe University Fine Arts Faculty Department of Interior Architecture and Environmental Design in Türkiye and Academy of Art in Szczecin Department of Interior Architecture in Poland. The study aims to investigate and reveal the design process applied in interior architecture education studio courses and the methods applied in the process. In order to provide data for this analysis, fieldwork was carried out and participation in the said studio classes as an observer researcher was ensured. The fieldwork was carried out in line with the structure and functioning of the studio courses, the methods applied in the design process, and the analysis of the lecturer and student, who are the parties of the course. While the comparative analysis of the studio lessons was carried out at the design scale, design education and process researches were used to create the theoretical basis of the study. In the field study carried out in line with this thought graph (model), various findings were reached within the scope of studio course training. In line with these findings obtained as a result of the field study, approaches in studio lessons are presented as similarities and differences, as well as advantages and disadvantages. There are clearly observed differences in the methods applied during the design process. While there is an engineering-centered approach in Academy of Art in Szczecin Interior Architecture Department studio education, applications at the design and engineering scale have equal importance in Afyon Kocatepe University Interior Architecture and Environmental Design Department studio courses. While the assessment and evaluation of studio courses are made by a studio master in Studio 213 and 214, in Interior Architecture Project 2, it is realized by a jury system with more than one lecturer. The number of students in Studio 213 and 214 is between 5 and 7; there are 17 students in the studio course included in the fieldwork in Interior Architecture Project 2.

Studies on interior architecture education in design research have remained at the level of curriculum analysis or interior architecture education has been evaluated on a larger scale and the studio courses that form the center of the education in question have not been examined with all its elements. In addition, in the studies carried out, interior architecture studio courses were examined within the scope of educational institutions within the same education system. In this context, the study has an important position in terms of the scale it examines in design education. The study analyzed the studio courses, which are in different design education systems, with all elements comparatively. Past design education studies have been concerned with the mental process of design action, which cannot be dealt with concretely. These analyzed the interior architecture education in the discipline of design within the scope of the structure, functioning, elements and in class methods of the studio courses and examined the design process by positioning it on a concrete ground. For this reason, the thesis study is in a unique position in the field it studies. In addition, the study analyzes the interior architecture education studio courses, since it is expected to contribute greatly to the development of the education methods related to professional practice, and to be an example and a source for the research for other studies within the scope of the field.

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References

Aşkın, G. D. (2020). İç Mimarlık Eğitimi Temel Tasarım Sürecinde Yaratıcı Düşüncenin Geliştirilmesine Yönelik Bir Yöntem Önerisi. (Unpublished PhD Thesis). Mimar Sinan Güzel Sanatlar Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

Canbay Türkyılmaz, Ç. (2010). Mimari Tasarım Eğitiminde Erken Tasarım Evresinde Bilginin Dönüşümünün İrdelenmesi ve Bir Model Önerisi. (Unpublished PhD Thesis). Yıldız Teknik Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

Ciravoğlu, A. (2001). Mimari Tasarım Eğitiminde Workshop-Stüdyo Paralelliği Üzerine. (Unpublished PhD Thesis). İstanbul Teknik Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

Çelik, G. İ. (2008). İç Mimarlık Eğitim Programlarının Karşılaştırmalı Analizine Yönelik Bir Çalışma. (Unpublished Master's Thesis). Karadeniz Teknik Üniversitesi Fen Bilimleri Enstitüsü, Trabzon.

Demirbaş, Ö. O. (2001). The Relation Of Learning Styles And Performance Scores Of The Students In Interior Architecture Education. (Unpublished PhD Thesis). Bilkent University The Institute of Economics and Social Sciences, Ankara.

Eren, E. T., & Var, M. (2017). Education process and development of environmental design project. *International Journal of Educational Sciences*, 19(2-3), 144-151.

Eren, E. T., & Yılmaz, S. (2022). The student attitudes towards digital and conventional drawing methods in environmental design studios and the impact of these techniques on academic achievement in the course. *International Journal of Technology and Design Education*, 32(1), 617-644.

Gülel, Z. (2018). İç Mimarlık Tasarım Stüdyosu Eğitimi Sürecinde Artırılmış Gerçeklik Teknolojilerinin Kullanımı. (Unpublished Master's Thesis). Mimar Sinan Güzel Sanatlar Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

Gül, Ö. (2016). Türkiye'de İç Mimarlık Lisans Eğitiminde Tasarım Stüdyosu Derslerinin Yürütülmesine Yönelik Geliştirme Modeli Önerisi. (Unpublished PhD Thesis). Mimar Sinan Güzel Sanatlar Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

Günday, Ç. G. (2015). Analyzing The Effects of Different Critique Techniques on The Success of Interior Architecture Students. (Unpublished Master's Thesis). İhsan Doğramacı Bilkent University Graduate School of Economics and Social Sciences, Ankara.

Şekerci, C. (2017). Sanal Gerçekliğin İç Mimarlık Eğitimine Etkisi. (Unpublished Master's Thesis). Hacettepe Üniversitesi Güzel Sanatlar Enstitüsü, Ankara.

Uluoğlu, B. (1990). Mimari Tasarım Eğitimi: Tasarım Bilgisi Bağlamında Stüdyo Eleştirileri. (Unpublished PhD Thesis). İstanbul Teknik Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

Yıldız, A. (2019). İç Mimarlık Eğitiminde Teknik Resim Dersinin Uluslararası Değerlendirme Ölçütlerine Göre Yeri ve Önemi. (Unpublished Master's Thesis). Mimar Sinan Güzel Sanatlar Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

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Exploring the Interplay of Architectural Design, Privacy Boundaries, and Cultural Values in Iranian Architecture: A Comprehensive Analysis of Entrance Areas and Circulation Hierarchies

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1.Introduction

A complex web of variables, including location, climate, security, technology, culture, function, and natural components, interact to create architectural structures. This results in a tapestry of diversity, malleability, unique design paradigms, and creative inspirations. One notices the emergence of fluid design processes, architectural morphologies, amalgamations, and contextual subtleties in this environment, even when design requirements appear to correspond.

Traditional cultures have shaped their cultural and settlement patterns while cultivating and perfecting their architectural vernacular through time through a tried-and-true crucible of experimentation. As a concrete outgrowth of this tradition, architectural endeavor draws its energy from a diverse range of factors, including but not limited to environmental realities, modern technological frontiers, construction techniques, intricate webs of production and consumption, spiritual beliefs, and the profound legacies of previous generations. It is noteworthy that architecture is not just a result of physical limitations but is also influenced by the diverse cultural traditions that coexist in a certain area.

Construction methods, functional variations, material typologies, conceptual and symbolic underpinnings, the tapestry of user diversity, fluid circulation dynamics, imbued meanings, and the sacred tethering of individual and societal bonds – these diverse elements, within the societal milieu, coalesce to breathe life into architectural narratives that defy easy classification. As a result, in this setting, architectural phenomena first emerge, always bearing the unmistakable mark of design sensibility.

Examining the unique functional-visual characteristics of entrances turns out to be a crucial tool for understanding spatial legibility, overall goals, and functional clarity.

Architectural wonders emerge from the traditional landscapes as the visible result of a long battle against challenging environmental conditions, entwining a maze of physical, social, economic, technical, and environmental facets and dimensions that bear undeniable witness to their evolutionary journey. An obvious gap in the current architectural landscape frequently appears as a lack of attention to the conceptual significance of entrances. To provide a compass for the stewardship and continuation of design ethos, classic architecture must be meticulously and comprehensively reinterpreted. In this study, the phrase "traditional Iranian architecture" has been purposefully omitted at various points throughout this discourse due to empirical data, astute observations, and insightful revelations that have been gleaned through the meticulous prism of observation, scrutiny, and scholarly inquiry applied to traditional Iranian buildings.

Theoretical Framework

1.1. Architecture and Influencing Factors

1.1.1. History

Due to its strategic position in Asia, ancient Iran was able to absorb the architectural styles of its neighbors while yet maintaining its own unique traits. Despite being enhanced by the cultural and architectural influences of the Assyrian and Greek civilizations, civilizations like Elam, Mad, Parthia, Arsacid, Achaemenid, and Sassanid Empires were able to preserve and draw inspiration from their own culture and architecture. As a result, a more dependable, rich, and experienced architectural style emerged.

For instance, the Elamites built the Ziggurat temple for their deity who created Susa, and archaeologists refer to it as "Onteş's Fortress." In reality, ziggurats were huge pyramids with three to seven storeys that were off-limits to the common public. The sanctuary atop the Ziggurat, however, was home to Mesopotamian priests (Niroumand, H., 2012).

Bricks were used in the construction of buildings not only as filler but also as a structural element. In terms of its layout, the Chogha Zanbil Ziggurat may be divided into two phases: the first phase contains a first-floor central courtyard that is encircled by chambers (Figure 1). The spaces gradually got smaller when the other floors' volumes were built on top of the first during the second phase. Brick and adobe were the primary building materials in the city, and most of them have withstood the test of time unharmed.

The architectural arrangement and shape required by this idea are reflected in architectural design, which is seen as the art of spatial organization anchored in belief. Traditional architects did not see buildings as transient because of their environment and education, which stressed the concept of the world as temporary. As a result, they did not produce designs that were transient, local, or time specific. Architects picked designs that were timeless in their search for immortality since regional and temporal design trends tend to fade away over time. However, architectural works are classed and evaluated within the context of architectural history using temporal classifications.

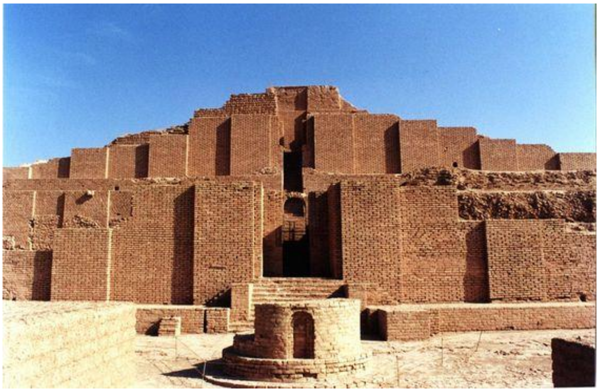

Figure 1. Chogha Zanbil Ziggurat; A view from the entrance area of the Elamite place of worship(Iran Ministry of Culture and Islamic Guidance).

1.1.2. Culture and belief

Art and architecture are formed and grow in large part as a result of culture and belief. Architecture, like other types of art, represents the love and beauty that people have believed in throughout history, seen from all facets of nature and living. Architecture has mostly been affected by people's beliefs and the gods they worship, which has resulted in the development of distinctive styles. Changing ideologies influenced design thought both before and after Islam, and new architectural components developed as a result. There was no demand for a distinct enclosed area for worship or for performing the common rites in the early faiths. We may say that shifts in belief systems have influenced the evolution of art throughout history. Belief, which has a direct impact on people, consists of unchanging norms, tales, feelings, and behaviors. The mysterious journey of life is represented in art as a result of this impact, and this reciprocal interplay never ends.

Within architectural semiotics, Umberto Eco clarified semiotics' function as a cultural phenomenon and a communication channel (Eco, 1986). This method claims that architectural symbols may be read and understood in the context of a text. In this way, symbols and signs act as the foundation for the interpretation process and carry the signals of the respective cultural settings in which they were created. For instance, four has long been revered as a sacred number, and numerous aspects of architecture have reflected this notion. The number four represents the four cardinal directions, the four seasons, the square's core, the elements of nature, the cross, and temperaments. It represents the four cardinal directions, the seasons, the elements, and the phases of the moon and is connected to completeness and universality. Both the cross and the square have symbolic meanings that suggest symmetry, rigidity, and order.

For instance, the Egyptians thought that the number four represented the core of physicality and that the soil, air, wetness, and sky were the primary ingredients in the creation of the world. The four-leaf clover is thought to symbolize God's grace in Irish mythology. The number four is a belief-based symbol that also represents wholeness and stability. There are four rivers of heaven, four cardinal virtues, and four archangels in Christianity. The number four is also symbolic of the four faces of Brahma in Hinduism and the four unending desires in Buddhism. The number four is widely used in religiously-inspired architectural design. Heaven and the celestial regions are frequently depicted as squares with four gates. The Four Eyvans notion, which refers to a square area with a dome, and the design principle are frequently observed in Islamic mosques.

Throughout history, architectural forms have mirrored social stratifications and lifestyles (Meier et al, 2012). This categorization has resembled a pyramid from ancient times to the present. The group at the top of the pyramid has placed itself there because it is the most economically, politically, and intellectually powerful group. The peak, the middle, and the base of the pyramid represent the diverse economic situations, and their divisions are proportionate to one's economic standing. This knowledge informed the planning of ancient cities. The wealthy members of society lived in the city center, which was at the tip of the pyramid and was frequently walled in. The remaining regions served as homes for the pyramid's other two halves. During dangerous periods, such as wars or natural catastrophes, the lowest class frequently suffered the most in such city designs (Smith,2013). Different facets of art's creation and evolution in ancient civilizations can be seen as emblems for the emergence of politics, dominating figures, conflict kinds, political entities, and ideologies.

1.1.3. Social values and traditions

Traditions have evolved throughout history as a result of the convergence of culture and society. The whole and its pieces are defined and identified in large part by the hierarchy principle. To put it another way, hierarchy is crucial in establishing the discipline, order, and coordination both inside and between a whole and its component pieces (Fig. 2). The delineation of the viewpoint and respect for the user is the primary idea behind the development and shape of the entry area in traditional architecture. At Sheikh Lotfollah Mosque, the entrance's layout and relationship to the plaza are reflections of a cultural view that transcends the user's gender. The hierarchy concept is present in numerous Islamic cultural branches that divide human existence into three primary categories, just like it is in other belief systems (Figure 2).

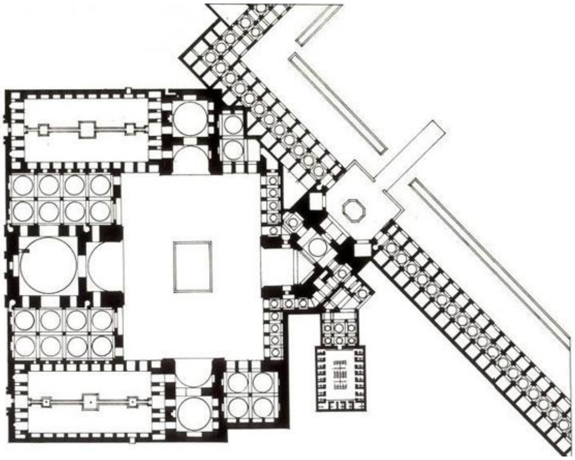

Figure 2. Defining Its Spatial Relationship to the Square, the Sheikh Lotfollah Mosque in Isfahan Has a Distinctive Angled Entrance Connecting to the Courtyard. (Iran Ministry of Culture and Islamic Guidance)

The placement of the entry area within mosque blueprints, the qibla axis' orientation, and the courtyard's symmetry axis are all regarded as crucial architectural considerations in Islamic architecture. The components and nuances that make up the entry area might fundamentally vary to follow these principles depending on the urban structure. They line up with the courtyard and qibla axis while also harmonizing with the orientation of the corridor or square plan.

The hierarchy principle is especially shaped by the physical, psychological, and spiritual ideas and ideals that make up human existence. Whatever the faith, the idea of hierarchy is a concept of gradation. The spatial, functional, aesthetic, and circulatory categories may be used to group the hierarchy-related aspects of the built environment. It is clear from this that design hierarchy is not unilateral in terms of direction, context, or size.

2. Material and Method

2.1.On-Site Visits

Selecting a diverse range of architectural sites across Iran stands as a pivotal strategy in comprehensively grasping the multifaceted intricacies prevalent within the country's rich architectural legacy. This deliberate diversity is structured to encapsulate the multifaceted cultural, historical, and regional variations inherent in Iran's architectural heritage. Embracing an array of historical periods, from the ancient marvels of Persian architecture to the Islamic, Seljuk, Safavid, Qajar, and modern architectural styles, each epoch embodies unique design philosophies, construction techniques, and cultural influences, allowing for an intricate exploration of architectural evolution over time. Furthermore, the consideration of various geographical regions within Iran—encompassing the distinct architectural styles of the northern, southern, central, and eastern regions—underscores the influence of climatic conditions, available materials, and regional traditions on architectural expressions. Furthermore, the selection of sites with diverse functions, ranging from religious edifices to residential structures, public spaces, and contemporary landmarks, aims to unravel the distinct cultural values ingrained within each architectural typology, portraying them as artifacts reflecting societal norms, rituals, and values prevalent at the time of their inception. This methodological emphasis on diversity serves several critical functions. For starters, it integrates cultural representations within each architectural location, creating a microcosm of the cultural environment common during a specific age or region. Second, it enables the tracing of architectural progress, highlighting transitions, innovations, and adaptations impacted by cultural, religious, and social changes, offering a narrative of continuity or alteration of cultural aspects throughout time.

The architectural growth in Iran from the Seljuks to the Qajars represents an enthralling progression within these transitional zones. From the ornate gateways of the Seljuk era to the monumental entrances of the Safavid period, such as those in Isfahan, and on to the Qajar period's fusion of Persian and European influences in entry designs such as those found in Tehran's Golestan Palace, these periods demonstrate the evolving cultural, social, and functional aspects embedded within the architectural fabric of entrance areas. Geographically, sites in Isfahan, Tehran, Gilan, Mazandaran, Yazd, and Kerman offer distinct entry typologies that reflect the impact of local traditions, materials, and environmental factors in forming these key thresholds. Exploring these eras and locales reveals the complex interaction of societal requirements, cultural subtleties, and historical settings, providing essential insights into the complicated history of entrance spaces and their relevance in Iranian architecture.

2.2.Terminology and Concepts

2.2.1. Entrance: (Vestibule, Vestibulum, Entrance Hall)

The transition between the exterior door and the inside rooms is referred to architecturally as the entrance (also known as a vestibule, vestibulum, or entrance hall). It is the corridor that connects a building's interior to a lobby, entry hall, or exterior door. It acts as a space-separating airlock. A popular practice in many buildings is an entry lobby, which has preparations for both exterior and inside entrances. This practice is frequently essential for security or environmental reasons. An entrance is described in literature as the position where the act of entering occurs, a spot inside a building that one enters, a threshold, an entryway, and a spot located at the boundary and point of differentiation of a limited space, among other things. Entrances are adaptable areas created to make moving from one location to another easier.

Perkins had always said that architecture must always have an ethical, social, and aesthetic component; otherwise, it cannot progress beyond being a passing fashion (Lobell,1986). A well-designed entry area separates two different private rooms and ensures solitude in addition to influencing changes in perception, behavior, surroundings, function, and rhythm. The line separating time, community traits, pre-identity creation in people, and the new hierarchy-based system is hazy at each step of transition.

In order to signify comprehensible changes, hierarchy or a chain of relationships is specifically built. When designing living spaces, spatial characteristics (private, personal, social, and public areas) must work in concert with user behaviors, much as human behavior and perception entail a sequence of and hierarchy.

In contrast to spontaneously occurring events and settings, tradition and rituals are impacted by human involvement in a hierarchical setting. The purpose of the architect is to produce and reflect a subjective and personal atmosphere that is in harmony with the objective and objective space and environment since the development of space is a design idea and approach built in philosophy and belief. The preservation of spiritual and cultural values has led to the creation of various interior layouts. Climate, geographic circumstances, religious and philosophical practices, moral codes, and opinions and viewpoints from different generations are sometimes represented in both great and substantial architectural projects as well as in smaller architectural components. Entrance area designs and historical periods may be shown to have undergone tremendous change, development, and maturation. Even while traditional buildings' entry sections have experienced substantial and significant alterations over time, certain common traits remain.

2.2.2. Shaping the entrance area

One's ability to recognize boundaries or to define their personal space is natural. The interaction between inner and external spaces, as well as the ties and connections they create, has been explored as a key issue in architecture. This connection and way of defining things act as a gauge for the architectural approach and style. One of the cultural foundations has been recognized as the imposition of borders and privacy in the construction and development of cities and architecture.

Public space denotes that it belongs to everyone, whereas private space implies the borders or territory of one or more persons. The problem, though, is the separation, the differences, and the number and quality of the connections between these two areas. The region that serves as a boundary between a person's private and public environment is crucial to privacy and is regarded as its most crucial component. The entryway signifies the start or finish of a journey by acting as a gateway from an open area to a separate and private place. The entry area, which serves as the dividing line between inner and outside areas, has been shaped by culture, ideology, and personal seclusion. It has evolved into a social right through time, and many architectural solutions have been created to protect this inherent right. It has occasionally been challenging to represent this topic due to the idea of privacy's boundaries, meaning, and ambiguity. The breadth, meaning, and limitations of privacy are influenced by factors including ideology, philosophy, lifestyle, cultural understanding, and viewpoint. The design, hierarchy of circulation, and architectural elements all convey how important and highly valued privacy and individual independence are. This value, which begins at the entry area, is established in the majority of plan solutions. A socio-cultural term, gender evolves over time and in many contexts. Therefore, how social spaces are claimed, owned, and described in various cultures depends on the socio-cultural traits of the individuals who make up such societies. Similar to this, it is now considered dogma to discourage people from entering particular locations or to urge them to do so based on their gender. Definitions and attitudes about women and gender identities have evolved throughout time, and it's possible that prevailing social, economic, cultural, and belief paradigms contributed to these changes. Additionally, many viewpoints have contributed to the growth or contraction of gender-specific areas. Door knockers have been used across civilizations not only as utilitarian hardware but also as symbolic elements representing society standards, prestige, and even gender disparities. In some communities, the shapes and designs of door knockers have been used to discriminate between men and women. This distinction is frequently used to denote gender roles or to acknowledge social factors in a subtle but culturally established manner.

Door knockers with varied shapes or designs, for example, may subtly signify the gender of the guest coming to the house in some regions. These distinctions are not always obvious; they can be nuanced, visible only by people who are familiar with the cultural codes or customs. Size, intricate craftsmanship, or symbolic patterns that discreetly imply gender associations could all be used to differentiate the designs.

Figure 3. Example of the Gender-Specific Approach and Understanding Found in Traditional Residential Architecture. Source: Iran Ministry of Culture and Islamic Guidance.

In some cultures, door knockers may have more rounded or floral motifs to reflect femininity. More angular, strong, or even animal-themed knockers, on the other hand, may represent masculinity. These distinctions are frequently the result of strongly ingrained cultural ideas of gender roles, in which certain shapes or symbols are traditionally associated with specific genders or societal traits. Furthermore, these disparities may not be universal and may vary greatly among cultural contexts. They may also vary over time as a result of societal developments, modernization, or changes in cultural attitudes. While the usage of different door knocker shapes to distinguish between genders may appear modest, these cultural nuances demonstrate the delicate ways in which everyday things, such as door knockers, can hold deeper meanings, reflecting societal values and practices surrounding gender identity and roles (Figure 3).

Door knockers have symbolic importance in traditional Iranian architecture that goes beyond their ornamental purpose. The round shape of the knocker evokes the sun, while the strike plate, studded with twelve stars, represents the moon. These components function as adornment as well as symbolic guardians, attempting to protect the home from negative energy and tragic events. These finely constructed door knockers express cultural meaning, providing insights into ancient beliefs and the protecting essence buried within architectural features in Iranian society (Taravati,2008). Traditional Iranian architecture is built on five key principles, according to Pirniya (2001), a historian of traditional Iranian architecture: privacy, avoiding extravagance, human scale, self-sufficiency, and static knowledge. In every kind of arrangement, privacy is seen as having the utmost value. A fundamental right that emphasizes reflection and individual freedom has always been and continues to be privacy.

2.2.3. Entry area facilities

Instead of being a single place, the entrance area includes all the areas that let people go from one location to another. It contains the interaction between the interior and outside, the direction and course of travel, and the area where decisions about whether to wait or pass are made in the context of the entry's crucial function. The entering area is the place where the public and private spaces—the street and the courtyard—converge. The transitions and functions in the communication hierarchy, as well as how this location interacts with the most significant public space next to it, are significant. In order to maintain the privacy of the interior space, different levels of general passage are said to affect how the entry area is formed.

On the other hand, how this area is affected and how its boundaries are maintained and monitored are also taken into consideration (Table 1).

Table 1. Entrance area's characteristics. Independent of building kinds, the conceptual character, and architectural parallels of the entry space.

Characteristic	**Method/Purpose x**
Private/public differentiation	Formal/spatial alteration, definition, pause, emotional change, amenities
Importance and Emphasis	Symbolic role, spatial attraction, depth/cavity ratio and quality, facade and doorway header
Movement Route	Guidance, functional diversity, facilitation, extension and deceleration, control, waiting
Hierarchy	Formation of respect, movement, viewpoint, function, form, and ornamentation, vertical confrontation and surveillance scenes

Due to a variety of varying circumstances, including function, temperature, user profile, culture, and quantity, the entry area, which extends from the public space to the courtyard, changes and evolves with time. Large and important architectural structures have been positioned at the urban scale so that they may be seen from nearby buildings, roadways, and public areas. Additionally, if feasible, key components and areas of structures have been made to stand out and attract attention from the start and upon arrival. The kind, degree, and quality of privacy as well as the interplay between public and private places have been examined at the neighborhood and unit sizes, though.

2.2.4. Entrance area’s ornament

The décor of traditional Iranian-Islamic dwellings' entry regions reflects a cultural focus on seclusion, social hierarchy, and climatic factors. According to Safarian and Azar (2020), these designs frequently include components such as finely carved wooden doors and vestibules that serve as transition places between the public and private realms. According to Varmaghani, Soltanzadeh, and Tahaee (2019), the doorways to Qajar homes in the Gilan and Mazandaran areas are covered with exquisite tile work and geometric designs, indicating cultural aesthetics and regional variances. The spatial structure of these entrances, according to Khozaei Ravari et al. (2022), is intentionally planned to provide visible seclusion while preserving a link to the outside. Zabihzadeh et al. (2019) emphasize the cultural importance of privacy in Iranian society, which influences the portrayal and design of entering spaces as a transition that protects personal space. Rizi (2022) underlines how these designs meet the demands of residents for comfort and energy efficiency, demonstrating how the adornment of entry spaces also serves utilitarian functions within traditional Iranian residential architecture.

The entering area separates interior privacy from outward publicity by acting as a space at the intersection of these two zones. Additionally, it links and connects interior and outside areas. The building's entrance is a "In-between" space because it defines the structure and reacts to actions in public areas while also being a component of the private space on the one hand and the public space on the other. Although it has historical origins and has affected art and architecture, privacy has achieved its pinnacle, with effective examples seen in post-Islamic architecture. The courtyard has evolved the most among architectural features because of the effect of variables that have changed through time and have influenced the shape of the majority of buildings. The architecture of traditional ways and philosophies reflects their lifestyle, which is centered on the close connection between nature and people.

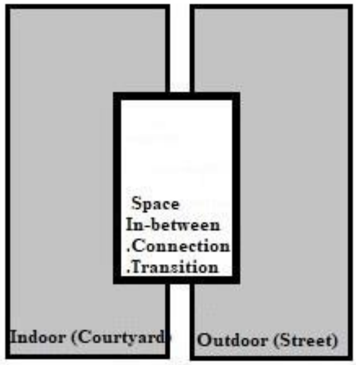

Figure 4. Spatial Configuration Analysis; Location of the Entrance Area and Nearby, Connected Areas.

In the past, all architectural constructions embraced the design aesthetic that emerged from the notion of a direct interaction between nature and people, which appreciates and respects both equally. By examining the natural components involved in the architectural design process, this research seeks to identify the variables that influence the categorization and molding of the fundamental design element. Architectural solutions, shapes, and functions that are inspired by nature are among the strategies used today. In order to prevent rain in the winter and direct sunshine in the summer, and to highlight the importance of the structure with seasonal adornment, decorative geometry is frequently used on the outside of buildings (Figure 4). To differentiate between buildings and the street, several techniques have been devised. In the portion of the entry area that separates from the street, many forms of visual privacy can be seen depending on the density, breadth, position of passageways, and features of the structure. The main passage and cul-de-sac entrance spaces are confined to one door or another and are divided into semi-private and semi-public passages. We can observe that this section contains common elements and compounds in practically all constructions. In this instance, it not only provides space for activities of daily life like meetings, encounters, resting, conversing, and pausing, but it also directs indoor relations related to user gender, position quality (night/day, rest/work, solitary/group, spring/winter), and relationships suitable for building function (long/short, private/public, individual/social).

The concept of "In-between" is an important transition zone in Iranian architecture, carefully spanning the gap between public and private areas. The entry area, which serves as "In-between" space, not only delineates the boundary between two realms but also orchestrates the flow of movement into the structure while providing a waiting room. The core of the "In-between" concept is embodied in this diverse area, which embodies structural and functional duties. Nonetheless, despite its importance, the concept of "In-between" space in Iranian design has received little attention. As a result, the purpose of this study is to dive into the substance of "In-between" space, particularly in the Iranian architectural context, with an emphasis on its significance and usability in entry spaces. This study aims to improve our understanding of spatial organization, privacy issues, and cultural implications in Iranian architecture by providing light on the function and complexities of "In-between" space, particularly inside entry spaces (Figure 5). The street's look and the facade's furnishings also reflect the socioeconomic standing of the community. Sekku often comprises of single or double platforms that are wide enough and tall enough to allow people to sit on both sides of them. The term "سکو" (Sekku) in traditional Iranian architecture refers to a space on either side of the entry door where people can relax as they wait to enter or converse with neighbors.

Figure 5. The External Perspective of the Entry Area and the First Level of Hierarchy, Qazvin Ali Ghapu. Source: Iran Ministry of Culture and Islamic Guidance.

Stone and brick countertops adjacent to the doors serve as areas for waiting, listening, and other activities. Bricks and adobe make up the building's outside walls. The outer walls of the building are composed of plain walls to minimize excess and symbolize simplicity and humility. But it's already established that the entrance location is distinctive and highlighted.

The entry area that faces the public space may have different characteristics and particulars. The front entry space enclosed on all sides is referred to as the first level in the hierarchy. Decorations for doors serve as symbols for identities, worldviews, and ideologies. Door headers were essential components of the entry area, especially during the Safavid era, and are now seen in all structures. Doors often have twin wings, are made of wood, and include door knockers for both sexes. Usually literary passages, Quranic words, compositions invoking religion, and inspirational poems cover the panels on door headers. The door header panels vary depending on the purpose of the structure and the social standing of its owner (Fig.5). The worth of the door header is obvious in all the information, talents, and arts utilized to create door headers. The door header has significance and sanctity for the general public, but especially for artists. The door header has always been a crucial part of any structure, regardless of changes in themes and materials over time and according to differing beliefs.

The focal point of the entry area is Haşti. One enters the waiting room as a closed space after passing through the entrance. This space, which can take on numerous forms depending on the architecture, frequently has the shape of a straightforward rectangle and is perceived as a unit connecting the exterior entrance to the courtyard. Depending on the building's purpose and user density, this space can be designed in a variety of shapes, including square, pentagon, hexagon, octagon, and semi-octagon. The amount of furniture in this area can go up or down depending on things like the building's purpose and user density. Additionally, the basic transitional meaning of this room has been enhanced with ceiling decorations, geometric patterns, and materials like plaster, glass, and paint. Windows on the ceiling or above the entrance offer natural lighting for this confined space. The main goal is to maintain seclusion and to block visibility of the courtyard from the exterior door. In other words, by shifting the direction of the vision, corridors can distort perception. The characteristic of the hallway linking Haşti to the courtyard might change depending on the building's shape, purpose, placement within the urban fabric, and degree of seclusion. For instance, seclusion is prioritized in a home, yet the qibla (Mecca's direction) is significant in religious structures. The architectural approach for reducing heat loss in a hammam (bathhouse) may entail alterations to the corridor's physical attributes, such as its length, breadth, form, and orientation (Figure 6).

Figure 6. Haşti's Natural Lighting System and Ceiling Cavity. Source: Iran Ministry of Culture and Islamic Guidance.

Within architectural discourse, the concept of a courtyard contains a comprehensive notion of spatial order, representing a convergence of cultural, historical, and functional components. Molaei and Sabermand (2020) investigate the characteristics and archetypes of courtyard layouts in the context of Iranian history, focusing on the Tabriz Historical Bazaar. Their research undoubtedly highlights the cultural relevance and functional arrangement of courtyards, showing how these spaces were essential to the spatial organization and flow of ancient architectural environments.

Yazdi et al. (2022) employ deep learning and remote sensing to investigate the field of historical architecture, focusing on the automated recognition of medieval courtyard dwellings in Yazd, Iran. Their research could give light on how technological improvements interact with courtyard spatial arrangement, potentially exposing the complex intricacies or distinguishing elements that differentiate these places within historical contexts. Goharipour (2019) conducts a semiotic analysis of central courtyards in Iranian cinema, most likely in order to investigate the symbolic representations and narratives buried within these architectural spaces. Such an investigation is likely to reveal the rich cultural and metaphorical components associated with courtyards, demonstrating how they go beyond just architectural constructions to reflect deeper societal values. Furthermore, Mahdavinejad et al. (2013) analyze the central courtyard's acceptance as a classic paradigm in contemporary Iranian architecture, underlining the spatial concept's continuity across time. Their investigation undoubtedly underscores courtyards' lasting significance as important aspects in Iranian architectural tradition, demonstrating how these spaces continue and change within current architectural practices. Furthermore, Shokouhian et al.'s (2007) study of the environmental consequences of courtyards in sustainable design in cold parts of Iran, namely the case study of courtyard residences in Tabriz, should highlight how these spaces contribute to environmental sustainability. This viewpoint most likely emphasizes courtyards' utilitarian elements, emphasizing their role in controlling microclimates and improving environmental performance within building projects.

The courtyard is often rectangular in shape and frequently free from the impact of the urban framework, serving as a place where social life takes place. The number of users and the neighboring uses are two criteria that affect the size and quantity of courtyards. Typically, the main courtyard, which includes components like gardens and water features, is the center of the architectural axes and is an essential part of the design. Since the functional design was made to accommodate the weather, different areas of the courtyard may be used throughout the year. The courtyard has been a consistent element throughout history thanks to the adaptation of the spatial organization to the axis and courtyard. According to the peculiarities of the courtyard, architectural or structural layouts can be categorized in this situation. Hierarchical, axial, and symmetrical design concepts have been used in plans, interior facades, and even decorations, with the courtyard serving as the key interior space planning component (Figure 7).

Figure 7. The Enderuni, Biruni, and Narenjestan Courtyards are Examples of Classic Iranian Domestic Architecture in Terms of Quantity, Geometry And Placement (Iran Ministry of Culture and Islamic Guidance).

The courtyard is essential to balancing the irregularity of urban environments in terms of the architectural notion of spatial order. Traditional architects carefully change interior spaces into proportionate and well-designed shapes in this setting, frequently in a subtle manner that is undetectable to consumers. The entry area is where the organization and change start and end. The courtyard serves as the essential and important feature of the structure in terms of function, hierarchy, organization, and circulation, independent of where exactly it is located inside the building.

Interior areas are frequently at lower heights than the exterior parts, both geometrically and programmatically. Landscape and environmental design also incorporate architectural details, such as reliefs, carved walls, arches, and windows, in addition to natural elements like trees, plants, and water features.

3. Result

The study examined several entrance areas at a wide range of architectural locations in Iran, concentrating on both ancient and contemporary constructions. The study yielded several crucial conclusions about the history, cultural significance, and functional value of entrance areas in Iranian architecture.

3.1. Differences in Architectural Styles and Eras

The chosen sites showcased a diverse range of architectural styles, including ancient Persian, Islamic, Seljuk, Safavid, Qajar, and modern. The study found that the cultural, religious, and social circumstances of each era had a significant impact on the entryway designs. For example, Seljuk entry designs were distinguished by ornate gateways that emphasised grandeur and symbolism, but Safavid entrance areas, particularly in Isfahan, had massive designs that mirrored the period's architectural accomplishments. Qajar-era entrances, such as those found at Tehran's Golestan Palace, combined Persian and European influences, demonstrating the period's exposure to Western architectural ideas.

3.2. Geographic and Regional Variations

The study found considerable regional variances in entryway designs, which were affected by local traditions, available materials, and environmental conditions. For example, entrances in Isfahan were frequently magnificent and beautifully ornamented, reflecting the city's historical importance as a cultural hub. In contrast, entry designs in northern regions, like as Gilan and Mazandaran, were more humble and appropriate to the humid climate, with timber constructions and minimal embellishments. The research of entrance spaces in Yazd and Kerman revealed adaptations to arid climates, with designs that prioritized ventilation and shade, demonstrating how environmental factors influence architectural expression.

3.3. Cultural and Symbolic Significance.

The study discovered that entrance areas in Iranian architecture are more than just practical spaces; they also have substantial cultural and symbolic significance. Entrances were frequently used as markers of social status and identity, with extravagant decorations and architectural aspects representing the power and prestige of the building's inhabitants. In particular, doorknockers in traditional Iranian homes were discovered to be symbolic items indicating society standards and even gender disparities. The employment of various designs, such as rounder or floral themes for femininity and angular or animal-themed designs for masculinity, represented deeply embedded cultural views about gender roles.

3.4. Privacy and Hierarchical Design.

The concept of privacy was discovered to be an important issue in the design of entrance areas, particularly in residential building. The study discovered that entrance areas frequently served as transitional places, balancing the requirement for privacy and the desire for social connection. This was accomplished by hierarchical architectural components that generated a progression of locations, from public to semi-public, and lastly to private sections. The physical structure of entrance areas was purposefully created to regulate visibility and access, preserving the seclusion of the internal spaces while allowing for social interactions at the threshold.

3.5. Ornamental and Functional Adaptations

The study discovered that ornamentation in entrance areas had both decorative and utilitarian purposes, frequently reflecting the region's climatic and environmental characteristics. For example, ornate geometric patterns on building exteriors were utilized to offer shade and protect the structure from the weather, as well as to improve the visual appeal of the entry. The study also discovered that ornamentation in entrance areas frequently had symbolic implications, such as the portrayal of celestial bodies like the sun and moon in door knockers, which were thought to provide protection against negative energy.

4. Discussion

This study's findings highlight the complexity and relevance of entrance areas in Iranian architecture, illustrating how these spaces are influenced by a variety of cultural, historical, environmental, and functional elements. The study's findings add to a better understanding of the significance of entrance spaces in Iran's architectural fabric, providing insights into the larger cultural and social settings that shaped their development.

4.1. Cultural continuity and transformation.

The study's research of entrance areas from various historical periods demonstrates the continuity and evolution of cultural values in Iranian architecture. While some design aspects, such as the emphasis on solitude and the use of symbolic adornment, have persisted across time, the adaptation of entrance designs to new cultural and environmental circumstances exemplifies Iranian architecture's dynamic nature. The merging of Persian and European elements throughout the Qajar period, for example, demonstrates how Iranian architecture absorbed and assimilated exterior influences while retaining its cultural character.

4.2. Regional Adaptation and Environmental Considerations

The study's findings about regional variations in entrance designs highlight the importance of environmental considerations in architectural design. The adaptation of entrance areas to diverse climatic conditions, such as the use of timber buildings in humid regions and vented designs in drier areas, exemplifies traditional Iranian architecture's ability to adjust to local environmental difficulties. These findings indicate that the principles of sustainable design, which promote adaptability to local conditions, have long been ingrained in Iranian architectural practice.

4.3.Gender and Social Identity in Architectural Design.

The study's findings on the symbolic use of door knockers to designate gender roles offer unique insights into how architectural features reflect social identity. This subtle yet culturally significant practice exemplifies Iran's complex relationship between architecture and social conventions. The use of gender-specific designs in entrance areas emphasizes architecture's role in reinforcing social hierarchies and cultural values, implying that entrance areas are more than just physical spaces; they are also social constructs that embody the beliefs and practices of the society that built them.

4.4. The Function of Privacy in Spatial Configuration

The study's emphasis on seclusion in entrance area design highlights the relevance of spatial configuration in accomplishing social and cultural goals. The hierarchical organization of areas, from public to private, reflects the larger social structure and the importance of privacy in Iranian culture. This finding is consistent with traditional Iranian architectural ideals, which emphasize personal space protection and the building of surroundings that promote both social interaction and individual privacy. The study's findings indicate that the architecture of entrance spaces is critical in regulating the interaction between public and private life, offering a controlled and subtle transition between the two spheres.

4.5.Ornamentation: Symbolism Meets Functionality

The study's investigation of entrance ornamentation demonstrates that these decorative components serve both as cultural emblems and functional adaptations. The employment of geometric patterns for shading and protection, as well as the symbolic representation of heavenly bodies, demonstrates the versatility of ornamentation in Iranian architecture. These findings imply that ornamentation in entrance areas is more than just an aesthetic decision, but a planned design strategy that reflects both the cultural priorities and practical necessities of society. This dual purpose of ornamentation underscores the notion that architecture in Iran is a holistic discipline in which aesthetic, cultural, and functional concerns are smoothly intertwined.

5. Conclusion and Suggestions

Courtyards in architecture are a synthesis of cultural, historical, and utilitarian features that may be viewed through numerous lenses. They are crucial to architectural discourse, as evidenced by research into their qualities, technological adaptations, symbolic representations, long-term relevance in current design, and environmental effect in sustainable architecture. Courtyards, which are typically rectangular and separated from urban contexts, function as communal areas influenced by user demands and nearby usage. The main courtyard, which includes gardens and water features, responds efficiently to weather variations and has been a stable architectural element throughout history, inspiring layout ideas and ornamental conceptions. The courtyard is typically at the center of hierarchical and symmetrical design concepts, regulating interior space layout and architectural aesthetics. Courtyards are critical in function, hierarchy, and circulation inside structures, serving as both the starting and finishing point of spatial organization, while landscape design integrates architectural and natural components, establishing the essence of courtyards within architectural spatial order.In the architectural context, user profiles frequently divide people into Enderuni (residents) and Biruni (guests/foreigners). Enderuni refers to residents of the home, whereas Biruni alludes to visitors or strangers. This difference denotes the dual role of spaces in reflecting the dynamism of their occupants within the built environment. Enderuni spaces are designed to meet the requirements of residents by stressing familiarity and solitude, whereas Biruni spaces are designed to welcome guests by emphasizing hospitality and social interaction. This user classification influences spatial design, influencing layouts that combine private comfort for inhabitants (Enderuni) with communal openness for visitors (Biruni), expressing cultural and social complexities in architectural arrangements. The entry area is crucial in architectural design because it serves as the threshold that connects exterior and internal habitats, notably connecting outdoor spaces to the courtyard. This architectural feature, which serves as a transitory zone, has a varied role that goes beyond basic passing. It defines the transition from the exterior environment to the intimate domain of the courtyard by delineating the boundaries between public and private domains. It represents the beginning or end of a spatial trip, symbolizing a symbolic and practical shift. It is frequently the architectural focal point, highlighted by design elements such as ornamental doors, vestibules, or transitional spaces that heighten the experience character of passage. This region not only allows for physical movement but also represents socio-cultural values such as privacy, hospitality, and social hierarchy, demonstrating the merging of practical and symbolic features within architectural space.

The study sheds light on the intricate interplay of cultural, historical, and environmental aspects in the design of entrance areas in Iranian architecture. The findings emphasize the importance of these spaces as functional and symbolic features that reflect the larger social and cultural circumstances of their time. The data also show that entrance spaces act as key thresholds, bridging the gap between public and private life while expressing Iranian society's cultural values and social conventions. As a result, the study adds to a better understanding of the function of architecture in forming and expressing Iran's cultural identity, providing new insights into the importance of entrance areas in the country's architectural legacy.

All locations could serve as threshold spaces by acting as transitional areas between distinct regions, assuming properly defined borders. When seen as thresholds in this context, passageways can be divided into the following categories:

- Accumulative Threshold: It developed as a static area for the congregation of individuals or members of social groups with the intention of generating bigger gatherings. The requirement for everyday usage is therefore evident.
- Outward-Related Threshold: It improves the quality of space. It may connect with the natural or man-made surroundings around it aesthetically, but seldom physically.
- Transition Threshold: The concept of a transition threshold frequently includes movement. This threshold's main purpose is to link the beginning and finishing points in terms of the length of the route. The number of stops and changes in direction along the route directly relates to its length. Therefore, from a design standpoint, more sophisticated transition thresholds contain a variety of pauses and transitions.
- Entrance-Exit Threshold: As a spatial transformer, the entrance-exit threshold serves as a point of transition. It emphasizes solitude and private space in addition to being a role in perception, environment, behavior, and rhythm alterations.

Entrance spaces serve as cultural barriers in Iranian architecture, symbolizing the difficult balance between seclusion, societal standards, and spatial hierarchy. These gates represent the meeting of cultural value and utilitarian need, indicating the passage from public to private spheres. They convey a sophisticated narrative, representing the rich fabric of Iranian society's ideals, which combine privacy, hospitality, and social order. The circulation hierarchy shown in these entry regions not only directs movement but also reflects society structure. These places, which are embellished with symbolic components and precise design, transcend their practical function, becoming representations of cultural history and spatial order. The architectural manifestation of privacy boundaries within these entrances represents the preservation of personal space within the societal fabric, highlighting how architecture in Iran becomes a testament to enduring cultural values and the art of navigating between public interaction and private sanctuaries.

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Author Contribution and Conflict of Interest Declaration Information

The author worked entirely and equally on the research, writing, and revision of this paper. There are no conflicts of interest to disclose.

References

Ching, F. (1996). Architecture, Form, Space and Order. New York: Van Nostrand Reinhold.

Eco, U. (1986). Semiotics and The Philosophy of Language. Bloomington: Indiana University Press.

Falamaki, M. M. (2007). The Formation of Architecture in the Experiences of Iran and the West. Tehran: Faza Publication.

Goharipour, H. (2019). Narratives of a lost space: A semiotic analysis of central courtyards in Iranian cinema. *Frontiers of Architectural Research*, 8(2), 164-174. https://doi.org/10.1016/j.foar.2019.01.004

Habibi. A. (2012) Bastac's Traditional Architecture. *Journal of Culture of People*, 10, Tehran.

Heidegger, M. (1971). Poetry, Language, Thought. Trans. Albert Hofstadter. New York: Harper & Row.

Kenner, T. A. (2006). Symbols and their hidden meanings. London: Carlton.

Khozaei Ravari, F., Sanusi Hassan, A., Abdul Nasir, M. H., & Mohammad Taheri, M. (2022). The development of residential spatial configuration for visual privacy in Iranian dwellings, a space syntax approach. International *Journal of Building Pathology and Adaptation*. Advance online publication. https://doi.org/10.1108/IJBPA-02-2022-0037

Lobell, J. (2004) Cultural concerns of Computational Architecture, (Online) Accessed on: 17.03.2020

Lobell, J. (1986). Cultural Concerns in Computational Architecture. Lobell.com.

Mahdavinejad, M., Moradchelleh, A., Dehghani, S., & Mirhosseini, S. M. (2013). The Adoption of Central Courtyard as a Traditional Archetype in Contemporary Architecture of Iran. *World Applied Sciences Journal*, 21(6), 802-811. DOI: 10.5829/idosi.wasj.2013.21.6.1426.

Meier, S., & Karsten, L. (2012). Living in commodified history: Constructing class identities in neotraditional neighbourhoods. Pages 517-535. doi:10.1080/14649365.2012.704641

Molaei, A., & Sabermand, M. (2020). Characteristics and Archetypes of Courtyard Pattern in Iranian Historical Bazaar (Case Study: Tabriz Historical Bazaar). Athar.

Nersisianse, E. (2012). Anthropology of Gender. Tehran: Afkar.

O'Connor, M., & Airey, R. (2007). Symbols, signs and visual codes. London: Southwater.

Pallasmaa J. (1995) Identity, Intimacy and Domicile, Journal of Cinema Industry. N.D. Benjamin.

Pirnia, M. K. (2001). Iranian Architectural Stylistics. Tehran: Soroush Danesh.

Rizi, R. A. (2022). Occupants' migration in residential buildings towards comfort and energy efficiency (case of traditional residential architecture in Iran). *Journal of Housing and the Built Environment*, 37(2), 179–211. https://doi.org/10.1007/s10901-021-09700-5

Safarian, P., & Azar, A. (2020). A survey of the effect of cultural roots of society on design of house architecture (Case study: Traditional culture of Iran society, Iranian-Islamic houses). *Kurmanj*, 2(3), 1-7. http://kurmanj.srpub.org/article-2-32-en.html

Shokouhian, M., Soflaee, F., & Nikkhah, F. (2007). Environmental effect of courtyard in sustainable architecture of Iran (Cold regions) (Case study: courtyard houses in Tabriz). In 2nd PALENC Conference and 28th AIVC Conference on Building Low Energy Cooling and Advanced Ventilation Technologies in the 21st Century, September 2007, Crete island, Greece.

Sklair, L. (2010). Iconic Architecture and the Culture-Ideology of Consumerism. Theory, Culture & Society, 27. Los Angeles, London, New Delhi, Singapore: SAGE.

Smith, M. L. (2013). The Social Construction of Ancient Cities. Smithsonian Institution.

Taravati, G. (2008). PORTA: The Language Of Doors. UWSpace. http://hdl.handle.net/10012/4113

Truman Reconstruction: (1948-1952) (Online) Accessed on: 17.03.2020

Varmaghani, H., Soltanzadeh, H., & Tahaee, S. A. (2019). A comparative study of the influence of culture on entrances of Qajar houses .*Gilan and Mazandaran*, 11(25), 237-249.

Yazdi, H., Berenji, S. S., Ludwig, F., & Moazen, S. (2022). Deep Learning in Historical Architecture Remote Sensing: Automated Historical Courtyard House Recognition in Yazd, Iran. *Heritage*, 5(4), 3066-3080. https://doi.org/10.3390/heritage5040159

Zabihzadeh, A., Mazaheri, M. A., Hatami, J., Nikfarjam, M. R., Panaghi, L., & Davoodi, T. (2019). Cultural differences in conceptual representation of "Privacy": A comparison between Iran and the United States. *The Journal of Social Psychology*, 159(4), 357-370. https://doi.org/10.1080/00224545.2018.1493676

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Determination of Design Criteria for Child-Friendly Indoor Playgrounds in Shopping Malls

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1. Introduction

The sociological impact of changes in the urban fabric on children is discussed in today's literature. In the concrete urban fabric, children have difficulty finding their playgrounds in unsettled streets without connection with their users. Due to both the physical inadequacies in urban playgrounds and the problems experienced by working parents in creating time, the demand for indoor playgrounds for children's entertainment needs and desires has increased. The main purpose of this study is to determine the design criteria for indoor playgrounds in shopping malls using a survey technique. The method of the study is based on a quantitative research design consisting of 5 steps. A survey study was conducted on 234 parents with children between the ages of 3-14 between March 2024 and June 2024. As a result of the study, the spatial adequacy of shopping malls is questioned and explained with a field study and survey technique; suggestions were made for child-friendly indoor playground design criteria.

Child-friendliness is seen in the scientific literature of many different disciplines through studies conducted in different fields such as “child-friendly city, tourism, media, health, education, etc.” Although the concept of child-friendliness has been explained by researchers with different theories, it is briefly expressed as allowing the child the rights and freedoms of “being a child”. According to the 2022 data from the Turkish Statistical Institute, 26.8% of the population of Türkiye consists of children, and it is seen that it is higher than the European Union (EU) countries (TUIK, 2021). Today, more than one billion children live in cities, and it is predicted that 7 out of every 10 people in the world will live in cities by 2050 (URL 1).

It is being discussed how cities will adapt to this change, how solutions will be found for needs such as shelter, education, and health, and what kind of policies should be followed for children, who constitute a significant minority of the population. In this respect, when we look at the political studies carried out on children at the international level, we see that it started with the Geneva Declaration of the Rights of the Child in 1924. It was followed by the Declaration of the Rights of the Child adopted by the United Nations General Assembly in 1959. The Declaration emphasizes, especially in its 31st article, “the right of children to spend their free time, play and find entertainment appropriate to their age, and to participate freely in cultural and artistic life”. In the Malta Declaration published in 1977, which was declared the World Year of the Child, the vital importance of children's play rights for the development of every child, as well as nutrition, health, shelter, and education, were emphasized (URL 1).

According to these diplomatic decisions, the party states have started to work on recognizing the right of children to spend their free time, to rest, and to be provided with appropriate and equal opportunities in terms of art and cultural activities. The Republic of Turkiye, which has sufficient service power in the fields of health and education, also has the means to protect and develop children's rights. Child-friendly education, tourism, media, and city studies can be exemplified as a few of these means. In our country, investments and studies are carried out, especially for the "child-friendly city" policy. However, studies indicate that the fact that national standards for playgrounds, which are the most basic right of children, have not been fully determined, incorrect urban planning, and that not enough space is given to play in daily life are making cities less child-friendly. Open children's playgrounds in our country are also considered children's gardens, and the design criteria of these gardens vary according to the urban planner. However, since parks and entertainment facilities are not distributed equally within the city, access is not the same for children from all segments of society (Price & Rodrigo, 2009).

Children who cannot find safe urban spaces such as playgrounds, parks, and gardens are deprived of their most fundamental right to play among concrete structures. Children who do not come from economically strong families are left to experience life in adverse conditions in the physical environment (Gür and Zorlu, 2002). For this reason, children are left without a physical and social environment and are unable to go out and live a life confined to a narrow environment (Özservet & Sirkeci, 2016). The fact that playgrounds that show a city as child-friendly are not of sufficient quality in our country is seen as a reason that pushes children to spend time in playgrounds in shopping malls. Although it is known that matriarchal and patriarchal thoughts are effective in shopping mall selection, child-male thinking is now dominant. The concept of child-male is explained as parents acting according to the wishes and needs of children and tending to places where there are activities that ensure their development and where they can have fun together (Tuna, 2018).

Families tend to turn to indoor playgrounds instead of spending time with their children in outdoor playgrounds, which they find inadequate in terms of many qualities such as security, design, and variety of activities.

Shopping malls have also been accepted as a place to come together and share for the last few years. Therefore, shopping malls are considered an important, popular, and ideal public space for spending free time. When national and international publications are examined, it is seen that many qualitative, quantitative, and mixed-method research and compilation studies have been conducted on child-friendly spaces. The concept of child-friendly is given priority in different areas such as urbanism, architecture, media, tourism, education, and health. When the studies conducted on the design criteria of shopping malls with the concept of child-friendly are examined; Tuba Ünlükara & Lale Berköz (2016) touched on the effect of location selection for shopping malls on the urban fabric. Kiriri (2019) analyzed the criteria that make shopping malls preferable under 5 headings in his study: design/aesthetics; service, security; employee service, and usage value. As a result of his survey, he determined the security criterion as the criterion that increases the preferability of the shopping mall the most. Yalçınkaya (2015) conducted a study to determine children's free time preferences and space usage and to determine the place of shopping malls among these places. Tavşan, Sipahi &Gerçek (2016) analyzed the importance of indoor playgrounds in winter cities and compared the indoor playgrounds in these cities with examples from Türkiye and abroad.

As a result of literature readings, it was seen that studies were included in the subjects of "child-friendly", "city and shopping mall", and "shopping mall preference trends"; The fact that there is no research on child-friendly indoor playgrounds in shopping malls in Türkiye province in the literature reveals the originality of the study.

It is thought that there is a knowledge gap in the literature regarding child-friendly shopping mall playgrounds and that this study will contribute to the determination of parents' tendencies to choose indoor playgrounds in shopping malls in the context of interior design criteria. Within the scope of this study, 10 different shopping malls located in the central district of Antalya, one of the metropolitan cities in Türkiye, which is the most crowded and has the most entertainment venues, and which have been in service for at least 5 years, were selected as a sample. Antalya, which is humid in every season, is quite hot in the summer months. It is predicted that the climate conditions direct parents to indoor areas, especially shopping malls that provide different activities such as food, shopping, entertainment, art and culture, rather than outdoor areas for children in the city. It is thought that there is a knowledge gap in the literature regarding child-friendly shopping mall playgrounds and that this study will contribute to the determination of parents' tendencies to choose indoor playgrounds in shopping malls in the context of interior design criteria.

1.2. The Problem and Hypothesis of the Study

The main problem of the research is whether indoor children's playgrounds in shopping malls meet the child-friendly criteria. In the context of the research questions created, the main hypothesis of this study was established according to the parents' survey responses about the design criteria of child-friendly indoor playgrounds. Another hypothesis of the study is that there is a relationship between the answers given by parents to demographic questions and their answers given to Likert-scale questions. For example, the attitudes of mothers and fathers differ or the design criteria that parents prioritize according to their educational status differ.

The research questions created within this scope are as follows:

Q1: What are the criteria for parents to choose children's playgrounds in shopping malls?

Q2: Which design criteria should be taken into consideration to ensure aesthetic, entertainment, ergonomic, and safety criteria in indoor children's playgrounds?

2. Material and Method

A quantitative research design consisting of 5 stages was applied in the study. In the first step of the study, the literature review was conducted, and the problem was defined by identifying gaps in the subject. In the second stage of the study, visual analyses were created on children's playgrounds in shopping malls around the world. In the third stage, an online survey was applied to parents with children aged 3-14 in Antalya. A total of 30 parents with children in 10 shopping malls were selected and the survey link was sent.

The survey was applied to 234 participants online. The survey included demographic and descriptive questions followed by a Likert scale question. In Likert scale questions, survey participants were asked which was the most important criterion for a children's playground (aesthetic, entertainment, economy, safety etc.) and rank the criteria of aesthetics, entertainment, safety, ergonomics and economy from very important to not important. In the fourth stage, the data obtained as a result of the survey and the data obtained as a result of the visual analysis were included. In the last stage, the study was concluded by including the information obtained, suggestions, and evaluations (Figure 1).

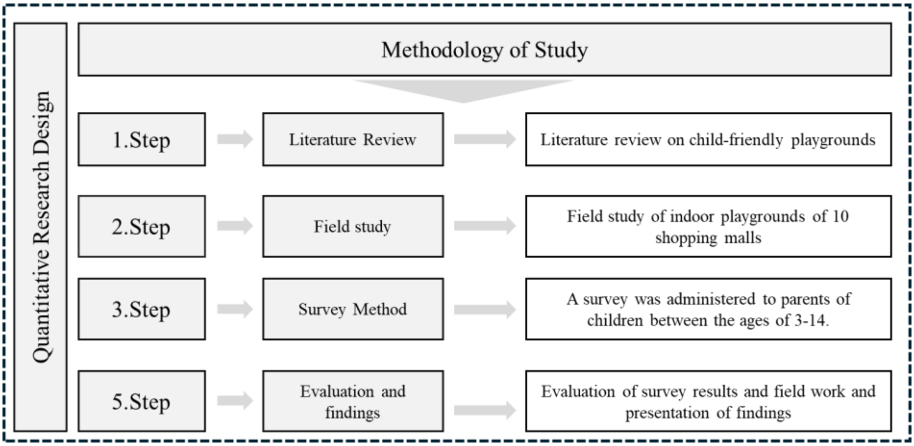

Figure 1. Methodology of Study (Created by authors)

The main problem of the research is whether indoor children's playgrounds in shopping malls meet child-friendly criteria. A field study was conducted to identify this problem, and a survey was conducted to determine the design criteria required for its solution. If the shopping centers in Antalya province are listed by region; there are 2 shopping centers in Alanya district (Kipa Alanya and Alanyum), 2 shopping centers in Manavgat district (Novamall and Manavgat City AVM), and 15 shopping centers in the city center. The shopping centers located in the city center are as follows: Erasta AVM, 5M Migros, Mark Antalya, Özdilek Park AVM, Laura, Shemall, Terracity, Mall of Antalya, Agora AVM, Deepo AVM, Kipapark AVM, Akkapark, Antalium Premium Mall, Land of Legends, Sultan Bazaar. Within the scope of the field study, 10 different shopping centers belonging to the Konyaaltı, Muratpaşa and Kepez regions, which have the highest population in Antalya, have been operating for at least 5 years and have a closed area of at least 5,000 m2 according to the regulation were determined. The sample group to which the survey was applied in the study consists of Mark Antalya, 5M Migros, Deepo AVM, Özdilek, Terracity, Laura, Shemall, Erasta, Agora and Mall of Antalya shopping centers, respectively.

3. Findings and Discussion

The concept of shopping is a concept with very wide-ranging perimeters that have strong social, economic, and political effects today. Although shopping centers have reached their current forms as a result of centuries of change, they are also the source of many ecological, economic, and social problems today (İlhan, 2018). When we look at the historical development process of shopping centers, it is known that the first steps were taken in Europe (Birol, 2013). In a short time, similar ones to modern shopping centers began to be seen in different countries, including Türkiye. Galleria AVM in Istanbul (1988) and Atakule AVM in Ankara (1989) are considered the first examples of shopping centers in Türkiye (Ceylan, Özbakır, & Erol, 2017). When we look at the development of shopping centers in Türkiye between 2000 and 2020, it is seen that 361 shopping centers were opened (Ünlükara & Berköz, 2016). According to the 2022 data from the Shopping Centers Investors Association, there are a total of 436 shopping centers in Türkiye(URL 4). Most shopping malls are located in Istanbul (147), Ankara (48), Izmir (30), and Antalya (19), respectively.

3.1. Indoor Children's Playgrounds in Shopping Malls

Playgrounds are a means of entertainment and education for children regardless of the location. For the child to develop spatial awareness and stimulate perception and motor development, he/she should experience various spaces. In order for the child to have a sense of space, he/she needs to learn various concepts such as above-below, inside-outside, open-closed, right-left, near-far. Repetition of shapes, textures, colors, designs and sounds is important for children to learn (Tavsan, İsmailoğlu & Ergun, 2018).

When we look at the implemented or concept projects in the world, we see that the spaces for playgrounds in shopping malls are designed based on very creative, abstract concepts. In the concept project seen in Figure 2, a children's playground with a nature concept was designed. Floor, ceiling, and wall surfaces were included in the design, and color and texture studies were included. Vertical and horizontal physical activity playgrounds were created to increase children's motor and mental skills. At the same time, indoor plants were included and elements that would appeal to children's senses such as touch, smell, and sound were included (Figure 2).

Figure 2. Nature Concept Children's Playground (URL 2)

It is seen that children's playgrounds are mostly located on the ground or basement floors of shopping malls or planned in gallery spaces. For example, it is seen that the playground in the Milaneo shopping mall in Stuttgart, Germany is also planned in the gallery space. It is not preferred to use fences or dividing panels to separate the playground from the shopping circulation. The playground is limited by creating a color and pattern difference only on the ground. The columns are covered and adapted to the form of tree branches in a way that refers to the forest/nature concept. Seating benches are placed around for parents to observe their children. Unlike the example in Figure 2, the nature concept in this space is reflected with the tree and branch forms characterized by the designer, without using live or artificial plants (Figure 3).

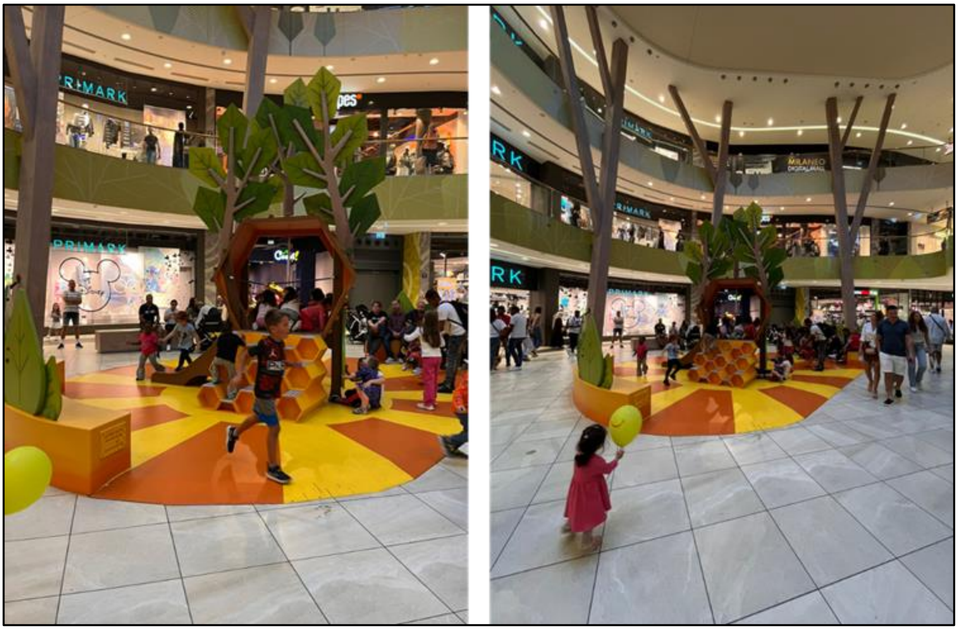

Figure 3. Children's Playground at Milaneo Shopping Mall in Stuttgart, Germany (Tavşan, 2023)

The playground designed for the Colombo Shopping Mall in Lisbon, Portugal is designed in the ocean concept. The playground is placed in circulation areas (Figure 4).

Figure 4. Children's Playground in Colombo Shopping Mall in Lisbon, Portugal (URL 3)

Another example found in Portugal is a space-concept playground designed for the Nova Arcada Shopping Centre. This design won the bronze award in the CCP 2016 Equipment Design competition (Figure 5). This playground not only includes physical play areas, but also interactive surfaces with modern digital screens.

Figure 5. Nova Arcada Shopping Mall Children's Playground (URL 4)

The Parque Aventura children's playground in Gran Casa, Spain, was designed with a forest concept on the restaurant floor. Play areas for physical activities were designed on raised profiles above the dining tables. Parents can both observe their children and spend time in the surrounding cafes by sitting in the seating areas on the lower level. This space, limited to children between the ages of 5 and 12, was designed on an area of 640 m2. Compared to other spaces, the space is illuminated with natural daylight from the opening in the ceiling. Artificial indoor plants are hung from the grid ceiling system created on the ceiling, and landscape elements are also included (Figure 6).

Figure 6. Spain Gran Casa Children's Playground (URL 5)

If we look at the 459 m2 indoor playground for parents called Mama Smile located in a shopping mall in Japan, it is seen that it is more comprehensive than other playgrounds. Parents can entrust their children to a playmate and continue shopping, or they have the freedom to stand in the observation area and observe their children. It is seen that soft and pastel color tones are used in the space, tatami is preferred on the floor, and no specific concept is designed (Figure 7).

Figure 7. Mama Smile Indoor Playground (URL 6)

The Meland-Longhua children's playground in Shenzhen, China, is a visually intense playground designed with the Alice in Wonderland concept. It includes a variety of play equipment for children of all ages (Figure 8).

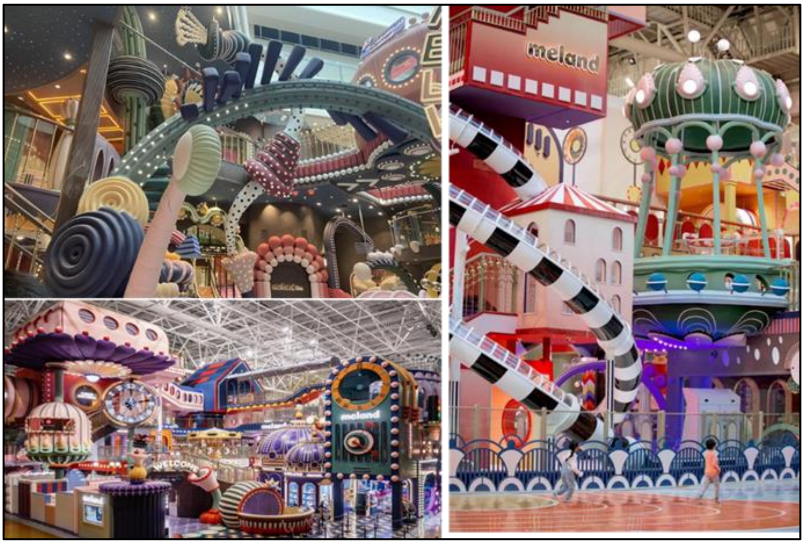

Figure 8. Indoor Playground in Meland-Longhua (URL 7)

Another example is the 17-meter-high slide that follows the gallery space in the Istanbul Akmerkez shopping mall, designed by GAD Architecture. In addition to this fun structure created in the gallery space, a playground was designed on the first floor (Figure 9).

Figure 9. Indoor Playground in Istanbul Akmerkez (URL 8)

In the Agora shopping mall in Antalya, there are playgrounds in the gallery space on each floor. There is a playground for children of all ages on the 3rd floor of the shopping mall. Compared to other examples, the playground is limited and surrounded by bars (Figure 10).

Figure 10. Agora AVM Children's Playground (Göksel, 2024)

3.2.Survey Results

A total of 234 participants responded to the survey, 210 female and 24 males. When the participants' level of education is examined, 6 have primary school, 24 have secondary school, 60 have high school, 18 have an associate degree, 90 have a bachelor's degree, 36 have a master's degree or doctorate. 120 of the participants have one child, 108 have 2 children, and 6 have 3 children.

When survey participants were asked which was the most important criterion for a children's playground, 60% stated safety, 14.3% ergonomics, 11.4% entertainment, 8.6% aesthetic, and 5.7% economic (Figure 11).

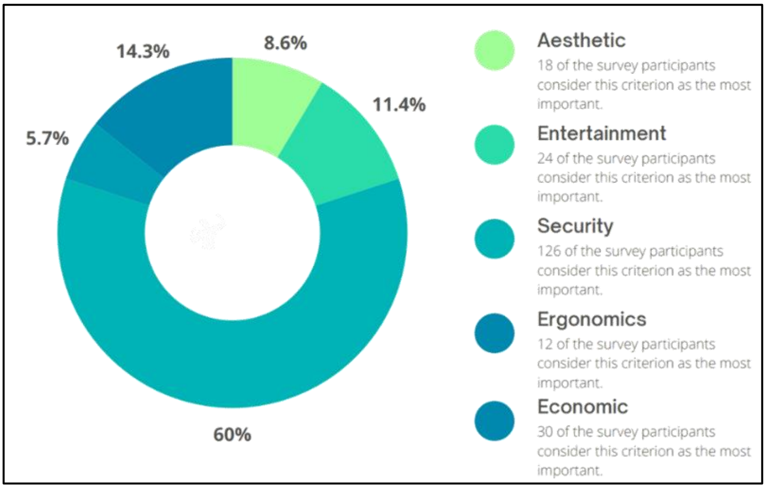

Figure 11. Survey Q1 Results (Created by authors)

When asked to rank the criteria of aesthetics, entertainment, safety, ergonomics and economy from very important to not important:

- Very important (5) safety /security
- Important (4) economic
- Neutral important (3) ergonomics
- Slightly important (2) entertainment
- Not important (1) aesthetics criteria were specified.

It was determined that the aesthetics criterion was selected as the not important, entertainment as neutral important, safety as very important, ergonomics as slightly important and economy as the not important criterion. As can be understood from the survey results, when parents choose indoor children's playgrounds in shopping malls, they first give importance to the safety criterion. This is followed by economy, entertainment, when they are asked to choose a single criterion, the safety criterion is mostly stated. However, when parents are given the criteria of aesthetics, entertainment, security, ergonomics and economy together and asked to rank them according to their importance, the results vary relatively. The most important criterion is again selected as the safety criterion, and the entertainment criterion is taken into consideration as important. The entertainment criterion is also stated as neutrally important. At this point, it has been determined that families choose between entertainment and ergonomic criteria after safety. It is seen that the ergonomic criterion is as important as the entertainment criterion. The criterion stated as unimportant is mostly ergonomic. The least important criterion is stated as economy. When the criteria are asked to be evaluated alone, families find the economy criterion important, but when they are asked to rank them, they evaluate this criterion last (Figure 12).

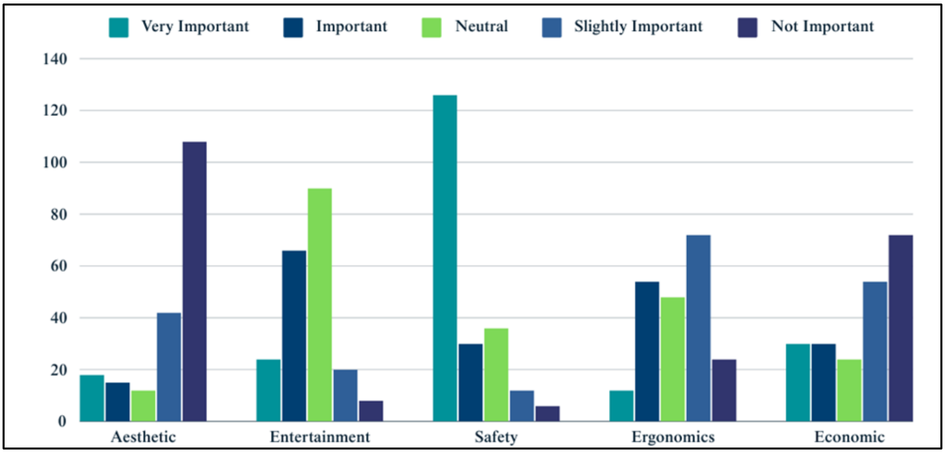

Figure 12. Likert Scale Q2 Results (Created by authors)

- **Very important:** Safety, Economic, Entertainment, Aesthetic, Ergonomics
- **Important:** Entertainment, Ergonomics, Economic, Safety, Aesthetic
- **Neutral:** Entertainment, Ergonomics, Safety, Economic, Aesthetic

- **Slightly important**: Ergonomics, Economic, Aesthetic, Entertainment, Safety
- **Not important:** Aesthetic, Economic, Ergonomics, Entertainment, Safety

When questioned about whether there was a relationship between parents' educational status and their criterion selection, it was determined that 54% of students, regardless of whether they had a high school, associate's degree, undergraduate degree or postgraduate degree, chose the security criterion as the most important criterion. Regardless of the situation of the survey participants, 44% chose the aesthetic and 31% economic criteria as the least important criteria. When asked whether there was a difference in the choices of mothers and fathers, it was determined that there was no significant difference; families mainly gave importance to the safety criterion and chose the aesthetic criterion as the least important criterion. Based on the survey data and sample analysis, design criteria (Aeshetic, ergonomics, entertainment, safety, economic) and subheadings were determined (Figure 13).

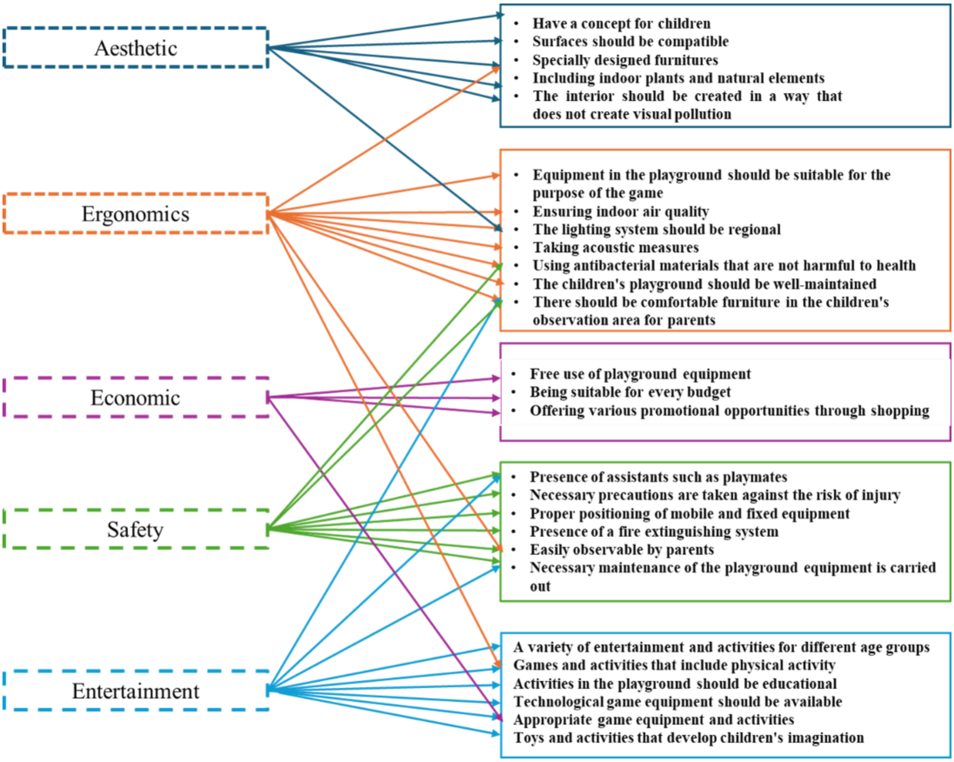

Figure 13. Design Criteria for Indoor Playgrounds in Shopping Malls (Created by authors)

a. Aesthetic

- The children's playground should have a concept for children
- The colors and textures used on the surfaces should be compatible
- The furniture in the playground should be specially designed
- Including indoor plants, natural elements such as sand, natural stone, solid wood, water
- The interior layout of the play equipment and other furniture should be created in a way that does not create visual pollution

b. Ergonomics

- The shape and size of the mobile and fixed equipment in the playground should be suitable for the purpose of the game
- Ensuring indoor air quality
- The lighting system should be regional and adjustable
- Taking acoustic measures
- The floor, flooring and all play equipment in the children's playground should be made of antibacterial materials that are not harmful to health
- The children's playground should be well-maintained and clean
- There should be comfortable furniture in the children's observation area for parents

c. Economic

- Free use of playground equipment
- Being suitable for every budget
- Offering various promotional opportunities through shopping

d. Safety

- Presence of assistants such as playmates and supervisors in the children's playground
- Necessary precautions are taken against the risk of injury such as falling or hitting in the playground
- Proper positioning of mobile and fixed equipment within the space and separation according to different age groups
- Presence of a fire extinguishing system, first aid button in the playground and easy access to the emergency exit stairs

- The children's playground is easily observable by parents
- Necessary maintenance of the playground equipment is carried out and those that have not been maintained are marked as out of service

e. Entertainment

- A variety of entertainment and activities for different age groups
- Games and activities that include physical activity and help with muscle and bone development
- Activities in the playground should be educational (emotional, social, motor and cognitive skills in total)
- Technological game equipment should be available (computer, video, console game, 4D cinema, etc.)
- Appropriate game equipment and activities where children with physical or mental disabilities can socialize
- Toys and activities that develop children's imagination should be available

If the findings of the study are discussed with the findings of different studies in the literature: In some literature, comparing design criteria for indoor child-friendly playgrounds involves analyzing various aspects like safety, accessibility, play value, aesthetics, and inclusivity. Some authors suggest that safety is paramount, with standards such as Standard Safety Performance Specification for Soft Contained Play Equipment and EN 1176 (European Standard for Playground Equipment) offering guidelines. These guidelines present for use of antibacterial, fire-resistant, and soft materials to minimize injury risks.

Some studies in the literature address the criteria through accessibility, health and well-being. Universal design and inclusive play equipment use are recommended. Following principles of universal design to ensure accessibility for children with disabilities, such as ramps, wide pathways, and sensory play elements. Some sources to provide aesthetic criteria bright, cheerful colors and thematic elements (e.g., nature, fantasy worlds) and cultural sensitivity. Most of the studies shows that safety is universally prioritized, with standards guiding the design. Entertainment and aesthetics criteria depend on cultural and age-specific considerations, with thematic and adaptable designs being more prominent in contemporary literature. For example, Reggio Emilia approach suggest flexible and modular playing areas where children can shape the playground with their own imagination. Also, sustainability, stability, maintenance, accessibility, health and well-being criteria are considered as design parameters in the studies.

4. Conclusion and Suggestions

As a result of the survey data and sample analyses, various design parameters were determined under the criteria that parents consider when making their choices. It is obvious that safety criteria should be given importance in every space, but especially in spaces designed for children, great importance should be given to safety. Each design that will prevent accidents physically should also make the child feel safe perceptually.

In this context, it is seen in the examples that the furniture dimensions, space volume, and ceiling heights are designed in proportion to the child's own body in a way that does not make him feel empty. In addition, it is seen that spatial boundaries are emphasized with differences in color and material on the floor and texture and shape on the surfaces so that he can perceive his position and space boundaries correctly. The entertainment criterion is a normal requirement that should be in children's playgrounds. Entertainment opportunities should be selected in a way that is educational and appealing to children of all ages and physical conditions, and that will nourish their physical and mental worlds.

Ergonomics criteria should also be taken into consideration in a way that will provide physical comfort conditions for both parents and children. The air quality of the space, along with acoustic measures; the dimensions of the play equipment are also important. The economic criteria are quite important both in the world and in our country. It is seen that the examples abroad are mostly designed as free and open to use. In the examples in our country, it is seen that the ease of use is provided in return for campaigns and draws won during shopping. In this respect, it is thought that being suitable for every budget or offered for free will also provide opportunities for equal and fair use.It is anticipated that it would be more appropriate to charge additional fees in such commercial venues to parents who are only looking for additional services such as a monitoring sister, tea/coffee service, etc. to meet the play needs of their children.

Finally, although the aesthetic criterion is not very critical, it is one of the most important elements affecting the user's visual and perceptual satisfaction with the space. Since children's playgrounds are examined in a commercial space, it is also thought that the aesthetic concept will have a positive effect especially on the commercial space owner. Interior designs that will not create visual pollution and the construction of abstract concepts that will feed the imagination of children are necessary to meet the aesthetic criterion. Although examined as a separate heading, each of the 5 headings affects and is important for another criterion.

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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.

References

Birol, G. (2013). Çağdaş alışveriş merkezlerinde kent dokusunun yeniden yorumlanması. *Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi*, 20 (4). Retrieved from https://dergipark.org.tr/tr/pub/gazimmfd/issue/6666/88943

Ceylan R. & Özbakır B. & Erol I., (2017). Alışveriş merkezlerinin türkiye'deki mevzuat çerçevesinde değerlendirilmesi *METU JFA*, 2017/2, 34:2, DOI: 10.4305, 245-264

Gür,Ö.Ş & Zorlu,T. (2009). *Çocuk Mekanları*, Yem Yayınevi, İstanbul.

İlhan, E. (2018). Sürdürülebilir alışveriş merkezleri üzerine keşfedici bir araştırma: yaklaşımların ve esasların ortaya koyulması. *Modular Journal*, 1 (1), 65-78. Retrieved from http://modular.gedik.edu.tr/tr/pub/issue/42542/514606

Kiriri, (2019). Determinants of Shopping Mall Attractiveness: the Case of Shopping Malls in Nairobi, Kenya.

Özservet, Y. Ç. & Sirkeci, I. (2016). Editörden: Çocuklar ve Göç. *Göç Dergisi*, 3(1), 1-4.

Price, Gordon & Reis, Rodrigo. (2009). Making kid-friendly cities: Lessons from two cities. *Preventive medicine*. 50 Suppl 1. S95-6. 10.1016/j.ypmed.2009.10.013.

Tavşan, F., İsmailoğlu, S., & Tuna, B. (2018). Restoranlardaki kapalı çocuk oyun alanlarını fiziksel çevre koşullarına ilişkin değerlendirme, *Uluslararası Sosyal Araştırmalar Dergisi*, 11(59),568-576.

Tavşan, F., Sipahi, S., & Gerçek, M. (2016). *Kış Kentlerinde Çocuk Aktivite Mekânları*, Uluslararası Kış Kentleri Sempozyumu, Erzurum, Türkiye.

Tuna, M. (2018). Temalı parklar ve çocuk dostu turizm. *Sivas Interdisipliner Turizm Araştırmaları Dergisi* , (1) , 47-53 . Retrieved from http://sita.cumhuriyet.edu.tr/en/pub/issue/39756/470957

TUIK, (2021). 25. Türkiye – Unıcef, Ülke İşbirliği Programı 2016-2020.

URL 1: https://www.unicef.org/turkey/%C3%A7ocuk-haklar%C4%B1na-dair-s%C3%B6zle%C5%9Fme

URL 2: https://www.behance.net/gallery/70954491/Playground-Design-and-Visualization?tracking_source=search_projects_recommended%7Cavm%20playground

URL 3: https://www.behance.net/gallery/25890563/Colomboland?tracking_source=search_projects_recommended%7Cavm%20playground

URL 4: https://www.behance.net/gallery/37563791/LunaKids?tracking_source=search_projects_recommended%7Cavm%20playground

URL 5: https://www.behance.net/gallery/67611299/Gran-Aventura?tracking_source=search_projects_recommended%7Cavm%20playground

URL 6: https://www.archdaily.com/630717/mama-smile-emmanuelle-moureaux-architecture-design?ad_source=search&ad_medium=search_result_all

URL 7: https://www.yourequinestore.com/how-to-maintain-indoor-soft-play-equipment-for-sale/

URL 8: https://www.designboom.com/architecture/gad-architecture-giant-spiral-slide-istanbul-department-store-wepublic-12-13-2016/

Ünlükara, T. & Berköz, L., (2016). Shopping centers' selection criteria in Turkey: the case of Istanbul. *Megaron*. 11(3), 437-448.

Yalçınkaya, Ş. (2015). Modern Kentin Yeni Kamusal Alanında Çocuk, Alışveriş Merkezleri ve Serbest Zaman Etkinlikleri. *İdealkent*, 6(17), 80-105.

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The Place of Biophilic Design Studies in the Literature Specific to the Discipline of Architecture

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1. Introduction

The term biophilia, which is formed by the combination of the words bio (life) and philia (affection), was first introduced by sociologist Erich Fromm in 1964 and is defined as love for nature (Fromm, 1964). Later in the 1980s, biologist Edward Wilson customised this definition and put forward the biophilia hypothesis. This hypothesis is based on an evolutionary perspective and argues that it carries an innate sense of love and attachment to the natural environment. It aims to maintain the productivity and functioning of natural systems over time (Kellert & Calabrese, 2015). Individuals with a biophilia approach feel an intrinsic attraction to plants, animals, natural landscapes and other natural elements in the environment. In other words, this approach suggests that human beings are instinctively close to nature and living things since birth (Kellert, 2008; Wilson, 2017). The common point in both definitions is the human desire to live together with nature.

Biophilic design is a design philosophy that encourages individuals to establish a stronger connection with the environment in which they live and combines natural elements with the built environment (Kellert, 2018). The essence of this approach is to create a feeling of comfort, happiness and health with the presence of natural elements in individuals' living spaces. In biophilic design, which aims to improve the quality of life by enabling individuals to establish a strong relationship with the natural environment, natural elements reduce the stress levels of individuals (Gillis & Gatersleben, 2015), as well as supporting mental and physical health, increasing concentration and productivity, and improving overall well-being.

Biophilic design is a design philosophy that encourages people to establish a stronger connection with nature and integrates natural elements into the built environment (Kellert, 2018). This design approach aims to create a feeling of comfort, happiness and health with the presence of natural elements in people's living spaces. The aim of biophilic design is to improve the quality of life by enabling people to establish a strong relationship with the natural environment. In addition to reducing stress, the presence of natural elements supports mental and physical health, increases concentration and productivity, and improves overall well-being. Biophilic design, which is in constant interaction with nature, focuses on the natural environment and the adaptation of individuals, which increases the well-being of individuals. On the other hand, this approach, which supports emotional attachment to specific places, creates positive interactions between the individual and nature and strengthens the individual's sense of responsibility towards nature. Focusing on adapting nature to human life, biophilic design encourages mutually reinforcing and integrated architectural solutions.

There are various classifications on space design for the application of biophilic design. Within the scope of this study, the classification made by Browning et al. According to the classification made by Browning et al. biophilic design parameters are grouped under three main headings as nature in space, natural similarities and the nature of the space and consist of 14 items (Browning, Ryan & Clancy, 2014) (Table 1). Nature in space the direct, physical and temporary presence of nature in a space or place. Natural similarities are related to organic, inanimate and indirect associations, while the nature of place deals with spatial configurations in nature.

Table 1. Biophilic Design Parameters (Browning et al., 2014).

Nature in space	**Natural similarities**	**The nature of space**
Visual connection with nature	Bioformic forms and patterns	Perspective on space
Non-visual connection with nature	Material connection with nature	Shelter
Non-rhythmic sensory stimuli	Complexity and order	Mystery
Thermal and air flow		Risks and hazards
Presence of water		
Dynamic and diffused light		
Connection with natural systems		

One of the parameters under the heading of nature in space is related to the visual connection with nature. This connection focuses on being in direct communication with the natural environment and offers a visual view of living systems and natural processes. The non-visual connection with nature represents an indirect relationship through various stimuli such as tactile, auditory, etc. Another design parameter is non-rhythmic sensory stimuli (Ryan & Browning, 2020). This parameter is associated with temporary connections that are difficult to predict with certainty. While thermal and air flow focus on the differences in temperature and humidity in the space, the presence of water is oriented towards the sensory perception of water based on experiencing water in various ways such as seeing, hearing, etc. The presence of water in space designs has a healing effect as well as reducing stress and increasing life satisfaction (Zhong et al., 2022). Dynamic and diffused light is a parameter related to the different intensities of light and shadow during the day. At this point, especially the controlled use of natural light has positive effects on the well-being of users in space design. On the other hand, the use of natural light facilitates movement and orientation in the space. The creative interaction of light and shadow creates an aesthetically striking effect by integrating light into the space (Kellert & Calabrese, 2015). Another parameter, the connection with natural systems, focuses on the awareness of seasonal and temporal changes (Figure 1).

Figure 1. Nature in Space At Biophilic Design (URL-1, URL-2, URL-3)

Bioformic forms under the heading of natural similarity are associated with referring to nature through mathematical calculations. It is possible to see the reflections of this parameter in space design through various numerical calculations such as fractals and fibonnaci sequences. The material connection with nature focuses on the use of natural materials that reflect the local ecology and are minimally processed. At this point, various natural material preferences such as wood, stone, clay are some of the most preferred materials in biophilic space designs. Another parameter, complexity and order, is aimed at creating a rich atmosphere by creating the regularity of complexity with organic forms (Zhong et al., 2022) (Figure 2).

Figure 2. Natural Similarities At Biophilic Design (URL-4, URL-5, URL-6)

The perspective parameter in the nature of the space category aims to leave the distances unobstructed in order to control. On the other hand, the shelter sub-parameter focuses on getting away from the ambient conditions. The mystery focuses on exploring the hidden in depth, revealing the sense of discovery. Risk is associated with staying away from dangers (Kellert & Calabrese, 2015) (Figure 3).

Figure 3. The Nature of Space at Biophilic Design (URL-7, URL-8, URL-9)

This study is a bibliometric analysis of biophilic design studies, which is a current research topic. The study contributes to the literature in terms of deciphering bibliographic parameters related to biophilic design studies and provides information about current trends. There are various bibliometric analyses in the literature on the subject. Akyıldız (2023) on postgraduate theses on biophilic design; Özağan and Aluçlu (2023) only on biophilic design keyword group; Katuk and Köseoğlu (2023) on environmental psychology and biophilic design; Tiri, Swanson and Meenar (2021) on biophilic urban planning. This study aims to conduct a bibliometric analysis of the articles in the Web of Science database between 2006 and 2023 with a search on biophilic design, biophilic architecture and biophilic interior.

2. Material and Method

This study, which aims to reveal the current structure of biophilic design studies in the discipline of architecture, seeks answers to the following questions.

- Which is the most productive country, institution and author in the studies conducted in the field?
- Which is the most influential journal in the field of study?
- Which are the most cited publications?
- How do the study topics change chronologically?
- What are the trending topics in current studies?
- What is the distribution of author and country collaborations in studies related to the field?

The study was conducted in three main stages. In the first stage, the theoretical framework of the study was established by conducting a comprehensive and detailed literature review on the concept of biophilia, biophilic design, biophilic design model and biophilic design criteria. The second stage of the study is to determine the sample. Within the scope of the study, Web of Science, the world's most widespread and well-established database, was selected as the database. The reason for choosing this database is that it is a comprehensive source of scientific studies in various disciplines, provides access to reliable and qualified studies, allows advanced search-filtering options, has a high indexing speed and is compatible with data visualisation programs. Afterwards, a search was conducted on the title, abstract and keywords of the studies in the selected database through the word groups biophilic design, biophilic architecture and biophilic interior and 317 studies were reached. A search was carried out again by limiting the search result with article, review article, document types and 264 results were obtained. Finally, the search was limited to the English language and 259 studies constituted the sample of the study. The third stage of the study is the analysis of the data. Bibliometric analyses were performed in the analysis of the data obtained. Bibliometric analysis is a data analysis technique that allows looking at the field of study from a broader perspective, exploring the structure of the research topic in the literature and revealing trends. In this study, bibliometric analysis was carried out in two stages: performance analysis and science maps. In the performance analysis, it is aimed to reveal the studies conducted in the field with numerical data. In this context, year, author, country, journal, journal, institution, journal, index distributions of the studies were made. With science maps, it was aimed to reveal the collaborations and relationship networks between research components and network maps were made. Within the scope of the study, bibliometric analyses were carried out in VOSviewer and Biblioshiny programs, taking into account the high number of studies and the rapid advancement of technology day by day.

3. Findings and Discussion

Considering the publication years of 259 studies that constitute the sample in the study, it was seen that the most productive year was 2022 with 64 studies. However, 2021 with 52 studies and 2020 with 32 studies are the other years with the most studies (Figure 4). The first studies on the field were conducted in 2005 and the number of studies increased over time. The fact that the number of studies gained momentum especially between 2020 and 2022 can be associated with the pandemic, which has effects all over the world. Pandemic effects were observed in many of the studies conducted between these years (Almusaed, Almssad & Najar, 2022; Yeom, Kim & Hong, 2021; Huntsman & Bulaj, 2022; Lee & Park, 2022; Newman Ao, 2020).

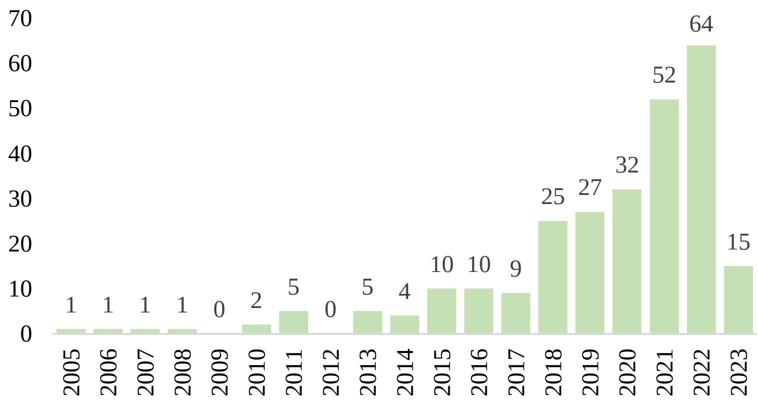


Figure 4. Distribution of Studies According to Years of Publication

When we look at the authors who published in the field, the most productive author is Potvin A with 9 studies. It is possible to say that this researcher, who produced the most publications, is one of the authors who contributed the most to the field. While Demers CMH and Newman P share the second place with 7 studies, Almusaed A is another author who produced the most publications with 6 studies. It was observed that Potvin and Demers mainly addressed studies on biophilic design in educational buildings as a building group (Watchman, Demers & Potvin, 2022a; Watchman, Demers & Potvin, 2022b, Watchman, DeKay, Demers & Potvin, 2022). Newman has conducted biophilic design studies at the urban design scale (Beatley & Newman, 2013; Cabanek & Newman, 2017). The relatively limited number of studies produced by the researchers can be associated with the fact that the subject of the study is a new subject (Figure 5).

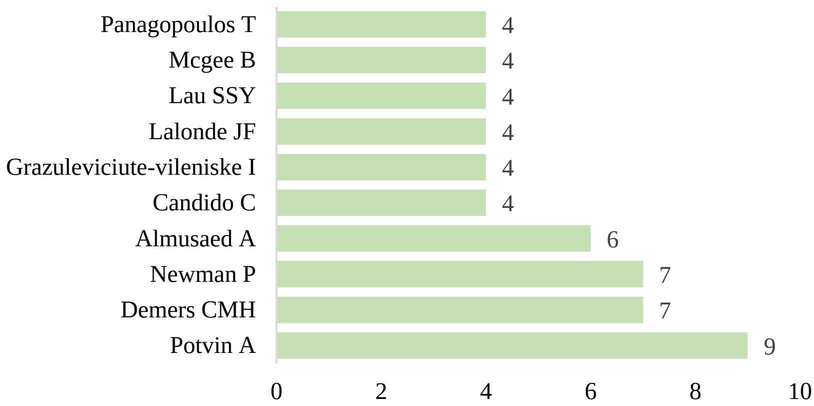


Figure 5. Most Productive Authors

When we look at the topics addressed by the prominent authors, it is seen that they mainly focus on common topics such as stress, health, recovery, design, exposure, benefits, impact and environment (Figure 6). Potvin, the most prolific author, mainly focussed on biophilic design, well-being, biophilic architecture and biophilia. In his studies, he mainly focused on stress, health, design, exposure and impact. Demers, another prolific author in the field, in addition to Potvin, has conducted studies on the topic of biophilic urbanism, but has also included stress and design. Newmann, on the other hand, focused on benefit, health and recovery in his biophilic design studies.

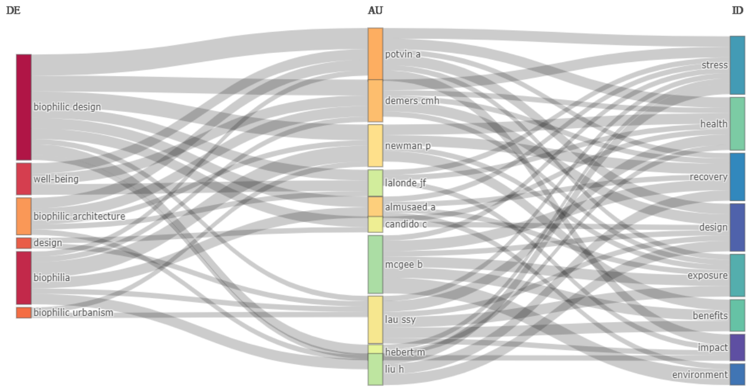


Figure 6. Map of Authors and Research Topics

Considering the disciplines of the studies, Environmental Sciences is the most prominent discipline with 60 studies. 59 studies in Environmental Studies and 45 studies in Green Sustainable Science are the other prominent disciplines (Figure 7). Based on this, it is possible to say that biophilic design is an interdisciplinary research topic that can be examined interdisciplinary and is addressed by researchers in many different disciplines, especially in design, social and humanitarian fields.

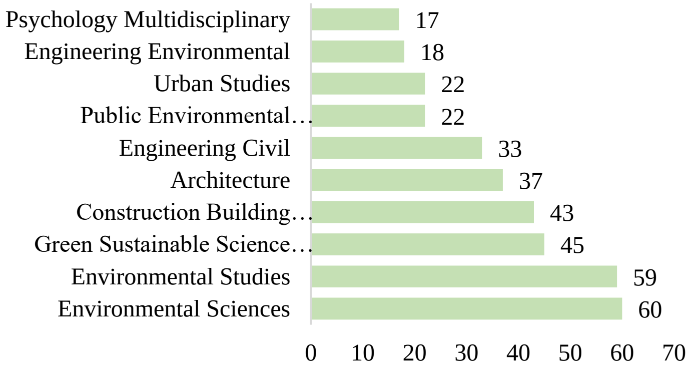


Figure 7. Distribution of Studies According to Disciplines

Looking at the journals in which biophilic design studies were published, it was seen that Sustainability magazine was at the top with a significant difference with 29 studies. The fact that biophilic design studies aiming to integrate nature into the built environment by taking inspiration from nature is directly compatible with the purpose and scope of the journal supports the inclusion of many studies on the subject in the journal. On the other hand, Building and Frontiers in Psychology are other prominent journals with 12 studies. On the other hand, the prominence of these journals may be related to the number of studies published during the year. However, when we look at the years in which journals included biophilic design studies, it is possible to say that 2020 is the breaking point (Figure 8 and Figure 9). It is thought that the pandemic is effective in the high number of biophilic design studies in journals in 2020.

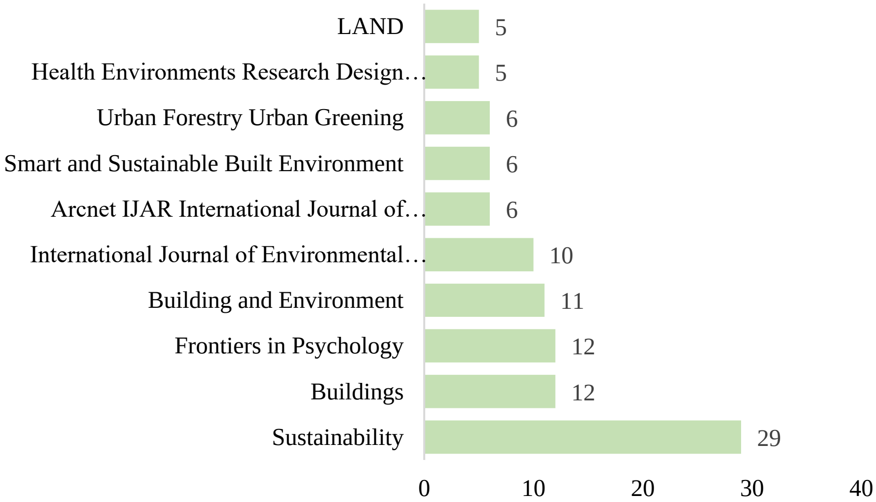


Figure 8. Journals That Include Studies in the Field

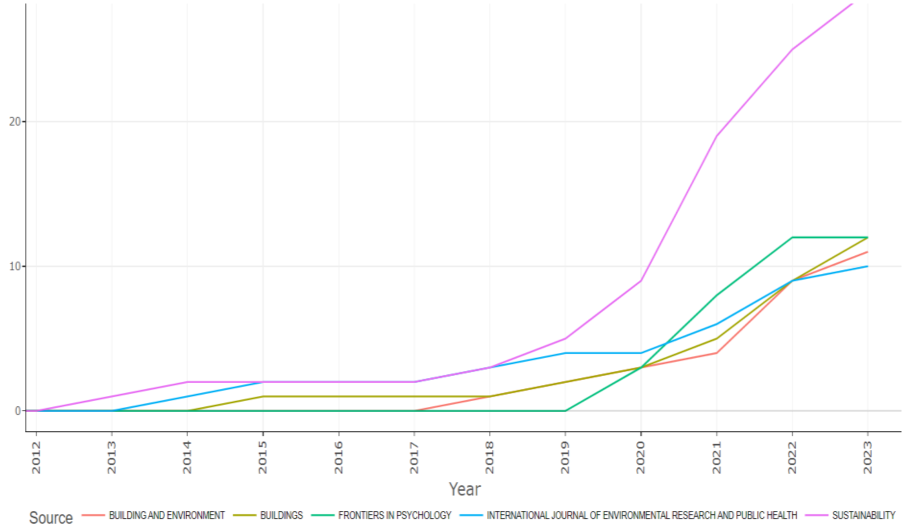


Figure 9. Publication Distribution of Prominent Journals According to Years

When the scientific production of the countries is analysed, it is seen that the field of study is a global issue and many researchers from many countries in the world are actively conducting research. When country productivity is evaluated, the United States of America is at the top as the most productive country with 75 studies.

Australia with 49 studies, England with 22 studies, and China with 19 studies are the other countries that contribute to the production of biophilic design studies (Figure 10). The fact that the United States of America ranks first can be associated with the resource intensity of the country, the financial support allocated to scientific research and the number of expert researchers.

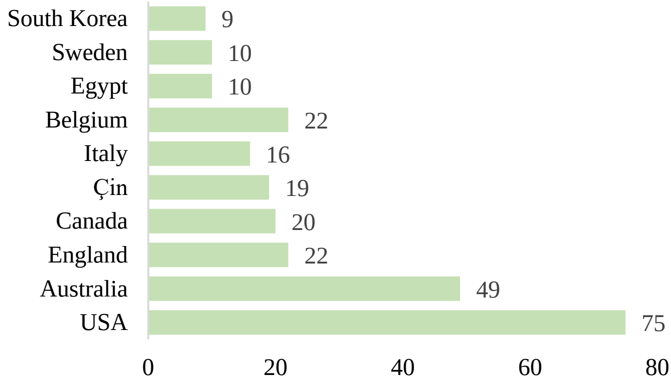


Figure 10. Most Productive Countries

Considering the country collaborations, it is possible to say that there are various country collaborations in the studies conducted in the field. In biophilic design studies, which are directly related to human health, it has been observed that international collaborations have been made by combining knowledge and experience from different cultures on a global issue. The United States of America has been by far the country with the strongest interaction with other countries with 73 studies in terms of cooperation. With 44 studies, Australia was the other country with the highest level of co-operation. These two countries frequently collaborated with each other in the studies they produced. On the other hand, it is possible to say that the collaborations of these two countries were mainly in 2018 and 2019. It is possible to say that Japan and Belgium were open to cooperation mainly between 2015-2017 with their studies. On the other hand, it is possible to say that many countries, especially Canada, China and England, are in cooperation with each other in today's studies (Figure 11). These collaborations increase the universality of biophilic design and contribute to sustainable and human-oriented design solutions on a global scale.

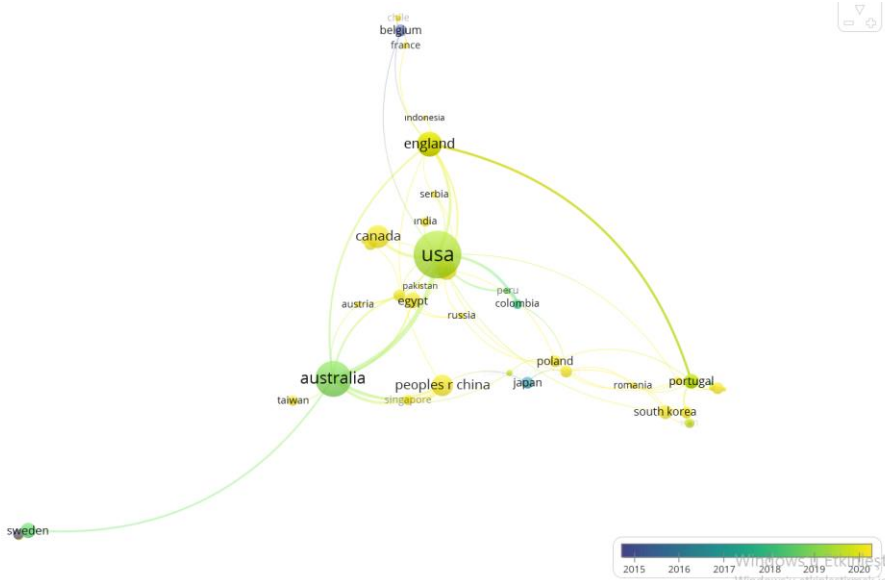
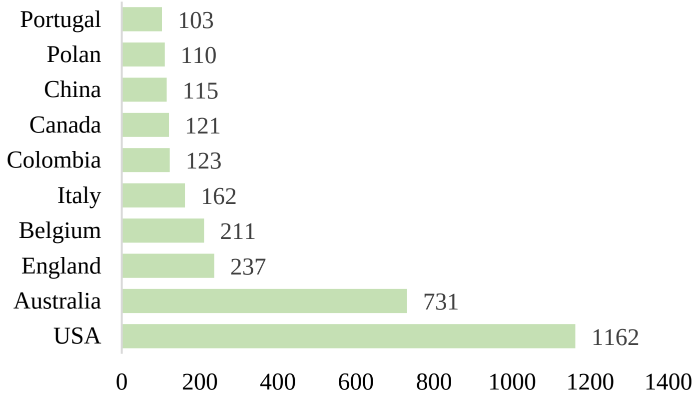


Figure 11. Country Co-Operations

Looking at the countries with the highest number of citations, the United States of America ranks first with 1162 citations. Australia with 731 citations, England with 237 citations and Belgium with 211 citations are the other prominent countries. This situation shows that in addition to being the country that produces the most publications, the United States of America also produces studies with high impact value in the field. When the relationships between citations are analysed, it is seen that the citation network between the United States of America and Australia is the strongest and the research interaction is high (Figure 12). This situation shows that in addition to producing publications together, the studies produced are followed by each other.



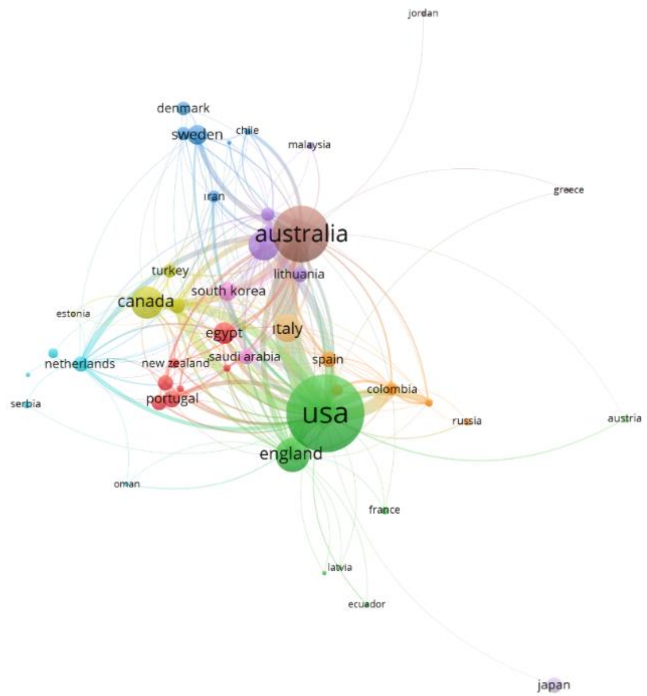


Figure 12. Most Cited Countries (Top) And Citation Relationships (bottom)

Looking at the most cited biophilic design studies, the study titled "Architectural Lessons from Environmental Psychology: The Case of Biophilic Architecture" is the most cited study with 145 citations (Table

2). The study is related to the increase in positive affective responses and the reduction of stress by incorporating natural elements into the design using fractal geometry (Joye, 2007). The study titled "Physiological and cognitive performance of exposure to biophilic indoor environment" was the other most cited study with 119 citations. The study examines the physiological and cognitive benefits of indoor biophilic design parameters using virtual reality technology (Yin, 2018). "Biophilic Cities Are Sustainable, Resilient Cities" was another prominent study with 117 citations. The study emphasises the importance of biophilic urban design in terms of urban resilience and sustainability (Beatley, 2013).

Table 2. Most Cited Articles

	Title of the Study	**Author/s**	**Journal**	**Citations**
1	Architectural Lessons from Environmental Psychology: The Case of Biophilic Architecture	Joye, 2007	Review of General Psychology	145
2	Physiological and cognitive performance of exposure to biophilic indoor environment	Yin, Zhu, MacNaughton, Allen & Spengler, 2018	Building and Environment	119
3	Biophilic Cities Are Sustainable, Resilient Cities	Beatley & Newman, 2013	Sustainability	117
4	Biophilic Design Patterns: Emerging Nature-Based Parameters for Health and Well-Being in the Built Environment	Ryan, Browning, Clancy, Andrews & Kallianpurklar, 2014	Archnet-IJAR Internatıonal Journal of Archıtectural	105
5	Modern Compact Cities: How Much Greenery Do We Need?	Russo & Cirella, 2018	International Journal of Environmental Research and Public Health	96

When the keyword map is examined, it is seen that there are tendencies towards green walls, green roofs in the studies conducted between 2015-2017 in the studies conducted in the field. Between 2017-2019, environmental psychology, biophilic urbanism, green infrastructure, urban nature and public open space are at the forefront. In 2020, well-being, climate change, health, sustainable design, architectural design, built environment are at the forefront (Figure 13).

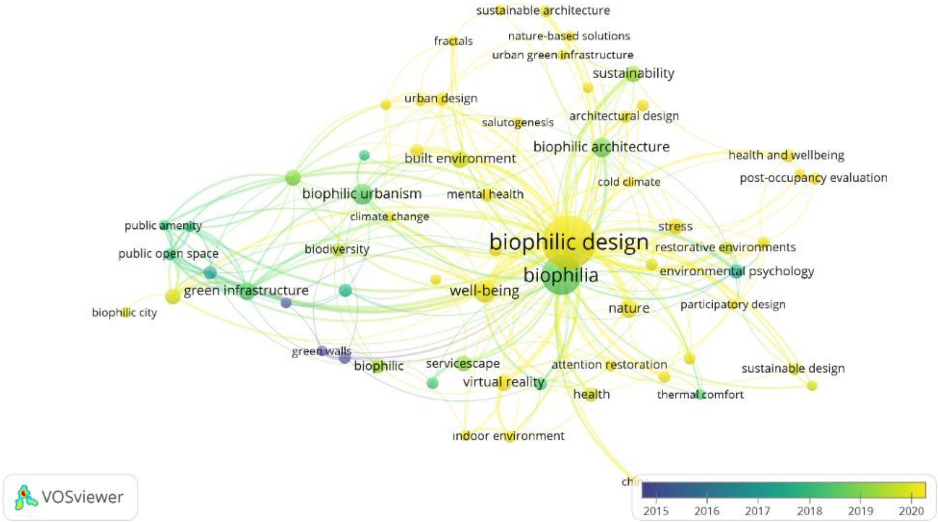


Figure 13. Keyword Map

4. Conclusion and Suggestions

In this study, the emergence, development and place of biophilic design in the existing literature were revealed through various performance analyses and visualisations. Through bibliometric analysis, which enables a comprehensive analysis and evaluation of a specific field of study, findings on the performance analysis and science mapping of the field have been deciphered. Performance analyses are related to numerical analyses and are examined with science maps and various network visualisations. In the light of the findings obtained from the performance analysis and science mapping related to the bibliometric analysis, various evaluations and recommendations are summarised below:

- Studies on the field have an increasing momentum especially in the last five years. Today, the increasing interest in the natural environment, the tendency towards healthy and sustainable living spaces, the increase in welfare awareness, and the search for improving the quality of work and life have influenced biophilic design studies to be a current issue.
- In the chronological deciphering of the keyword maps giving information about the research areas, the concept of well-being, which is expressed as the state of well-being of the individual in terms of physical and psychological health, is at the forefront in current studies. These studies reveal the positive effects of biophilic design approach on users. Approaches that integrate the natural environment into the design increase mental health and quality of life. On the other hand, it is possible to say that biophilic design applications are important in stress management and emotional balance.
- Potvin A, Demers CMH and Newman P are the most productive authors in biophilic design studies. In the studies conducted, stress, health, recovery, design and benefit are the most preferred topics. Educational buildings have been the prominent building group in the studies analysed in biophilic design as they reduce stress, encourage creativity, and positively affect health and focus.
- Considering the number of publications, citations and country collaborations, the United States and Australia are the leading

countries in this field. In terms of productivity and publication impact value, the United States is the leading country in biophilic design studies. The prominence of the United States in the field can be attributed to the fact that it is home to the world's leading universities and research institutions, resource and funding opportunities, and the potential for expert researchers.

- It is believed that training and awareness raising activities to be organised on biophilic design are important for designers such as architects and urban planners to obtain more detailed information about this design approach. In addition, it is believed that new policy recommendations and regulations will be an effective incentive mechanism to promote biophilic design.
- Biophilic design is an interdisciplinary study subject such as health, psychology and social sciences as well as architecture. For this reason, it is thought that planning new studies by bringing together experts from different fields will enrich the literature in terms of information diversity and scope.

This study provides researchers who will conduct comprehensive and detailed research on biophilic design to have information about the development and current trends of the field. Considering that biophilic designs are at the forefront of human interaction with space today, it is important for both researchers and designers to determine the research areas and to know in which direction international studies are concentrated. However, it should be added that the data and analyses of this study are limited to the data obtained from the Web of Science database in June 2023. Therefore, it is not possible to predict the direction and diversity of the studies to be carried out in this field in the coming years. From this point of view, analysing the studies on biophilic design can be enlightening on this issue.

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Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article.

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References

Akyıldız, N. A. (2023). Biyofilik tasarım konulu lisansüstü tezlerin bibliyometrik analizi. *Kent Akademisi*, 16(2), 879-904. Online ISSN: 2146-9229. Access Addres (02.08.2024): https://dergipark.org.tr/tr/download/article-file/2514690

Almusaed, A., Almssad, A. & Najar, K. (2022). An innovative school design based on a biophilic approach using the appreciative inquiry model: Case study scandinavia. *Advances in Civil Engineering*, (4), 1-18. Online ISSN: 1687-8094. Access Address (25.03.2024): https://www.hindawi.com/journals/ace/2022/8545787/

Beatley, T. & Newman, P. (2013). Biophilic cities are sustainable, resilient cities. *Sustainability*, 5(8). Online ISSN: 2071-1050. Access Address (25.03.2024): https://www.mdpi.com/2071-1050/5/8/3328

Browning, W., Ryan, C. & Clancy, J. (2014). 14 *Patterns of biophilic design improving health & well-being in the built environment*. Terrapin Bright Green LLC, New York.

Cabanek, A. & Newman, P. (2017). Biophilic urban regeneration: can biophilics be a land value capture mechanism. Brebbia, CA, Zubir, SS, Hassan, AS (Ed.) *Sustainable Development and Planning VIII* (pp.65-74). WIT Press.

Fromm, E. (1964). *Psicoanálisis de la sociedad contemporánea: Hacia una sociedad sana*. Fondo De Cultura Económica.

Gillis, K. & Gatersleben, B. (2015). A review of psychological literature on the health and wellbeing benefits of biophilic design. *Buildings*, *5*(3), 948-963. ISSN: 2075-5309. Access Addres (03.08.2024): https://www.mdpi.com/2075-5309/5/3/948

Huntsman, D. D. & Bulaj, G. (2022). Healthy dwelling: Design of biophilic ınterior environments fostering self-care practices for people living with migraines, chronic pain, and depression. *International Journal of Environmental Research and Public Health*, 19(4). Online ISSN: 1660-4601. Access Address (26.03. 2024): https://www.mdpi.com/1660-4601/19/4/2248.

Joye, Y. (2007). Architectural lessons from environmental psychology: the case of biophilic architecture. *Review of General Psychology*, 11 (4), 305-328. Online ISSN: 1939-1552. Access Address (02.04.2024): https://journals.sagepub.com/doi/10.1037/1089-2680.11.4.305

Katuk, D. & Köseoğlu, E. (2023). Bibliometric analysis of water at the intersection of environmental psychology and biophilic design. *Architecture Papers of the Faculty of Architecture and Design STU*, 28, 17-35. ISSN: 2729-7640. Access Address (04.08.2024): https://sciendo.com/article/10.2478/alfa-2023-0003

Kellert, S. & Calabrese, E. (2015). The practice of biophilic design. *London: Terrapin Bright LLC*. Access Address (04.08.2024): https://biophilic-design-course.s3.amazonaws.com/module-2/practice-of-biophilic-design-kellert-calabrese.pdf

Kellert, S. R. (2008). Dimensions, Elements, and Attributes of Biophilic Design. *Biophilic design: the theory, science, and practice of bringing buildings to life* (pp.3-19).

Kellert, S. R. (2018). *Nature by design: The practice of biophilic design*. Yale University Press.

Lee, E. J. & Park, S. J. (2022). Biophilic experience-based residential hybrid framework. *International Journal of Environmental Research and Public Health*, 19(14), 8512. Online ISSN: 1660-4601. Access Address (01.04.2024): https://www.mdpi.com/1660-4601/19/14/8512

Newman Ao, P. (2020). Cool planning: how urban planning can mainstream responses to climate change. *Cities*, 103. Online ISSN: 1873-6084. Access Address (01.04.2024): https://www.sciencedirect.com/science/article/abs/pii/S0264275119311138

Özğan, A. O. & Aluçlu, İ. (2023). Doğayla Uyumlu Mekânlar: Biyofilik Tasarımın Bibliyometrik Değerlendirmesi. *İDEALKENT*, *15*(41), 483-505. Online ISSN: 2602-2133. Access Address (05.08.2024): https://dergipark.org.tr/en/download/article-file/3365994

Russo, A. & Cirella, G. T. (2018). Modern compact cities: how much greenery do we need?. *International Journal of Environmental Research and Public Health*, 15(10), 2180. Online ISSN: 1660-4601. Access Address (01.04.2024): https://www.mdpi.com/1660-4601/15/10/2180

Ryan, C. O. & Browning, W. D. (2020). Biophilic design. *Sustainable Built Environments*, 43-85, Springer. Online ISBN: 978-1-0716-0684-1.

Ryan, C. O., Browning, W. D., Clancy, J. O., Andrews, S. L. & Kallianpurkar, N. B. (2014). Biophilic design patterns: emerging nature-based parameters for health and well-being in the built environment. *ArchNet-IJAR: International Journal of Architectural Research*, 8(2), 62. Online ISSN: 2631-6862. Access Address: https://www.archnet.org/publications/9767

Tirri, C., Swanson, H. & Meenar, M. (2021). Finding the "heart" in the green: conducting a bibliometric analysis to emphasize the need for connecting emotions with biophilic urban planning. *International Journal of Environmental Research and Public Health*, 18(18), 9435. ISSN: 1660-4601. Access Address (05.08.2024): https://www.mdpi.com/1660-4601/18/18/9435

URL-1 Apple Park Visitor Center. Access Address (08.08.2024): https://www.apple.com/retail/appleparkvisitorcenter/

URL-2 Bosco Verticale. Access Address (08.08.2024): https://www.archdaily.com/777498/bosco-verticale-stefano-boeri-architetti

URL-3 Jewel Changi Airport. Access Address (08.08.2024): https://www.architecturaldigest.com/story/moshe-safdie-singapores-jewel-changi-airport

URL-4 Orquideorama. Access Address (09.08.2024): https://www.archdaily.com/832/orquideorama-plan-b-architects-jprcr-architects

URL-5 Tree House Hotels. Access Address (09.08.2024): https://www.roomandwild.com/blog/5-design-driven-treehouse-hotels

URL-6 Amazon Spheres. Access Address (09.08.2024): https://www.archdaily.com/920029/amazon-spheres-nbbj

URL-7 Nanyang Technological University. Access Address (10.08.2024): https://sitimustiani.com/2016/01/nanyang-technological-university (10.08.2024)

URL-8 Copenhagen Opera Park. Access Address (10.08.2024): https://www.designboom.com/architecture/david-altrath-cobe-oasis-biodiversity-copenhagen-opera-park-06-15-2024/

URL-9 Edn Garden. Access Address (10.08.2024): https://www.edntech.com/blogs/news/biophilic-design-what-it-is-and-why-it-matters

Watchman, M., DeKay, M., Demers, C. M. & Potvin, A. (2022). Design vocabulary and schemas for biophilic experiences in cold climate schools. *Architectural Science Review*, 65(2), 101-119. Online ISSN: 1758-9622. Access Address (01.04.2024) https://www.tandfonline.com/doi/abs/10.1080/00038628.2021.1927666

Watchman, M., Demers, C. M. & Potvin, A. (2022a). Biophilia in school buildings: Towards a simplified assessment method based on spatial geometry. *Architectural Engineering and Design Management*, 18(4), 434-452. Online ISSN: 1752-7589. Access Address (01.04.2024): https://www.tandfonline.com/doi/abs/10.1080/17452007.2021.1956419

Watchman, M., Demers, C. M. & Potvin, A. (2022b). Towards a biophilic experience representation tool (bert) for architectural walkthroughs: A pilot study in two canadian primary schools. *Intelligent Buildings International*, 14(4), 455-472. Online ISSN: 1756-6932 Access Address (01.04.2024): https://www.tandfonline.com/doi/abs/10.1080/17508975.2021.1925209

Wilson, E. O. (2017). *Biophilia and the conservation ethic. In evolutionary perspectives on environmental problems*. Routledge.

Yeom, S., Kim, H. & Hong, T. (2021). Psychological and physiological effects of a green wall on occupants: a cross-over study in virtual reality. *Building and Environment,* 204, 108134. Online ISSN: 1873-684X. Access Address (01.04.2024): doi: https://www.sciencedirect.com/science/article/abs/pii/S0360132321005357

Yin, J., Zhu, S., MacNaughton, P., Allen, J. G. & Spengler, J. D. (2018). Physiological and cognitive performance of exposure to biophilic indoor environment. *Building and Environment*, 132, 255-262. Online ISSN: 1873-684X. Access Address (01.04.2024): https://www.sciencedirect.com/science/article/abs/pii/S0360132318300064

Zhong, W., Schröder, T. & Bekkering, J. (2022). Biophilic design in architecture and its contributions to health, well-being, and sustainability: A critical review. *Frontiers of Architectural Research*, 11(1), 114-141. Online ISSN: 2095-2643. Access Address (15.08.2024): https://www.sciencedirect.com/science/article/pii/S2095263521000479

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Exploring Sustainable Architectural Practices: A Case Study of Design-centered Architectural Firms in Türkiye

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1.Introducion

Significant changes have occurred in construction and design, which work to provide solutions for people's living, working, and other activities within the bounds of available resources, as a result of industrial revolutions. These revolutions have introduced both technological and methodological innovations, transforming these fields. The examination of structures built up to the present day reveals that different geographical regions, societies, and techniques have played significant roles in the design and construction of buildings, resulting in considerable diversity. With the increase in population, urbanization, and industrial developments, architectural designs, materials, and construction production techniques have developed innovations and methods that offer more efficient, comfortable, and cost-effective industrial solutions. The discussed changes have contributed to solving many problems up to the present day. Although the rapid transition from materials such as stone, soil, and wood to the use of cement has provided swift and durable solutions to many problems, the use of processed materials have led to the depletion of global resources and has contributed to environmental pressures through the direct and indirect carbon footprint created by the sector.

With the development of the concept of sustainability and its active practices, a process of change and adaptation has begun in all sectors. According to current statistics, when examining the carbon footprint impacts of various sectors, the carbon footprint burden of building stock is found to be higher compared to many products produced by other sectors. Due to the comprehensive impacts and applications of sustainability on life, radical changes in innovative designs and methodologies within the architectural and construction sectors have become imperative. Fundamentally, sustainability has fostered the development of a systematic perspective across sectors.

The development of sustainability principles in the architectural and construction sectors, through systematic and strategic efforts using new technologies and designs, will contribute to sustainability. The advancement and implementation of these principles will play a crucial role in enhancing sustainability within the sector (Okwandu et al., 2024). In architectural design, an innovative systematic approach, incorporating eco-design strategies, project-based component design, and material properties, offers opportunities to reduce environmental impacts. When these elements are integrated, they represent an approach that provides effective solutions for minimizing environmental effects (Ahram et al., 2023; Minson, 2024). The design of structures for purposes such as housing, industrial use, and education, incorporating sustainable and eco-design strategies, contributes to global sustainability. This field has evolved into an interdisciplinary cluster through research and technological development across various disciplines.

Architectural design plays a critical role in reducing carbon footprints and promoting environmental sustainability with sustainable practices. Green building applications, smart technologies, and low-energy consumption strategies enhance environmental sustainability and operational efficiency (Mi, 2024). Building orientation is key in maximizing energy efficiency, leveraging natural resources, and optimizing performance while reducing carbon emissions (Sharma & Dongre, 2024). Machine learning models, such as Transformers, minimize energy consumption and carbon emissions with optimized building designs (Li et al., 2023).

Architectural design can significantly reduce the carbon footprint of construction by using alternative materials, efficient systems, and waste recycling, achieving up to a 90% reduction in CO_2 emissions during the construction phases (Sizirici et al., 2021).

Additionally, architectural design can significantly reduce the carbon footprint and promote environmental sustainability in building construction by integrating sustainable elements and ensuring minimal environmental impact within the principles of sustainable development (Majerska-Pałubicka, 2018).

The construction sector has been influenced by global sustainability and green transformation. The architectural field, which provides know-how to the construction sector, has adapted to sustainability the most rapidly. In the process of developing sustainable solutions to address human needs, the alignment of design and the elements used in design has significantly impacted this field. The focus on ensuring that all components of the design are harmonized has played a crucial role in achieving effective and successful outcomes in the realm of sustainability. Thus, the coherence of each design element with others has substantially influenced the development of this field and the attainment of sustainability objectives. These initiatives and commercialized applications contribute to the reduction of CO_2 footprints, enhance the effectiveness of the circular economy in the field, advance the development of sustainable architecture, and support the roles of designers in this domain (Agarwal,2023; Minson,2024). New designs made with defined standards and compatible materials create positive success stories both for users and for improving the current situation. In this transformation process, the targets set by countries and their incentive mechanisms contribute to the advancement of solutions in this field. Within the framework of the European Union's Green Deal (Fit for 55: making buildings in the EU greener; 2024), targets have been set for reducing the carbon footprint of the construction sector for 2030 and 2050. Additionally, Türkiye’s development plans include goals for sustainable architectural design. The design centers established by the regulatory framework introduced in 2016 provide incentives for the development of sustainable practices in the construction and architecture sectors.

The Republic of Türkiye Ministry of Industry and Technology, through Law No. 5746, provides tax reductions, exemptions, and incentives to design centers in areas such as technological knowledge production, innovation, efficiency, and cost reduction, aiming to enhance design activities. The law also aims to increase the number of R&D and design employees as well as attract more foreign direct investment in these fields. Currently, there are 333 active design centers in Türkiye, and it has been observed that only 9 of the companies with websites provide information on sustainability, with 2 of them operating in the field of architectural design. In this context, the study first involved a review of sustainability criteria in the literature, followed by a technical evaluation of the projects of two firms based on these criteria.

The purpose of this study is to emphasize the importance of more effective and comprehensive implementation of sustainability criteria in the fields of architecture and construction, examining how sustainability principles in these sectors can be integrated into a holistic approach that encompasses environmental, economic, and social dimensions. Furthermore, the study aims to systematically address design activities within the framework of sustainable architecture and green transformation, evaluating whether architectural design and technology integration in these projects align with findings in the literature.

1.1 Understanding and Embracing the Sustainability

Sustainability is an idea that was developed to ensure that the demands of future generations are addressed by reducing the adverse effects of human activity on the environment and protecting natural resources (Kuhlman & Farrington, 2010). According to the International Organization for Standardization (2019), ISO 15392:2019 focuses on three main aspects of sustainability: the environmental, social, and economic. Environmental sustainability includes stopping climate change, reducing pollution of the environment, and protecting biodiversity and the natural environment, according to F. Rana et al. (2024). Subhan et al. (2024) define economic sustainability as involving issues with resource efficiency, job growth, economic progress, and innovative and technical advancements. According to Saladert (2024), social sustainability includes maintaining human rights, promoting gender equality, and providing greater access to healthcare and education.

The development of the concept of sustainability dates back to ancient times. Ancient civilizations developed various laws to protect forests and use water resources effectively (Timsina & Weerahewa, 2023). During the Middle Ages, soil fertility became important (Paché, 2023). In the 18th and 19th centuries, especially with the Industrial Revolution, environmental issues drew attention, and efforts were made to prevent population growth and resource scarcity. 1972 Stockholm and 1987 Brundtland conferences helped address this issue globally, and the 1992 Rio Conference laid the foundations of sustainable development. The 2015 UN Sustainable Development Goals aimed to achieve 17 specified goals by 2030, promoting sustainability. The 2015 Paris Climate Agreement was seen as a significant step in combating climate change, and the 2019 European Green Deal aimed to make Europe carbon neutral by 2050 (Battaglini, 2024). The cooperation of different governments, the private sector, civil society, and individuals in working for sustainability has been encouraged by the 2021 United Nations Climate Change Conference, the 2021 Convention on Biological Diversity, the IPCC Reports, the 2021 United Nations Sustainable Development Report, and the 2022 World Economic Forum Global Risks Report (Convention on Biological Diversity, n.d.; Framework Convention on Climate Change, n.d.; IPCC, 2024; Spindler, 2013; Republic of Türkiye Presidency Strategy and Budget Directorate, 2019; TISK, 2022).

Today, sustainable development is observed globally in many areas. In Haiti, the rate of children weakened due to malnutrition decreased by 2.2% in 2017 compared to 1990 (Our World in Data team, 2023a). The share of the population with access to basic services such as electricity, water, clean fuels, and waste disposal increased by approximately 17% in 2022 compared to 1998 (Our World in Data team, 2023b). Academic publications on gender equality have increased by 4.5% in the last five years compared to the past (Spagnolo & Capodanno, 2024). Similarly, the number of studies conducted on the health of the world and sustainable development has shown a linear increase between 2006 and 2022 (Pham et al., 2024).

1.2 Sustainable Design in Architecture

Building is one of the key industries influencing sustainable development. Approximately 13% of the global gross domestic product (GDP) is attributed to buildings, and it is anticipated that this percentage will rise to 15% soon. Building development, maintenance, and construction, along with infrastructure and urban projects, now have a budget of about 294 quadrillion TL; by 2023, this amount is predicted to increase to 359 quadrillion TL (Santamouris & Vasilakopoulou, 2021). According to IAE 50 (2023), building operations account for 26% of worldwide energy-related emissions and 30% of global final energy consumption.

Sustainable design minimizes the environmental impact of buildings and protects natural resources to meet current requirements without sacrificing the ability of future generations to meet their own. Multifaceted tactics including material selection, waste management, energy efficiency, water conservation, and social sustainability are used to put this concept into practice (Li, 2011). Despite growing demand, the construction industry is still not realizing sustainable buildings at a high rate (du Plessis, 2005). The difficulties in striking a balance between economic and environmental performance are assumed to be the cause of this low rate. To address this issue, it is advised that decision support tools be created that demonstrate to building owners and architects how environmental constraints can be reduced by incorporating Life Cycle Costing (LCC) into the design process from the beginning. These technologies support sustainable design decisions by assessing costs and environmental impacts at an early stage of development (Kang, 2015).

1.3 Methods for reaching sustainability

Several tactics that architects can use during the design phase can help them achieve sustainability. The Integrated Design Process (IDP), Voigt et al. (2023) evaluate the potential technical needs of the building, energy efficiency, environmental impact, indoor environment, functionality, and many other important factors using data analysis. In the same way, the process of creating and managing digital representations of a building's functional features is called Building Information Modeling, or BIM. BIM encourages collaboration between different fields (Gao et al., 2019). Altan et al. (2016), passive design provides guidelines for designing buildings that fit into the surrounding environment and are aesthetically pleasing. Creating ecological areas and sustainable living conditions is the goal of green urbanization (Lehmann, 2010).

Many techniques that lower expenses, lessen environmental impact, and increase energy efficiency can be used to improve a building's energy performance. Tools like EnergyPlus, eQUEST, or IESVE simulate the prospective energy performance of buildings to determine the optimal design criteria (El-Gohary et al., 2023; Mushtaha et al., 2021; U.S. Department of Energy, 2020). High-Performance Building Envelopes contribute to sustainability by applying building materials and systems that create a comfortable environment sensitive to external and internal conditions (Aslani & Hachem-Vermette, 2022). Smart Building Technologies use sensors, automation systems, and energy management systems to monitor and reduce energy use, improving the building's energy performance (Ejidike & Mewomo, 2023). Solar panels help generate electricity from solar energy (Laabab et al., 2023). Solar thermal systems are used for heating water or air in the building (Tschopp et al., 2020). Wind turbines assist in generating electricity from wind energy (Jiang, 2021). Geothermal systems meet the heating and cooling needs of a building by utilizing underground heat sources (Sowiżdżał, 2022).

Conserving and efficiently using water resources is crucial for a sustainable future. Water conservation can be accomplished through a variety of strategies. Systems for collecting and storing rainwater are made to be used for purposes other than drinking, such as irrigation and toilet flushing (Villarreal & Dixon, 2005). Greywater recycling systems enable the repurposing of water from sinks, washers, and showers for landscape irrigation and other non-potable uses (Elhegazy & Eid, 2020). Low-flow fixtures contribute to sustainability by using water-efficient showerheads, toilets, and faucets to reduce water usage (Maleki Nasab et al., 2007).

Sustainable building design and construction also give waste management and material selection priority in order to lessen their detrimental effects on the environment. Life cycle assessment, or LCA, is a systematic procedure that evaluates the environmental consequences of materials throughout their life cycles to identify sustainable choices, according to Chau et al. (2015). Recycled and renewable materials help conserve raw materials, energy, and water by utilizing pre-existing resources (Mohammadabadi et al., 2021; Papadaki et al., 2022). The construction waste management process includes the reduction, reuse, and recycling of construction trash (Ismaeel & Kassim, 2023).

Improving comfort levels in interior design is also essential to sustainable design. Several tools and strategies are applicable in this case. Measurement and control of ventilation, humidity, and pollutants are made possible by monitoring indoor air quality (Saini et al., 2020). Building biology aims to create sustainable environments based on 25 fundamental principles that establish a relationship between humans and the environment (Kokulu, 2017). Filters can be used to prevent various pollutants from entering indoor spaces from the outside environment (A. K. Rana et al., 2023).

Green building certification and rating systems are important tools for evaluating buildings based on sustainability criteria. BREEAM (Building Research Establishment Environmental Assessment Method) was developed by the United Kingdom (Yang, 2016). BEPAC (Building Environmental Performance Assessment Criteria) was developed by Canada (Cole, 1994). The WELL Building Standard was developed by the United Kingdom (WELL Building Standard — IIDA New England, n.d.). CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) was developed by Japan (Potbhare et al., 2009). ABRI was developed by Taiwan (Cheng, 2008). DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) was developed by Germany. LEED (Leadership in Energy and Environmental Design) was developed by the United States (Bahale & Schuetze, 2023). GBC (Green Building Challenge) was initially developed by Canada and subsequently by an international consortium (Larsson, 1999). BEAM Plus and HK-beam were developed by Hong Kong (Wadu Mesthrige & Chan, 2019). HQE (Haute Qualité Environnementale) was developed by France. LiderA (Sistema

Voluntário para Avaliação da Construção Sustentável) was produced by Portugal. Spain developed VERDE (Bednarik, 2009). TGNBS was developed by India. NABERS (National Australian Buildings Environmental Rating System) was developed by Australia (Lee et al., 2022). GBAS was developed by China (Wang et al., 2017).

2. Material and Method

The Republic of Türkiye's Ministry of Industry and Technology drafted Law No. 5746 on February 26, 2016, to further design activities (Statistics | Ministry of Industry and Technology, Republic of Türkiye, n.d.). Design centers are entitled to discounts, exemptions, support, and incentives under this legislation to encourage the creation of technological knowledge, innovation in product and production processes, improvement of product quality and standards, increased efficiency, reduced production costs, commercialization of technological knowledge, establishment of partnerships before competition, technology-intensive production, entrepreneurship, and investments in these areas. The law also intends to increase the number of R&D and design employees as well as the amount of direct foreign capital investments for innovation, design, and R&D that come into the country. The law also seeks to increase the number of skilled workers and R&D and design staff in the country, as well as to accelerate the inflow of direct foreign capital investments for these areas into the country. According to figures released by the Ministry of Industry and Technology of the Republic of Türkiye, there are 333 active design centers as of right now. Of these centers, 44 are made up of engineering/architecture firms, and 14 are made up of construction enterprises. (Data | Ministry of Industry and Technology, Republic of

Türkiye, n.d.). Out of 49 businesses having websites, it was discovered that only 9 shared information about sustainability. Two of these firms were found to be engaged in the architectural design industry upon closer inspection of their respective areas of expertise. The initial step in the study process was a review of the literature on studies that define sustainability criteria. Due to the identification of only two architectural firms in the architectural design sector that provide information on sustainability through their websites among the active design centers, the most recent and up-to-date projects of these two firms were evaluated according to sustainability standards developed through the literature review. The framework of the study is given in Figure 1.

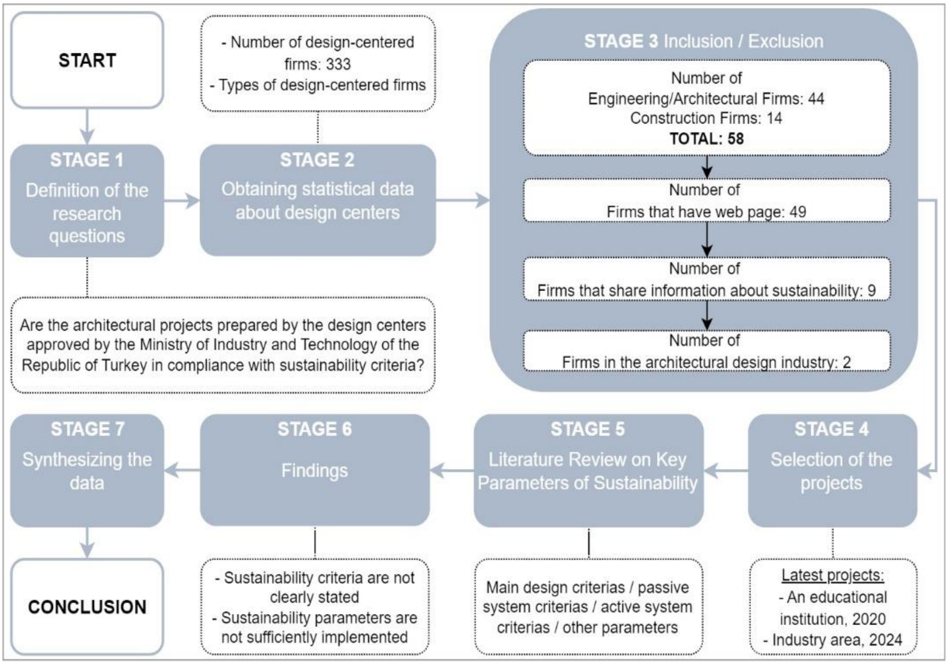

Figure 1. The Framework of the Study

Due to the confidentiality of company information and the technical examination of the projects, project images have not been included in the scope of the study.

2.1 Literature Review

Ibiyeye et al. (2024) assess architectural students' awareness and application of sustainability principles in Nigeria, noting gaps in using sustainable materials and renewable energy despite acknowledging health and environmental impacts. Akadiri & Olomolaiye (2012) address the challenge of prioritizing sustainable building materials in the UK, identifying aesthetics, maintainability, and energy saving as crucial factors through literature review and surveys. Feria & Amado (2019) advocate integrating economic, social, and environmental factors into architectural design early on, proposing guidelines to enhance sustainability practices and improve existing assessment tools. Nguyen et al. (2010) use BIM to create a framework for assessing sustainability and apply it to a hotel project that follows the LEED Green Building Rating System. Bauer et al. (2010) give practical recommendations and case studies on sustainable building design, highlighting examples like Hamburg Dockland and Landesbank Baden-Wuerttemberg in Stuttgart, acting as a compact reference for energy efficiency and sustainability in architecture. Markelj et al. (2014) present SMEBS, a simplified method of evaluating building sustainability that uses expert-assigned weights using AHP to analyze aspects unique to early project planning. A comprehensive examination of the sustainability evaluation method in architectural design, construction, renovation, and restoration is given by Pons-Valladares & Nikolic (2020). They give particular weight to grading systems, life cycle approaches, and the rising acceptance of probabilistic scenarios and their combinations. Patel et al. (2022) advocate for green building practices in India promoted by organizations like IGBC and TERI, and propose steps to enhance awareness and adoption of sustainable construction practices. Gökşen et al. (2017) emphasize the high energy consumption and environmental impact of residential buildings, advocating for ecological and sustainable design measures from planning through use stages to support sustainable development in architecture. Shahda (2018) proposes a framework for sustainable architecture by linking architectural composition principles (MASS - COVER - SITE) with six sustainable architectural guidelines through a literature review, analytical study of buildings, and a matrix alignment of composition approaches with sustainability criteria. Using six study scopes to define sustainability criteria and a case study of a printing company to show its efficacy, San-José Lombera & Cuadrado Rojo (2010) introduce an Integrated Value Model for Sustainable Assessment with an emphasis on industrial buildings. They establish a "environmental sustainability index" using both qualitative and quantitative indicators. Xia et al. (2014) analyze the procurement process in the US public sector for specifying sustainability requirements in design-build (DB) projects, emphasizing the importance of clear sustainability criteria in requests for proposals (RFPs) to achieve green construction goals. Assefa et al. (2022) developed and implemented a Building Sustainability Assessment System (BSAS) tailored for Ethiopia, addressing local challenges and promoting sustainable building practices in economically least-developed countries.

2.2 Key parameters in sustainability

When the concept of sustainability was incorporated into the field of architecture, the parameters of architectural design also changed. In addition to the basic architectural design criteria, sustainability parameters also became more important, and thus a more holistic design approach began to be adopted. In the planning phase of the building, some objectives must be taken into account so that the principles of sustainable development are realized according to appropriate methods and specific criteria.

According to Dias Cordeiro Féria (2018), sustainability includes renewable energy, natural light, thermal comfort, natural ventilation, visual comfort, wastewater reuse, rainwater harvesting, a healthy environment, reusable/recyclable materials, local materials, and ease of maintenance. It depends on parameters like Liu et al. (2022) added low-carbon materials and certification systems. Wen et al. (2024) considered criteria such as innovative technologies, service life, safety, accessibility, and acoustic comfort. Gökşen et al. (2017) considered criteria such as solutions to global and local environmental problems, interdisciplinary cooperation, nature conservation, regional climate suitability, topographic suitability, and solid waste/biological waste conversion. Bragança et al. (2010) added parameters such as building pre-occupancy costs, maintenance costs, operating costs, post-construction costs, and added value. Considering all these parameters, sustainability was considered in this study under four main headings: main design criteria, passive system criteria active system criteria, and other parameters (Belek & Yamaçlı, 2023).

3. Findings and Discussion

The projects of the design centers were examined primarily in the context of the main design criteria (Table 1). It was observed that both projects emphasized open/closed/semi-open areas, accessibility, enough openings, climatic conditions, spatial comfort, site-specific landscaping, and topographic suitability. Additionally, it was found that flexible design criteria were not applied in either project, and implementation was done without considering the functional changes of the spaces. Specifically, no information was shared regarding durable materials and low-cost maintenance in both projects. Different approaches were observed in the projects concerning local culture parameters, local materials, recyclable/reusable materials, solutions to global and local environmental problems, climate suitability, and the preservation of natural life. Overall, Project 1 incorporated sustainability criteria at a rate of 62.5%, while Project 2 did so at 56.25%.

When sustainability is examined according to passive system criteria, it is observed that both projects include mechanical shafts and skylights. However, neither of them gives sufficient importance to passive system criteria. Project 1 features an atrium and shading devices, while Project 2 includes soundproofing applications. Notably, neither project has information regarding rainwater storage and use. The rate of meeting passive system criteria is 26% Project 1 and 33% for Project 2.

When sustainability is examined according to active system criteria, it was observed that Project 1 used solar panels and solid/biological waste recycling, while no efforts were made in Project 2 to meet active system criteria. Neither project included heating and electrical systems using vegetable oil, biogas, landfill gas, solid biofuel, greywater treatment systems, or blackwater management. The compliance rate with active system criteria was observed to be 33% for Project 1 and 0% for Project 2. When sustainability is examined according to other parameters, in both projects, there is no information available regarding the use of a certification system. While Project 1 provides superficial information about cost, Project 2 lacks any information on this matter. Project 1 incorporates innovative techniques, whereas Project 2 employs conventional methods. Additionally, neither project shares any information regarding indoor air quality. The rate of meeting other sustainability criteria is 50% for Project 1 and 33% for Project 2.

4. Conclusion and Suggestions

The construction industry is one of the important sectors of our country, as well as in the world. With numerous internal and international projects, our country has significant know-how in this field. The construction sector is interconnected with many other industries within the scope of the infrastructure it produces. In addition to the economic value and employment it generates, the sector’s interactions with other industries result in significant outcomes for the national economy. However, the high potential carbon footprint arising from the sector’s current business and production routines highlights the need for change in this area. The construction sector's interaction with economic, environmental, and social values in terms of sustainability shows that improvements and impacts that contribute to green transformation in this field will be essential. Many national and international action plans include roadmaps for the construction sector, setting targets for changes in the existing paradigm.

Table 1. The Comparison of Design-Center Projects (Belek & Yamaçlı, 2023; Bragança et al., 2010; Dias Cordeiro Féria, 2018; Gökşen et al., 2017; Liu et al., 2022; Wen et al., 2024).

	CRITERIAS	METHODS	PROJECT 1: INDUSTRY AREA			PROJECT 2: EDUCATIONAL INSTITUTION		
			YES	NO	NO INFO	YES	NO	NO INFO
MAIN DESIGN	Space organization and design	Open /closed / semi-open areas	√			√		
		Local culture parameters		√		√		
		Accessibility	√			√		
		Flexible design		√			√	
		Enough opening	√			√		
	Building form	Climatic conditions	√			√		
		Spatial comfort	√			√		
	Building material selection	Local materials		√		√		
		Recyclable/reused materials	√					√
		Durable materials			√			√
		Low-cost maintenance			√			√
	Ecological artificial environmental design	Solutions to global and local environmental problems	√				√	
		Preservation of natural life	√				√	
		Site spesific landscaping	√			√		
	Land relationship	Topographic suitability	√			√		
	Climate suitability	Adaption to climate change			√		√	
PASSIVE SYSTEM	Natural ventilation	Wind chimney		√			√	
		Atrium	√				√	
		Mechanical shaft	√			√		
	Natural light /Illumination control	Skylights	√			√		
		Shading devices	√				√	
		Openings in each room		√			√	
		Double skin facade			√		√	
		Trombe wall		√			√	
		Solar chimney			√		√	
		Winter garden		√			√	
	Acoustic control /acoustical design	Soundproofing applications			√	√		
		Afforestation		√			√	
	Land use	Roof gardens		√			√	
		Edible landscape elements		√			√	
	Rainwater use	Piping, gutter systems, tank			√			√
ACTIVE S.	Renewable energy	Wind tribune, wind collector		√				√
		Solar panels	√				√	
		Heating and electrical sy.			√		√	
	Waste management	Greywater treatment system			√		√	
		Blackwater management			√		√	
		Waste recycling	√					√
OTHER	Certification system	LEED/ BREAAM/ DGNB			√			√
	Innovative tech.	Design/ construction/ usage	√				√	
	Indoor air quality	Indoor pollutants protection			√			√

Implementing green transformation has become an essential framework for achieving the targets outlined in roadmaps by changing existing paradigms. The production of knowledge and technology for green transformation is an area where many researchers and experts work across various fields. In this sector, the integration of innovations derived from research and development and design activities, conducted collaboratively by internal and external stakeholders within a holistic approach, is a key activity for both achieving targets and maintaining competitiveness. When the literature is examined, there are publications, products, and patents produced by researchers and companies in many different fields to contribute to this field. Supporting and systematizing these activities positively impacts the sector's sustainability compliance and competitiveness, leading to favorable outcomes for countries in economic, environmental, and social domains.

Our country supports this field with its public policies and funding mechanisms. One of the important support mechanisms in making this support systematic in the sector is R&D and Design Center support. Law no. 5746 (2016), which supports R&D, innovation, and design activities, offers systematic value creation. In this context, the aim is to trigger positive contributions to the sector through design, technology, and innovation that contribute to green transformation, particularly in the construction, architecture, and engineering sectors.

When the sectors of design centers in our country are examined, the fact that there are nearly 18% of companies operating directly in this field shows that a significant critical mass has formed in this field. Additionally, due to the relevance of sustainability in the field of architecture, the performance of design activities, when integrated with technology, will create opportunities for implementing sustainable projects.

As part of this study, sustainable projects shared on the websites of businesses of various sizes engaged in systematic design activities in our country were examined within the framework of a set of sustainable criteria. Limited data has been accessed on projects that will contribute to sustainable and green transformation carried out by businesses with design centers. From this perspective, it can be said that there is room for improvement in how businesses showcase their work in this field on their websites, which serve as external promotional tools. Additionally, the visibility of completed projects and the sharing of their impacts within the sustainability framework is an important process for social and economic integration.

The information gathered from the projects analyzed based on the criteria developed in this study is important for understanding the current state of design-focused architectural firms in our country regarding sustainable practices. While aspects such as the organization of open, enclosed, and semi-enclosed spaces, accessibility, provision of adequate openness, consideration of climatic conditions, analysis of spatial comfort for users, and evaluation of local landscape and topographic conditions are important architectural design principles and are viewed positively in the two projects examined, there are notable deficiencies. These include the insufficient consideration of flexible design criteria and the failure to design spaces to accommodate potential functional changes. Furthermore, the lack of emphasis on material selection and characteristics, which are crucial for sustainability, represents a significant shortcoming. Allowing for functional changes in designs to adapt to changing conditions will enhance the usability and adaptability of the design to the evolving era. The use of environmentally friendly materials in designs is globally important. Within the scope of sustainability, especially recently, the use of passive systems in designs for energy saving has become extremely important. Literature reviews indicate that implementing passive ventilation and lighting in architectural designs yields significant economic and environmental benefits. This ultimately reduces carbon emissions. Similarly, in terms of water conservation, the collection and use of rainwater and the implementation of insulation practices to prevent energy loss in buildings are crucial for sustainability. Although mechanical shafts and sky windows were included in the examined projects, it was observed that passive systems were not used sufficiently in their designs and the necessary importance was not given to passive systems.

Focusing on energy conservation has become essential in contemporary designs, where the use of solar panels and the recycling of solid/biological waste are crucial for sustainability. In this context, the presence of efforts toward active system criteria in Project One and the lack of such efforts in Project Two are negative aspects from the perspective of sustainable design.

In terms of other parameters, the lack of information on certification systems and the absence of details regarding indoor air quality in both projects indicate that sustainability criteria are not fully met. While the inclusion of innovative techniques in Project One is considered a positive feature, the use of traditional methods in Project Two falls short in terms of sustainability.

This study provides important and comprehensive findings on how sustainability criteria should be applied in architectural projects. The compliance levels of the examined projects with sustainability criteria provide valuable information about the current status of sustainability practices in the field of architecture. In this context, it should be emphasized that sustainability is not only limited to reducing environmental impacts but also provides long-term economic and social benefits.

Sustainable architecture aims to achieve environmental goals such as the efficient use of natural resources, minimizing energy consumption, and reducing waste production. Additionally, it addresses social and economic goals by ensuring suitable indoor conditions for users' health and comfort, responding to the needs of local communities, and producing economically sustainable solutions. Therefore, careful application of sustainability criteria in projects requires architectural designs to be handled with a holistic approach.

In future projects, the carefull application of sustainability criteria will be of utmost importance. In this context, it is essential to increase the use of innovative sustainability solutions, integrate energy-efficient technologies, prefer local and recyclable materials, and adopt design principles that are harmonious with nature. In addition, eliminating the deficiencies identified in current projects will contribute to the further implementation of sustainable architecture.

In this way, architectural projects can better respond to the needs of both today and the future. Creating more livable, environmentally friendly structures not only improves the quality of life of individuals but also makes a significant contribution to the solution of global environmental problems. Sustainable architectural approaches play a critical role in combating climate change, protecting natural resources and promoting sustainable urbanization.

As a result, this study once again reveals the importance of applying sustainability criteria more effectively and comprehensively in architecture. Adopting sustainability principles in architectural projects requires a holistic approach with environmental, economic and social dimensions. This holistic approach is an important step towards building a sustainable future and emphasizes the role and responsibility of the architecture discipline in this process.

This study examined projects in terms of systematic design activities in the fields of construction and architecture within the framework of sustainability and green transformation in our country, providing access to current application information in the field. It has been observed that the architectural design and technology integration criteria in the executed projects are consistent with the findings in the literature. The economic, social, and environmental impacts of the innovations in this sector, which plays a crucial role in sustainability compliance and integration through interdisciplinary interactions in design, are significant. Increasing the number of applications in the sustainable architecture and construction sector is an important economic and social issue that requires the development of a skilled workforce in design and product development to contribute to the application processes. It is believed that continued support through public policies during the development process in this field will contribute to the growth of the existing critical mass. In addition, it is anticipated that making sustainable architectural projects carried out by design centers more visible and presenting them as success stories by public authorities will be important for social integration.

The aim of this study is to highlight the importance of more effective and comprehensive implementation of sustainability criteria in the fields of architecture and construction, and to examine how sustainability principles can be integrated into a holistic approach encompassing environmental, economic, and social dimensions. Additionally, the study aims to systematically address design activities within the framework of sustainable architecture and green transformation, evaluating whether architectural design and technology integration in these projects align with findings in the literature. The projects reviewed were found to be consistent with the literature. However, it was observed that insufficient attention is given to the concept of sustainability

Information Note

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

Author Contribution Conflict of Interest Declaration Information

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

References

Agarwal, A. (2023). Building Design from an Environmental Perspective: A Review on Sustainable Building Design Models and Analysis of their Application in Practice. *Indian Scientific Journal Of Research In Engineering And Management*, doi: 10.55041/ijsrem25508

Ahram, H, F., Zakaria, S, A, S. (2023). The contribution of green building in reducing the carbon footprint and attaining SDG 13. IOP conference series, doi: 10.1088/1755-1315/1205/1/012034

Akadiri, P. O., & Olomolaiye, P. O. (2012). Development of sustainable assessment criteria for building materials selection. *Engineering, Construction and Architectural Management*, 19(6), 666–687. https://doi.org/10.1108/09699981211277568

Altan, H., Hajibandeh, M., Tabet Aoul, K. A., & Deep, A. (2016). Passive Design (pp. 209–236). https://doi.org/10.1007/978-3-319-31967-4_8

Aslani, A., & Hachem-Vermette, C. (2022). Energy and environmental assessment of high-performance building envelope in cold climate. *Energy and Buildings*, 260. https://doi.org/10.1016/j.enbuild.2022.111924

Assefa, S., Lee, H.-Y., & Shiue, F.-J. (2022). A building sustainability assessment system (BSAS) for least developed countries: A case of Ethiopia. *Sustainable Cities and Society*, 87, 104238. https://doi.org/10.1016/j.scs.2022.104238

Bahale, S., & Schuetze, T. (2023). Comparative Analysis of Neighborhood Sustainability Assessment Systems from the USA (LEED–ND), Germany (DGNB–UD), and India (GRIHA–LD). Land, 12(5). https://doi.org/10.3390/land12051002

Battaglini, F. (2024). Will the European Green Deal enhance Europe's security towards Russia? A political economy perspective. *Energy Economics,* 134, 107551. https://doi.org/10.1016/j.eneco.2024.107551

Bauer, M., Mösle, P., & Schwarz, M. (2010). Green Building. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-00635-7

Bednarik, R. G. (2009). Fluvial erosion of inscriptions and petroglyphs at Siega Verde, Spain. *Journal of Archaeological Science*, 36(10). https://doi.org/10.1016/j.jas.2009.06.019

Belek, A. N., & Yamaçlı, R. (2023). Ekolojik binaların sürdürülebilir tasarım kriterleri ve değerlendirme süreci. *Kocaeli Üniversitesi Mimarlık ve Yaşam Dergisi*. https://doi.org/10.26835/my.1219441

Biyolojik Çeşitlilik Sözleşmesi. (n.d.). Retrieved June 14, 2024, from http://www.surdurulebilirkalkinma.gov.tr/wp-content/uploads/2016/06/Bi.pdf

Bragança, L., Mateus, R., & Koukkari, H. (2010). Building sustainability assessment. *Sustainability*, 2(7), 2010–2023. https://doi.org/10.3390/su2072010

Chau, C. K., Leung, T. M., & Ng, W. Y. (2015). A review on life cycle assessment, life cycle energy assessment and life cycle carbon emissions assessment on buildings. *In Applied Energy*, 143(1). https://doi.org/10.1016/j.apenergy.2015.01.023

Cheng, Y.-L. (2008). Green Renovation for Existing Buildings in Taiwan. *Green Building -Policy and Strategies.*

Cole, R. (1994). Building environmental performance assessment criteria, BEPAC. In U.S. green building conference.

Dias Cordeiro Féria, M. (2018). Sustainability in Architectural Design Guidelines for a Sustainable Project [M.S. thesis]. Tecnico Lisboa.

Du Plessis, C. (2005). Action for sustainability: preparing an African plan for sustainable building and construction. *Building Research & Information*, 33(5), 405–415. https://doi.org/10.1080/09613210500218974

Ejidike, C. C., & Mewomo, M. C. (2023). Benefits of adopting smart building technologies in building construction of developing countries: review of literature. *Applied Sciences*, 5(2). https://doi.org/10.1007/s42452-022-05262-y

El-Gohary, M., El-Abed, R., & Omar, O. (2023). Prediction of an efficient energy-consumption model for existing residential buildings in Lebanon using an artificial neural network as a digital twin in the era of climate change. *Buildings*, 13(12). https://doi.org/10.3390/buildings13123074

Elhegazy, H., & Eid, M. M. M. (2020). A state-of-the-art-review on grey water management: A survey from 2000 to 2020s. *In Water Science and Technology*. 82(12). https://doi.org/10.2166/wst.2020.549

Feria, M., & Amado, M. (2019). Architectural Design: Sustainability in the Decision-Making Process. *Buildings*, 9(5), 135. https://doi.org/10.3390/buildings9050135

Fit for 55: making buildings in the EU greener. (n.d.). https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55/

Gao, H., Koch, C., & Wu, Y. (2019). Building information modelling based building energy modelling: A review. *In Applied Energy* , 238(3). https://doi.org/10.1016/j.apenergy.2019.01.032

Gökşen, F., Güner, C., & Koçhan, A. (2017). Sürdürülebilir kalkınma için ekolojik yapı tasarım kriterleri. *Akademia Disiplinlerarası Bilimsel Araştırmalar Dergisi*, 3(1), 92–107.

IAE 50. (2023). Binalar. https://www.iea.org/energy-system/buildings

Ibiyeye, A. I., Shamang, K. J., & Malachy, G. (2024). Awareness of building sustainability: A case of architectural students of Kaduna state university. *Social Sciences & Humanities* Open, 10, 100927. https://doi.org/10.1016/j.ssaho.2024.100927

International Organization for Standardization. (2019). Sustainability in buildings and civil engineering works - General principles (ISO Standard No. 15392:2019). In https://www.iso.org/standard/69947.html .

IPCC. (2024). Reports — IPCC. https://www.ipcc.ch/reports/

Ismaeel, W. S. E., & Kassim, N. (2023). An environmental management plan for construction waste management. *Ain Shams Engineering Journal*, 14(12). https://doi.org/10.1016/j.asej.2023.102244

İklim Değişikliği Çerçeve Sözleşmesi. (n.d.). Retrieved June 14, 2024, from https://webdosya.csb.gov.tr/db/iklim/webmenu/webmenu12421_1.pdf

İstatistikler | T.C. Sanayi ve Teknoloji Bakanlığı. (n.d.). Retrieved June 25, 2024, from https://www.sanayi.gov.tr/istatistikler/istatistiki-bilgiler/mi0203011503

Jiang, Z. (2021). Installation of offshore wind turbines: A technical review. *Renewable and Sustainable Energy Reviews,* 139. https://doi.org/10.1016/j.rser.2020.110576

Kang, H. J. (2015). Development of a systematic model for an assessment tool for sustainable buildings based on a structural framework. *Energy and Buildings,* 104, 287–301. https://doi.org/10.1016/j.enbuild.2015.07.015

Kokulu, N. (2017). The Effects of Building Materials on Building Biology and the Resultant Air Quality, *EJSDR*, 2(1).

Kuhlman, T., & Farrington, J. (2010). What is Sustainability? Sustainability, 2(11), 3436–3448. https://doi.org/10.3390/su2113436

Laabab, I., Ziani, S., & Benami, A. (2023). Solar panels overheating protection: a review. *Indonesian Journal of Electrical Engineering and Computer Science*, 29,(1). https://doi.org/10.11591/ijeecs.v29.i1.pp49-55

Larsson, N. K. (1999). Development of a building performance rating and labeling system in Canada. *Building Research and Information*, 27(4–5). https://doi.org/10.1080/096132199369444

Law no. 5746 (2016). Araştırma, Geliştirme ve Tasarım Faaliyetlerinin Desteklenmesi Hakkında Kanun, Resmi Gazete, 12.03.2008

Lee, C. L., Gumulya, N., & Bangura, M. (2022). The role of mandatory building efficiency disclosure on green building price premium: evidence from Australia. *Buildings*, 12(3). https://doi.org/10.3390/buildings12030297

Lehmann, S. (2010). Green urbanism: formulating a series of holistic principles. survey and perspectives *Integrating Environment & Society*, 3(2).

Li, W. (2011). Sustainable design for low carbon architecture. *Procedia Environmental Sciences,* 5, 173–177. https://doi.org/10.1016/j.proenv.2011.03.064

Li, H., Yang, X., Zhu, L, H. (2023). Reducing carbon emissions in the architectural design process via transformer with cross-attention mechanism. Frontiers in Ecology and Evolution, doi: 10.3389/fevo.2023.1249308

Liu, T., Chen, L., Yang, M., Sandanayake, M., Miao, P., Shi, Y., & Yap, P.-S. (2022). Sustainability considerations of green buildings: a detailed overview on current advancements and future considerations. *Sustainability*, 14(21), 14393. https://doi.org/10.3390/su142114393

Maleki Nasab, A., Abrishamchi, A., & Tajrishy, M. (2007). Assessment of residential water conservation due to using low-flow fixtures. *Journal of Water and Wastewater; Ab va Fazilab (in Persian*), 18(2).

Markelj, J., Kitek Kuzman, M., Grošelj, P., & Zbašnik-Senegačnik, M. (2014). A simplified method for evaluating building sustainability in the early design phase for architects. *Sustainability*, 6(12), 8775–8795. https://doi.org/10.3390/su6128775

Majerska-Pałubicka, B. (2018). Architectural Design in the Context of Sustainable Development. doi: 10.1007/978-3-319-94199-8_12

Mi, Z. (2024). Sustainable architectural practices: Integrating green design, smart technologies, and ultra-low energy concepts. *Theoretical and natural science,* doi: 10.54254/2753-8818/40/20240203

Minson, A. (2024). Carbon Reduction in Concrete Design and Construction. Rilem bookseries, doi: 10.1007/978-3-031-53389-1_41

Mohammadabadi, M., Yadama, V., & Dolan, J. D. (2021). Evaluation of wood composite sandwich panels as a promising renewable building material. *Materials*, 14(8). https://doi.org/10.3390/ma14082083

Mushtaha, E., Salameh, T., Kharrufa, S., Mori, T., Aldawoud, A., Hamad, R., & Nemer, T. (2021). The impact of passive design strategies on cooling loads of buildings in temperate climate. *Case Studies in Thermal Engineering*, 28. https://doi.org/10.1016/j.csite.2021.101588

Nguyen, T. H., Shehab, T., & Gao, Z. (2010). Evaluating sustainability of architectural designs using building ınformation modeling. *The Open Construction and Building Technology Journal*, 4(1), 1–8. https://doi.org/10.2174/1874836801004010001

Okwandu, C. A., Akande, O, D., Nwokediegwu, S, Q, Z. (2024). Sustainable architecture: Envisioning self-sustaining buildings for the future. *International journal of management & entrepreneurship research*, doi: 10.51594/ijmer.v6i5.1098

Our World in Data team. (2023a). End hunger, achieve food security and improved nutrition and promote sustainable agriculture. OurWorldInData.Org. https://ourworldindata.org/sdgs/zero-hunger

Our World in Data team. (2023b). End poverty in all its forms everywhere. OurWorldInData.Org. https://ourworldindata.org/sdgs/no-poverty

Paché, G. (2023). Sustainable city: learning from the middle ages. resources, *Conservation and Recycling*, 197, 107083. https://doi.org/10.1016/J.RESCONREC.2023.107083

Papadaki, D., Nikolaou, D. A., & Assimakopoulos, M. N. (2022). Circular environmental ımpact of recycled building materials and residential renewable energy. *Sustainability (Switzerland*), 14(7). https://doi.org/10.3390/su14074039

Patel, N., Patel, R., & Maitrey, B. (2022). A revıew on sustaınable development by constructıng green buıldıngs in Indıa. - *A Journal Of Gujarat Unıversıty*, 1(2), 45–50. https://doi.org/10.47413/vidya.v1i2.69

Pham, L. T., Kumar, P., Dahana, W. D., & Nguyen, H. D. (2024). Advancing sustainable development through planetary health – A holistic approach to global health: *A systematic review. Environmental Science & Policy*, 155, 103709. https://doi.org/10.1016/J.ENVSCI.2024.103709

Polli, G. H. B. (2020). A comparison about european environmental sustainability rating systems: Breeam UK, DGNB, LiderA, ITACA and HQE. *U.Porto Journal of Engineering*, 6(2). https://doi.org/10.24840/2183-6493_006.002_0005

Pons-Valladares, O., & Nikolic, J. (2020). Sustainable design, construction, refurbishment and restoration of architecture: a review. *Sustainability*, 12(22), 9741. https://doi.org/10.3390/su12229741

Potbhare, V., Syal, M., Arif, M., Khalfan, M. M. A., & Egbu, C. (2009). Emergence of green building guidelines in developed countries and their impact on India. *Journal of Engineering, Design and Technology*, 7(1). https://doi.org/10.1108/17260530910947286

Rana, A. K., Mostafavi, E., Alsanie, W. F., Siwal, S. S., & Thakur, V. K. (2023). Cellulose-based materials for air purification: A review. *Industrial Crops and Products*,(194-). https://doi.org/10.1016/j.indcrop.2023.116331

Rana, F., Hussain, B., Nassani, A. A., Hussain, A., Haffar, M., & Naqv, S. A. A. (2024). Contribution of hydro energy production, economic complexity and technological innovation in achieving an environmentally sustainable Asia. *Geoscience Frontiers*, 101876. https://doi.org/10.1016/j.gsf.2024.101876

Saini, J., Dutta, M., & Marques, G. (2020). A comprehensive review on indoor air quality monitoring systems for enhanced public health. *Sustainable Environment Research*, 30,(1). https://doi.org/10.1186/s42834-020-0047-y

Saldert, H. (2024). Social sustainability for whom? The role of discursive boundary objects in Swedish strategic urban planning. *Geoforum*, 152, 104022. https://doi.org/10.1016/J.GEOFORUM.2024.104022

San-José Lombera, J.-T., & Cuadrado Rojo, J. (2010). Industrial building design stage based on a system approach to their environmental sustainability. *Construction and Building Materials*, 24(4), 438–447. https://doi.org/10.1016/j.conbuildmat.2009.10.019

Santamouris, M., & Vasilakopoulou, K. (2021). Present and future energy consumption of buildings: Challenges and opportunities towards decarbonisation. *Advances in Electrical Engineering, Electronics and Energy*, 1, 100002. https://doi.org/10.1016/J.PRIME.2021.100002

Shahda, M. M. (2018). Criteria and guidelines for employing architectural composition to support sustainable architecture. *International*

Journal of Architecture, Engineering and Construction, 7(3). https://doi.org/10.7492/IJAEC.2018.017

Sharma, S., Dongre, R. (2024). Using building orientation to promote sustainability. *International Journal For Multidisciplinary Research*, doi: 10.36948/ijfmr.2024.v06i02.16316

Sizirici, B., Fseha, H, Y., Cho, S, C., Yildiz, İ., Byon, Y, J. (2021). A review of carbon footprint reduction in construction ındustry. *Design to Operation. Materials*, doi: 10.3390/MA14206094

Sowiżdżał, A. (2022). Geothermal Systems—An Overview. *In Energies*, 15(17). https://doi.org/10.3390/en15176377

Spagnolo, M., & Capodanno, D. (2024). Gender equality in medical research: A cardiology-informed examination. *American Heart Journal*, 272, 113–115. https://doi.org/10.1016/J.AHJ.2024.03.011

Spindler, E. A. (2013). The History of Sustainability The Origins and Effects of a Popular Concept. In Sustainability in Tourism (pp. 9–31). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-8349-7043-5_1

Subhan, M., Irfan, M., Pan, X., Ahmad, G., Naeem, M. H., & Zamir, M. N. (2024). Unveiling the dynamic impact of energy generation on economic sustainability in Canada: A roadmap towards sustainable development. *Journal of Cleaner Production*, 434, 139783. https://doi.org/10.1016/J.JCLEPRO.2023.139783

TC Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı. (2019). Sürdürülebilir Kalkınma Amaçları Değerlendirme Raporu. https://www.sbb.gov.tr/wp-content/uploads/2020/03/Surdurulebilir-Kalkinma-Amaclari-Degerlendirme-Raporu_13_12_2019-WEB.pdf

Timsina, J., & Weerahewa, J. (2023). Restoring ancient irrigation systems for sustainable agro-ecosystems development: Reflections on the special issue. *Agricultural Systems*, 209, 103668. https://doi.org/10.1016/J.AGSY.2023.103668

TISK. (2022). Dünya Ekonomik Forumu (WEF) Küresel Riskler Raporu 2022.

Tschopp, D., Tian, Z., Berberich, M., Fan, J., Perers, B., & Furbo, S. (2020). Large-scale solar thermal systems in leading countries: A review and comparative study of Denmark, China, Germany and Austria. *Applied Energy*, 270-(). https://doi.org/10.1016/j.apenergy.2020.114997

U.S. Department of Energy. (2020). EnergyPlus | EnergyPlus. In U.S. Department of Energy's.

Villarreal, E. L., & Dixon, A. (2005). Analysis of a rainwater collection system for domestic water supply in Ringdansen, Norrköping, Sweden. *Building and Environment*, 40(9). https://doi.org/10.1016/j.buildenv.2004.10.018

Voigt, M. P., Chwalek, K., Roth, D., Kreimeyer, M., & Blandini, L. (2023). The integrated design process of adaptive façades – A comprehensive perspective. *Journal of Building Engineering*, 67. https://doi.org/10.1016/j.jobe.2023.106043

Wadu Mesthrige, J., & Chan, H. T. (2019). Environmental certification schemes and property values: Evidence from the Hong Kong prime commercial office market. *International Journal of Strategic Property Management*, 23(2). https://doi.org/10.3846/ijspm.2019.7434

Wang, Z., Wang, S., Zhu, Y., & Xin, P. (2017). Assessment of ionospheric gradient impacts on ground-based augmentation system (GBAS) data in Guangdong Province, China. *Sensors (Switzerland)*, 17(10). https://doi.org/10.3390/s17102313

WELL Building Standard — IIDA New England. (n.d.). Retrieved June 25, 2024, from https://www.iidane.org/iida-ne-wire/well-building-standard

Wen, X., Zhao, D., Lv, Z., Zhang, K., & Zhang, Y. (2024). A sustainability-oriented approach for performance assessment of existing buildings and a case study. *Heliyon*, e32151. https://doi.org/10.1016/j.heliyon.2024.e32151

Xia, B., Skitmore, M., Zuo, J., Zhao, Z., & Nepal, M. (2014). Defining Sustainability Requirements for Design-Build (DB) Contractor Selection in Public Sector Projects. In Proceedings of the 18th International Symposium on Advancement of Construction

Management and Real Estate (pp. 59–66). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-44916-1_7

Yang, H. (2016). The Financial Performance of BREEAM Certified Buildings in the United Kingdom. Real Estate Finance (Aspen Publishers Inc.), 33(2).

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Evaluation of the Use of 3D Printing Technology in Furniture Production in Terms of Sustainability

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1. Introduction

With the mechanisation brought by the industrial revolution, manpower has been replaced by machines and computerised technologies. Especially since the 1980s, the manufacturing industry started to develop rapid prototyping, three-dimensional (3D) printing technology and other additive manufacturing techniques. These technologies have enabled designers and engineers to create physical models from 3D computer models quickly, easily, accurately and at a lower cost than traditional methods (Eke, 2019; Greenhalgh, 2016). One of the most widely used technologies today is three-dimensional printing technologies, which have gained a place in different sectors.

3D printing, also called "additive manufacturing", is a manufacturing technique defined as the process of combining materials layer by layer to create products from three-dimensional model data (Saad, 2016). It is a rapidly developing production technology that makes it possible to produce, repair or modify products in any environment. In this technique, the three-dimensional object modeled in the computer environment is divided into layers and the construction process is carried out by pouring the raw material melted into each layer during the production phase (Felek, 2019). Many materials such as plastic, ceramics, metal, sand, food and living cells can be used in object production with 3D printing technique (Wijk & Wijk, 2015).

Industrial designers and architects can make use of 3D printing techniques to produce prototypes, model a building or a design object (Wijk & Wijk, 2015). The 3D printing technique enables not only prototyping but also life-size production in architectural and interior design projects, from building and space construction to furniture production. With the introduction of digital technologies in the construction industry, a new era has begun in the sector, and it has become possible to produce structures quickly, cost-effectively and with less labor. Especially the efficiency and advantages offered by 3D printing technologies have enabled solutions that will eliminate the limitations of traditional production methods.

With the increase in environmental concerns, new concepts have entered our lives and pro-environmental reformist movements have emerged in response to these concepts. The importance of concepts such as "sustainable", "ecological", "environmentally friendly", which have been discussed especially since the 1980s, has gradually increased until today. In the 1987 Brundtland Report, sustainability was defined as "meeting the needs of the present without depriving future generations of the ability to meet their own needs" (WCED, 1987). As can be understood from this definition, sustainability rejects the unlimited use of resources and emphasizes that future generations also have the right to a livable world. In order to speak of a sustainable world, the built environment must first be designed accordingly. So much so that the discipline of architecture has been one of the main actors of environmentally sensitive theories and practices regarding its effects on the environment (Eyüboğlu & Faiz Büyükçam, 2024). The built environment is handled in a wide range of scales, from the urban scale to the scale of furniture. Furniture, which is the smallest scale of this design spectrum, is extremely important to be handled with a sustainable approach due to its environmental impacts in production, use and post-use processes.

In addition to the construction industry, the furniture industry is one of the sectors with the largest share in issues that directly affect the environment such as waste generation, greenhouse gas emissions and resource utilization. Therefore, in recent years, solutions have been sought for environmentally friendly production methods in order to minimize the negative environmental impacts of the production process. As a result, sustainable furniture design and production process has become increasingly important in the sector (Bumgardner & Nicholls, 2020). Sustainable production, which is realized by eliminating environmental impacts at the source before they occur (Güneş & Demirarslan, 2020), covers the entire life cycle of the product from the design stage to the post-use stage. Furniture has a shorter lifespan compared to architectural space due to user preferences, changing fashion and aesthetic understanding, change of function, etc. Therefore, it is an important part of the sustainable design process that old furniture can be recycled instead of creating waste in such a change & transformation. As an environmentally sensitive design approach in furniture production, the use of materials that are identical to or substitute natural (Bekar & Cürgül, 2024) and recyclable materials are among the first solutions found (Güneş & Demirarslan, 2020).

Over time, the furniture industry has started to search for different materials and production methods due to their flexibility in design and affordability. As a result of this search, the use of 3D printing technologies in furniture production has become increasingly widespread. With the 3D printing technique, which is completely machine-powered and minimizes the margin of error, it has become possible to perform the entire production process with 3D printers, especially in cases where part assembly is not required (Canbolat & Aydın, 2019). 3D printing technology makes significant contributions to sustainable furniture production as it provides many advantages such as fast production, reduced transportation and assembly costs, reduced waste generation, and recycling opportunities.

The aim of this study, which deals with the use of 3D printing technology in furniture production, is to reveal the advantages of 3D printing in the furniture production process and how it directs the furniture design process within the framework of sustainability. Considering the importance of fast production, recyclability and waste reduction in sustainable furniture design, it is important to discuss the potential of 3D printing technologies on the subject. In this context, it is among the objectives of the study to contribute to the literature and to raise awareness of the stakeholders in the furniture industry.

1.3. Previous Studies on Sustainable Furniture

There are many studies on sustainable furniture design in previous years. If we take a general look at some of them; Bal (2017) examined sustainable furniture design specifically for children's furniture in his master's thesis titled "Sustainability Approach in Children's Furniture Design". In this context, sustainable children's furniture was identified and analyzed according to design criteria. Bumgardner & Nicholls (2020), "Sustainable Practices in Furniture Design: A Literature Study on Customization, Biomimicry, Competitiveness, and Product Communication" synthesizes the literature on the sustainable design, use and disposal of wood furniture and related products in global markets. Güneş & Demirarslan (2020), in the study titled "Sustainability and Environmentalist Approaches in

Furniture Design", aimed to examine the developments, designers and designs that shape sustainable furniture design worldwide, and sustainable environmental policies on the subject. Kılıç & Sungurlu (2021), in the study titled "Sustainable Urban Furniture", the concept of sustainability, historical development and design criteria of sustainable urban furniture such as ecological material, durability / easy maintenance, performance, functionality, relationship with space, economy, recyclability, aesthetics are emphasized. Söğüt & Kandemir (2023), in the article titled "The Relationship between Biomimicry Approach in Furniture Design and Sustainability", seek answers to how sustainability can be achieved within the framework of the biomimicry approach not only in form but also in material, texture and other directional choices while responding to anthropometric and ergonomic needs in furniture design.

There are also studies on the contributions of 3D printing to sustainable design. Accordingly, in the article titled "Additive Technologies and Their Applications in Furniture Design and Manufacturing" by Jarža et al. (2023), the advantages of 3D printing technologies in terms of sustainability are discussed.

2. Material and Method

This study, which was designed with a descriptive design, generally consists of three steps (Figure 1). The first step is the literature review, where information on general topics such as the development of 3D printing technology, its use in architecture and interior architecture, sustainability in furniture design and the use of 3D printing technologies, and previous studies on sustainable furniture design are presented. In the second step, 12 pieces of furniture produced with 3D printing were selected to be examined within the scope of the study. Information about the sample group was obtained from the websites of designer companies and architecture portals. The analyzed furniture was evaluated in terms of their physical and chemical properties. In the final step of the study, the advantages and potentials of using 3D printing in furniture design in terms of sustainability are discussed.

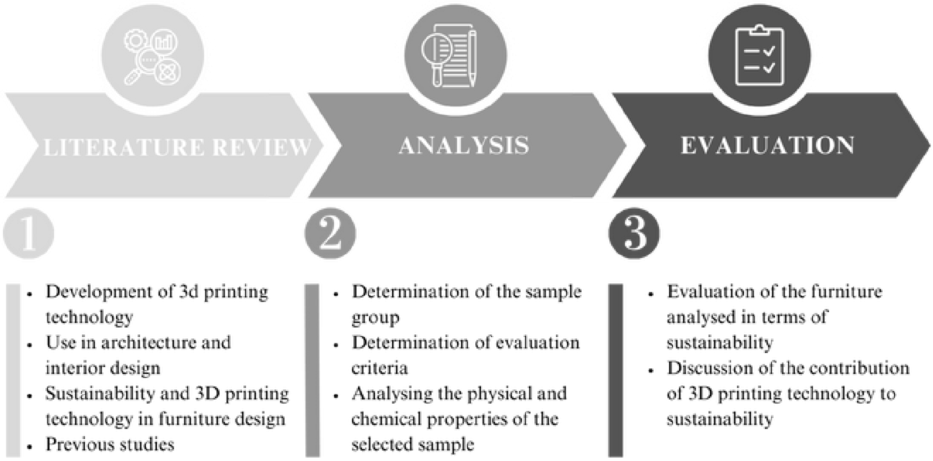

Figure 1. Stages of the Study

3. Findings and Discussion

The use of 3D printing technologies in furniture production and their contribution to sustainable design have been widely discussed in recent years. In this context, 12 3D printed furniture selected within the scope of the study were evaluated within the framework of sustainability.

The Twine seating unit, designed by the HagenHinderdael design office, was produced for the Rossana Orlandi Guiltless Plastic competition (Figure 2). The designers Sofia Hagen and Lisa Hinderdael stated that they aimed for this furniture to be "fun, comfortable and durable". Waste hospital trays were used as raw material for the production of this furniture.

Each Twine module is 1,06 m long and 50 cm high, with a width of 30 or 45 cm. The product was awarded the 2021 Rossana Orlandi Guiltless Plastic Prize Finalist (URL-1).

Figure 2. Twine Bench (URL-1)

Developed by the same design office with sustainability and local context in mind, Contour is a concrete bench that combines eco-friendly printing technology with custom design (Figure 3). It takes its form from the topography of Vorarlberg. Organic curves are printed layer by layer to reveal the topographical layers of the mountain landscapes and form the seat. Available in two different sizes, Contour S and Contour L are interlocking, creating more dynamic dialogues between the furniture set with negative space between them. It can be used as both indoor and outdoor furniture (URL-2).

Figure 3. Contour Bench (URL-2)

The Cocoon lighting element, also designed by HagenHinderdael design office, was developed as an innovative way to reduce timber waste against deforestation (Figure 4). Made from waste wood chips, Cocoon's sculptural form was developed to resemble an organic structure, referring to the natural materials used. Using 3D printing technology, layers of pulverized wood are bonded together with lignin into a cocoon measuring 25 cm (w) x 46 cm (h). After printing, each piece is hand-painted. Natural can be produced in many wood colors, including oak, teak and walnut. Believed to raise awareness of the significant social impact of deforestation, Cocoon is considered a sustainable initiative with its form, raw materials, production method and message. It was awarded the Dezeen Shortlist 2021 and Sustainable Design awards (URL-3).

Figure 4. Cocoon Lighting (URL-3)

Designed by Manuel Jiménez García, co-founder of MadMDesign, the Nobu chair is conceived as a membrane that transitions from a smooth skin to a complex interior, concealing an inner cellular universe (Figure 5). The chair reflects smoothness, regularity and arrhythmia, moderation and madness. Measuring 55 X 42 X 85 cm, the chair is made of recycled PETG Polymer. PETG (Polyethylene Terephthalate Glycol-Modified) is a thermoplastic polymer and is widely used in many industries due to its strength, transparency and chemical resistance. The chair can be produced in white, red, lime green, blue, black, gray, translucent, orange fluo colours (URL-4).

Figure 5. Nobu Chair (URL-4)

Designed by 3D printing expert Janne Kyttanen, the sofa, called Sofa So Good, was 3D printed in one piece using the structures of a spider web and a silkworm cocoon (Figure 6). Computer software was used to create the geometric diamond mesh, which can be arranged to give the curved shape of the sofa. Only 2.5 liters of resin were used to produce the 1.5 m long sofa. It is structured to provide maximum durability with minimum materials. The designer aimed to minimize energy consumption and reduce costs in furniture production by using less material (URL-5).

Figure 6. Sofa so good (URL-5)

Supermod is a modular wall system designed and produced by Sebastian Misiurek and Arianna Lebed, founders of Simplus Design (Figure 7). It serves as both storage and a semi-permeable separator. As it is a modular furniture, it offers the flexibility to be organized in different ways according to need and taste. The outer surface of the modules has a texture that will reflect light and create shadows in different ways (URL-6).

Figure 7. Supermod Modular Wall System (URL-6)

Bow, designed by Zaha Hadid Architects, is inspired by underwater ecosystems and coral formations (Figure 8). Polylactic acid plastic was used in the production of the chair. This plastic is a biodegradable, non-toxic, non-toxic material produced from renewable resources such as corn starch, making it both lightweight and robust. Bow chair has a color palette dominated by black & purple and black & white tones. The chair measures 78 x 81 x 118 cm (URL-7).

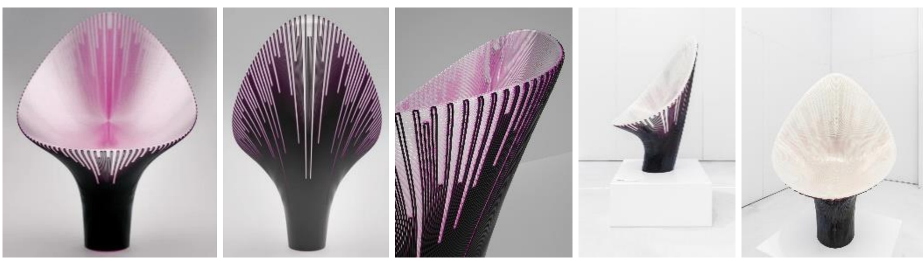

Figure 8. Bow Chair (URL-7)

Designed by NYXO Studio design office, Primavera is an iconic coffee table collection evoking the world of flowers and the circularity of the seasons (Figure 9). The organic and fluid shapes combined with a geometric regularity symbolize the renewal of natural cycles, recalling the sustainable material used in the tables. Lightweight foamed bioplastic (PLA), a biodegradable thermoplastic made from corn starch and sugar cane, was used to produce these 3D printed coffee tables (URL-8).

Figure 9. Primavera Coffee Table (URL-8)

The Second Nature Series, developed by The New Raw design office, is a furniture series modeled after the shapes and textures of marine life and digitally produced from recycled marine plastic (Figure 10). This series, which uses plastics thrown into the sea as raw material to combat marine pollution, consists of furniture such as vases, benches, chairs in different functions, sizes and colors (URL-9).

Figure 10. Second Nature Series (URL-9)

Designed by The New Raw design office, Stratum is a waiting and work bench for a company's entrance area (Figure 11). Inspired by geological stratification, this 18-meter-long sculptural and multifunctional piece of furniture is made from 880 kg of waste plastic (URL-10).

Figure 11. Stratum Bench (URL-10)

Robotica, designed by industrial designer Ross Lovegrove, is a stool shaped by the merging of two fields: botany and robotics (Figure 12). It presents a new design approach that crystallizes robotic programming in artificial production with natural programming in nature. Constructed from a rotational geometry, Robotica can be used as a table for hot food, a pedestal for objects, a side table or a seat thanks to the heat-resistant silicone inserts on the seat. Bioplastic (PLA) was used as raw material in production (URL-11).

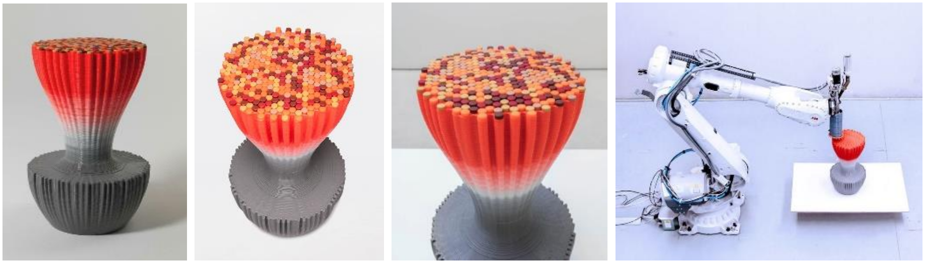

Figure 12. Robotica Stool (URL-11)

Designed by architect Aleksandrina Rizova, Aleksa table consists of 3D printed legs and a CNC milled walnut wood table top (Figure 13). Although the legs are lightweight, they have the strength to carry a heavy wooden table sahiptir (URL-12).

Figure 13. Aleksa Table (URL-12)

4. Conclusion and Suggestions

It is clear that computerized technologies have taken the design and production process to an advanced dimension and brought innovative solutions to the limitations of traditional methods. The use of computerized design technologies has increased considerably in recent years due to its contribution to reducing the negative effects on the ecosystem with an environmentally friendly approach as well as flexibility in design. In this study, which focuses on the evaluation of the use of 3D printing technologies in furniture production within the framework of sustainability, 12 3D printed furniture in the literature were examined. Information on the name, designer, raw material used in the production and form of these furniture is given in Table 1.

Table 1. Information on the Furniture Analysed

Furniture				
Name	Twine	Contour	Cocoon	Nobu
Designer	Hagen & Hinderdael	Hagen & Hinderdael	Hagen & Hinderdael	Manuel Jiménez García
Material	Medical Tray Waste	Concrete	Sawdust	Recycled PETG
Form	Organic	Organic	Circular	Organic
Furniture				
Name	Sofa So Good	Supermod	Bow	Primavera
Designer	Janne Kyttanen	Sebastian Misiurek & Arianna Lebed	Zaha Hadid Architects	NYXO Studio
Material	Resin	Plastic	Biodegradable PLA	Biodegradable PLA
Form	Organic	Honeycomb	Circular	Circular

Furniture				
Name	Second Nature	Stratum	Robotica	Aleksa Table
Designer	The New Raw	The New Raw	Ross Lovegrove	Aleksandrina Rizova
Material	Waste Plastic	Waste Plastic	Biodegradable PLA	Plastic
Form	Organic	Circular	Circular	Organic

The use of recyclable materials in sustainable furniture design is important in terms of the environmental impact of the product. In this context, it is seen that the use of recyclable biobased materials is preferred in furniture production with 3D printing technology. In addition, waste materials stand out as another raw material preference in order to draw attention to environmental problems. In the furniture analyzed, it has been determined that although it is quite light with the use of a small amount of material, products with the durability to carry kilos of weight are obtained. Thanks to this advantage offered by 3D printing technology, both the amount of raw materials and transportation costs are saved.

3D printing technology offers unlimited flexibility in terms of form selection. The production of any form that can be modeled on a computer is possible with 3D printers. Therefore, as seen in the furniture examined in the scope of the study, even forms that are too difficult and complex to be obtained by traditional methods can be produced quickly and easily with 3D printers. For this reason, circular and organic forms inspired by nature are frequently used in 3D furniture designs.

It is understood from the conceptual approaches of existing examples that 3D furniture designers and manufacturers show an increasing sensitivity to environmental problems and reflect this in their designs. There is a quest to develop methods, products and standards that will ensure the implementation of sustainable design in furniture production and to ensure their continuity. There is a tendency to improve the applications developed for this with 3D printing and to find more environmentally friendly solutions.

It is possible to summarize the advantages of using 3D printing in furniture production in terms of sustainability as follows:

- Fast production,
- Reduction of transportation and assembly costs through on-site production,
- Reducing waste generation,
- End-of-life furniture can be recycled and used as raw material,
- Easy raw material supply,
- Reducing carbon emissions,
- Reduced labor force,
- Ability to produce lightweight, durable and long-lasting furniture.

All these advantages reveal that 3D printing technologies are an important innovation in terms of sustainability. Increasing the use of such innovative approaches as well as traditional methods in the furniture industry and raising awareness of manufacturers will bring a new perspective to the sector. In particular, designing elements of the physical environment with a high potential for temporary use, such as furniture, in line with sustainability principles is extremely important in order to leave a livable world for future generations.

On the other hand, the challenges and limitations of 3D printing technologies in the sector compared to traditional methods should not be ignored. 3D printers have some difficulties for the manufacturer, such as the cost of procurement and use of 3D printers, and the employment of sufficient personnel to use these machines. In order to overcome such difficulties, solutions such as providing the necessary support to manufacturers by relevant institutions and organizations, training trained personnel to work in this field by relevant departments in vocational schools, etc. should be developed.

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References

Bal, H. B. (2017). Çocuk Mobilyası Tasarımında Sürdürülebilirlik Yaklaşımı (Unpublished master thesis). Karadeniz Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Trabzon.

Bekar, İ. & Cürgül, T. (2024). The use of natural stone in furniture design within the context of limitations and creativity. *Sanat & Tasarım Dergisi*, 14(1), 61-85.

Bumgardner, M. S. & Nicholls, D. L. (2020). Sustainable practices in furniture design: a literature study on customization, biomimicry, competitiveness, and product communication. *Forests*, 11, 1-16.

Canbolat, T. & Aydın, K. (2019). Mobilya sektörü özelinde üç boyutlu yazıcılarla tasarım ve malzeme-biçim-üretim yöntemi üzerine ilişkisel düşünme. *Çukurova Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi*, 34(4), 181-191.

Eke, T. E. (2019). Mobilya Tasarım ve Üretiminde Üç Boyutlu Yazıcı Teknolojisi (Yayınlanmamış yüksek lisans tezi) Marmara Üniversitesi, İç Mimarlık Anasanat Dalı, İstanbul.

Eyüboğlu, H. & Faiz Büyükçam, S. (2024). Tracing the evolution of sustainable architecture: an analysis spanning five decades. *ICONARP International Journal of Architecture and Planning*, 12(1), 46-74.

Felek, S. Ö. (2019). Mimari yapılarda 3 boyutlu yazıcıların kullanımı. *International Journal of 3d Printing Technologies and Digital Industry*, 3(3), 289-296.

Greenhalgh, S. (2016). The effects of 3d printing in design thinking and design education. *Journal of Engineering, Design and Technology*, 14(4), 752-769.

Güneş, S. & Demirarslan, D. (2020). Sürdürülebilirlik ve mobilya tasarımında çevreci yaklaşımlar. *International Journal Of Humanities And Art Researches*, 5(6), 81-99.

Jarža, L., Čavlović, A. O., Pervan, S., Španić, N., Klarić, M. & Prekrat, S. 2023). additive technologies and their applications in furniture design and manufacturing. *Drvna industrija*, 74(1), 115-128.

Kılıç, M & Sungurlu, A. (2021). Sürdürülebilir kent mobilyaları. *Online Journal of Art and Design*, 9(2), 276-286.

Saad, R. M. (2016). The revolution of materials used in 3d printing applications in furniture & ınterior design. *International Design Journal*, 6(3), 143-163. DOI: 10.12816/0036501. Access Address (10.06.2024): https://idj.journals.ekb.eg/article_90852.html

Söğüt, M. A. & Kandemir, A. (2023). Mobilya tasarımında biyomimikri yaklaşımının sürdürülebilirlikle ilişkisinin irdelenmesi. *International Journal of Humanities and Art Researches*, 8(4), 332-349.

URL-1, https://hagenhinderdael.com/products/twine/ (Date of access: 10.06.2024).

URL-2, https://hagenhinderdael.com/products/contour/ (Date of access: 10.06.2024).

URL-3, https://hagenhinderdael.com/products/cocoon/ (Date of access: 10.06.2024).

URL-4, https://nagami.design/en/product/nobu/ (Date of access: 12.06.2024).

URL-5, https://www.dezeen.com/2015/06/02/janne-kyttanen-3d-printed-sofa-so-good-minimal-mesh-spider-web-cocoons/ (Date of access: 13.06.2024).

URL-6, https://www.arch2o.com/supermod-simplus-design/ (Date of access: 15.06.2024).

URL-7, https://archello.com/product/bow-and-rise (Date of access: 15.06.2024).

URL-8, https://www.nyxostudio.com/3dprinted-tables (Date of access: 05.06.2024).

URL-9, https://thenewraw.org/Second-Nature-Furniture (Date of access: 05.06.2024).

URL-10, https://thenewraw.org/Stratum (Date of access: 05.06.2024).

URL-11, https://nagami.design/en/product/robotica/ (Date of access: 12.06.2024).

URL-12, https://www.aleksastudio.co.uk/3d-printed-table/15yv4mai5w0oarn0onri7k84vyfd92 (Date of access: 12.06.2024).

WCED. (1987). *Our Common Future, The World Commission on Environment and Development Report*. Oxford: Oxford University Press.

Wijk, A. V. & Wijk, I. V. (2015). *3D Printing With Biomaterials Towards a Sustainable and Circular Economy*. Delft: IOS Press.

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The Transformation of Private to Public Open-Green Space Use: The Case of Diyarbakır

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1. Introduction

Various definitions have been proposed regarding the concept of the public and public space. In its most general sense, the public is used to refer to being open to everyone, visible and audible by everyone as opposed to private (Sunay, 2002).

The debates regarding the public space are based on Habermas's work The Structural Transformation of Public Sphere published in 1962. The public space highlighted by Habermas is a space where individuals can express themselves freely (Nalbant, 2016). According to Habermas, the public space is defined as a lifeworld shaped by means, processes, and spaces wherein private persons engage in rational discussions around common issues that concern them and form a consensus about these issues through this discussion process forming the public opinion (Tekel, 2009).

The Council of Europe (1986) defines public spaces as areas left to the consumption of the public, even if they belong to a private individual (Çakar, 2016). Public spaces are environments where human-specific phenomena such as values, culture, and language are transmitted, shared, or given life; they are places outside of private space where people come together and engage in interaction and sharing through communication (Donat and Savaş Yavuzçehre, 2016; Nalbant, 2016). Public spaces play an important role in meeting individuals' physicals, social, and personal needs in urban life. They are vibrant areas where individuals shop particip assumptionize insocial activities make their voices heardand interact with other people (Çakar, 2016).

Publicly related concepts include semi-public, private, semi-private and similar concepts. Private open spaces encompass everything from personal gardens to homes. Public open space can be defined as parks, streets, squares, and plazas. Semi-public spaces are places used by a limited number of people but generally not welcomed for use by the general public. These areas may include courtyards, community-owned gardens in houses or apartment complexes, and play areas. In the cultural richness of Anatolia, courtyards of the traditional houses have an important role in the development of house plans. Courtyard, which is transition space between the house and street, is gathering and distribution area of the house and social area where a lot of daily needs are met (Aklıbaşında and Özhancı, 2016)

Semi-public areas are generally openly accessible and used by certain groups in society. Sometimes the entrance stairs of a museum or a house's garden with its gate create a semi-private area between public and private space (Çakar, 2016). These areas have ownership as private spaces but also have public aspects that affect those around them positively or negatively (Taşçı, 2020). Semi-private and semi-public spaces actually lie at the intersection points of private and public spaces (Çakar, 2016).

The public spaces that benefit the community are grouped as exterior usage areas and circulation channels in urban open spaces. Exterior usage areas are functional spaces such as play and sports fields, parks, etc., providing light, air, outdoor living opportunities and increasing the livability of indoor spaces. Circulation areas establish pedestrian, vehicle transportation and communication relations between buildings and various parts of the city; complementary spaces such as passages, streets, avenues, squares. In addition to private exterior use areas (balcony, garden), there is a gradual open area usage gradation towards channel spaces conveying movement (street) and places where movement gathers and disperses (square) (Karayılmazlar and Çelikyay, 2018).

Especially socio-cultural, economic, and technological developments cause changes in public spaces. Today, economic restructuring has accelerated the change in social structure and diversified lifestyle choices. Different groups in society have started to prefer different living and public space units which prepared the infrastructure for the transformation of urban public spaces (Tekel, 2009). Public spaces have been common usage areas that show diversity over time according to the cultural characteristics of societies. These shared use areas include;

- Organized pedestrian areas: Parks, rest, recreation and sports areas
- Shopping areas: Market shopping street, market area
- Transition zones: Streets, roads, transportation zones, sidewalks
- Regions: Squares; open prestigious places in urban settings (Karayılmazlar and Çelikyay, 2018).

In this context, changes in the use of open-green spaces have been addressed within the scope of traditional and modern housing texture in Diyarbakır, which was chosen as the study area. In the study, firstly, the historical development of public space was examined; then, by evaluating the growth and development of Diyarbakır city, past and present green area usage were revealed.

1.1. Historical Development of Public Space

In pre-urban agricultural cities, there was no street, avenue or public space and the houses were attached to each other (Roth, 2000; Gökgür, 2008; Esermiş Özcü and Atanur, 2020). The first recognized public open space seen in Ancient Greece known as agoras facilitated trade and education while also serving as a venue for political discussions. Initially defined by private homes and shops in Athens, the agora was later characterized by stoas and shelters (Esermiş Özcü and Atanur, 2020). The Roman forum which served a similar function as the Greek agoras is also surrounded by stoas and public buildings; however unlike agoras forums have evolved from deliberation spaces into areas of entertainment connected to theaters, circuses and odeons (Roth, 2000; Dickenson, 2017; Esermiş Özcü and Atanur, 2020) (Figure 1).

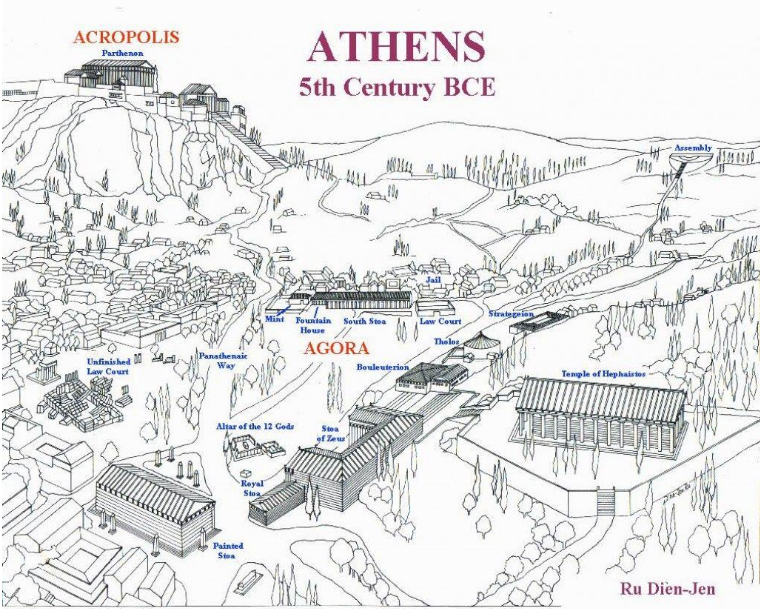

Figure 1. Map of Ancient Greece (Url 1)

During the Middle Ages, the loss of power by nobles in France and England led to the emergence of strong centralized monarchies, while walls were constructed around cities to provide protection against invaders. The medieval city confined within these walls emerged as a prominent trading center, with one or more marketplaces designated as the main public spaces for commercial activities (Smith and Gadeyne, 2016; Esermiş Özcü and Atanur, 2020).

In the 14th century, with the emergence of the Renaissance, significant changes occurred in urban areas. In the Renaissance, squares were planned in an extremely symmetrical form. Mostly, streets would converge at a certain center and then disperse symmetrically afterwards (Esermiş Özcü and Atanur, 2020). During the Renaissance period open spaces that are interconnected were considered as squares; however, with Baroque period (16th-18th centuries), they began to be perceived as public spaces. In this respect, squares and public spaces aim to create a social environment and interaction between buildings and individuals. Streets are identified as the most crucial component necessary for ensuring social and economic interaction within squares (Kuru and Özkök, 2017). By late 18th century the use of urban governance and architecture as a political and social instrument led to reinterpreting public space and acquiring different functions. Both politically or economically, they have been redesigned to represent a new face of power by reconstructing public buildings and residential areas (Esermiş Özcü and Atanur, 2020).

Over time, the public space, which has evolved with different functions, began to take place in the Ottoman Empire from the 16th century onwards (Nalbant, 2016). The development of public space in the Ottoman Empire differed from that of the West due to the dominance of Islam (Nalbant, 2016). While in Western cities belonging to ancient Greece "squares" were central, in the Ottoman Empire "mosques" were located at city centers. Additionally, the Islamic concept of "privacy" led to inward-facing spaces in the Ottomans' domain (Nalbant, 2016). Ottoman houses generally open onto a courtyard enclosed by high walls and then onto a street (Nalbant, 2016). In traditional Turkish cities, outside and inside courtyards of mosques and religious complexes are considered as public areas along with small squares formed naturally or through shaping streets and coffeehouses around mosques or markets (Nalbant, 2016).

With the declaration of the Republic, the process of modernization resulted in transformation in public spaces and these spaces have been shaped according to the social structure (Sağlam, et al., 2019). The expected functions of public spaces built by the state during the Early Republican Period have diverged, with cultural functions gaining prominence (Sağlam, et al., 2019). In recent times, public spaces have moved away from authority control and transformed into more individually created or used spaces (Sağlam, et al., 2019).

The increasing share of the private sector in the production of urban space in the 20th century has led to changes in the ways public and private sectors relate to each other and their own characteristics, with implications for the public space (Esermiş Özcü and Atanur, 2020). The privatization of functions has led to the transformation of public areas into private spaces (Uysal Bilge, 2021). As streets and squares have given way to new living centers, public open spaces are being used less (Uysal Bilge, 2021). With the concentration of shopping malls and businesses in the city, street usage as one form of public space has begun to disappear. (Akyol et al., 2017; Sağlam, et al., 2019). Open-green spaces continue to be utilized by society due to their numerous social, economic and ecological benefits. Both privately owned or publicly accessible green areas maintain significance as open spaces where people engage in activities such as leisure and relaxation. From residential gardens to urban parks, various scales and types of green area uses exist, they change frequencies when they become attractive through accessible, effective, and sustainable designs.

2. Findings and Discussion

In this part of the study, historical development and the use of open-green space in Diyarbakır is discussed.

2.1. Historical Development of Diyarbakır City

In the city of Diyarbakır, which has a deep-rooted historical past and where many civilizations lived, the Suriçi region took the appearance of a typical medieval city with narrow streets around a church or mosque and a marketplace during the Byzantine and Islamic periods, and the neighborhood units developed around the mosques or masjids seen in Islamic cities formed the general character of the city (Erginbaş, 1953; Özyılmaz, 2017). Two main streets intersecting each other perpendicularly in Suriçi reach four main gates.

The city developed outside the city walls towards Yenişehir in the north, and while it maintained a balanced and planned urban development until the 1960s, it faced an unplanned development after 1960 due to the pressure of migration and population growth (Kejanlı and Koç, 2020). The Bağlar Region, located in the west of the city and located after the railway axis, was previously a region where vineyards were located, but with the increase in migration since 1963, it has turned into a region where unplanned and uncontrolled construction was built and where immigrants chose a place (Kejanlı and Koç, 2020). The zoning plan prepared in 1965 decided to ensure the regular development of the empty and unbuilt area in the southeast of Suriçi (Kejanlı and Koç, 2020) (Figure 2).

The 1970s were a period when development continued in Yenişehir, and with the changes in the zoning plan, houses with gardens and single-house layouts were demolished and turned into apartments (Arslan, 1999). The Master Zoning Plan covering Sur, Yenişehir, Bağlar and the Kayapınar region, which had village status at that time, was prepared in 1984, and the Implementation Zoning Plan was prepared in 1985 (Kejanlı and Koç, 2020) (Figure 2). The growth of the city after 1985 was in the Şanlıurfa and Elazığ road and the Kayapınar Region between these roads (Kejanlı and Koç, 2020).

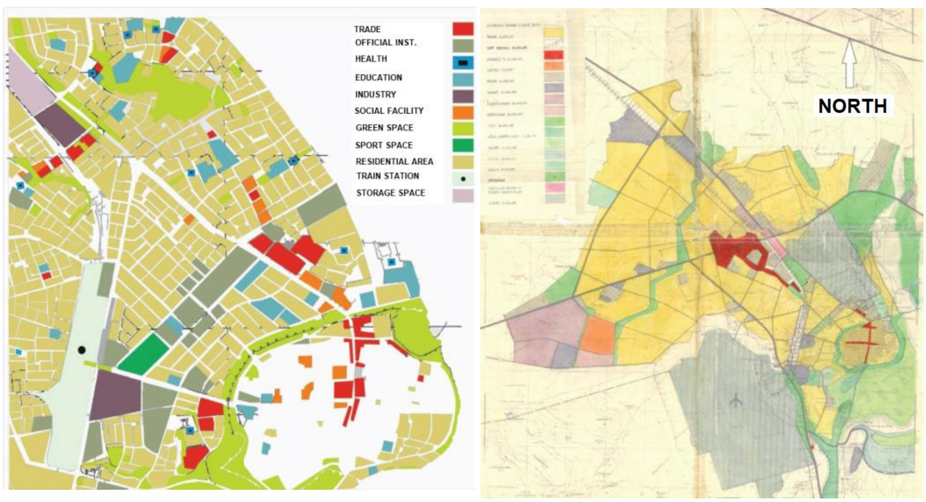

Figure 2. 1965 Zoning Plan (left) (Diyarbakır Metropolitan Municipality) and 1984 1/25000 Scale Master Plan (right) (Gölcük, 2010).

Today, the city continues to grow in the northwest and west axis, and Kayapınar district continues its development that started after 1985.

2.2. The Use of Open-Green Space in the City of Diyarbakır From the Past to the Present

In this part of the study, the use of green areas in areas with traditional and modern housing texture is discussed.

2.2.1. Use of Green Space in Traditional Housing Area

The hot-dry climate has led to the production of adjacent buildings with courtyards that allow spatial articulation and the formation of an organic street texture (Özyılmaz, 2017). The fact that the region has a hot-dry climate enabled the development of the forms of the buildings around the courtyard, and the buildings around the courtyard consisted of one, two or three floors (Ergin Oruç, 2017). In traditional Diyarbakır houses, water, shade and semi-open areas play an active role in the design, and the iwan with a pool, water channels, and a semi-buried basement (Mesopotamian serdab) are the priorities of the hot climate (Yıldırım, 2006). The plants and water element in the courtyard played an important role in the ecological and social benefits provided by green areas (Figure 3).

Figure 3. Cahit Sıtkı Tarancı House

In addition to the use of courtyards in traditional houses, there are public open spaces such as squares and mosque fronts that were used in the past, but today some of them have been preserved or developed. New open-green spaces, such as the landscaping in the “inner castle”, have been added to the historical area of Suriçi.

2.2.2. Use of Open-Green Space in Modern Residential Areas

Green areas of different types and sizes within the modern housing texture selected from different points of the city were evaluated.

In the modern residential fabric, there are green areas in the form of parks or site gardens. In the green areas of the examined gated communities, in addition to sports fields and children's playgrounds, there are pools or fountains as water elements, urban furniture such as seating units, garbage bins, lighting elements and various plant species (Figure 4-5-6). Within the scope of the study, Selahattin Aşar Site located in Bağlar district, Evrim Site located in Yenişehir district and Çeysa Gold Park Site located in Kayapınar district were examined and it was observed that they had similar characteristics in terms of green area use (Figure 4-5-6).

Figure 4. Use of Open-Green Space in Selahattin Avşar Housing Site

Figure 5. Use of Open-Green Space in Evrim Site

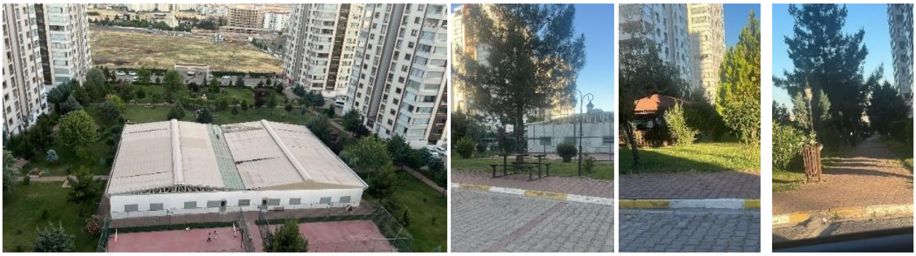

Figure 6. Use of Open-Green Space in Çeysa Gold Park Site

Altınkent Site, located in the north of Silvan Road, is one of the residential areas preferred by upper income groups, with detached buildings designed as duplexes or triplexes. The gardens of the buildings within the site are designed in line with the needs of the user and have different features (Figure 7). While some of them have pools, attempts have been made to block the view of the garden and the building with plant species that are generally restrictive and provide privacy. In addition to everyone having their own individual garden, a children's playground has been arranged at the central point of the site. In this area, there are urban furniture such as seating units, garbage bins, lighting elements and various plant species.

Figure 7. Use of Open-Green Space in Altınkent Site

Kırk Konak Site, located opposite the Altınkent site, has similar qualities, and the gardens within the site have been designed in line with the needs of the user (Figure 8).

Figure 8. Use of Open-Green Space in Kırk Konak Site

Gökkuşağı Site, located in Bağlar district, covers a larger area and accommodates more population compared to other gated communities with low-rise buildings. Therefore, in addition to residential gardens, active green areas used as parks within the site are greater in number and size (Figure 9).

Figure 9. Use of Open-Green Space in Gökkuşağı Site

There are green areas of different sizes and arrangements throughout the city. One of the neighborhood-scale parks examined is approximately 2 ha in size and is located in Bağcılar Neighbourhood of Bağlar district. There are urban furniture such as seating elements, garbage bins, lighting units and different plant species in the park (Figure 10). Since it is a new park, the trees do not provide shade. There is also a sports facility in the northwestern part of the park.

Figure 10. Neighborhood park (Bağcılar Neighborhood, Bağlar)

The second park example examined on a neighborhood scale is located between 499th and 523rd Streets in Kayapınar district. The park, which has an area of approximately 20,000 m^2, includes green areas, walking paths, sports fields, children's playgrounds, camellias and an ornamental pool (Figure 11).

Figure 11. Neighborhood Park (Fırat Neighborhood, Kayapınar)

In Diyarbakır, there are large park areas that serve the whole city, especially in newly developing residential areas. In this context, “75 Park, City Squares and Theme Park” in Kayapınar were examined.

Located in Kayapınar and with an area of approximately 100,000 m^2, 75 Park is one of the largest parks in Diyarbakır. The park includes a skateboard rink, cafe, pond, children's playgrounds, musical water games, sports area, walking paths, seating areas such as camellias and an ecological education garden (Figure 12). Since it is located in a central area, 75 Park is used intensively, especially on summer evenings.

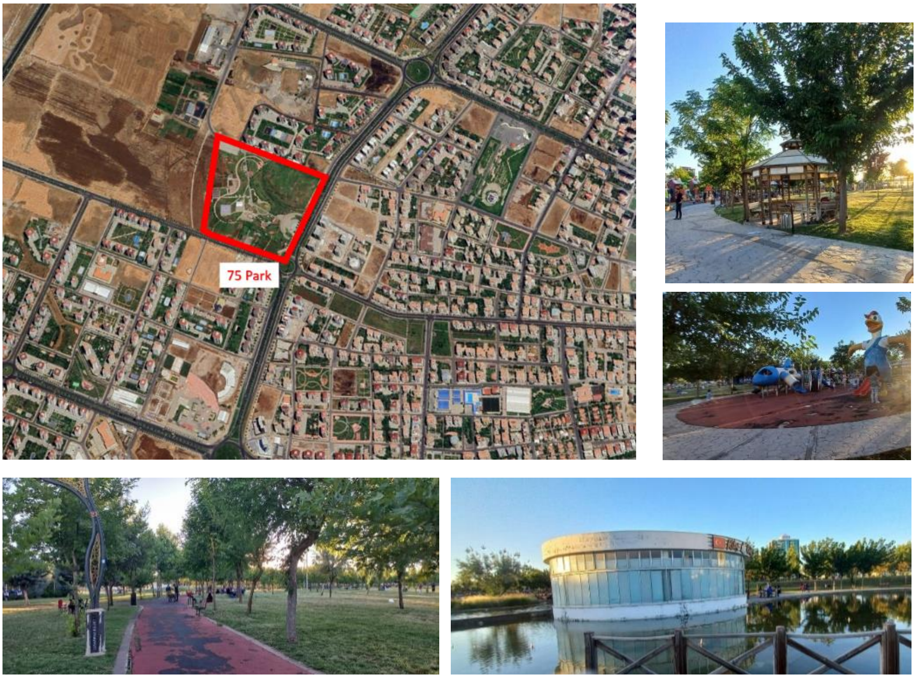

Figure 12. 75 Park (Kayapınar)

City Square, located on Selahattin Eyyübi Boulevard, covers an area of approximately 62,000 m^2. There are children's playgrounds, water games, skateboard rinks, sports areas, walking paths and seating areas such as camellias in the city square (Figure 13). Additionally, there is a book cafe, prayer room and WC within the park.

Figure 13. City Square (Kayapınar)

The Theme Park, located between Sipan Street and 588th Street in Kayapınar district, is divided into two by Nazım Hikmet Street. The park includes a book cafe, administrative building, light and water playgrounds, adventure islands, sports fields, climbing wall, seating units, walking areas, prayer room and WC (Figure 14).

Figure 14. Theme Park (Kayapınar)

4. Conclusion and Suggestions

As the city grows, the use of public space has changed and green areas have developed from the garden and courtyard scale to the neighborhood, district or city scale. The fact that the traditional residential structure has a courtyard has enabled the development of neighborly relations and activities such as entertainment, rest and relaxation. In the city of Diyarbakır, where apartment building is common, courtyards have been replaced by gardens in gated communities with low-rise buildings serving the upper income group. Gardens, which are private areas, are shaped in line with the wishes and needs of the user. In addition, public parking areas have been arranged at central points of the site. Gated communities with high-rise buildings mostly have arrangements shaped by children's playgrounds, pools and urban furniture.

The presence of parks of various sizes in the city has provided many economic, ecological and social benefits. Social needs change and develop. Accordingly, the use of green areas is diversifying. Therefore, it is of great importance to include it in planning decisions without ignoring the need for accessible and sufficiently large green areas throughout the city.

References

Aklibasinda M., Ozhanci E. (2016). The Courtyard Culture in Traditional Avanos Houses and Design Properties. *XI. European Conference on Social and Behavioral Sciences,* September 1-4, 2016 Rome, Italy

Akyol, D., Çiğdem, A., Düzenli, T. (2017). Toplumsal değişim sürecinde "kamusal mekan"ın dönüşümü. *Akademik Sosyal Araştırmalar Dergisi*, 5 (56), 545-554.

Arslan, R. (1999). Diyarbakır Kentinin Tarihi ve Bugünkü Konumu, *Diyarbakır Müze Şehir,* İstanbul: Yapı Kredi Yayınları, 80-107.

Çakar, N. (2016). Kent, kamusal alan ve anıt heykel ilişkisi. *Sanat Dergisi*, 0(26), 37-54. Retrieved from https://dergipark.org.tr/tr/pub/ataunigsfd/issue/45081/563074

Dickenson, C.P. (2017). *On the agora: The evolution of a public space in Hellenistic and Roman Greec*e, Brill Publication.

Donat, O., Savaş Yavuzçehre, P. (2016). Sakin kent (Cittaslow) üyeliğinin kamusal mekânlara etkisi. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi,* 35, 115-126.

Erginbaş, D. (1953) *Diyarbakır Evleri,* Doktora Tezi, İstanbul Teknik Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

Ergin Oruç, Ş. (2017). Diyarbakır Suriçi bölgesindeki geleneksel konut mimarisinde iklimsel faktörlerin rolü. *Dicle Üniversitesi Mühendislik Dergisi,* 8 (Özel Sayı): 383-394.

Esermiş Özcü, A., Atanur, G. (2020). KOVID-19 pandemisinin kent yaşamına etkisi: kamusal alan üzerine değerlendirmeler. *Paradoks Ekonomi Sosyoloji ve Politika Dergisi* , 16 (2) , 237-250 .

Gökgür, P. (2008). *Kentsel Mekânda Kamusal Alanın Yeri*, Bağlam Yayınevi, İstanbul.

Gölcük, A. (2010). *Kentsel Planlama Sürecinde Kent Formundaki Değişimlerin Diyarbakır Kenti Örneğinde Araştırılması,* Yüksek Lisans Tezi, Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Adana.

Karayılmazlar, A. S., Çelikyay, H. S. (2018). Kentlerde kamusal alanların tasarımı ve önemi. *Bartın Üniversitesi İktisadi ve İdari Bilimler*

Fakültesi Dergisi, 9 (17), 83-90 . Retrieved from https://dergipark.org.tr/tr/pub/bartiniibf/issue/38805/452797

Kejanlı, D.T., Koç, C. (2020). Diyarbakır'ın Kentsel Gelişimi Üzerine Bir Değerlendirme, *Gelecek ve Kent*, Nobel Yayınları.

Kuru, A., Özkök, M. K. (2017). Yaşanabilirlik Kavramı Bağlamında Kamusal/Açık Mekânların Değerlendirilmesi: Kırklareli Kent Merkezi Örneği. *Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi,* (28), 43-60.

Nalbant, M. (2016). Türkiye'de kentsel mekânlarda kamusal alanın konumu: tarihsel perspektiften bir değerlendirme. *Bitlis Eren Üniversitesi İktisadi Ve İdari Bilimler Fakültesi Akademik İzdüşüm Dergisi,* 1(1) , 12-27.

Özyılmaz, H. (2017). Geleneksel Diyarbakır evlerinde toplumsal yapıya bağlı gelişen fiziki değişimler. *Dicle Üniversitesi Mühendislik Dergisi,* 8 (Özel Sayı), 371-382.

Roth L.M. (2000). *Mimarlığın Öyküsü,* Kabalcı Yayınevi, İstanbul.

Sağlam, A. İ. , Öztürk, A. Ç., Kaçar, A. D. (2019). Türkiye'de kamusal mekânın gelişimi. *ATA Planlama ve Tasarım Dergisi,* 3(1) , 47-58.

Smith, G., Gadeyne, J. (2016). *Perspectives on Public Space in Rome, from Antiquity to the Present Day,* Routledge Publication.

Sunay, R. (2002). Cumhuriyetçi – liberal – müzakereci kamusal alan modelleri ve türkiye'de kamusal alanın gelişimi. *Selçuk Üniversitesi Hukuk Fakültesi Dergisi,* 10 (3-4) , 51-78.

Taşçı, H. (2020). Kamusallığın gelişimi ile kamusal alanların nitelikleri arasındaki ilişki. *OPUS International Journal of Society Researches,* 16 (30), 3018-3037 . DOI: 10.26466/opus.779844

Tekel, A. (2009). Alışveriş merkezlerinin 'kamusal mekân' nitelikleri üzerine bir değerlendirme: Ankara Panora Alışveriş Merkezi Örneği. *Hacettepe Üniversitesi Türkiyat Araştırmaları (HÜTAD)* , 10 (10) , 141-154 .

Url 1. (2024). https://i.pinimg.com/originals/5f/19/46/5f1946305f378b2a5e5b4ca1f7e004fb.jpg, Erişim Tarihi: 04.07.2024.

Uysal Bilge, F. (2021). Kamusal alanların evrilmesi. *Mimarlık ve Yaşam, 6* (1) , 141-156 . DOI: 10.26835/my.846096

Yıldırım, M. (2006) Diyarbakır Suriçi geleneksel evlerinde koruma sorunları ve çözüm önerileri. *Tasarım+kuram,* 87-94.

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A Mutualistic Relationship: Historical Buildings and Annex

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1. Introduction

Symbiotic life is the most general definition of symbiotic life and it is a common life of two or more living things that are different from each other. In this relationship, living organisms act as an organism and continue their lives by helping each other. Symbiosis or common life is the living associations formed by plants, fungi, animals and micro-organisms. Living species that establish a relationship between each other live an integrated life for the rest of their lives. In this complex relationship, living organisms share various features such as reproduction and continuity of life, which they obtain from different environments and play a vital role in each other's life (Kurokawa, 1994). Such associations between living species can be long-term or at the same time have a permanent characteristic (Douglas, 2010).

In symbiotic relationships, the species that usually provides food and shelter as the host is called the host, and the other species is called the symbiont. This relationship network formed by two or more species can be established in various ways, both inside and outside the host organism, or both inside and outside, including its tissues (Paracer & Ahmadjian, 2000). In these relationships, the symbiont species can increase its dominance over the host and prevent it from reproducing. In other words, the function of the host species can be conditioned by the symbiont. Symbiont plays a key role in the production of functional novelty of the host species. The host species gains the ability to respond to changes in the habitat by transforming its metabolic capabilities through the symbiotic relationship (Ferrari & Vavre, 2011; Peacock, 2011). The species that have a symbiotic relationship have different characteristics from each other.

Due to this situation, this relationship is expressed as the relationship of species that need each other and some restrictions and opposition situations may occur from time to time between these species. Symbiotic life is divided into three categories as mutualistic, commensal and parasitic according to the benefit of the organisms involved in this relationship (Figure 1). A mutualistic relationship is defined as one in which both species mutually benefit and support each other to survive. A parasitic relationship is one in which one species benefits while the other is harmed; a commensal relationship is one in which one species benefits but the other species is not affected positively or negatively (Douglas, 2010).

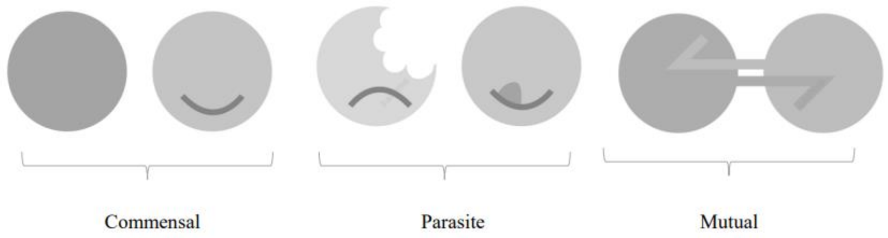

Figure 1. Symbiotic Relationships (URL-1)

It is possible to address these symbiotic lives with various characteristics in different scopes. Šijaković and Perić (2018) evaluated symbiotic life in re-functionalised buildings within the scope of architecture. In the aforementioned study, while the existing building is referred to as the host, each material, building element and spatial units added to the building are defined as symbionts. The symbiont preserves the characteristic features of the host structure and undertakes a task that protects and develops it. However, the host structure establishes a dependent or independent relationship with the symbiont structure. On the other hand, the symbiont is shaped according to the needs of the host structure (Šijaković & Perić, 2018). Parisi (2019) discussed the symbiotic relationship within the scope of analogue and digital approaches in architectural design.

It is known that historical buildings are subject to a number of construction activities for their adaptation to contemporary life or function. These construction activities include forms of intervention such as maintenance, simple repair or restoration. In restoration, which is a fundamental repair, it is applied with various techniques such as consolidation, integration, renovation, reconstruction, cleaning and transportation (Ahunbay, 2019). Within the scope of these techniques, additional structures may also be built to the historical building from time to time. Although the quality and quantity of this addition is limited by various international laws and regulations of ICOMOS (Athens Charter, 1931; Venice Charter, 1964; Washington Charter, 1987; Valetta Principles, 2011), the new function is shaped by the programme and the approach of the designer. The additional building constructed within the scope of the sanitisation of the historic building often brings along various debates. However, these discussions are not within the scope of this study. The study intends to create a new discussion on such a dual life (historic building and annex) by looking from the outside to the discussions on harmony, effect, proportion, scale, etc. of the historic building and the annex.

In this study, symbiotic life, one of the research topics of biology discipline, is integrated into the discipline of architecture. Symbiotic life in architecture is based on the relationship between the historical building and the additional building. The historical building, which is considered as two separate organisms, corresponds to the host species, while the additional structure refers to the symbiont. The symbiotic relationship between these two species is considered as a mutualistic life within the scope of mutual benefit. It is assumed that the dependent and supportive relationship between the historic and additional structure represents mutual benefit.

2. Material and Method

Living organisms, which are in constant interaction, establish a complex network of relationships with each other in order to sustain their lives. Symbiosis is one of these relationships. In this study, the concept of symbiosis in the discipline of biology was integrated into the discipline of architecture and a reading was made through the relationships established between the buildings. Within the scope of the study, the symbiotic relationship in the discipline of architecture represents an interaction in which the building provides mutual benefit with other buildings. In this study, which aims to reveal the symbiotic relationship established by the idle historical buildings with additional structures in order to maintain their functions, it is aimed to present a perspective on the balance between the protection of historical heritage and meeting today's needs Initially, a literature review on symbiosis and symbiotic relationship was conducted in the study. Then, sample buildings were determined.

All of the selected buildings consist of worship buildings. One of the reasons for preferring worship buildings is that they reflect social, cultural and historical values. Another criterion is that it is a kind of building rich in the sense that it generally has long-term use and survives with various restorations over time. On the other hand, these buildings with spiritual and symbolic value are the types of buildings that attract attention in their immediate surroundings. In addition to all these, accessibility to detailed information and visuals about the buildings was also taken into consideration in determining the buildings. In this direction, three buildings were identified within the scope of the study. The information obtained from the literature about the symbiotic relationship was integrated into the discipline of architecture and matched with the historical building and the annex building, and descriptive analyses of the buildings were carried out (Figure 2). Finally, the general results of the study were presented with the evaluations obtained from the analyses.

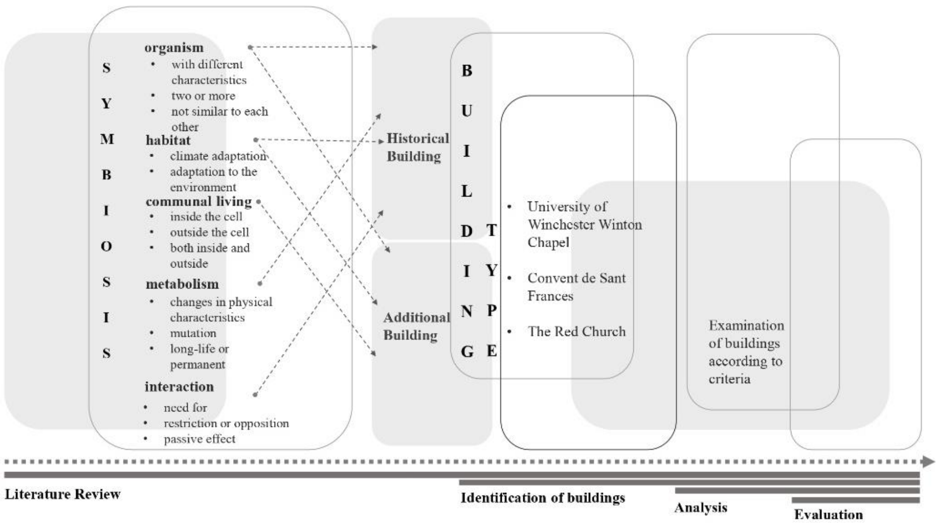

Figure 2. Research Design of the Study

The church of the Convent de Sant Frances, built in the 1700s within the Convent of Sant Frances, fell into disuse in 1835 when the monastery was looted and was renovated in 2003. The church, which is an integral part of the monastery complex, was restored with modern construction techniques and saved from ruin. With the construction techniques used, the structure has been strengthened without losing the signs of exposure. Today, it is used as an auditorium and a cultural facility in addition to its worship function (URL-2).

Winton Chapel is another one of the buildings analysed within the scope of the study. Located within the Winchester University complex, Winton Chapel was restored for the university's anniversary celebrations. The chapel was originally built in 1880 and has a vital role for all university staff and students within the campus campus. It has been fully restored inside and out, with the addition of a small side chapel and social meeting space. The building has a remarkable appearance, being described as a jewel in the university complex. Today, in addition to its religious function, the chapel hosts various events such as music choirs and concerts (URL-3).

The Red Church is another building analysed. Since the 1950s, the building has not fulfilled its original function of worship, but has been used as a building that meets the storage needs of various public buildings in the city. The historical building has been restored and transformed into a hybrid building that hosts events such as reading areas and art shows that cover cultural and social life (URL-4) (Figure 3).

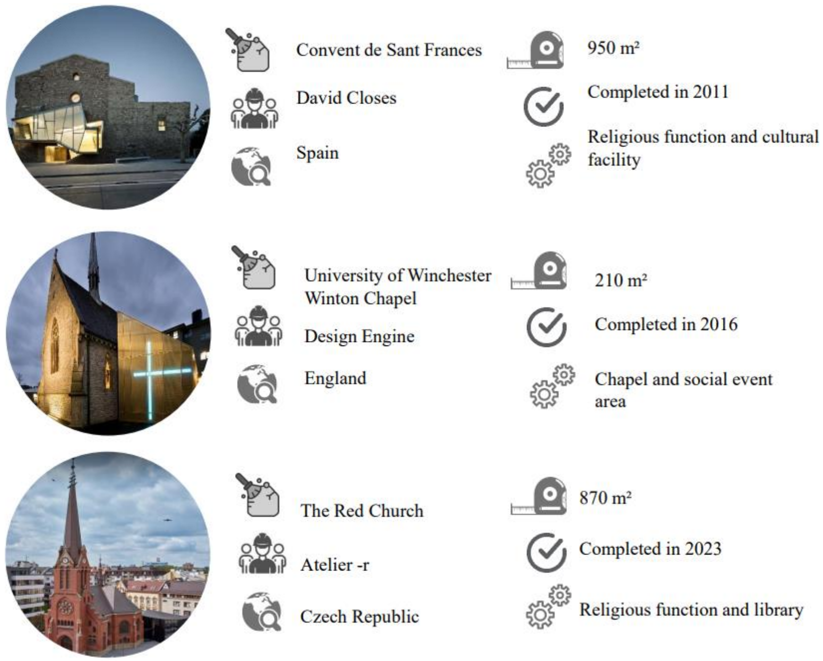

Figure 3. Buildings Analysed in the Study

3. Findings and Discussion

The church in the town of Santpedor in Spain was built between 1721-1729. The church, which had been in ruins for many years, was converted into an auditorium and multi-purpose cultural centre in 2011. Necessary additions were made due to the new function. The historical church building, which is used as a cultural facility, consists of two separate masses with different characteristics and dissimilar in terms of construction system. The historical heritage of the building was preserved by using contemporary construction system and forms in the interventions. The massive stone construction system of the historic building and the glass and steel lightweight structural circulation annex together respond to the cultural facility function. With these two contrasting construction techniques, the original physical characteristics of the historic building have changed. While the contemporary circulation annex added outside the original mass has caused the form to change, it has also enabled the formation of new functions and spaces (Figure 4).

Figure 4. Sant Fransesc Church (URL-5)

The circulation, wet areas and technical unit spaces added in the adaptation to the new function have caused changes in the volume characteristics of the original building, and the spatial organisation has changed with the increasing number of spaces. With the new stairs and ramps added, new horizontal planes were created within the church. While the staircase and ramp added in the adaptation of the historical building to the new function meets the requirements of the new function, it also supports the experience of the visitors with the route it creates within the building. The building units that emerged within the scope of these interventions were placed both outside and inside the building in order to preserve the original volume, space and aspect ratios of the church. These adaptations prevented the idle building from being demolished and destroyed over time and enabled the use of future generations (Figure 5).

Figure 5. Sant Fransesc Church (URL-5)

The various relationships between the historic building and the annex provide the opportunity for communication and interaction between environmental and social structures. The massive stone construction system seen in the historic building has minimal negative effects on the environmental systems as a renewable material. By re-functionalising the building, a possible destruction was prevented and negative effects on nature and climate such as carbon emission were prevented.

With the re-functionalisation, the use of labour and materials has been at an optimum level. In addition, contrary to the original spatial organisation, it was observed that a compatible approach was adopted with the surrounding systems in terms of resource use by providing natural light flow through the gaps opened from the ceiling.

In addition, the existing building has been functionalised within the scope of a new programme in line with the requirements of contemporary life in order to provide optimum benefit. In this context, in the transformation of the church into a cultural facility, it was primarily aimed to strengthen the building without erasing the traces of deterioration. On the other hand, the additional building, which is attached to the main structure and especially supports the circulation, does not have a meaningful functionality on its own. However, the functional and efficient use of the historical building, which is considered as a mansion, is possible with the existence of the annex structure. However, the existence of the additional building only gains meaning with the building to which it is added. It has been observed that the two buildings need each other and there is a mutual benefit between them (Figure 6).

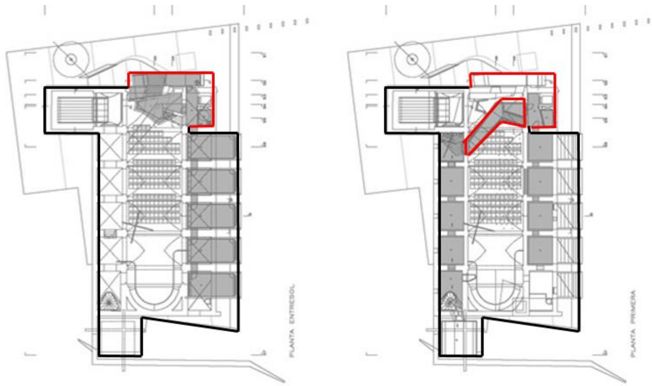

Figure 6. Plan scheme of Sant Fransesc Church (URL-6)

Winton Chapel is a prayer building built in 1880 on the campus of the University of Winchester in England. It plays a vital role in university life for students, staff and community members. In addition to worship, a number of different events such as group meetings and concerts are organised in the building. The restoration of the building was started by the Design Engine Architects team in 2015, and at the same time, an additional structure was built to increase the functional use of the spaces in the chapel.

The additional structure, which is seen to differ from the historical structure in terms of construction system and material, is covered with perforated aluminium panels. In terms of design, it is compatible with the existing building in terms of height, slope and form, but it differs with its surface coating Material (Figure 7).

Figure 7. University of Winchester Winton Chapel (URL-7)

It has been observed that the additional building located to the north of the chapel is completely outside the historic building with its design and connection type despite the existing space constraints. This situation shows that no intervention was made to the original interior spaces of the historic building. Although the main entrance of the building is provided from the historic building, there is also access to the building from the contemporary annex.

With the adaptation of the annex to the historic building, new spaces and new sightseeing routes have been created with new spaces that visitors can experience with the entrance fiction and space diversity. In terms of function, the historic building mainly consists of the main place of worship.

The annex building is a small side chapel, consisting of social and gathering space functions as well as a small place of worship. With this transformation, which responds to the changing needs of the campus, the design has received many awards, including the 2017 RIBA award. In this way, the building has become more functional and has been transferred to future generations with its active and long-lasting use without disappearing in the face of today's needs (Figure 8).

Figure 8. University of Winchester Winton Chapel (URL-7)

In the restoration of this building, which is located at the centre of the campus campus, a number of renovation works were carried out on the wall and ceiling surfaces, as well as stone floors and heating and lighting systems were strengthened. The original state of the building has been preserved and its heritage value has been respected. On the other hand, a contemporary altar in the chapel was designed in Purbeck limestone, one of the local materials of England, consisting of seven horizontal sections referring to the depiction of numbers in the Christian faith. This altar also represents the 7 periods of 25 years of the university. It is possible to see the use of natural materials in the interior design of the chapel and the annex building. Wood is preferred in many equipment designs, especially seating elements, storage units and tables.

In the annex building, there is a mezzanine window that allows both natural lighting and natural ventilation. In addition to this, with the voids created on the wall surfaces in the form of a pilgrimage, the building both takes natural lighting into the interior space and creates a spiritual effect on the visitors. Both the annex and the historical building make an effort to adapt to the environment in terms of social and climatic characteristics. Both the annex and the historic building make an effort to adapt to the environment in terms of social and climatic characteristics. The spatial and functional efficiency of the historic building has increased with the annex. The slopes and folds in the form of the annex building and the aluminium cladding material used on the facade draw attention from different distances and different scales of the building complex.

The functionality of the historical building used for worship has been increased by adding gathering and socialising spaces. In this context, while the additional building supports the historical building especially in terms of function, the historical building also contributes to the additional building spatially. The active use of the historic building, which is handled as a mansion, with new functions has been provided with the additional building. On the other hand, although the isolated existence of the annex building does not allow the creation of structurally closed spaces, there is a mutual benefit relationship between the two buildings (Figure 9).

Figure 9. Plan scheme of University of Winchester Winton Chapel (URL-8)

The Red Church is a religious building in Olomouc in the Moravian region of the Czech Republic, which has been used as a library closed to the public since 1959. The church was intended to be used as an information and art centre. In this context, while a new library building was being constructed, a modern annex was built between the historic church and the library. This annex connects the church and the library. Small concerts, art shows and conferences are planned in the church building, while reception and café functions are planned in the new annex. The church, which is intended to be used as a cultural facility, has undergone a comprehensive restoration process from the foundation to the roof in its adaptation to its new function. The building, whose historical heritage characteristic was preserved, was able to meet the new function programme with an additional building. The original church building in neo-gothic style meets the function of cultural facility and information centre together with the new building with steel structure, glass and aluminium cladding (Figure 10).

Figure 10. The Red Church, Czech Republic (URL-9)

These two contrasting construction techniques and the new function established by two separate organisms have caused changes in the physical characteristics of the original historic building, especially the façade layout. The new structure added outside the original mass has changed the spatial organisation of the church with its reception, café and library units. In order to preserve the original qualities of the historic building at the maximum level in the adaptation to the new function, the additional building responding to the additional functions was kept completely outside the church. This situation shows that the original interior spaces of the historic building were not intervened. With the aforementioned renovations, the cultural heritage value of the church, which was used as a warehouse closed to the public, has been brought to the forefront and its use for many years has been paved by preventing its aging and destruction (Figure 11).

Figure 11. The Red Church, Czech Republic (URL-9)

The relationship between the church and the annex has an impact on environmental and social systems. The church underwent a comprehensive restoration process, firstly the foundation was strengthened and dehumidified. The floors were renewed and the deterioration of the wall surfaces was repaired and the roof was rebuilt. Thus, a possible destruction of the church was prevented. In addition, by preserving the construction system and materials, the negative effects on the environment and climate in terms of carbon emissions were minimised. On the other hand, the complex, which has been turned into a small square with the social facilities added to the church garden, has become socially harmonised with the environment. The additional structure connecting the church and the library meets the environmental and climatic effects in terms of reflecting and absorbing the sun rays with the use of glass and aluminium. The interior of the annex refers to the traditional elements of the church, from the seating units to the lighting equipment. Thus, a social harmony has been achieved with the surrounding systems. The annex building, which supports the church functionally, has provided integrity with the church spaces. Functional and efficient use of the main building was made possible by the annex. At this point, it is seen that the existence of both buildings is interconnected (Figure 12).

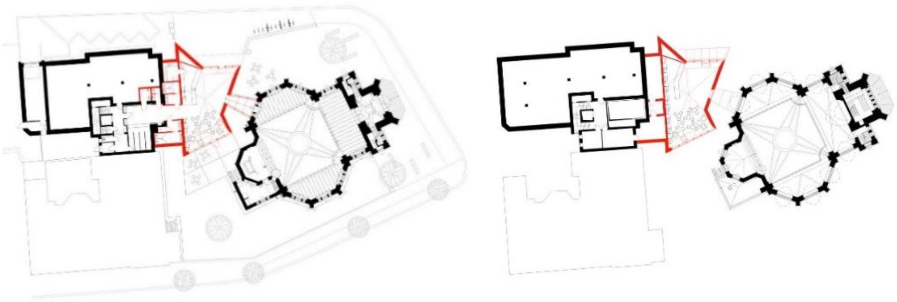

Figure 12. Plan scheme of the Red Church (URL-10)

4. Conclusion and Suggestions

Life on earth is the scene of direct or indirect relationships between species. Indirect relationships and interactions can be explained by the existence of living species. Food chain, food web and habitat changes are examples of indirect relationships between species. Similarly, the direct relationship between living things appears as symbiosis. Although these relationships are common in nature, they have evolved to increase the ability of organisms to survive and reproduce. These associations are established between terrestrial bacteria or fungi and various living species living in the depths of the ocean, from the countries where they are established, and even between human-like mitochondria and organelles (Šijaković & Perić, 2017). Coexistence, which has a number of determinant features, is in three different forms: mutual, commensal and parasitic, according to the characteristics of the relationship and interaction between living species. All of the relationships between living species have a complex and chain effect. Organisms are not alone and isolated like an island and each of them has direct or indirect relationships with other organisms. Although there is an ecological relationship between living species in symbiotic life (Myburg, 2014), there are important clues in terms of the history of life and evolution (Ferrari & Vavre, 2011). It is possible to read these relationships in the natural environment through the built environment (Yeang, 2008). While transport and infrastructure systems indirectly affect the location and functions of buildings, it would not be wrong to talk about a direct relationship between the additional structures built within the scope of new functions of cultural and historical buildings. Developing or re-functionalising the existing functions of historical buildings may create a need for additional space. Such relationships show the complexity and versatility of architectural design. Within the scope of the study, the interaction between the historic building and the newly constructed annex was evaluated within the scope of the determined symbiotic relationship parameters. In the whole sample, it can be said that the historic building and the annex building are separate organisms that are not similar to each other as at least two separate components. One of them is the historic building that preserves its original construction systems, and the other is the annex building where modern construction systems are preferred.

In terms of metabolic characteristics and abilities, it can be said that the physical characteristics of all the historical buildings considered as mansions have changed and their permanence has been ensured. It can be said that the new physical characteristics are the façade layout and usage, which are now associated with the additional building, together with all the renovations made within the scope of the restoration stages. On the other hand, it can be said that the additional structures, which are built inside and outside the historical building in a holistic way and cause changes in dimensional features such as interior volume, cause mutation in historical buildings (Table 1).

Table 1. Symbiosis Relationships in Buildings

Buildings	Organism			Metabolism			Symbiosis			Habitat		Interaction		
	Unlike each other	Two or more	With different characteristics	Changes in physical substance	Long-lived or permanent	Mutation	Inside the cell	Outside the cell	IInside or outside the cell	Adaptation to the environment	Climate adaptation	Needing	Restriction and opposition	Passive impact
Sant Fransesc Church	●	●	●	●	●	●			●	●	●	●		
Winton Chapel	●	●	●	●	●			●		●	●	●		
The Red Church	●	●	●	●	●			●		●	●	●		

Symbiotic Characteristics

The symbiosis defined between the mansion (historic building) and the simboyont (annex) is excluded from the structure within the scope of the least intervention to the structural characteristics of heritage buildings. It can be said that the quality of cohabitation - inside, outside, both inside and outside - is a factor affecting the physical and structural changes in the historic building. It would not be wrong to say that the historic building and its annex adapted to the surrounding systems and climate within the scope of living spaces. With the re-functioning, carbon emissions and intensive labour consumption that may arise during the demolition process of the buildings have been prevented. In addition, they are in integrity with other elements in the environment within the scope of both their functions and heritage values. It can be said that the interactions between the historical building and the additional building, which is the starting point of the study, are based on mutual benefit. While the permanence of the historic building depends on the annex, similarly, the annex is not independent from the historic building. In such interactions, a passive relationship with restriction and opposition can also be mentioned (Table 1). However, this study is based on the effect and value of the annex on the permanence of the historic building and the relationship between the existence of the annex and the historic building.

Living organisms often develop complex relationships with other species in order to exist in their habitats. Living things that adapt to these relationships change and transform and continue their existence. Similarly, it is clear that the elements of the built environment live in symbiosis with each other. Re-functioning, which is an important tool especially in carrying heritage buildings to the future, provides important examples in this context.

Thanks and Information Note

The e-book section complies with national and international research and publication ethics.

Ethics Committee approval was not required for the study.

Author Contribution and Conflict of Interest Disclosure Information

All authors contributed equally to the e-book section. There is no conflict of interest.

References

Ahunbay, Z. (2019). *Kültür Mirasını Koruma İlke ve Teknikleri.* İstanbul: YEM Yayın.

Athens Charter. (1931). https://www.icomos.org.tr/Dosyalar/ICOMOSTR_en0660984001536681682.pdf

Douglas, A. E. (2021). *The symbiotic habit*. Princeton University Press.

Ferrari, J., & Vavre, F. (2011). Bacterial symbionts in insects or the story of communities affecting communities. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1569), 1389-1400.

Kurokawa, K. (1994). *The philosophy of symbiosis: from the age of machine to the age of life*. London: Academy Editions

Myburg, J. (2014). *Mesoparasite: A symbiotic affair* (Yayımlanmamış yüksek lisans tezi). Unitec Institute of Technology, Auckland, Yeni Zelanda

Paracer, S. & Ahmadjian, V. (2000). *Symbiosis: an introduction to biological associations*. Oxford University Press, USA.

Parisi, L. (2009). Symbiotic architecture: Prehending digitality. *Theory, Culture & Society*, *26*(2-3), 346-374.

Peacock, K. A. (2011). Symbiosis in ecology and evolution. In *Philosophy of ecology* (pp. 219-250). North-Holland.

Šijaković, M. & Perić, A. (2018). Symbiotic architecture: Redefinition of recycling design principles. *Frontiers of Architectural Research*, *7*(1), 67-79.

Yeang, K. (2008). *Ecoskyscrapers and ecomimesis: New tall building typologies*. Council on Tall Buildings and Urban Habitat (CTBUH) 8th World Congress 2008.

URL-1 https://tropicalgrasslandsavannahksmith.weebly.com/symbiotic-relationships.html Access address (15, June, 2024)

URL-2 https://www.archdaily.com/251389/convent-de-sant-francesc (Access address 15, June, 2024)

URL-3 https://www.architecture.com/awards-and-competitions-landing-page/awards/riba-regional-awards/riba-south-award-winners/2017/univer sity-of-winchester-winton-chapel (Access address 16, June, 2024)

URL-3 https://www.archdaily.com/1002827/the-red-church-reconstruction-atelier-r?ad_medium=gallery (Access address 15, June, 2024)

URL-4 https://www.archdaily.com/1002827/the-red-church-reconstruction-atelier-r (Access address 17, June, 2024)

URL-5 https://www.arquitecturacatalana.cat/ca/obres/conversio-en-auditori (Access address 17, June, 2024)

URL-6 https://www.dezeen.com/2012/07/26/convent-de-sant-francesc-by-david-closes/ (Access address 18, June, 2024)

URL-7 https://www.designengine.co.uk/projects/winton-chapel-university-of-winchester/ (Access address 18, June, 2024)

URL-8 https://www.archdaily.com/868112/university-of-winchester-winton-chapel-design-engine-architects/58db0c09e58ece3360000162-university-of-winchester-winton-chapel-design-engine-architects-floor-plan (Access address 19, June, 2024)

URL-9 https://atelier-r.cz/en/portfolio-en/the-red-church/ (Access address 19, June, 2024)

URL-10 https://www.metalocus.es/en/news/new-vision-a-cult-space-red-church-reconstruction-atelier-r (Access address 19, June, 2024)

Venice Charter. (1964). https://www.icomos.org.tr/Dosyalar/ICOMOSTR_en0243704001536681730.pdf

Valetta Principles. (2011). https://www.icomos.org.tr/Dosyalar/ICOMOSTR_en0593034001536912260.pdf

Washington Charter. (1987). https://www.icomos.org.tr/Dosyalar/ICOMOSTR_en0627717001536681570.pdf

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Architectural Analysis and Detection and Evaluation of Structural Problems of Diyarbakır Historical Mansions

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1. Introduction

Diyarbakır is one of the historical cities that has hosted many civilizations. Walled City Region is the first settlement of the city surrounded by historical walls, which was included in the UNESCO cultural heritage list in 2015. There are many monumental and traditional buildings in the region that were built during the periods of various civilizations and contain the traces of these civilizations. Mosque, church, inn, bath, masjid etc. In addition to commercial and monumental buildings such as, there are mansions, mansions and houses of different sizes and plans that constitute the traditional civil architecture of the city.

According to Diyarbakır Provincial Yearbooks (Diyarbakır Salnameleri), there are 28 mosques, 32 masjids, 4 madrasahs, 11 churches, one each of the Rüşdiye-i Military and Civil School and the School of Civil Engineering, thirty-five Mekteb-i-İdadi, 7 libraries, 5 lodges, 6 Christian schools, 2 executive offices, 100 schools. It is stated that there are spirit levels and 130 fountains (Tellioğlu, 1999; 314).

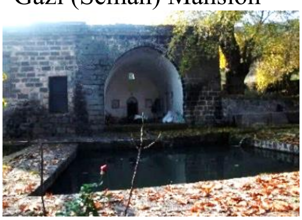
Located in the east of the Walled City Region and west of the Tigris River, there are historical mansions with the plan layout of traditional houses, where some spaces are arranged according to the climate. Historical mansions were built as summer residences outside the city walls in the city, which is under the influence of a continental climate with hot summers and cold winters. These structures are among the important architectural and cultural heritages that carry the social life, culture, tradition, and memory of the city.

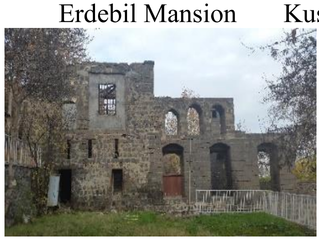
It is stated in the sources that the construction date of the majority of Diyarbakır Historical Mansions is in the 19th century. These mansions; Gazi Mansion (Seman Mansion), Erdebil Mansion, Kuşdili Mansion (Bekir Pasha), Cihannüma (Kavs) Mansion, Pamuk Mansion, Hacı Ağa Mansion, Şair Hami Mansion, Ağuludere Mansion, Ömer Bekir Pasha Mansion and Ferit Mansion. Except for the Ferit Mansion located in the northwest of the Tigris River, all other mansions are located close to each other (Figure 1).


Gazi (Seman) Mansion


Erdebil Mansion


Kuşdili (Bekir Pasha Mansion)


Pamuk Mansion


Hami Mansion


Ömer Bekir Pasha Mansion


Ağuludere Mansion

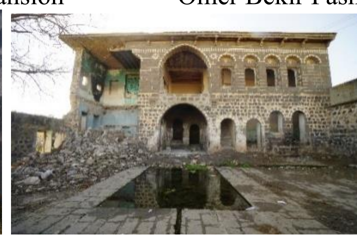

Ferit Mansion

Figure 1. Examples of Historical Mansions in Diyarbakır (2024)

Figure 2. Location of Diyarbakir Mansions (Işık, 2021)

1.1.General Description and Architectural Features of Mansions

The word mansion is of Persian origin and is defined as "a house with a garden in rural and open areas". It was expressed as "Against or Doubt" by Kaşgarlı Yusuf Has Hacip in Divanı Lügat-ı Türk[1].

Arseven (1947) mansions are classified according to their architectural definition. According to this;

• Country house in rural and open areas surrounded by trees,

• Detached and decorated, elegant house in the garden of the palace and mansion,

• House with shaded areas,

• Open or glazed rooms on the upper floors of buildings with views,

• Defined as canopies built high above the ground in rural areas.

Until the mid-19th century, Turkish Palaces consisted of separate buildings and apartments with gardens and courtyards surrounded by high walls, except that they were single structures, as in similar structures in Europe. For this reason, palaces, and mansions, which are expressed as seasonal or daily, were called "hadika"[2] until the 19th century (Eldem, 1975, p.12).

In the Turkish palace tradition, mansions consist of single volumes with a rectangular plan, usually with a sofa in the middle, and with different plans around them, with or without a "portico". Built high above the ground, these structures have dome and conical roofs and large eaves. (Kuban, 1995, p.80).

[1]Encyclopedia of Islam 1957, (6), p.923

[2] Hadika: Ağaçlı, bahçe; bostan; meyve bahçesi; etrafı duvarlarla çevrilmiş bahçe (Devellioğlu, 2004, s.309).

Mansions are generally two or three stories high, built to suit a sloping topography. The mansions, which have spaces overlooking the view, are in an introverted, tree-lined garden.

2. Material and Method

In the study, a comprehensive literature research was conducted to determine the architectural and structural features of historical mansions, which have an important place in Diyarbakır traditional city architecture. A field study was carried out to determine the current conditions of the mansions, and after the field study, the structural problems of the historical mansions were determined observationally.

By making architectural analyzes of historical mansions with their architectural features and construction techniques, structural problems were evaluated specifically for each building. The study was completed by presenting suggestions for structural problems identified in their architectural features and current conditions.

2.1. Architectural Features of Diyarbakır Historical Mansions

The historical mansions in Diyarbakır are in the east of the Suriçi Region, overlooking the banks of the Tigris River. Generally, the mansions where wealthy families in the city spend the hot summer months are built with one or two floors. Surrounded by high courtyard walls, the mansions consist of an iwan positioned in the north direction and summer rooms overlooking the Tigris River. In the mansions with bright windows and arched iwans on the ground floor, there are water elements called "selsebil" inside the iwans, and large pools of different shapes (rectangular, round, elliptical) in the courtyard of the building (Figure 3).

Gazi (Seman) Mansion

Erdebil Mansion Bekir Pasha Mansion (Kuşdili)

Figure 3. Examples of Iwans and Pools in Mansions in Diyarbakır (2024)

Many of the mansions used as summer residences in Diyarbakır are empty or abandoned. Apart from the Ferit Mansion located in the northwest of the Tigris River, Gazi Mansion (Seman Mansion), Erdebil Mansion, Kuşdili Mansion (Bekir Pasha), Cihannüma (Kavs) Mansion, Pamuk Mansion, Hacı Ağa Mansion, Hami Mansion, Ağuludere Mansion, Ömer Bekir Pasha Mansion is located close to each other.

Today, Gazi (Seman) Mansion is used as the Atatürk Museum, Erdebil Mansion is used as a restaurant-café, and the other mansions are empty or unused. This situation has caused the buildings to fall into disrepair over time and to develop structural problems.

Although the plan features of the mansions overlooking the Tigris coast are similar, their sizes are different. Mansions that have survived to the present day partially or damaged;

Gazi (Seman) Mansion:

It is in the south of the Walled City Region and west of the Tigris River. The construction date of the mansion, which is stated to be an Akkoyunlu structure in the sources (Sözen, 1971, Tuncer, 2012), is unknown. The building, which was used as a headquarters by Atatürk during World War I and belongs to Diyarbakır Metropolitan Municipality, was registered in 1993. (Çiftçi, 2007) (Figure 4, Figure 5, Figure 6).

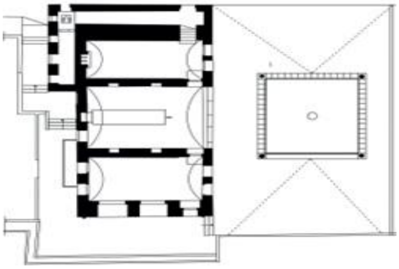


Figure 4. Gazi Mansion Plan (URL 2) **Figure 5.** Gazi Mansion (URL3)

Figure 6. Gazi Mansion North and South Facade (2024)

Kuşdili Mansion (Bekir Pasha Mansion, Özbay Mansion)

It is located between the Suriçi Region and the Gazi Mansion and Erdebil Mansion in the south of the city. In the sources, it is stated that according to the inscription on the mansion, it was built in 1904 (Çiftçi, 2007) and was called Bekir Pasha Mansion (Tuncer, 2012). The mansion, which belongs to Ahmet Hazım Özbay, is registered and is currently empty and not actively used (Figure 7).

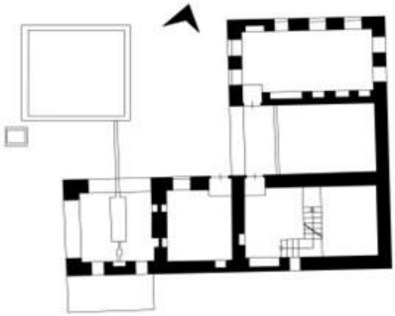


Figure 7. Kuşdili Mansion Plan (Çiftçi, 2007)

Figure 8. Kuşdili Mansion (2024)

The L plan type building was built as two floors. In the southwest of the ground floor, there is a double-arched iwan section with a rectangular pool in the middle and another pointed-arched iwan facing west. There is a square shaped pool in the northwest of the building (Figure 9).

Figure 9. Kuşdili (Bekir Pasha) Mansion (2024)

Hami Mansion

It is in the Mansions Region, in the southeast of the Suriçi Region. The building, which is stated in the sources to have been built in 1727, belongs to the poet Ahmet Hami (Tuncer, 2012). The building, which consists of a basement, ground floor and first floor, has an iwan with a "selsebil" on the ground floor, a Turkish bath, an observation terrace, and a staircase leading to the first floor. Many parts of the damaged building were destroyed, the south wall where the "selsebil" was located and the ruins of a few spaces have survived to the present day. The basement floor, which was used as a stable in the past, is covered with a barrel vault. Today, the building is empty and neglected (Figure 10, Figure 11, Figure 12).

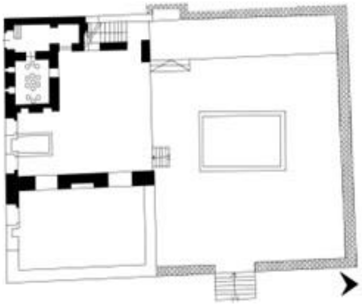


Figure 10. Hami Mansion plan (Çiftçi, 2007)

Figure 11. Hami Mansion (2024)

Figure 12. Hami Mansion (2024)

Erdebil (Fevzi Bey, Ber Der-I Pır) Mansion

It is in the south of the Suriçi Region, in the Mansion region west of the Tigris River. The exact construction date of the mansion is unknown, but sources state that it was built during the Akkoyunlu Period (Tuncer, 2012), towards the end of the 19th century (Tekin, 1997). The building, which belongs to the İbrahim Hafid Pasha Foundation, was used by the Ocak Family until 2004. It is stated in the sources that it is called "Ber Der-ı Pır" among the people (Çiftçi, 2007).

The building, which has a rectangular plan, consists of a basement, ground and first floor. The structure with a barrel vault and pointed arch iwan on the axis of the northern façade is like the Gazi Mansion in terms of plan and facade layouts. The facade layout is an alternating pattern of basalt and limestone. In the building, instead of a water table, there is a large window in the center. The first floor is reached by the stairs located in the west direction. The two-storey western section of the iwan has a large terrace opening to the east. The building has a rectangular pool on the north facade (Figure 13, Figure 14).

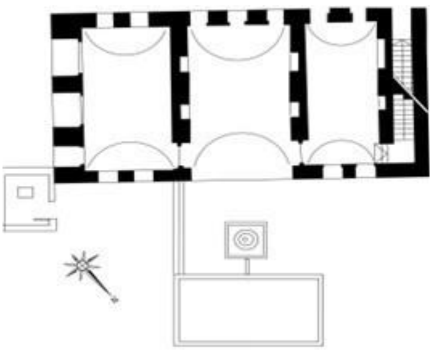


Figure 13. Erdebil Mansion plan (Çiftçi, 2007)

Figure 14. Erdebil Mansion (2024)

Ağuludere Mansion

It is in the south of the Suriçi Region and in the southwest of the Mansions Region. The building was registered by the Diyarbakır Cultural and Natural Heritage Preservation Board in 1996, but there is no exact information about its construction date. In the sources (Gürhan et al. 2018)

19th century. late or 20th century. It is stated that it was built in the beginning (Figure 15, Figure 16).

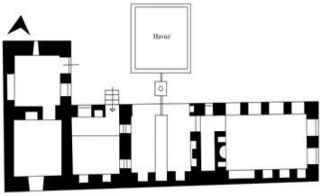


Figure 15. Ağuludere Mansion plan (Gürhan vd. 2018)

Figure16. Ağuludere Mansion (2024)

Pamuk Mansion

It is in the Mansions Region, west of the Tigris River and north of the Gazi Mansion. The construction date of the mansion is unknown, according to sources (Çiftçi, 2007) in the late 19th century or 20th century. It is stated that it was built in the early 1960s and is an Ottoman period structure. There is a pool in almost square form in front of the iwan on the east façade (Figure 17, Figure 18)

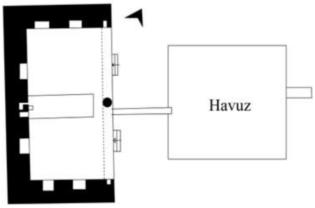


Figure 17. Pamuk Mansion plan (Gürhan vd. 2018)

Figure 18. Pamuk Mansion (2024)

Bekir Pasha (Ömer Bekir Pasha) Mansion

It is in the south of the Suriçi Region, overlooking the Hevsel gardens. Although the exact date of construction is not known, sources state (Çiftçi, 2007) that it is the 19th century. It is stated that it was built in the late and early 20th century and was named Ömer Bekir Pasha (Figure 19, Figure20)

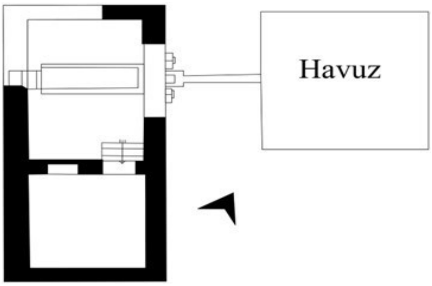


Figure 19 Bekir Pasha Mansion (Gürhan vd. 2018) **Figure 20.** Bekir Pasha Mansion (2024)

The mansion consists of a ground and basement floor. The building, which has a rectangular plan, has a room and a single-span iwan crossed by a pointed arch. The building has a pool in front of the iwan, and there are water fountains in the iwan section and niches on the walls. The mansion is not actively used today (Figure 21).

Figure 21. Bekir Pasha iwan and selsabil (2024)

Hacı Ağa Mansion

It is in the Mansions Region in the south of the Suriçi Region. The exact construction date of the mansion is not known. It is stated in the sources (Çiftçi, 2007) that the construction date belongs to the Ottoman Period in the 19th century. The mansion has survived to the present day in a heavily damaged state (Figure 22, Figure 23).

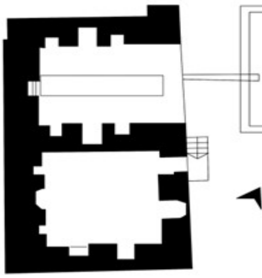


Figure 22 Hacı Ağa Mansion plan (Gürhan, 2018) **Figure 23.** Hacı Ağa Mansion (2024)

The building consists of a single storey iwan and a room to the south. The upper cover and most of the walls of the building, which has a water fountain in its iwan, have been destroyed. There is a rectangular pool in front of the building, which has niches on the room and iwan walls. An unqualified reinforced concrete beam was built instead of the arch of the building whose iwan arches were demolished (Figure 24).

Figure 24. Hacı Ağa Mansion and Delsabil (2024)

Kavs (Cihannuma, Çarbağ) Mansion

The mansion, located in the south of the Walled City Region and east of the Tigris River, was destroyed and has survived to the present day as a few masonry ruins. The building, whose construction date is stated as 1597 or 1634, is located far from the Mansions Region and close to Kırklar Mountain, where the Tigris River curves. In the sources (Tuncer, 2012), it is named as Aziz Mahmut Urmevi and Kavis Mansion and “Çarbağ Mansion” (Figure 25).

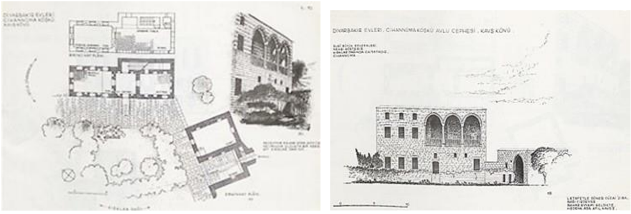


Figure 25. Kavs Mansion Plan and West Facade (Erginbaş, 1954)

The building, built on sloping land, was built as a two-storey building before it was demolished. In the sources, it is seen that there is a second wing with a single storey iwan directed to the northwest of the building and this structure is present in the images. On the first floor of the two-storey building, there is a three-eyed iwan crossed by pointed arches and directed to the courtyard in the west (Figure 26, Figure 27).

Figure 26. Kavs Mansion 1971 (URL 1)

Figure 27. Kavs Mansion ruins (2024)

Ferit Mansion

It is in the north of the Walled City Region, east of the inner castle walls, and northwest of the Tigris River. The mansion in the north of Ferit Köşk District of Fiskaya District has survived to the present day as empty and heavily damaged. Although it is stated in the sources (Tuncer, 2012) that it was built during the time of Ferit and Necip Pasha, who were governors in 1915, or that it may have belonged to Ferit Bey, who was the chief inspector of the courthouse at the time, the exact construction date of the mansion is not known (Figure 28, Figure 29).

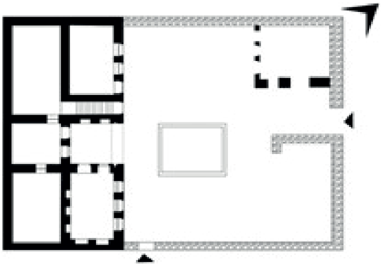


Figure 28. Ferit Mansion plan (Çiftçi, 2007)

Figure 29. Ferit Mansion north facade

Ferit Mansion was built as two floors using the masonry construction technique. The entrance of the mansion, in its original architecture, is in the southeast direction of the courtyard, and the entrance was closed later. The courtyard of the mansion, surrounded by high walls, is entered through an open gap in the north. There is a kitchen with a stove in the northwest of the courtyard. The ground floor entrance of the mansion is provided through a semicircular arched iwan. The upper floor of the mansion, which has an iwan on the ground floor and first floor, is reached by a single-armed stone-stepped staircase.

3. Findings and Discussion

Historical buildings are important cultural and architectural heritage that must be protected within the society and environment in which they are located. Mansions are buildings with a unique architecture and a traditional residential plan layout that are used as summer places due to their location. These structures have limited use only in the summer months, are located on sloping terrain, natural conditions and lack of maintenance, abandonment, etc. Partial or total deterioration and damage have occurred in the process of reaching the present day due to reasons such as. In some mansion buildings, failure to eliminate structural problems caused by deterioration and damage and failure to preserve the structures in their current condition has led to these structures entering a process of irreversible deterioration.

3.1. Structural Problems Identified in Diyarbakır Historical Mansions

It ensures the historical continuity of societies by preserving their cultural values and transferring these values from the past to the present and the future. The widespread and acceptance of the concept of conservation in recent years has increased conservation awareness. Increasing interest in historical buildings, people's curiosity, and desire to see these buildings, and their economic benefits have led to an interest in these buildings and the environment in which they are located. This situation contributed to the sustainability of the buildings through conservation, rearrangement, and functionalization.

In cities with historical and cultural values, "urban protection" is possible by preventing the destruction of historical and valuable buildings. To transfer these structures to future generations,

Protecting against impacts is one of the main principles of urban conservation (Keleş-Hamamcı, 1997:120).

The most important factor that causes the deterioration of historical buildings is the abandonment of these buildings. Unused structures may begin to deteriorate rapidly under the influence of external environmental conditions and may become damaged to the point of structural problems over time. It has been determined that many deterioration and structural problems have occurred in all Diyarbakır mansions due to neglect and abandonment, except for the structures that are functional and actively used.

Gazi (Seman) Mansion: Periodic maintenance and restoration of the building, which is in the southwest of the Tigris River in the Mansions Region and functioned as the Ataturk Museum, prevented deterioration and damage. However, in some places there are partial deteriorations due to plaster swelling due to moisture. The mansion, which is frequently visited today, is actively used (Figure 30).

Figure 30. Gazi (Seman) Deterioration in Plaster Due to Moisture in the Mansion (2024)

Erdebil Mansion; The building has been used as a restaurant-café and is actively used. The building, which is quite high above the road elevation, can be reached by vehicle. Apart from contamination due to outdoor conditions on the facades of the building, no deterioration or damage that would cause structural problems was observed (Figure 31).

Figure 31. Partial Deterioration Due to Facade Contamination in Erdebil Mansion (2024)

Kuş Dili Mansion (Bekir Pasha Mansion, Özbay Mansion);

The building is privately owned and is not actively used today. The building, which generally has no structural problems, is kept closed by the property owner. The first-floor slab and soil roof slab of the building, which was built with the masonry construction technique, were renewed with reinforced concrete slab. In addition, the losses in the first-floor walls were covered with unqualified briquette and brick materials (Figure 32).


Figure 32. Completion of Reinforced Concrete Cover and Walls With Bricks

Hami Mansion: The building has survived to the present day empty and abandoned. The upper cover and iwan walls of the building, which was not used and abandoned by the property owners, were demolished. The first-floor flooring and stairs of the building were damaged, and the upper floor windows were partially covered with unqualified materials (Figure 33).


Figure 33. Demolition of the Roof and Walls in the Hami Mansion (2024)

Ağuludere Mansion; The building is empty and unused today. Many walls of the heavily damaged building have collapsed and there is no upper cover. The northern wall on the first floor of the building, whose floodgates and iwan arches have survived to the present day, is unsupported and heavily damaged, and all the other walls have collapsed. The window and arch gaps on the south facade of the building have been closed (Figure 34)

Figure 34. The Roof Cover and Collapsed Walls in the Ağuludere Mansion (2024)

Pamuk Mansion; The mansion, which has two arch openings, is not used today. The iwan walls of the mansion, built with basalt stone material, were covered with plaster and paint. There are deteriorations in the unused structure due to soot and material losses. Partial damage occurred in other parts of the mansion, which has a small water fountain in its iwan, due to neglect and abandonment (Figure 35).

Figure 35. Deterioration Due to Neglect and Abandonment (2024)

Hacı Ağa Mansion; The building is empty and heavily damaged. The upper cover and walls of the iwan in the north were destroyed, and only the water fountain in the iwan has survived to the present day. Instead of the arch of the iwan, a wall was built, and reinforced concrete beams were added to it. The space to the northwest of the empty and unused building could not be entered because it was closed (Figure 36).

Figure 36. Ağuludere Mansion Floodplain and Collapsed Wall (2024)

Ferit Mansion; The mansion, located in the northwest of the Tigris River, is privately owned and empty. The mansion has structural problems, with damage increasing over time due to neglect and abandonment. The upper cover of the mansion, where no comprehensive restoration work was carried out other than simple repairs, was replaced with reinforced concrete flooring. Partial collapse occurred in the interior walls and floors of the ground and first floors, and the eastern part of the wall on the north facade was destroyed (Figure 37).

Figure 37. Wall and Floor Damage in the Ferit Mansion (2024)

Bekir Pasha (Ömer Bekir Pasha) Mansion; The building consists of a Selsebilli, an iwan crossed by a pointed arch, and a room, but it is not used today. The interior of the iwan is covered with plaster and paint and there are moisture problems. There are partial losses in the building walls due to outdoor conditions and lack of maintenance (Figure 38).

Figure 38. Moisture Damage in Bekir Pasha Mansion (2024)

Kavs (Cihannuma, Çarbağ) Mansion; In the past, the mansion was two-storey and had an L plan layout, but it has not survived to the present day. It is thought that the fact that the structure, which was destroyed, and a few wall ruins remained, did not survive to the present day, is a significant loss in terms of the cultural inventory of the city (Figure 39).

Figure 39. Ruins of the destroyed Kavs Mansion (2024)

4. Conclusion and Suggestions

The mansions built in high positions west of the Tigris River in Diyarbakır are among the cultural and architectural heritage that should be protected, bearing the traditional civil architectural style of the city, built by families active in the administrative and social life of the city.

Due to the hot climate, most of the mansions, which are located close to the banks of the Tigris River and are generally located on sloping land, where summer spaces are designed, with a large rectangular pool in the courtyard and water fountains and small pools in the iwan, are unfortunately not actively used today. Among these mansions, only the Gazi (Seman) Mansion was used as the Atatürk Museum and the Erdebil Mansion was used as a restaurant-café. Other mansions were not used actively by their owners and were abandoned. Repair and restoration work could not be carried out in the mansions, some of which temporarily resided in the mansions, and they have survived to the present day, generally empty and neglected.

In the mansions built using local basalt stone in the masonry construction technique and used as summer residences, partial deterioration and damage and structural problems have occurred over time due to external environmental conditions, neglect and abandonment, and user influence. Kavs (Cihannuma) Mansion was destroyed, and a few wall ruins remained. Hacı Ağa Mansion, Hami Mansion, Ferit Mansion are heavily damaged buildings with structural problems. The fact that most of the mansions are privately owned and unused has caused the problems and damages of the buildings to increase over time. It is important and necessary to urgently protect the mansions, which have not been restored and repaired and are not used and are exposed to neglect and outdoor conditions. In this context, to ensure the active participation of mansions in the inventory of urban cultural structures again.

- Unregistered mansions should be registered immediately. To ensure the protection and functionalization of the mansions, if necessary, an urgent expropriation decision should be taken, and functionalization works in line with the original should be initiated.
- In case of no expropriation, property owners should be encouraged to prepare survey, restoration, and restitution projects to protect the mansions and ensure their social and cultural sustainability.
- Environmental and zoning regulations should be made to ensure access to mansions located in high positions.
- Before starting the repairs in the mansions, the necessary safety precautions should be taken, and a covering system should be used to ensure protection against external environmental conditions.
- The collapsed walls and floors of heavily damaged mansions must be evacuated from the building without damaging the structure. In mansions with structural problems, the entire structure, especially the damaged walls and floors, should be suspended to prevent collapse. Reinforcement projects should be prepared for structural problems.
- Arrangements should be made to preserve the original architecture of the mansions that will be re-functioned after the

repairs. Re-functioning the mansions or using them with their original function will contribute greatly to the preservation and survival of these structures and will prevent them from being demolished and destroyed.

- Mansions should be made sustainable by repairs and restorations that will contribute to the city's economy and tourism.
- Arrangements should be made in accordance with the regulations and laws that ensure the protection of the current structure during the repair and post-repair functions in the mansions. Care should be taken to ensure that spaces that need to be added, such as wet areas (WC, sink, kitchen, etc.), are constructed with recyclable materials.
- Furnishings that reflect the cultural and social culture of the city should be made in the mansions that will be used after restoration, and they should be highlighted as architectural structures that promote the city.

As a result, Diyarbakır historical mansions are among the architectural heritages that have an important place in the social and cultural life of the city. For this reason, these structures must be preserved and kept alive and transferred to future generations with their social, cultural and originality. The contribution of all non-governmental organizations, especially local governments, and civil administrations, as stakeholders in the preservation of these structures will ensure that the structures and the traces of social and cultural life, they carry will be kept alive.

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References

Ahunbay, Z., (2011) Tarihi Çevre Koruma ve Restorasyon, *Yapı Endüstri Merkezi Yayınları*, İstanbul.

Arseven, C.E. (1947). (Köşk Maddesi), *Sanat Ansiklopedisi.* II. İstanbul,1139–1140.

Aygün, H.M. (2011). Kültürel mirası korumada katılımcılık. *Vakıflar Dergisi*. Sayı: 35

Bektaş, C., (1992), Koruma Onarım, *YEM Yayınları*, İstanbul.

Coşkun, M. (2005) Son dönemlerde çıkartılan yasalar çerçevesinde türkiye'de doğal, tarihi ve kültürel değerlerin korunmasında yerel yönetimlerin değişen rolleri. *Planlama Dergisi* TMMOB Şehir Plancıları Odası Yayını 2005/1 ISSN 1300-7319 Sayı: 31

Çiftçi, P., (2011) Diyarbakir Mansion Buildings, heritage of Civilizations Diyarbakir architecture, Diyarbakir.

Declaration of Amsterdam (1975): Congress on the European Architectural Heritage.

Develioğlu F. (2004). *Ottoman-Turkish Encyclopedic Dictionary*, Ankara: Aydın. Bookstore.

Eldem, S.H. (1975). *Köşkler ve Kasırlar*. II. (1969–1974). İstanbul.

Enlil, Z. (1992). Tarihi Bir Çevreyi Yaşatmak: Paris ve Bologna'da Bütüncül Koruma Yaklaşımları. Yerleşim Yazıları (Ed. A. Ökten) İstanbul: *YTÜ Mimarlık Fakültesi Yayını:* 199-201

Erder, C. (2007), *Tarihi Çevre Bilinci,* Ankara: ODTÜ Mimarlık Fakültesi. Ankara.

Erginbaş, Doğan (1954). *Diyarbakır Evleri*. İstanbul: Pulhan Matbaası

Halifeoğlu, F. M. (2007). Traditional Diyarbakır houses and reuse problems. *International Sinan Symposium: Historical City and Housing in Local Architecture,* 107-112, Edirne.

Halifeoğlu, F.M. Işık; N, Tekin, M, Güzel, E. İpekyüz, D.& Erkoç, B., (2020). Reused problems in traditional architecture: diyarbakır houses sampling. *International Journal of Social Research / The Journal of International Social Research*, Volume: 13 (75): 383-395.

Halifeoğlu, F.M& Gökçay, G. (2013). Restoration and refunction problems of Diyarbakır Traditional Houses. *Journal of Cultural Heritage* 14 (3):34-S37 .

Işık, N. (2021) Investigation of structural problems in Diyarbakır traditional houses in terms of materials and construction systems. *7th International Engineering and Architecture Congress*. Ankara.

Işık, N. (2021) Evaluation of refunctioning/adaptive reuse in terms of cultural tourism in the conservation of architectural heritage: The Example of Diyarbakır Ferit Köşk (Mansion). *Geographies, Planning & Tourism StudioS* Journal, 1 (2),.923

Keleş, R., & Hamamcı, C. (1997),*Çevrebilim,* Ankara, İmge Yayınevi.

Kılıç, Gürhan, P. (2016) Water structures (Pool, Selsebil, Serdab) as a design element in Diyarbakir civil architecture. *Fırat University, Institute of Social Sciences, Department of Islamic History and Arts*. Elazığ.

Kılıç, Gürhan, P. Aytaç, İ. (2018) The Example of Selsebilli Pool in Diyarbakır: Gazi Köşkü Selsebilli Pool, *e-oriental scientific research journal/journal of oriental scientific research (JOSR)* ISSN: 1308-9633 4 (22):1626-1652.

Köksal, G. (2012). Kültürel Miras Yönetimi. Eskişehir: T.C. *Anadolu Üniversitesi Yayını*, I. Baskı, Web-Ofset.

Kuban, D., (2000), *Tarihi Çevre Korumanın Mimarlık Boyutu Kuram ve Uygulama*, Birinci Baskı, YEM Yayını, İstanbul.

Kültür ve Tabiat Varlıklarını Koruma Kuruluna yönelik 5226 sayılı yasası

Orbaşlı, A. (2008). *Architectural Conservation*, London: Blackwell.

Schmidt, L. (2009). *Architectural Conservation: An Introduction*, Berlin: West-Kreuz Verlag

Tellioğlu, Ö. (1999). *Salname-i Diyarbakır- Diyarbakır Salnameleri,* Cilt.3. s.314, Diyarbakır Büyükşehir Belediyesi Yayınları. Diyarbakır

Tuncer, O. C., (1999). *Diyarbakir Houses,* Diyarbakir Metropolitan Municipality Publications, Ankara.

Tuncer; O.C. (2012). *Diyarbakir Suriçi Monuments, Mansions, and*

Vineyard Houses, Diyarbakir Metropolitan Municipality Publications": 411. Diyarbakır.

Yung, H. K. E. &Chan, H.W. E. (2012), Implementation Challenges to the Adaptive Reuse of Heritage Buildings: Towards the Goals of Sustainable, Low Carbon Cities", *Habitat 552 International*, 36: 352.

URL1 https://www.facebook.com/296205680832077/photos/a.416025368850107/518680971917879/?type=3

URL 2 https://focusmimarlik.com/

URL3 https://isteataturk.com/g/icerik/Diyarbakir---Gazi-Semanoglu-Kosku/1381

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The Use of Textile Recycling in Building Facades and Finishing Materials

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1. Introduction

The world population is projected to grow significantly, reaching 11.2 billion by 2100, which will lead to increased production and waste in the construction and textile sectors. Consequently, the focus on sustainability has intensified, prompting extensive research on recycling, upcycling, reuse, and reduction across various disciplines and sectors.

The starting point of this study is to investigate the production of innovative building materials by using textile wastes as a resource to support The Sustainability Development Goals (SDGs), sustainable architecture, and the circular economy. It puts stress on different usage areas of textile wastes other than the usual ones as insulation materials or concrete additive materials. It is focused mainly on building facades and interior finishing materials.

Textile waste holds significant potential as a valuable resource for creating innovative building materials. These materials mostly include (1) awnings and sunshades used as exterior shading elements, (2) geotextiles for vertical gardening applications and building exterior facade systems, (3) building exterior shell materials that integrate with other components in facade systems, and (4) finishing materials or partition walls that enhance both acoustic performance and interior design. Utilizing textile waste in the production of these materials aligns with principles of sustainable architecture, and circular economy.

Theoretical researches and implementation studies that have been done via the collaboration of universities and research institutes with architects and engineers as professionals and producers help accelerate the development of such innovative materials, contributing to the achievement of the

Sustainable Development Goals (SDGs). The results of this study show that mainly the following SDGs can be supported;

- Sustainable Cities and Communities (SDG 11): Enhancing urban living conditions through innovative materials.
- Responsible Consumption and Production (SDG 12): Promoting the efficient use of resources and sustainable practices in material production.
- Life Below Water (SDG 14): Reducing marine pollution by repurposing textile waste.
- Life on Land (SDG 15): Preserving terrestrial ecosystems by minimizing landfill waste.
- Partnerships for the Goals (SDG 17): Fostering collaborations that drive progress toward these sustainable objectives.

Another result obtained from this study is that innovative building materials that can be produced and developed from textile wastes have the potential to realize the relevant items of the sustainable architecture design criteria and methods related to the criteria.

The study is composed of five sections beginning with an introduction summarizing the importance of the topic. The second section includes an overview of the textile industry and textile wastes in the world and in Türkiye. The third and the fourth sections present recycling of textile waste for sustainable development and usage of textile wastes as building materials for sustainable architecture respectively. The conclusion includes the proposals developed for the transformation of textile waste into innovative building materials and for increasing research, collaboration, incentives, and awareness about the topic.

1.1.An Overview of the Textile Industry and Textile Wastes

The textile and ready-to-wear industry; is defined as the sector that covers fiber preparation, weaving, yarn, printing, knitting, dyeing, cutting, finishing, seaming, and production processes and is generally grouped as ready-to-wear, furniture, and technical textiles according to end-use (Öngüt, 2007). Textile: The ready-to-wear and fashion industry is positioned as an important sector in the economy with three main headings fabric production, marketing, and consumption activities (Mangır, 2023).

The global textile market was valued at €941.19 billion in 2021. It is projected to experience a compound annual growth rate of 4% between 2022 and 2030. The increase in clothing demand with e-commerce platforms affects the growth of the market. With the increase in clothing spending, the fashion segment accounted for more than 73% of the global revenue share in 2021 (Nistorac & Loghin, 2023).

According to the Textile, Ready-to-Wear, Leather and Leather Products Sectors Report 2021 published by T.R. Ministry of Industry and Technology, General Directorate of Industry (MoITGDoI, 2022), Türkiye has a 3.2% share in world exports. The textile sector constitutes approximately 10% of the Gross Domestic Product (GDP) in Türkiye and is one of the important sectors in Türkiye as well as in the world (T.C. Ministry of Industry and Technology & Bursa Eskişehir Bilecik Development Agency [MoIT & BEBDA], 2021).

In 2021, Türkiye ranked 4th among the top ten textile exporters, following China, India, and the USA, while placing 6th among the top ready-to-wear exporters, behind China, Bangladesh, Vietnam, Germany, and Italy. Türkiye was also the 7th largest textile importer, with the USA, Vietnam, and China leading the imports. In terms of ready-to-wear imports, Türkiye was not among the top ten, which were led by the USA, Germany, and France (MoITGDoI, 2022), As of December 2023, Türkiye's main textile export destinations included Italy, Iran, Spain, the USA, and Belarus, with fabrics, fibers, and yarns being the primary sub-sectors. For ready-to-wear exports, Germany, the Netherlands, the United Kingdom, Spain, and France were the top destinations, with outerwear, clothing accessories, home textiles, other ready-made goods, and bed clothes-bathrobes being the main sub-sectors. (Bursa Chamber of Commerce and Industry R&D and Projects Directorate [BCoCIRDPD], 2024). Globally, China remains the largest producer and consumer of cotton, while Türkiye ranks 7th in cotton production and 5th in consumption. The worldwide fiber demand is projected to reach 140 million tons by 2030, up from 100 million tons in 2018 (MoITGDoI, 2022). Key textile manufacturing regions in Türkiye include İstanbul, Bursa, Gaziantep, Kahramanmaraş, Uşak, İzmir, Denizli, Adana, and Tekirdağ (MoIT & BEBDA, 2021).

Based on the research conducted by Rashid, Khan, Haque, & Hasanuzzaman (2023), it can be interpreted that the amount of textile waste will be affected by the projected increase in the population and the textile and apparel market.

In the research conducted by Rashid et al. (2023), it is mentioned that the annual textile waste amounts of China, the United Kingdom, and the USA are estimated to reach 26.0, 1.0, and 12.4 million tons, respectively, due to the higher than expected production of global fiber production in 2018. In 2016, the fashion industry generated 92 million tons of waste, representing 4.3% of the total waste produced worldwide. Furthermore, the primary processing stage of the raw material accounted for more than 35% of pre-consumer waste. 20% of post-consumer waste is recycled or reused, and 80% goes to incinerators and landfills. In 2018, the amount of textile waste at the European level was determined as 2.3 million tons. In 2018, the quantity of textile waste generated at the European level was determined to be 2.3 million tons. Approximately 5.8 million tons of textiles are discarded by end consumers annually in the European Union (EU). Of this total, 1.5 million tons are recycled, while 4.3 million tons are sent to municipal waste incinerators and landfills. These amounts demonstrate the potential of textile waste as a secondary raw material (Nistorac & Loghin, 2023).

According to 2014 data, approximately 800 thousand tons of textile waste was generated in a year in Türkiye. 350 thousand tons of these wastes, 450 thousand tons of which are fiber textile products, are caused by domestic waste. When both domestic waste and industrial wastes are evaluated together, approximately 1,155,000 tons of recyclable textile waste has been generated in Türkiye. Approximately 2,500 tons of used clothing and textiles are discarded as waste on a daily basis. According to waste collection statistics, this quantity of waste is included in the category of textile waste, which represents 3% of the total amount of waste (MoIT & BEBDA, 2021).

The amount of textile waste (Manufacture of textiles, wearing apparel, and leather products) produced by manufacturing industry sub-sectors in Türkiye is 614,739 tons in 2018, 642,514 tons in 2020, and 824,364 tons in 2022 (Turkish Statistical Institute [TUIK], 2021; TUIK, 2023)

One of the primary causes of the increasingly severe climate crisis worldwide is inadequate and unregulated waste management. This study explores ways to beneficially utilize textile waste in the construction industry to mitigate environmental impacts. It is based on a literature review. The following sources were consulted in the preparation of this study: DergiPark Academic, Google Scholar, Presidency of the Republic of Türkiye Presidency of Strategy and Budget Specialization Theses, SpringerLink, ResearchGate, Sciendo, T.C. Sanayi ve Teknoloji Bakanlığı Kalkınma Kütüphanesi (The T.C. Ministry of Industry and Technology Development Library), T.C. Sanayi ve Teknoloji Bakanlığı Sektör Raporları (The T.C. Ministry of Industry and Technology Sector Reports), The Bursa Chamber of Commerce and Industry Sector Reports, ScienceDirect, Ilbank Incorporated Specialization Theses.

1.2.Textile Waste Recycling for Sustainable Development

"Recycling" is defined as the recycling of waste for direct or regenerative use as a raw material, "Reuse" is defined as the full or partial use of the waste produced to create other products, either directly, through repair or remanufacture, and finally "Reduction" is defined as reducing the use of resources, waste, and environmentally harmful outputs in the processes covering production and consumption (Yang, Zhou & Xu, 2014).

On the other hand, the circular economy system that is mandatory for sustainable development is defined by the concept of 3R, which stands for Recycle, Reuse, and Reduce. The circular economy approach in the textile sector can be achieved by creating a plan where each stage supports the other and generates no waste, re-evaluating textile waste produced during both production and post-use by integrating it into another production process (Macit, Tayyar, Şevkan Macit, & Alan, 2019).

The recycling process in the textile industry is the re-evaluation of pre-consumer and post-consumer textile wastes and obtaining textile or non-textile products again (Macit et al., 2019). The first step of recycling in the textile industry is the separation process, then it can be recycled by mechanical, thermomechanical, and chemical methods (Özdinç, 2021).

Tripathi, Sharma, Bala, Thakur, Singh, Dashora, ..., & Gupta (2024) examined the latest technologies used in the conversion of textile wastes into value-added products under the following headings; *Pyrolysis, hydrothermal method, gasification, biological method, glycolysis, ammonolysis, enzymatic hydrolysis, microbial engineering, bioethanol, biogas, bioplastics, renewable textile polymers, PLA fibers and synthetic fibres, thermomechanical recycling, monomer recycling, polymer recycling, succinic acid, cellulase, building construction material from textile waste* (Tripathi et al., 2019).

The re-evaluation of textile wastes generated during the production stages or after use makes the textile industry one of the most suitable sectors for recycling (Macit et al., 2019).

The recycling of textile waste presents a significant opportunity to develop innovative and eco-friendly materials that can be used in various sectors. This study conducts a comprehensive investigation into materials used in the construction industry, which offers important opportunities for each component of sustainability.

3. Findings and Discussion: Usage of Textile Wastes as Building Materials for Sustainable Architecture

Sustainable architecture and its criteria are one of the most important prerequisites for sustainability. The concept of sustainability, which has various interpretations in the literature, was first brought to attention at the United Nations Conference on the Human Environment held in Stockholm in 1972. This conference addressed environmental and ecological issues on a global scale, and developed principles emphasizing the connection between economic and social development and the environment, influencing environmental policies worldwide. On the other hand, Keitsch (2012) identifies the main criteria of sustainable architecture as follows: minimizing buildings' negative environmental impact by improving efficiency and reducing the use of materials, energy, and space; implementing design measures that relate to and adapt the form to the site, region, and climate; and fostering a harmonious, enduring relationship between inhabitants and their surroundings by emphasizing the principles of good form-giving (Zainal Abidin, Sigurjónsson, Liem, & Keitsch, 2008). All of these criteria support the 17 Sustainable Development Goals (SDGs) as seen in figure 1 (“American Library Association” [ALA], 2024).

Figure 1. The 17 Sustainable Development Goals ("ALA", 2024).

It can be summarized as that sustainable architecture is evident in a building's materials, construction methods, resource use, and overall design. The design must support sustainable operation throughout the building's life cycle, including its eventual disposal. While ensuring functionality and aesthetic quality, the space must be constructed with a focus on long-term energy and resource efficiency.

According to Kim & Rigdon (1998), three fundamental principles can be mentioned in sustainable architecture. These principles are resource conservation, life cycle design, and human-centered design. Resource conservation involves reducing, reusing, and recycling the natural resources used in a building. Life cycle design provides a methodology for analyzing the building process and its impact on the environment. Human-centered design focuses on solutions that emphasize interactions between people and the natural world. The principles they mentioned a quarter century ago have been still providing broad awareness of the local and global environmental impacts of architectural consumption. Belek & Yamaçlı (2023) indicate that while sustainable architecture is a set of approaches and principles that are effective during the construction of ecological and energy-efficient buildings, ecological building design is an understanding that deals with the principles of sustainable architecture and solutions, decisions and practices in accordance with design criteria. As seen in Table 1, the choice of building material is one of the basic sustainable architectural design criteria and preferring renewable-recyclable materials is one of the important methods to obtain this criteria.

Table 1. "Sustainable Architecture design criteria and methods related to the criteria" (Belek & Yamaçlı, 2023, Table 4).

Sustainable Architectural Design Criteria	***Methods for Sustainable Design Criteria***
Basic Design Criteria	
Space organization and design	*Designs should enable the principles of flexibility and variability:* • *Flexible design concept* • *Design according to the local culture* • *Indoor-outdoor-semi-open space*
Building shell	*Passive solar design facade systems:* • *The number, size, and location of openings created on the facade* • *Sunshade elements*
Building form	*Compact design* • *Building form design according to climatic characteristics* • *Shaping the building mass according to spatial comfort*
The choice of building material	*Selection of materials obtained locally and from the immediate environment* • *Turning to renewable-recyclable materials* • *Durable materials with low maintenance costs*
Ecological artificial environment design	*Landscaping suitable for the region* • *Conservation of the natural environment*

	• *Ecological artificial environment design*
The right way of interacting with the land	*Compliance with topography* • *Building layout* • *Building direction* • *Organization of the arrangement of the structures located on the plot*
Passive System Criteria	
Natural ventilation	• *Wind chimney* • *Atrium* • *Gallery Space* • *Mechanical shaft cavities*
Natural lighting/Light control	• *Light chimneys* • *Shading elements that provide light control in the space*
Temperature control/Heating-Cooling	• *Light rooms (greenhouses)* • *Two-shell facades* • *Glass facade system solutions* • *Trombe walls* • *Water wall (jerry cans)* • *Solar chimney* • *Rooftop pools* • *Thermal labyrinth system* • *Winter garden*
Sound control/Acoustic design	• *Sound insulation applications* • *Creating a sound barrier with afforestation in the land* • *Acoustic panels, and finishing used in the space*
Land use	• *The Orchard* • *Renewable landscaping elements* • *Rooftop gardens*
Rainwater use and storage	• *Green roof applications*

	• *Advanced piping and gutter systems that collect and distribute rainwater*
Integrated Active System Criteria	
Wind energy systems	• *Wind turbines* • *Wind collectors integrated into the building envelope* • *Integrated photovoltaic systems*
Solar energy systems	• *Solar collectors integrated into the building envelope*
Waste management	• *Use of grey water treatment system* • *Solid waste biological waste recycling* • *Use of black water*
Rainwater use and storage	• *Rainwater collection tank*
Biofuel-powered systems	• *Vegetable oils* • *Biogas* • *Heating and electrical systems using landfill gas and solid biofuels*

The usage of recycled textile materials and wastes serves to sustainable architecture by means of environmentally sensitive building material selection. The literature analysis shows that the research on the use of textile materials and textile wastes as building materials are mainly on (1) their use as thermal insulation material, (2) their use as sound insulation material, (3) their use in cement-based lightweight composite mortars, and (4)their use in concrete (Briga-Sá, Nascimento, Teixeira, Pinto, Caldeira, Varum & Paiva, 2013; Turak, 2013; Binici, Gemci, Küçükönder & Solak, 2016; Dönmez, 2017; Dönmez & Türker, 2017, Gounni, Mabrouk, El Wazna, Kheiri, El Alami, El Bouari & Cherkaoui, 2019; Kalkan & Gündüz, 2022; Idrees, Saeed, Farooq, Köksal & Shi, 2023; Nistorac &

Loghin, 2023, Sasi, Joseph, Haigh, Sandanayake, Vrcelj & Yaghoubi, 2024).

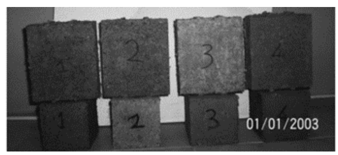
Some scholars have detailed studies about these main types of textile wastes usage in the building construction sector.

In Table 2, the usage areas of textile waste according to Kozak (2016), and in Table 3, some examples of the usage areas of textile waste according to Bennett-Heim (2021) can be seen.

Table 2. Some Examples of the Usage Areas of Textile Waste in the Research (Kozak, 2016).

Waste Type	Uses
Cotton linter pulp	*Nitrocellulose varnishes*
The white powder produced during the manufacture of velvet fabric	*Glue*
Textile waste and cotton linter pulp	*High viscosity and molecular weight, water-soluble ether polymers* *(Paint, oil well drilling sludge, wallpaper paste, and bonding elements are produced from methylcellulose, carboxy methyl cellulose and hydroxy ethyl cellulose, which are high viscosity and molecular weight, water-soluble ether polymers.)*
Cotton scraps	*Insulation materials are produced to be used on roofs by turning them into felt*
Cotton and jute scrasp	*Insulation material for hot water pipe insulatio*
Short asbestos fibers in waste form	*Preferred insulation materials against heat, sound, and fire*
Glass, polypropylene, and acrylic fibers	*Preventing concrete, plaster cracks, increasing tensile and flexural strengths*

Table 3. Some Examples of the Usage Areas of Textile Wastes in the Research Conducted by Bennett-Heim (2021)

Material	Explanation	Produced Material Image
Wall and Ceiling insulation	UltraTouch™ Denim insulation material from Bonded Logic Inc., which contains 80% recycled natural fibers from post-consumer waste (Bennett-Heim, 2021; "Bonded logic Inc", 2024) Bonded logic Inc. Access Adress (02.07.2024): https://www.bondedlogic.com/ultratouch-denim-insulation/	
Brick	Binici, Gemci, Aksoğan & Kaplan. (2010) obtained clay bricks mixed with cotton and textile ash.	
Gypsum board	Melo, da Silva, Coutinho, Sousa & Perazzo (2012) obtained a gypsum board made of ethylene-vinyl acetate material, which appears in the cuttings of boards used in the shoe industry, with better thermal insulation properties than conventional materials.	

In this study, the stress is put on another usage area of textile wastes in the building construction sector. It is their conversion into building facade elements and interior finishing materials. The in-depth literature analysis showed that there are three different types of building facade elements for which textile wastes were used as raw materials. Furthermore, there are some different kinds of interior finishings made of textile wastes. The specified usage patterns are summarized below.

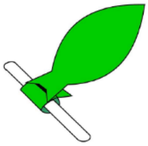
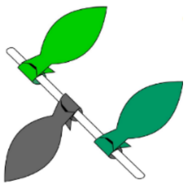
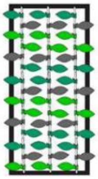
3.1. Use of textile waste in awnings

Glazed openings in buildings are an important component of the architectural design of the building. Glazed openings; While providing a panoramic view from inside the building to the outside, they are also natural light sources. Intensive use of glass in design; It can cause problems such as thermal comfort, visual comfort and privacy for users. As a solution to these problems, shading plays an important role in facade design. The use of awnings dates back to Ancient Egypt and remained popular in Ancient Greece and the Roman Empire. Awnings are widely used around the world to control adverse weather conditions, excessive heat, and uncontrolled sunlight entering the space caused by glazed openings. In non-industrial buildings, heating and cooling systems used for thermal comfort account for 60-70% of the total energy. With passive measures such as awnings, the energy requirement for thermal comfort will be lower (Santos, Sena, Carlos & Lanzinha, 2023).

This suggestion aims to produce innovative awnings that increase convection by reducing surface temperature by encouraging the reuse of textile waste, promoting circular economy and extended circularity in different industries, and promoting sustainable textile practices by raising awareness (Santos et al., 2023).

Santos et al. (2023) presented a healthy, sustainable, innovative study that combines recycled or reused textile fabrics with efficient shading techniques that reduce the consumption of electrical energy to be used in glazed openings in buildings in line with the circular economy's goal of minimizing waste and pollution and increasing the value of existing resources. Table 4 shows the formation scheme and explains the awning proposed by Santo et al. (2023).

Table 4. Proposal for a Shading System Designed to Be Made with Textile Wastes from the Study of Santos et al. (2023)

Design İmage	**Description**
	a) The sheets are fixed to the tubular parts.
	b) The sheets can be fixed in different combinations.
	c) The combination of the created parts in a frame.
	e) Application of the design on a traditional facade.

3.2. Use of textile waste in sunshades

Sunshades help to provide coolness and protection from solar radiation in the design of the building. Additional installation costs and fire hazards are disadvantages. Literature review; It has shown that there are many studies on hybrid composites created with combinations of natural and synthetic fibers, but not many studies evaluating the performance and characterization of hybrid composites made with a combination created with textile hard wastes together with glass fibers (Siddique, Siddiqui, Ali & Sun, 2022).

In this research study, Siddique et al. (2022) investigated the usability of the hybrid composite material made with glass fiber mats and textile hard wastes by testing the mechanical and thermal properties of the hybrid composite material instead of the sunshades currently available in the market. For comparison, a 1.5mm thick sunshade available on the market, which is usually used as a garden umbrella, was used. The materials for this study were obtained from the local supplier. Glass fiber mats, cotton and polyester as hard textile waste were used as materials in this study. The hard waste was obtained from the cone winding section of the spinning mill and was used as reinforcement to produce hybrid composites. In the study, one commercially purchased glass fiber composite sample, one laboratory-produced glass fiber composite sample, two hybrid composites consisting of different proportions of cotton hard waste and glass fiber, two hybrid composites consisting of mercerized cotton and glass fibers in different proportions, and two hybrid composites consisting of polyester and glass fibers in different proportions were produced (Siddique et al., 2022).

With this study, it was concluded that mercerized and non-mercerized cotton hybrid composites are not recommended as sunshades in terms of low tensile and thermal properties, while polyester rigid waste hybrid composites have the potential to be used as sunshades when this study is considered as a non-structural study, and that these composite materials will be further tested for their performance under real environmental conditions with future studies (Siddique et al., 2022).

3.3. Use of textile waste in geotextiles and applicability in vertical gardens

Geotextiles, which are woven or non-woven materials, are used in various ground-related applications, providing light filtration and heavy protection measures (Leon, Potop, Hristian, & Manea, 2016). Usage areas of geotextiles; erosion control, slope stabilization, prevention of groundwater pollution, environmental engineering projects such as revegetation, agricultural areas as crops and ground cover, road constructions, parking areas, building constructions, foundations, terrace and garden roofs, garbage and waste storage areas, sports fields, hydraulic structures, dam and harbor constructions, artificial ponds, drainage and filtration systems and riverbeds (Kozak, 2016; Leon et al, 2016).

Geotextiles are categorized into fiber-based and fabric-based types. Fiber-based geotextiles are divided into two types: natural fibers (such as jute, sisal, flax, hemp, abaca, ramie, and coir) and synthetic fibers (such as polypropylene, polyester, polyamide, and polyethylene). Fabric-based geotextiles are classified into woven, knitted, and nonwoven types. Woven geotextiles, known for their strong mechanical properties, are further divided into monofilament polyester and polypropylene-based types. Geosynthetics refer to synthetic fibers used in geotextiles (Hasan, 2020).

According to Leon et al. (2016), nonwoven geotextiles are classified based on raw materials into synthetic fibers, natural fibers, and composites. Synthetic fibers include polypropylene, polyester, polyethylene, polyamide, and PVC. Natural fibers consist of jute, coir, sisal, palm leaf, and split bamboo fibers. Nonwoven geotextiles offer advantages such as being lightweight, rot-resistant, chemical-resistant, isotropic in elasticity, resistant to bacteria and fungi, air-permeable, tolerant to temperature changes, water-permeable, and low in humidity (Leon et al., 2016).

Leon et al. (2016) highlight that polypropylene is preferred in geotextiles for its lightweight, low moisture absorption, high mechanical resistance, chemical and corrosion resistance, high wear resistance, and suitability for industrial processing.

Polyester (PET) has superior creep resistance and strength but undergoes hydraulic degradation in soils with pH above 10 (Hasan, 2020).

The most well-known polyamide fibers, also known as nylon, are polyamide 6,6 and polyamide 6 and they are used essentially in traditional geotextile (Kaveloğlu, 2010; Hasan, 2020). Felts made of polyamide are used as layers for seeds, cuttings, or grown plants in hydroponic systems in vertical gardens (Beyhan, 2014).

Polyethylene is a raw material which has minimum thermal expansion and contraction, high resistance to tearing and punctures, UV resistant, excellent heat seam resistance and is used only in woven geotextiles (Hasan, 2020). Both low-density polyethylene (LDPE) and high-density polyethylene (HDPE) are used in geotextiles (Sağıroğlu, 2015).

Leon et al. (2016) presented a research study on nonwoven geotextiles produced by recycling synthetic fibers. In this study by Leon et al. (2016); They aimed to produce nonwoven geotextiles by recycling pre-consumer waste from garment manufacturing companies, such as small polyester woven patches, and old product waste from polyacrylonitrile (PAN) knitting collected from users. Fibers, generally called acrylics, are made of polyacrylonitrile and acrylic fibers contain 85-94% polyacrylonitrile in copolymer, and modacrylic fibers contain 35-85% polyacrylonitrile (Zorcan, 2019). In the study, Leon et al. (2016) processed three different fiber blends containing; 67% first-use polypropylene (PP) fibers + 33% recycled fibers, 50% polypropylene (PP) fibers + 50% recycled fibers, 33% polypropylene (PP) fibers + 67% recycled fibers.

Leon et al. (2016), who applied the single-factor ANOVA method in this study, concluded that adding PP fibers to blends is important in terms of geotextile properties, but it is possible to reduce the ratio and maintain high quality nonwoven level for economic reasons. Leon et al. (2016) confirmed with this study that it is possible to implement the Circular Textile Industry concept in Romania by creating a regional closed-loop system by reusing all kinds of textile materials and producing nonwoven geotextiles. In addition, Leon et al. (2016) argued in the study that users and companies should be informed about how to collect textile waste correctly.

In cities with a large population, it is very important to plant urban surfaces in order to increase the amount of green space in cities in order to bring the citizens together with nature, to contribute to the ecosystem and to find solutions to environmental problems. Vertical gardens are defined in the literature with many different terms such as "living wall", "vertical systems", "green wall", "green facade" (Özalp, 2023). In his master's thesis, Özalp (2023) defined vertical gardens as:

> *Vertically developed planted surfaces that can be located indoors or outdoors as a part of a building or can be independent of the building as a landscape element, consisting mainly of plant,*

> *growing medium, carrier system, and irrigation system components and diversified according to their components* (p.30).

Vertical gardening, which is a sustainable practice that supports ecological balance, has started to take place in order to find solutions to environmental problems in metropolitan cities, especially in Europe, and all over the world. The goals of vertical gardens are; To absorb carbon in the air, to clean the air of the city by holding harmful gases and dusts, to provide thermal insulation in buildings, to create visual aesthetics at heavy traffic points, to prevent hot air flow caused by concretion, to create a barrier against noise pollution, to contribute to urban aesthetics, to be used for advertising purposes with the attractiveness of the design, to bring nature together with the city by offering biodiversity, to provide psychological and biological benefits to urban users. It can be listed as providing a positive effect. Vertical gardens according to the construction technique; green facades can be examined under three headings as planted walls and living wall systems (Özalp, 2023).

Vertical gardens in terms of application techniques; can be examined under the headings of hydroponic system, soil system, planting using felt, hanging system, fence system, biofiltration system, aeroponic system, and aquaponic system. In the planting system using felt, felt acts as soil and is lighter than other systems. In hydroponic vertical gardens where geotextile felt is used, it is important to keep the felt cover constantly moist (Özalp, 2023).

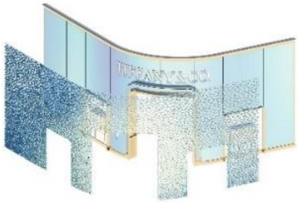
In Başaran's (2016) master's thesis, it was said that the reason for using a growing medium other than felt in the vertical garden felt system applied in Brandium Shopping Center is thought to be the preference of felt made from textile wastes instead of specially produced jute felt. In Başaran (2016)'s master's thesis, it is also stated that the difference between jute imported felt and textile felt is water retention and durability.

3.4. Use of textile waste in building facades and interior finishing Materials

Table 5 lists other examples of the use of textile waste in building facades and interior finishing materials.

Table 5. Other Examples of the Use of Textile Waste in Building Facades and İnterior Finishing Materials

	Material Image	**Description**	**Material Image and Description: Cited website addresses**
Building Facade/ Exterior Shell	 	Recycled fishing nets, a 50 mm thick 3D printed facade developed using recycled plastic for Dutch architecture studio MVRDV's Tiffany & Co. Store at Changi Airport in Singapore ("MVRDV", 2024)	("MVRDV", 2024) Access Adress (02.07.2024): https://www.mvrdv.com/projects/879/tiffany-facade-singapore-changi

			
Interior Finishing	 İmage 1.  İmage 2.	Acoustic wall coverings (Bennett-Heim, 2021): The covering material, also called textile plaster, from recycled denim fibers produced by the Denimtex company. Features: Fire-resistant, sound-absorbing, insulating, moisture-regulating, recyclable. (Bennett-Heim, 2021; “Denimtex”, 2024a)	For description: (“Denimtex”, 2024a) Access Address (02.07.2024): https://www.denimtex.nl/circulaire-wanddecoraties/jeans-on-the-wall/ For images 1: (“Denimtex”, 2024b) Access Address (02.07.2024): https://www.denimtex.nl/projecten/u-parkhotel/#gallery- For images 2 : (“Denimtex”, 2024c) Access Address (04.07.2024): https://www.denimtex.nl/projecten/de-knoef/#gallery-4

Interior Finishing Materials and Decoration Products	  	Bricks, which are interior cladding or decoration materials created from textile wastes produced by French Architect Clarisse Merlet, the founder of FabBRICK, pressed with ecological adhesives, and decoration element furniture and design products ("Doğan", 2024)	("Doğan", 2024) Access Address (11.06.2024): https://parametric-architecture.com/transforming-textiles-into-bricks-fabbrick/

4. Conclusion and Suggestions

As a result of this study, it has been observed that textile wastes can be used as a facade and shading element in buildings, as a part of green facade (green wall/living wall) systems, and as an alternative in interior finishing, except for the researches based on the use of textile wastes in the literature mainly as heat and sound insulation and reinforcement material in concrete.

Considering the textile waste potential in the world; The scale of building materials and design elements that can be obtained from textile wastes can be expanded, sustainable buildings can be obtained in accordance with sustainable architecture design criteria, and contributions can be made to the realization of sustainable development goals in the construction and textile sector.

Within the scope of the results obtained, the following issues are presented as suggestions:

- Under the leadership of universities, studies can be carried out to raise awareness on how to separate and store textile wastes for all groups from the first production to the end user, to produce building facade shading elements, building facade systems, building interior finishing materials with recycling opportunities and reproduction.
- Under the leadership of research universities, it can be ensured that sustainability targets can be supported by providing easily accessible seminars to manufacturing companies on the production of innovative materials from textile wastes.
- New researches can be carried out under the leadership of universities in order to develop and produce innovative materials and systems such as building facade shading elements, building facade systems, and building interior finishing materials from textile wastes.
- It can be ensured that the participation and cooperation of companies, architects, designers, engineers, manufacturers, and professional chambers in new researches to be carried out under

the leadership of universities is ensured and these researches are supported with funds.

- Architects and designers can be encouraged to use innovative materials such as building facade shading elements, building facade systems, and building interior finishing materials that have been obtained as a result of research and have become compliant with the standards.
- To raise awareness of sustainable buildings and sustainable development goals, the concepts of recycling, reuse, upcycling, and the possibilities of evaluating the textile waste potential in the region in terms of building materials, studies can be carried out for architecture students to design projects and exhibit these projects.

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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 % 50, 2nd Author %25, and 3rd Author %25 contributed. There is no conflict of interest.

References

ALA, American Library Association, (2024). ALA Task Force on United Nations 2030 Sustainable Development Goals. Access Address (02.07.2024): https://www.ala.org/aboutala/ala-task-force-united-nations-2030-sustainable-development-goals

Başaran, N. (2016). *İç mekân dikey bahçelerinin irdelenmesi İstanbul ve çevresi örneği [Investigation of vertical garden in the interior a sample of İstanbul and its enviroment]. (Yüksek Lisans Tezi). Düzce Üniversitesi, Düzce. Yükseköğretim Kurulu Ulusal Tez Merkezi Accessed from database Access Adress (24.04.2024): https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp*

BCoCIRDPD, Bursa Chamber of Commerce and Industry, R&D and Projects Directorate. (2024). *Tekstil sektör raporu 2023 yılı son çeyrek raporu [Textile sector report 2023 last quarter report]*. Bursa. Access Address (17.05.2024): https://btso.org.tr/?page=databank/sectoralreport.asp&id=180&qpage=&qorder=

Belek, A. N., & Yamaçlı, R. (2023). Ekolojik binaların sürdürülebilir tasarım kriterleri ve değerlendirme süreci [Sustainable basic design criteria and evaluation of ecological buildings]. *Mimarlık ve Yaşam*, 8(2), 529-550. https://doi.org/10.26835/my.1219441. Access Adress (12.06.2024): https://dergipark.org.tr/tr/pub/my/issue/77111/1219441

Bennett-Heim, H. (2021). Fashionable facade: Textile waste innovations for the built environment. In Di Lucchio, Loredana, Imbesi, Lorenzo, Giambattista, Angela, & Malakuczi, Viktor (Eds.). *Design Culture(s): Cumulus Conference Proceedings Roma 2021. Vol. 2*. (pp. 3458-3475.). Cumulus, International Association of Universities and Colleges of Art, Design and Media, Finland. Access Adress (10.06.2024): https://cumulusroma2020.org/proceedings/

Beyhan, M. İ. (2014). *Dikey bahçelerde yapı sistemleri [Construction systems in vertical gardens]. (Yüksek Lisans Tezi). İstanbul Üniversitesi, İstanbul. Yükseköğretim Kurulu Ulusal Tez Merkezi Accessed from database Access Adress (08.05.2024): https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp*

Binici, H., Gemci, R., Aksogan, O., & Kaplan, H. (2010). Insulation properties of bricks made with cotton and textile ash wastes. *International Journal of Materials Research*, 101(7), 894–899. https://doi.org/10.3139/146.110348. Access Adress (10.06.2024): https://www.researchgate.net/publication/250196110_Insulation_properties_of_bricks_made_with_cotton_and_textile_ash_wastes

Binici, H., Gemci, R., Küçükönder, A., & Solak, H. H. (2016). Pamuk atığı, uçucu kül ve barit ile üretilen sunta panellerin ısı, ses ve radyasyon geçirgenliği özellikleri [Thermal conductivity, sound insulation and radiation transmission of cotton waste, fly ash and barite reinforced chipboards]. *Yapı Teknolojileri Elektronik Dergisi,* 8(1), 16-25. https://doi.org/10.17780/ksujes.99477. Access Adress (08.01.2024): https://dergipark.org.tr/tr/pub/yted/issue/22208/238459

Bonded Logic Inc. (2024). UltraTouch™ Denim Insulation. Access Adress (02.07.2024): https://www.bondedlogic.com/ultratouch-denim-insulation/

Bozlağan, R. (2010). Sürdürülebilir gelişme düşüncesinin tarihsel arka planı [Historical background of the idea of sustainable development]. *Journal of Social Policy Conferences* (50), 1011-1028. Access Address (24.10.2023): https://dergipark.org.tr/tr/download/article-file/9155

Briga-Sá, A., Nascimento, D., Teixeira, N., Pinto, J., Caldeira, F., Varum, H., & Paiva, A. (2013). Textile waste as an alternative thermal insulation building material solution. *Construction and Building Materials,* 38, 155-160. ISSN: 0950-0618. https://doi.org/10.1016/j.conbuildmat.2012.08.037. Access Address (11.11.2023): https://www.sciencedirect.com/science/article/pii/S0950061812006332

Burkut, E. B., & Dal, M. (2023). Systematic literature review and scientific maps on ecological architecture and eco-architecture. *International Journal of Pure and Applied Sciences*, 9(2), 369–380. https://doi.org/10.29132/ijpas.1365407. Access Address (23.04.2024): https://dergipark.org.tr/en/download/article-file/3429549

Çüçen, A., & Solak, A. (2023). Sürdürülebilir yapı malzemeleri üzerine bir araştırma [Research on sustainable building materials]. *Teknik Bilimler Dergisi*, 13(1), 1-8. Online ISSN:2146-2119. https://doi.org/10.35354/tbed.1214469. Access Address (09.06.2024): https://dergipark.org.tr/tr/pub/tbed/issue/75946/1214469

Denimtex. (2024a). Circulair, Jeans on The Wall. Access Address (02.07.2024): https://www.denimtex.nl/circulaire-wanddecoraties/jeans-on-the-wall/

Denimtex. (2024b). U Parkhotel. Access Address (02.07.2024): https://www.denimtex.nl/projecten/u-parkhotel/#gallery-

Denimtex. (2024c). De Knoef. Access Address (04.07.2024): https://www.denimtex.nl/projecten/de-knoef/#gallery-4

Doğan, R. (2024, 5 February). Transforming textiles into bricks: FabBRICK. Access Address (11.06.2024): https://parametric-architecture.com/transforming-textiles-into-bricks-fabbrick/

Dönmez, E. T. (2017). *Geri Dönüşümü yapılmayan tekstil atıklarının kullanılarak elektromanyetik kalkanlama, ısı izolasyonu ve ses yalıtımı sağlayan yüzeylerin eldesi [Obtaining surfaces providing electromagnetic shielding, thermal and sound insulation by using textile wastes which are not recycled] (Doktora Tezi). Uşak Üniversitesi, Uşak. Yükseköğretim Kurulu Ulusal Tez Merkezi Accessed from database Access Adress (08.01.2024): https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp*

Dönmez, E. T., & Türker, E. (2017). Tekstil atıkları içeren yüzeylerin sahip olduğu elektromanyetik kalkanlama, ses ve ısı izolasyonu özellikleriyle ilgili literatür incelemesi [Literature investigation on electromagnetic shielding, sound and thermal insulation performances of surfaces generated from textile wastes]. *Tekstil ve Mühendis*, 24(106), 124-135. Online ISSN: 2147-0510. https://doi.org/10.7216/1300759920172410609. Access Address (08.01.2024): https://dergipark.org.tr/tr/download/article-file/322206

Erşan, R. R., & Demirarslan, D. (2020). Tarihi yapılarda sürdürülebilirlik ilkesi bağlamında Eskişehir Odunpazarı evleri [Eskişehir

Odunpazarı houses in the context of sustainability principle in historical buildings]. *Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi*, 21(1), 187–213. https://doi.org/10.17494/ogusbd.763605. Access Address (09.06.2024): https://dergipark.org.tr/tr/pub/ogusbd/issue/55772/763605

Gounni, A., Mabrouk, M. T., El Wazna, M., Kheiri, A., El Alami, M., El Bouari, A., & Cherkaoui, O. (2019). Thermal and economic evaluation of new insulation materials for building envelope based on textile waste. *Applied Thermal Engineering*, 149, 475-483. https://doi.org/10.1016/j.applthermaleng.2018.12.057. Access Address (08.01.2024): https://www.sciencedirect.com/science/article/pii/S1359431118350002

Hasan, R. (2020). An overview of geotextiles: Industrial application in technical textiles. *Journal of Textile Science & Fashion Technology*, 4(4). Online ISSN: 2641-192X. https://doi.org/10.33552/jtsft.2020.04.000593. Access Address (07.05.2024): https://irispublishers.com/jtsft/pdf/JTSFT.MS.ID.000593.pdf

Idrees, M., Saeed, F., Farooq, Z., Köksal, F., & Shi, J. (2023). Production of waste carpet fiber-reinforced concrete as sustainable material. *Journal of Building Engineering*, 77, 107499. https://doi.org/10.1016/j.jobe.2023.107499. Access Address (08.01.2024): https://www.sciencedirect.com/science/article/pii/S2352710223016790?via%3Dihub

Kalkan, Ş. O., & Gündüz, L. (2022). Structural strength properties of waste textile fiber reinforced cementitious lightweight composite mortars. *Sakarya University Journal of Science*, 26(6), 1180-1195. https://doi.org/10.16984/saufenbilder.1107127. Access Address (08.01.2024): https://dergipark.org.tr/en/pub/saufenbilder/issue/74051/1107127

Kaveloğlu, S. (2010). *Yün-akrilik ve yün-polyamid karışımı oranlarının, iplik mekanik özellikleri, halı ipliği kalite değerleri ve eğirme işlenebilirliği üzerine etkilerinin araştırılması [The investigation of* *effects of the yarn blending rates which are made of wool acrylic and wool polyamide on yarn mechanical properties, carpet yarn quality values, and spinning workability] (Yüksek Lisans Tezi). Niğde Üniversitesi, Niğde. Yükseköğretim Kurulu Ulusal Tez Merkezi Accessed from database Access Address: (02.05.2024): https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp*

Keitsch, M. (2012). Sustainable architecture, design and housing. *Sustainable Development*, *20*(3), 141–145. https://doi.org/10.1002/sd.1530. Access Address (02.07.2024): https://onlinelibrary.wiley.com/doi/epdf/10.1002/sd.1530?saml_referrer

Kim, J. J., & Rigdon, B. (1998). *Sustainable architecture module: introduction to sustainable design*. National Pollution Prevention Center for Higher Education. Ann Arbor.

Kozak, M. (2016). Tekstil atıkların yapı malzemesi olarak kullanım alanlarının araştırılması [Investigation of the usage of textile waste as construction materials]. *Yapı Teknolojileri Elektronik Dergisi*, 6(1), 62-70. Online ISSN:1305-631X. Access Address (07.05.2024): https://dergipark.org.tr/tr/pub/yted/issue/22212/238490

Leon, A. L., Potop, G. L., Hristian, L., & Manea, L. R. (2016). Efficient technical solution for recycling textile materials by manufacturing nonwoven geotextiles. *IOP Conference Series: Materials Science and Engineering*, 145(2). https://doi.org/10.1088/1757-899X/145/2/022022. Access Address (07.05.2024): https://iopscience.iop.org/article/10.1088/1757-899X/145/2/022022

Macit, H., Tayyar, A. E., Şevkan Macit, A., & Alan, G. (2019). Tekstil sektöründe geri dönüşüm olanakları ve Uşak İli'nde güncel durum [Recycling opportunities in textile sector and current situation in Uşak province]. *Uşak Üniversitesi Fen ve Doğa Bilimleri Dergisi*, 3(2), 91-102. Access Address (21.05.2024): https://dergipark.org.tr/tr/pub/usufedbid/issue/51303/641513

Mangır, A. F. (2023). Döngüsel ekonomi özelinde tekstil ve hazır giyim sektöründe sürdürülebilirliğin temel belirleyicileri: Dünya ve Türkiye örnekleri [Determinants of sustainability in the textile and apperal sector within the context of circular economy: Examples from the world and Türkiye]. *3. Sektör Sosyal Ekonomi Dergisi*, 58(3), 2323-2339. Online ISSN: 2587-0114. https://doi.org/10.15659/3.sektor-sosyal-ekonomi.23.08.2205. Access Address (17.05.2024): http://tisej.com//makale_ozet.php?MSID=-QQpvLHTrGQ6zarX3gzfYjDTiIIdpfs9eTLgVMtRMW8%

Melo, M. O. B. C., da Silva, L. B., Coutinho, A. S., Sousa, V., & Perazzo, N. (2012). Energy efficiency in building installations using thermal insulating materials in northeast Brazil. *Energy and Buildings*, 47, 35–43. https://doi.org/10.1016/j.enbuild.2011.11.021. Access Address (10.06.2024): https://www.sciencedirect.com/science/article/pii/S0378778811005676?via%3Dihub

MoIT & BEBDA, T.R. Ministry of Industry and Technology & Bursa Eskişehir Bilecik Development Agency . (2021). *Bursa ili tekstil geri dönüşüm tesisi ön fizibilite raporu [Bursa Province Textile Recycling Facility Pre-Feasibility Report]*. Ankara. Access Address (14.04.2024): https://www.kalkinmakutuphanesi.gov.tr/dokuman/bursa-ili-tekstil-geri-donusum-tesisi-on-fizibilite-raporu/2333

MoITGDoI, T.R. Ministry of Industry and Technology, General Directorate of Industry. (2022). *Tekstil, hazırgiyim, deri ve deri ürünleri sektörleri raporu 2021 [Textile, ready-to-wear, leather and leather products sectors report 2021]*. Ankara. Access Address (13.05.2024): https://www.sanayi.gov.tr/assets/pdf/plan-program/TekstilHazirgiyimveDeriUrunleriSektorleriRaporu2021.pdf

MVRDV. (2024). Tiffany Facade Singapore Changi. Access Adress (02.07.2024): https://www.mvrdv.com/projects/879/tiffany-facade-singapore-changi

Nistorac, A., & Loghin, M. C. (2023). The future of textile waste materials in construction. *The 18th Romanian Textiles and Leather Conference, Sciendo* , pp. 157-164. https://doi.org/10.2478/9788367405133-025. Access Address (20.05.2024): https://sciendo.com/chapter/9788367405133/10.2478/9788367405133-025

Önder, H. (2018). Sürdürülebilir kalkınma anlayışında yeni bir kavram: Döngüsel ekonomi. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi* (57), 196-204. Access Address (06.06.2024): https://dergipark.org.tr/tr/pub/dpusbe/issue/38899/416907

Öngüt, E. (2007). *Türk tekstil ve hazır giyim sanayinin değişen dünya rekabet şartlarına uyumu [A new concept in sustainable development approach: circular economy]. (Uzmanlık Tezi). Devlet Planlama Teşkilatı, İktisadi Sektörler ve Koordinasyon Genel Müdürlüğü. Türkiye Cumhuriyeti Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı Uzmanlık Tezleri Accessed from database Access Address (19.05.2024): https://www.sbb.gov.tr/uzmanlik-tezleri/*

Özalp, E. (2023). *Kentlerde dikey bahçe uygulamalarının sürdürülebilir kalkınmaya etkisi: İstanbul kent meydanları üzerinden öneriler [The effect of vertical gardening in cities on sustainable development: Suggestions on İstanbul city squares]. (Yüksek Lisans Tezi). Haliç Üniversitesi, İstanbul. Yükseköğretim Kurulu Ulusal Tez Merkezi Accessed from database Access Address (08.05.2024): https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp*

Özdinç, Ö. (2021). Tekstil sektöründe geri dönüşüm [Recycling in the textile industry]. *Umteb International Congress on Vocational & Technical Sciences-XI* (s. 291-305). Ankara, Türkiye. Access Address (22.05.2024): https://www.researchgate.net/publication/355059319_TEKSTIL_SEKTORUNDE_GERI_DONUSUM

Pamuk, R., & Kuruoğlu, M. (2016). İnşaat sektöründe sürdürülebilirlik ve bina inşaatlarında evrensel uygulama örnekleri [Sustainability in costruction sector and universal application of building costruction examples]. *Beykent Üniversitesi Fen ve Mühendislik Bilimleri Dergisi*, 9(1), 161-177. https://doi.org/10.20854/bujse.258173. Access Address (09.06.2024): https://dergipark.org.tr/tr/pub/bujse/issue/24355/258173

Rashid, M. E., Khan, M. R., Haque, R. U., & Hasanuzzaman, M. (2023). Challenges of textile waste composite products and its prospects of recycling. *In Journal of Material Cycles and Waste Management*, 25(3), 1267–1287. https://doi.org/10.1007/s10163-023-01614-x. Access Address (20.05.2024):

https://link.springer.com/content/pdf/10.1007/s10163-023-01614-x.pdf

Sağıroğlu, A. (2015). *Geotekstillerin incelenmesi ve uygulandığı yerler [Examination of geotextiles and where applicable] (Uzmanlık Tezi). İller Bankası Anonim Şirketi. İller Bankası Anonim Şirketi Uzmanlık Tezleri Accessed from database Access Address (07.05.2024): https://www.ilbank.gov.tr/userfiles/files/uzmanliktezleri/14451.pdf*

Santos, M. M., Sena, M., Carlos, J., & Lanzinha, G. (2023). *Reducing overheating in buildings with passive solar systems made from textile wastes*. Conference poster, Ecocity World Summit 2023, London. https://doi.org/10.13140/RG.2.2.14589.33760. Access Address (02.04.2024): https://www.ecocity-summit.com/media/qgemacrx/217-michael-m-santos.pdf

Sasi, S., Joseph, P., Haigh, R., Sandanayake, M., Vrcelj, Z. & Yaghoubi, E. (2024). A Review on the effects of waste textile polymer fiber on concrete strength: Exploring the key parameters. *Buildings*, 14(5), 1486. https://doi.org/10.3390/buildings14051486. Access Address (02.07.2024): https://www.mdpi.com/2075-5309/14/5/1486

Siddique, S. H., Siddiqui, M. O. R., Ali, M., & Sun, D. (2022). Hybrid composites based on textile hard waste: Use as sunshades. *Industria Textila*, 73(6), 680–686. https://doi.org/10.35530/IT.073.06.202158. Access Address (07.05.2024): http://revistaindustriatextila.ro/images/2022/6/012%20SHERAZ%20HUSSAIN%20SIDDIQUE%20INDUSTRIA%20TEXTILA%20no.6_2022.pdf

Tripathi, M., Sharma, M., Bala, S., Thakur, V. K., Singh, A., Dashora, K., ..., & Gupta, V. K. (2024). Recent technologies for transforming textile waste into value-added products: A review. *Current Research in Biotechnology*, *7*. https://doi.org/10.1016/j.crbiot.2024.100225. Access Address (06.06.2024): http://www.idaacademia.org/tr/pub/issue/68324/1029118

Turak, B. (2013). *Tekstil atıklarından elde edilen kompozit ısı yalıtım malzemelerinin incelenmesi [Investigation of thermal insulation composite materials obtained from textile waste] (Yüksek Lisans Tezi). Süleyman Demirel Üniversitesi, Isparta. Yükseköğretim Kurulu Ulusal Tez Merkezi Accessed from database Access Address*

(08.01.2024): https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

TUIK, Turkish Statistical Institude (2021). Haber Bülteni, Atık İstatistikleri,2020, Tablo-1 İmalat sanayi alt sektörler atık istatistikleri [News Bulletin, Waste Statistics, 2020, Table-1 Manufacturing industry sub-sector waste statistics]. Access Address (07.07.2024): https://data.tuik.gov.tr/Bulten/Index?p=Atik-Istatistikleri-2020-37198

TUIK, Turkish Statistical Institute. (2023). Haber Bülteni, Atık İstatistikleri,2022, Tablo-1 İmalat sanayi alt sektörler atık istatistikleri [News Bulletin, Waste Statistics, 2022, Table-1 Manufacturing industry sub-sector waste statistics]. Access Address (07.07.2024): https://data.tuik.gov.tr/Bulten/Index?p=Atik-Istatistikleri-2022-49570

Uçar, O. K., & Özdemir, O. (2022). Üniversitelerde sürdürülebilirlik faaliyetleri ve raporlama örnekleri [Sustainability activities in universities and reporting examples]. *Ida Academia Muhasebe ve Maliye Dergisi*, 5(1), 13–30. https://doi.org/10.52059/idaacmmd.1029118. Access Address (09.06.2024): http://www.idaacademia.org/tr/pub/issue/68324/1029118

Üçgül, İ., Turak, B. (2015). Tekstil katı atıklarının geri dönüşümü ve yalıtım malzemesi olarak değerlendirilmesi [Recycling of textile waste and evaluation of their potential as insulation material]. *APJES,* 3(3), 39-48. Access Address (08.01.2024): https://dergipark.org.tr/tr/pub/apjes/issue/2195/613121

Yang, Q. Z., Zhou, J., & Xu, K. (2014). A 3R implementation framework to enable circular consumption in community. *International Journal of Environmental Science and Development*, *5*(2), 217-222. doi: 10.7763/IJESD.2014.V5.481 Access Address (04.07.2024): https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=2042bd5d39635f5949f4c731e2dc082eb9e607b8

Zainal Abidin, S., Sigurjónsson, J., Liem, A., & Keitsch, M. (2008). On the role of forming-giving in design. *New Perspektives in Design Education- Proceeding of the 10th International Conference on Engineering and Produst Design Education* (pp. 365-370).

Universitat Politecnica de Catalnya, Barcelona. doi: DOI: 10.13140/2.1.1922.4649. Access Adress (02.07.2024): https://www.researchgate.net/publication/269932391_On_the_role_of_formgiving_in_design

Zorcan, M. (2019). *Poliakrilonitril esaslı nanokompozit lif üretimi ve karakterizasyonu [Production and characterization of polyacrylonitryl based nanocomposite fiber]. (Yüksek Lisans Tezi). Yalova Üniversitesi, Yalova. Yükseköğretim Kurulu Ulusal Tez Merkezi Accessed from database Access Address (07.05.2024): https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp*

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Structures, Usage Areas, Production and Case Studies of Mycelium-Based Bio-Composites

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1. Introduction

According to the United Nations data, the world inhabitants has reached 8 billion as of November 15, 2022 (Url-1). With the increasing inhabitants and urbanization, energy consumption rates are also increasing rapidly. As a result of unconscious consumption and mass production procedures, a significant amount of hard-to-control environmental waste piles are generated. The resulting wastes are either wholly abandoned to nature or are tried to be converted in inappropriate ways, causing permanent damage to the environment (Abdel-Shafy & Mansour, 2018; Joshi et al., 2020; Alemu et al., 2022).

The construction sector contributes significantly to global greenhouse gas emissions. The increasing use of non-renewable materials in buildings also confronts existing natural resources with the danger of extinction. Due to the current production policies that cause rapid and unconscious consumption of natural resources, it is necessary to seek alternative ways to use renewable and recyclable materials and to use resources correctly (Abdel-Shafy & Mansour, 2018; Joshi et al., 2020; Alemu et al., 2022). As a consequence of this gradually emerging public awareness, there is increasing attention to bio-based building materials and components. Biopolymers as an alternative to petroleum-based polymers are promising and attract research attention. The production of biopolymers relies on living organisms (Heisel & Rau-Oberhuber, 2020; Bitting et al., 2022). Mycelium-based bio-composites (MBC), formed by the growth of hyphae in the vegetative parts of fungi on the nutritional stocks, have recently become a popular research topic with their properties and rapid growth. Micelles are chitin-based biopolymers. Recent developments in MBCs show potential in transforming industrial waste streams into a viable source for producing more sustainable and circular materials. In addition to the low energy and high biodegradation profile used during the production of MBCs, it also stands out as it is considered highly customizable throughout the cultivation and production processes (Bitting et al., 2022). As a result, this situation enables the production of MBCs with various properties.

Micelles act as binders in composite production (Attias et al., 2020; Jones et al., 2020; Bitting et al., 2022). Various structural and production parameters affect the formation of a composite. These parameters consist of the type of mycelium used structurally and the characteristics of the substrate, production sterilization, inoculation, molding, growth condition and time, drying method, and finishing-touching. The structure of the produced composite varies according to the changes in the mentioned parameters. With these parameters, it is possible to produce MBCs with various properties that meet different criteria from different disciplines and are suitable for various applications.

While this study deals with the structure of MBCs, their production methods, and the effect of their variables on the composite, it also includes their usage areas and previous studies.

1.1.Definition and Classification of Mycelium

The mycelium is the name given to a complex network of interlocking, microscopic, tubular fibrous cell chains containing saprotroph fungi's vegetative parts or roots. In this way, it acts as a natural binder that holds organic fibers or particles together, forming a natural, lightweight bio-composite (Haneef et al., 2017; Etinosa, 2019; Attias et al., 2020). All living organisms are divided into groups to form a taxonomic hierarchy. Figure 1 shows the phylogeny of life.

The fact that fungi are living organisms means that they are subject to classification in the biological system. Fungi are part of eukaryotes that share the characteristic of having a nucleus in their cells, including animals and plants (Lelivelt, 2015; Vos, 2020).

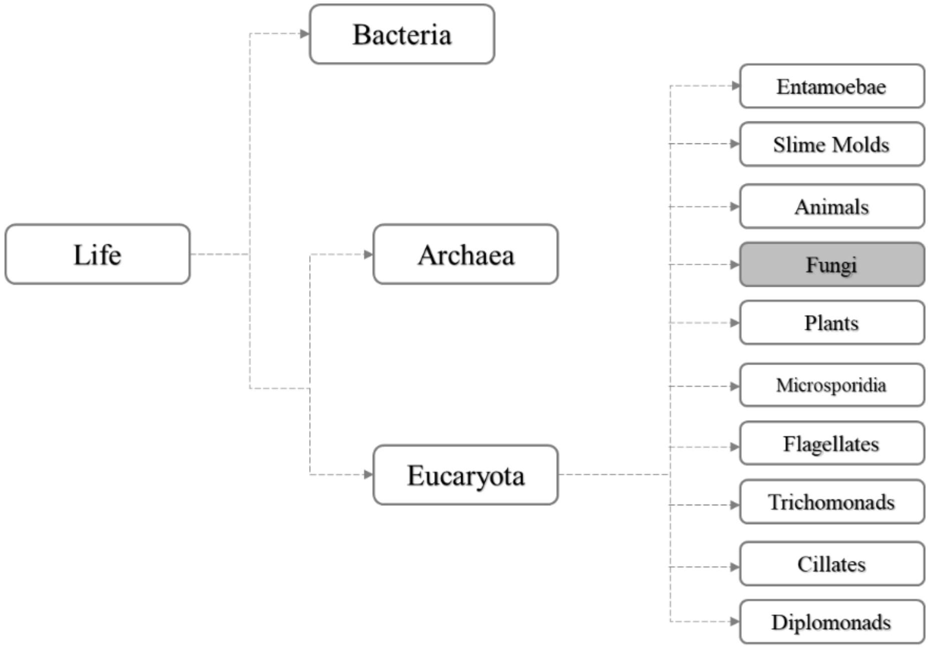


Figure 2. Phylogeny of Life (adopted by Lelivelt, 2015).

Fungi group is a large group that can be divided into sub-taxa. The genome-scale phylogeny of 1,644 species covering the diversity of fungi is shown in Figure 2. White rot fungi are preferred for the formation of MBCs. These fungi are mainly included in the basidiomycota and ascomycota taxa (Lelivelt, 2015). Basidiomycota is the septum, and its anastomosis structure is necessary to produce MBCs.

Septa dramatically increases the strength of the mycelium due to its ability to bind severed hyphae. On the other hand, anastomosis is considered necessary in terms of the rapid growth of mycelium, as it allows the creation of large networks (Lelivert, 2015).

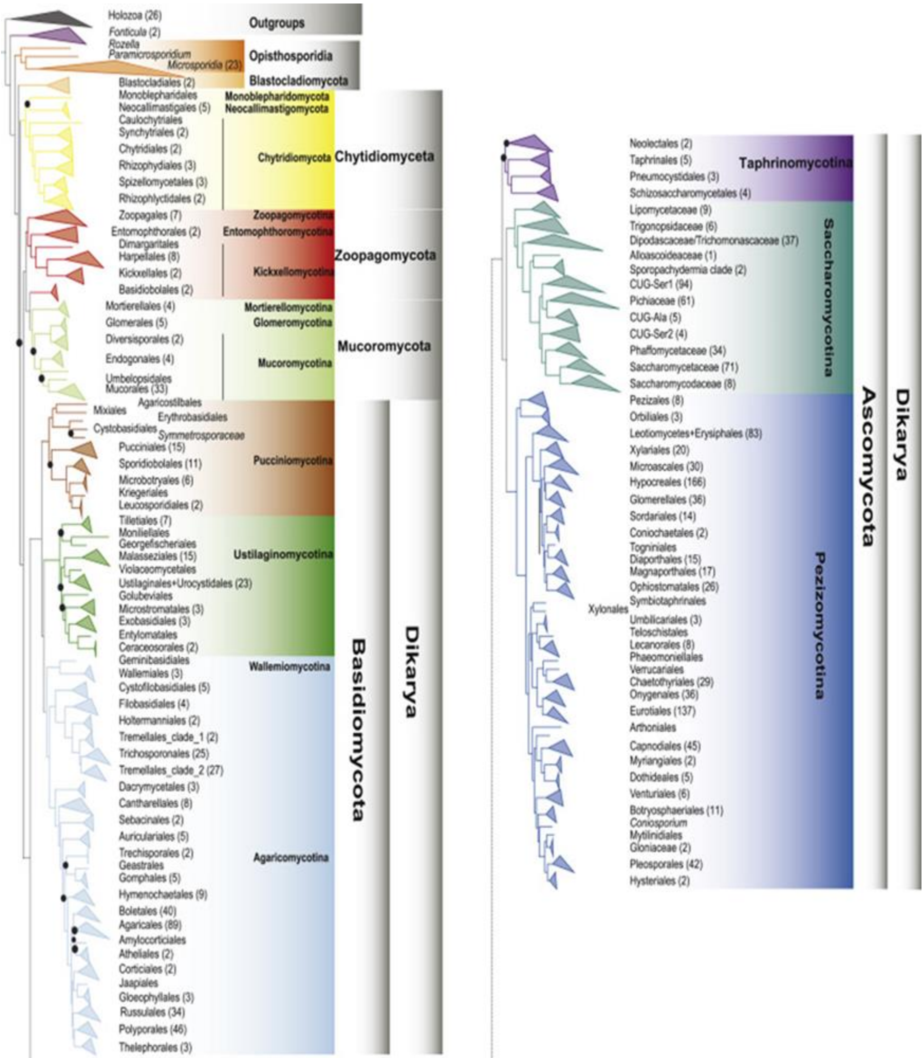


Figure 3. Genome-Scale Phylogeny of 1,644 Species Spanning The Diversity of Fungi (Li et. al., 2021).

2. An Overview Production and Growth Methods of MBCs

The production of materials made from mycelium requires a multi-layered process that involves several steps. The first step is to mix the mycelium with a nutritious substrate to promote its growth. Using substrates with high cellulose content is essential because mycelium can break down cellulose into glucose, unlike other organisms. However, the selected substrate must be purified before mixing with the mycelium to prevent contamination during production. This purification process requires sterilization. Once the substrates are sterilized, they should be kept at room temperature and mixed homogeneously with the selected mycelium type using pre-sterilized tools. This mixing process is crucial, ensuring that the mycelium is evenly distributed throughout the substrates. After thoroughly combining the mixture, it can be processed further to create various MBCs. Overall, the production process of MBCs requires careful attention to detail and a commitment to maintaining a sterile environment. By following these steps, it is possible to produce high-quality MBCs that are both sustainable and environmentally friendly. (Lelivelt, 2015; Etinosa, 2019; Elsacker et al., 2020).

During the incubation period, environment must be dark during the growth stage. As some types of fungi try to produce fruit in the presence of light. Besides darkness, the growing medium should contain high humidity (~ 70-90%), convenient temperature (~ 25-30 °C), and oxygen. Fungal growth takes about 14-16 days under optimized conditions. Drying should be done after the growth phase is completed. High-temperature drying is required to terminate this incubation period (Lelivelt, 2015; Etinosa, 2019; Elsacker et al., 2020). In summary, MBC's production is a gradual process, and several variables affect mycelium incubation. These factors affecting the production of MBCs are discussed under two main headings: structural and production variables. Table 1 shows the factors affecting growth.

Table 2. Factors Affecting Mycelium Growth (adopted by Elsacker et al., 2020).

Structural Factors	Production Variables
Mycelium Type Selection	Substrate Sterilization Method
	Inoculation Method
	Packing Method
	Growth Conditions
Substrate Selection	Growth Time
	Drying Method
	Post-Processing

2.1. Structural Factors

Structural factors include factors related to the effect of the structural properties of the composite constituents on the growth of the mycelium and the properties of the final composite formed.

2.1.1. Mycelium Type Selection

Since fungal hyphae are the main component of MBCs, the selected fungal species significantly affect the final bio-composites colonization, physical properties, and mechanical properties. Colonization rate, hyphae thickness, branching tendency, and surface topography vary according to the fungal species. Based on the publications, it is concluded that *Ganoderma lucium* and *Pleurotus ostreatus* fungi are widely used to create composites. However, when making this evaluation, it should be considered that most existing publications need to explain the fungal species used. The graph in Figure 3 shows the fungal species used according to the literature (Attias et al., 2020; Elsacker et al., 2020).

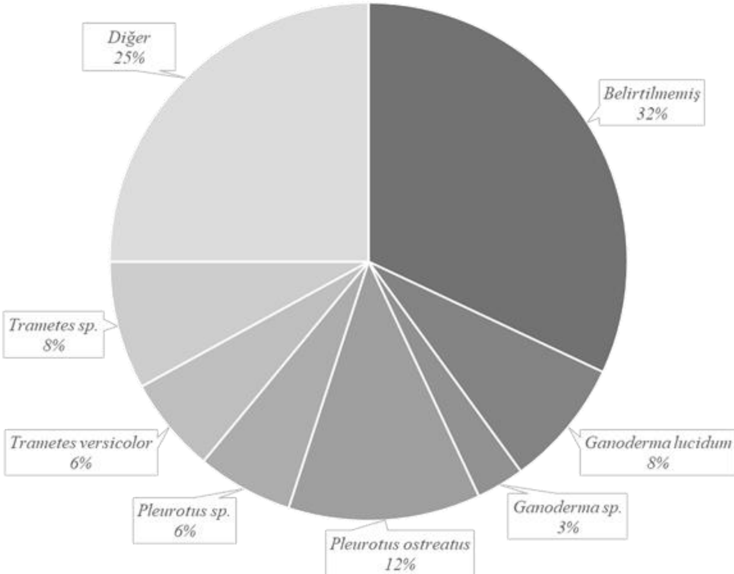


Figure 4. According to the Literature, the Main Fungal Species Used to Produce MBCs (adopted by Attias et al., 2020).

The choice of fungal species is critical regarding expected hyphal growth from the mycelium. Apical elongation and radial development into an interconnected lattice-like network are regulated by environmental conditions especial to the species involved, ecology, and lifestyle. It is known that different species show different hyphae and mycelium morphology when grown on the same medium (Elsacker et al., 2020).

Fungal cells have structures with a complex chemical composition, including glucan and chitin components, in addition to proteins such as hydrophobins and mannoproteins. The presence of chitin-containing fungal cell walls in MBCs is essential for the structural and mechanical properties of the material. It is known that the chitin-containing fungal cell wall exhibits a great deal of phenotypic diversity and plasticity, positively affecting material strength. The strength differences in the composites formed according to the fungal species used are explained by the polysaccharide content of the fungal species. Accordingly, high polysaccharide content provides a higher strength ratio (Gow et al., 2017; Haneef et al., 2017; Elsacker et al., 2020).

Only a tiny fraction of the fungal biodiversity has been tested. Based on the observation that growth characteristics, hyphae elongation, cell wall composition, and metabolic properties vary according to a species, it is thought that many more species may have suitable properties for use in various applications (Elsacker et al., 2020).

2.1.2. Substrate Selection

Most of the substrates used to produce MBCs contain lignocellulose. Lignocellulose is the main component of many plants, products, and woods. Lignocellulose consists of cellulose, hemicellulose, lignin, ash, protein, and pectin. The composition and proportions of these compounds vary depending on the vegetation type. The mechanical properties of natural fibers used when growing MBCs can be affected by fiber processing, chemical composition, and environmental conditions during growth period, all of which, in turn, affect the properties of MBCs. Essential factors to consider when choosing the fibers with the highest potential are their size, strength, and structure (Faruk et al., 2012; Elsacker et al., 2020).

The genetic structure and substrate properties affect the morphological characteristics of the fungal organism. Studies show that materials with a low chitin/polysaccharide ratio give more water uptake, lower Young's modulus, and higher elongation. Although only sometimes well-defined, similar substrate preferences and effects principles are expected to govern other fungal species (Haneef et al., 2017; Elsacker et al., 2020).

2.2. Production Variables

Production variables include factors related to the effect of the alternatives of the processes involved in the formation of the composite on the properties of the final bio-composite.

2.2.1. Substrate Sterilization Method

Substrates must be sterilized to eliminate other living organisms in the mixture that may later threaten mycelium growth, thereby preventing mold growth. Various methods are used for the sterilization process. These methods are carried out by temperatures, such as autoclaving and pasteurization, or by chemical or microbial means (Elsacker et al., 2020).

In sterilization by autoclaving, substrates are placed in autoclavable bags and are performed by applying heat treatment at values between 115 °C and 121 °C for 15-60 minutes. If the pasteurization process is preferred, the substrates are sterilized in 100 °C boiling water for approximately 100 minutes. Sterilization can also be performed with chemicals such as hydrogen peroxide and alcohol-based solution at various rates (Lelivelt, 2015; Appels et al., 2019; Elsacker et al., 2020; Ghazvinian et al., 2022).

2.2.2. Inoculation Method

The inoculation process required to produce MBCs is done in two ways. The first method is to directly add micelles grown with agar in petri dishes, called liquid micelles, to the substrate. The second method is to mix with solid micelles, called solid micelles, grown by grain spawn before mixing with the substrate. One of the two types can be preferred depending on the performance expected from the sample to be produced. The pre-grown and homogenized material consisting of fungal biomass facilitates homogeneous distribution in the substrate. In this way, it is ensured that the hyphae grow and become stronger (Haneef et al., 2017; Elsacker et al., 2020).

2.2.3. Packing Method

The compression of the material during production affects the mechanical responses in terms of compression stiffness. The hyphae grow in the air, and when they encounter a mold vertically across the surface to reach oxygen, they form a protective layer in contact with the air. Therefore, a second growth phase in the mold allows for homogeneous colonization at the edges previously in contact with the mold (Elsacker et al., 2019).

2.2.4. Growth Conditions

Optimum growth conditions are achieved under certain environmental conditions, which vary for each fungal species on various substrates. Incubation occurs mainly in the dark, where gas exchange and air circulation are controlled as much as possible. The growth environment should be dark, contain high humidity (~ 70-90%), suitable temperature (~ 21-30 °C) and oxygen (Lelivelt, 2015; Haneef et al., 2017; Elsacker et al., 2020).

It is known that the incubation period required for mycelium growth under optimized conditions varies between 7-30 days, depending on the fungal species and material size. Materials that grow over increasing time have a less porous structure. As the mycelium grows, the spaces between the fibers are filled, the substrate binds together more strongly, and the density increases (Ahmadi, 2016; Haneef et al., 2017; Elsacker et al., 2020).

3.2.5. Drying Method

When the growth phase is completed, the drying process should be done. Otherwise, the mycelium will produce fruit after consuming all the substrates. To terminate this growth, a high-temperature drying process must be applied. The studies' time and temperature values required in the drying process differ. In general, the applied temperature value and the time are inversely proportional (Elsacker et al., 2020).

3.2.6. Post-Processing

Various finishing methods are available for MBCs, including regrowth and natural resins and coatings applications. Depending on the material's function, different coating methods can be used. To make the bio-composite weatherproof, natural oils and polymers close the material's pores (Elsacker et. al., 2019). For example, Philip Ross used linseed oil and shellac to protect his design. Before adding the coating, the material was sterilized with essential oils (Scott, 2012). In another study, edible films made of carrageenan, chitosan, and xanthan gum were applied to create a physical barrier to water with antimicrobial properties (López Nava et al., 2016). Besides the structural perspective, other industries offer different possibilities. The leather industry has developed a moisture barrier strategy based on water-insoluble proteins. These proteins include corn zein, wheat gluten, and fish myofibrillar protein extracted from agricultural by-products (Deeg et al., 2017). Besides weatherproof applications, natural resins are known to increase the material's mechanical properties. When used as a sandwich structure, both strength and stiffness are improved by adding bio-resin to the reinforcement surfaces of the MBCs (Jiang et al., 2014; Jiang et al., 2017).

3. Findings and Discussion :Usage Areas of MBCs and Current Studies

Nowadays, there is an increasing interest in MBCs. The companies are partnering with the academy to study this promising new material. In most academic studies, commercial concerns arise due to cooperation with companies. For this reason, it is thought that information about the materials used and experimental data is superficially included in the publications (Attias et al., 2020).

One of the companies in the mycelium industry is Ecovative Design LLC. The company focuses on developing mycelium in protective packaging products and producing insulation materials to replace traditional polystyrene-based materials. Grown.bio is owned by Ecovative Design LLC. is a company that focuses on creating an ecological-based alternative to petroleum-based products such as expanded polystyrene (EPS), expanded polypropene (EPP) in the packaging industry, industrial products, and construction sector by using mycelium technology pioneered by Mogu, another company that carries out MBC works, aims to develop sustainable alternatives for architectural applications. It produces acoustic insulation and floor tiles made of mycelium. Another company operating on the industrial potential of MBCs is MycoWorks Inc. The company, which started its activities with works on mycelium bricks, today focuses on producing mycelium-based leather (Url 2-5).

According to the application scale of MBCs, it is divided into product-based and architectural project-based. Some applications at the product scale include consumer-oriented products such as interior furniture, industrial design products, clothing, insulation materials, and building components. On the other hand, the architectural scale includes large applications with the combination of individual modules. (Bitting et al., 2022).

This section explains the literature review and current research on MBCs. An overview of MBCs in commercial applications, architectural trials, experimental design projects, and the current point of academic studies are presented.

3.1. Product-Scale Application Areas of MBCs

Applications of MBCs in product-scale furniture, packaging, textile, electronics and building materials are diversifying. MBCs have a lot of advantages, such as lower energy consumption, low carbon footprint, recyclability, low cost, and density compared to traditional composites. The combination of completely organic materials forms MBCs. In this way, materials that can be separated into building blocks and recycled support the transition to a circular economy by preserving their economic value and preventing waste generation. MBCs, which are advantageous in many aspects, not only produce advanced solutions in various fields such as traditional plastic films and synthetic foams, but also create a new developing research field for the building science (Javadian et al., 2020).

Chairs designed by Eric Klarenbeek are essential examples of use in the furniture industry (Elbasdı, 2016; Attias et al., 2020; Bitting et al. 2022). The first example of using mycelium in packaging is Ecovative Design

LLC. They were produced by the company. Packages that have completed their useful life can decompose naturally without additional processing and rejoin the life cycle (Url-2).

Mycelium is used in the textile field, especially in potential productions that can create an alternative to leather. The work of MycoWorks Inc., one of the companies in mycelium production, focuses on the production of mycelium-based leather. In addition, designer Aniela Hoitink developed a flexible composite product called MycoTex due to her studies by combining textile elements and mycelium. As a consequence of the fashion world's search for options to plastic and leather, MYCL has offered a series of products made of mycelium (Elbasdi, 2016; Url-5-7). As an alternative to the plastic parts used in the electronics, mycelium blocks grown in molds and then shaped by laser for the necessary equipment are used. The properties of mycelium, such as the lack of high fire resistance, and electrical conductivity, provide advantages in such applications (Vasquez & Vega, 2019; Bitting et al., 2022).

MBCs thermal and fire resistance properties pave the way for their use as insulation material in structural applications. Biohm produces mycelium insulation materials with a thermal conductivity coefficient of 0.03 W/m.K. It is claimed that these materials can compete with traditional materials regarding performance properties and production costs (Url-8).

Another feature of MBCs is that they are suitable for acoustic insulation. In addition to its insulating performance, it has used such as floor coverings and tiles produced by Mogu (Bitting et al., 2022; Url-4).

Despite the ecological advantages of MBCs, there are a lot of limitations to their use in structural applications. These limitations are due to the low strength properties of the material and its low water resistance compared to its synthetic alternatives due to its organic origin. However, studies show that production methods can improve these limitations, the type of mycelium, and the substrate used (Appels et al., 2019; Javadian et al., 2020).

3.2. Architectural Scale Applications of MBCs

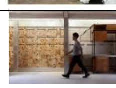
There are examples of using MBCs in varies applications as building materials and components in the architecture field. Since MBCs have only recently become widespread, their architectural-scale applications are primarily seen in installation works. Architectural scale application examples are given in Table 2.

The common feature of these projects is the need for components that require an exoskeleton or an auxiliary structure to provide the principal stability of the MBC. In addition, insufficient material strength cannot accommodate the increased weight as the size of the structure increases. As a result, it is seen that the most successful applications of MBCs in reaching the construction sector are thermal or acoustic insulation panels (Bitting et al., 2022).

3.3. MBCs in Academic Studies

MBCs encourage interdisciplinary collaborations on sustainable and future-proof innovative solutions, as their ingredients are accessible and locally available. MBCs have been known and accepted as an invention since approximately 2007.

Table 3. Architectural Scale Applications of MBCs.

Project Name	Year	View	Referance
Mycotecture	2009		Url-9
Hy-Fi Tower	2014		Url-10
Shell Mycelium	2016		Url-11
MycoTree	2017		Heisel et. al., 2017
The Growing	2019		Url-12
MY-CO-X	2021		Url-13,14
MycoKnit	2021		Url-15
MycoCreate 2.0	2022		Url-16
La Parete Fungina	2022		Url-17
Tallinn Architecture Biennale	2022		Url-18
Hanging Myco-Sheets	2022		Dessi-Olive, 2022
Biobo	-		Url-19

At the same time, its great potential and numerous advantages have made MBCs a popular subject of scientific research. When the literature is scanned, it is seen that the interest in MBCs has increased over the years, and the scope of the study area has expanded. In addition to the articles describing the production of many experimental MBCs, review and review publications are also included in the literature (Attias et al., 2020, Sydor et al., 2022). In academic studies, the subject areas of MBCs vary. Figure 4 illustrates this diversity.

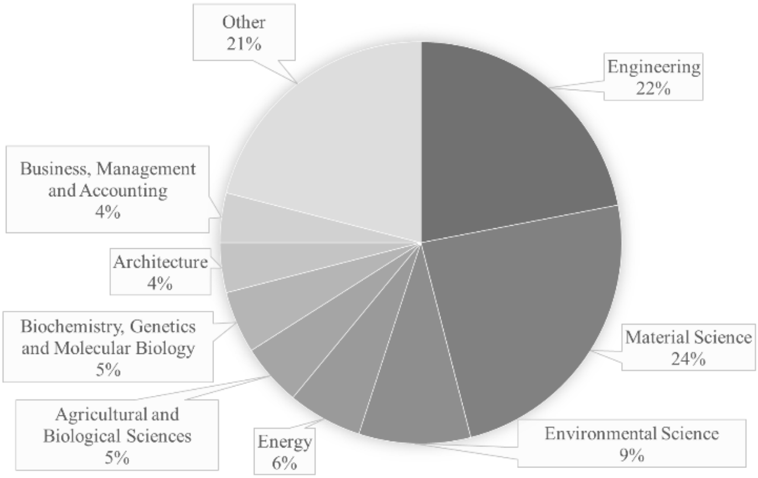


Figure 5. Subject Areas of Scientific Articles on MBCs (adopted by Sydor et. al., 2022).

The ingredients for the production of mycelium-based lignocellulosic materials are plentiful and renewable. For this reason, it is a promising resource for the construction industry. As a result of the literature review, MBCs have the potential to replace existing products such as insulation panels, acoustic absorbers, floor tiles, building blocks, and carrier components in the construction sector (Elsacker et al., 2020; Jones et al., 2020).

The physical, chemical, mechanical, and biological properties of the finished MBCs produced as a result of scientific studies are critically important in evaluating their potential for use in various functional applications. The research conducted by Sydor et al. (2022) presents the critical evaluation of MBCs by compiling the experimental studies' data.

According to the results of the study in Figure 5, MBCs are promising for future studies.

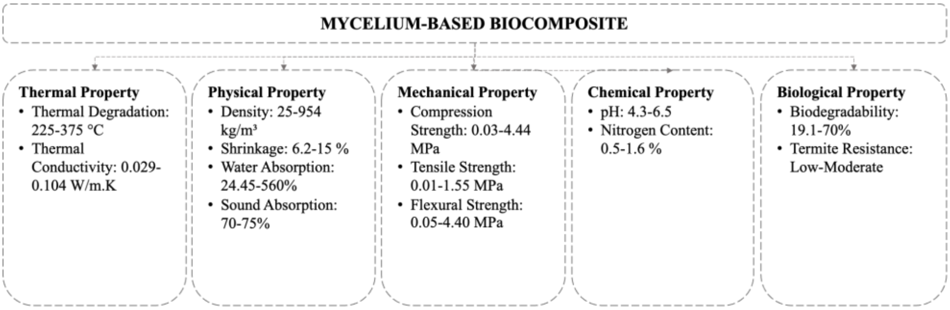


Figure 6. Thermal, Physical, Mechanical, Chemical, and Biological Properties of the MBCs (adopted by Aiduang et. al., 2022).

Although the results of these studies are promising, the difficulty of scaling composite materials to the macro scale of the building requires attention to the energy consumption in the production process while at the same time avoiding the externalization of the damage to the ecosystem (Elsacker et al., 2020; Jones et al., 2020).

4. Conclusion and Suggestions

As a result of the literature study, MBCs represent a strong alternative because they have properties similar to those of the petroleum-based materials widely used today. However, since it is a new research topic and the studies carried out need to clearly explain the types and production procedures they use in industry-university cooperation, more information must be needed. However, there are still unresolved challenges to support the economic and social aspects of the material and its ecologically optimal production and future development. First, the parameters of the production processes need to be explained so that the material can be used in large-scale applications, and experimental studies should support the process to develop a standardized production procedure for the relevant productions.

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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.

References

Abdel-Shafy, H. I., & Mansour, M. S. (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorization. *Egyptian journal of Petroleum*, 27 (4), 1275-1290.

Ahmadi, H. (2016). Cellulose-Mycelia foam: novel bio-composite material. (Doktora Tezi). University of British Columbia, The Faculty of Graduate and Postdoctoral Studies, Vancouver.

Aiduang, W., Chanthaluck, A., Kumla, J., Jatuwong, K., Srinuanpan, S., Waroonkun, T., Oranratmanee, R., Lumyong, S., & Suwannarach, N. (2022). Amazing fungi for eco-friendly composite materials: *A Comprehensive Review. Journal of Fungi*, 8 (8), 842.

Alemu, D., Tafesse, M., & Mondal, A. K. (2022). Mycelium-based composite: the future sustainable biomaterial. *International Journal of Biomaterials*, 1-12.

Appels, F. V., Camere, S., Montalti, M., Karana, E., Jansen, K. M., Dijksterhuis, J., Krijgsheld, P., & Wösten, H. A. (2019). Fabrication factors influencing mechanical, moisture-and water-related properties of mycelium-based composites. Materials & Design, 161, 64-71.

Attias, N., Danai, O., Abitbol, T., Tarazi, E., Ezov, N., Pereman, I., & Grobman, Y. J. (2020). Mycelium bio-composites in industrial design and architecture: Comparative review and experimental analysis. *Journal of Cleaner Production*, *246*, 119037.

Bitting, S., Derme, T., Lee, J., Van Mele, T., Dillenburger, B., & Block, P. (2022). Challenges and opportunities in scaling up architectural applications of mycelium-based materials with digital fabrication. *Biomimetics*, *7* (2), 44.

Deeg, K., Gima, Z., Smith, A., Stoica, O., & Tran, K. (2017). Greener Solutions: Improving performance of mycelium-based leather. *Final Report to MycoWorks*, 1-24.

Dessi-Olive, J. (2022). Advancements in the craft of growing structures with mycelium-composite materials. *International Conference on Non-conventional Materials and Technologies NOCMAT 2022.* USA.

Elbasdı, A. G. (2016). *An Investigation On Growth Behavior Of Mycelium Based Material In A Fabric Formwork.* (Yüksel Lisans Tezi). İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul.

Elsacker, E., Vandelook, S., Brancart, J., Peeters, E., & De Laet, L. (2019). Mechanical, physical and chemical characterisation of mycelium-based composites with different types of lignocellulosic substrates. *PLoS One*, *14* (7), 1-20.

Elsacker, E., Vandelook, S., Van Wylick, A., Ruytinx, J., De Laet, L., & Peeters, E. (2020). A comprehensive framework for the production of mycelium-based lignocellulosic composites. *Science of The Total Environment*, *725*, 1-16.

Etinosa, O. P. (2019). *Design and Testing of Mycelium Biocomposite*. (Yüksek Lisans Tezi). African University of Science and Technology, Material Science and Engineering, Abuja.

Faruk, O., Bledzki, A. K., Fink, H. P., & Sain, M. (2012). Biocomposites reinforced with natural fibers: 2000–2010. *Progress in Polymer Science*, *37* (11), 1552-1596.

Ghazvinian, A., & Gursoy, B. (2022). Basics of building with mycelium-based bio-composites: a review of Built Projects and Related material research. Journal of Green Building, 17(1), 37-69.

Gow, N. A., Latge, J. P., & Munro, C. A. (2017). The fungal cell wall: structure, biosynthesis, and function. Microbiology Spectrum, 5(3), 10-1128.

Haneef, M., Ceseracciu, L., Canale, C., Bayer, I. S., Heredia-Guerrero, J. A., & Athanassiou, A. (2017). Advanced materials from fungal mycelium: fabrication and tuning of physical properties. *Scientific Reports*, *7* (1), 1-11.

Heisel, F., & Rau-Oberhuber, S. (2020). Calculation and evaluation of circularity indicators for the built environment using the case studies of UMAR and Madaster. *Journal of Cleaner Production*, *243*, 118482.

Javadian, A., Le Ferrand, H., Hebel, D. E., & Saeidi, N. (2020). Application of mycelium-bound composite materials in construction industry: a short review. *SOJ Materials Science and Engineering*, *7*, 1-9.

Jiang, L., Walczyk, D. F., & McIntyre, G. (2014).Vacuum infusion of mycelium-bound biocomposite preforms with natural resins. *In CAMX Conference Proceedings* (pp. 13-16). USA: Arlington, October 13-16.

Jiang, L., Walczyk, D., McIntyre, G., Bucinell, R., & Tudryn, G. (2017). Manufacturing of biocomposite sandwich structures using mycelium-bound cores and preforms. *Journal of Manufacturing Processes*, *28*, 50-59.

Jones, M., Mautner, A., Luenco, S., Bismarck, A., & John, S. (2020). Engineered mycelium composite construction materials from fungal biorefineries: A critical review. *Materials & Design*, *187*, 108397.

Joshi, K., Meher, M. K., & Poluri, K. M. (2020). Fabrication and characterization of bioblocks from agricultural waste using fungal mycelium for renewable and sustainable applications. *ACS Applied Bio Materials*, *3* (4), 1884-1892.

Lelivelt, R. J. (2015). *The mechanical possibilities of mycelium materials.*(Master Thesis). Eindhoven University of Technology, Graduate School, Eindhoven.

Li, Y., Steenwyk, J. L., Chang, Y., Wang, Y., James, T. Y., Stajich, J. E., Spatafora, J.W., Groenewald, M., Dunn, C. W., Hittinger, C. T., Shen, X., & Rokas, A. (2021). A genome-scale phylogeny of the kingdom Fungi. *Current Biology*, *31* (8), 1653-1665.

López Nava, J. A., Méndez González, J., Ruelas Chacón, X., & Nájera Luna, J. A. (2016). Assessment of edible fungi and films bio-based material simulating expanded polystyrene. *Materials and Manufacturing Processes*, *31* (8), 1085-1090.

Sağlam, S. S., & Özgünler, S. A. (2022). An experimental study on production opportunities of biocomposite by using fungal mycelium. *Journal of Design for Resilience in Architecture and Planning*, 3(2), 237-260.

Scott, A. (2012). Philip Ross crafts furniture from mycelium. SFGate. Access: 10.03.2022, https://www.sfgate.com/homeandgarden/article/Philip-Ross-crafts-furniture-from-mycelium-4116989.php

Sydor, M., Bonenberg, A., Doczekalska, B., & Cofta, G. (2021). Mycelium-based composites in art, architecture, and interior design: a review. *Polymers*, *14* (1), 145.

Vasquez, E. S. L., & Vega, K. (2019). From plastic to biomaterials: prototyping DIY electronics with mycelium. *In Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers*, (pp. 308-311). United Kingdom: London, September 9-13.

Vos, J. (2020). *Mycelium Acoustic Panel: Growing, testing and designing with a novel bio-composite material.* (Master Thesis). Delft University of Technology, Institute of Science. Delft.

URL-1<https://www.un.org/en/global-issues/population> ET:26.07.2023

URL-2<https://www.ecovative.com/> Access: 22.07.2022.

URL-3< https://www.grown.bio/> Access: 22.07.2022.

URL-4<https://mogu.bio/> Access: 22.07.2022.

URL-5<https://www.mycoworks.com/> Access: 22.07.2022.

URL-6<https://www.dezeen.com/2016/04/01/aniela-hoitink-neffa-dress-mushroom-mycelium-textile-materials-fashion/> Access: 22.07.2022.

URL-7<https://inhabitat.com/bro-do-x-mylea-better-shoes-are-made-from-mushroom-leather/> Access:22.07.2022.

URL-8<https://www.biohm.co.uk/> Access:22.07.2022.

URL-9<https://www.treehugger.com/mycotecture-mushroom-bricks-philip-ross-4857225> Access:22.07.2022.

URL-10<https://urbannext.net/hy-fi/> Access:22.07.2022.

URL-11<https://www.dezeen.com/2017/08/26/shell-mycelium-fungus-pavilion-beetles-3-3-yassin-arredia-design-kerala-india/> Access:22.07.2022.

URL-12<https://thegrowingpavilion.com/> Access:22.07.2022.

URL-13<https://tinybe.org/en/artists/my-co-x/> Access:22.07.2022.

URL-14<https://www.v-meer.de/my-co-space> Access:22.07.2022.

URL-15<https://somfoundation.com/fellow/davis-ghazvinian-gursoy-oghazian-pecchia-west/> Access:26.07.2023.

URL16<https://www.biomaterialbuilding.com/mycocreate>Access:22.07.2022.

URL-17<https://www.archpaper.com/2022/05/university-of-virginia-school-of-architecture-biomaterials-exhibition-showcases-material-potential-of-clt-and-mushrooms/> Access:22.07.2022.

URL-18<https://simulaa.com/ >Access:22.07.2022.

URL-19<https://www.materially.eu/en/m-news/110-design/289-the-chromatic-shades-mycelium/> Access:26.07.2023.

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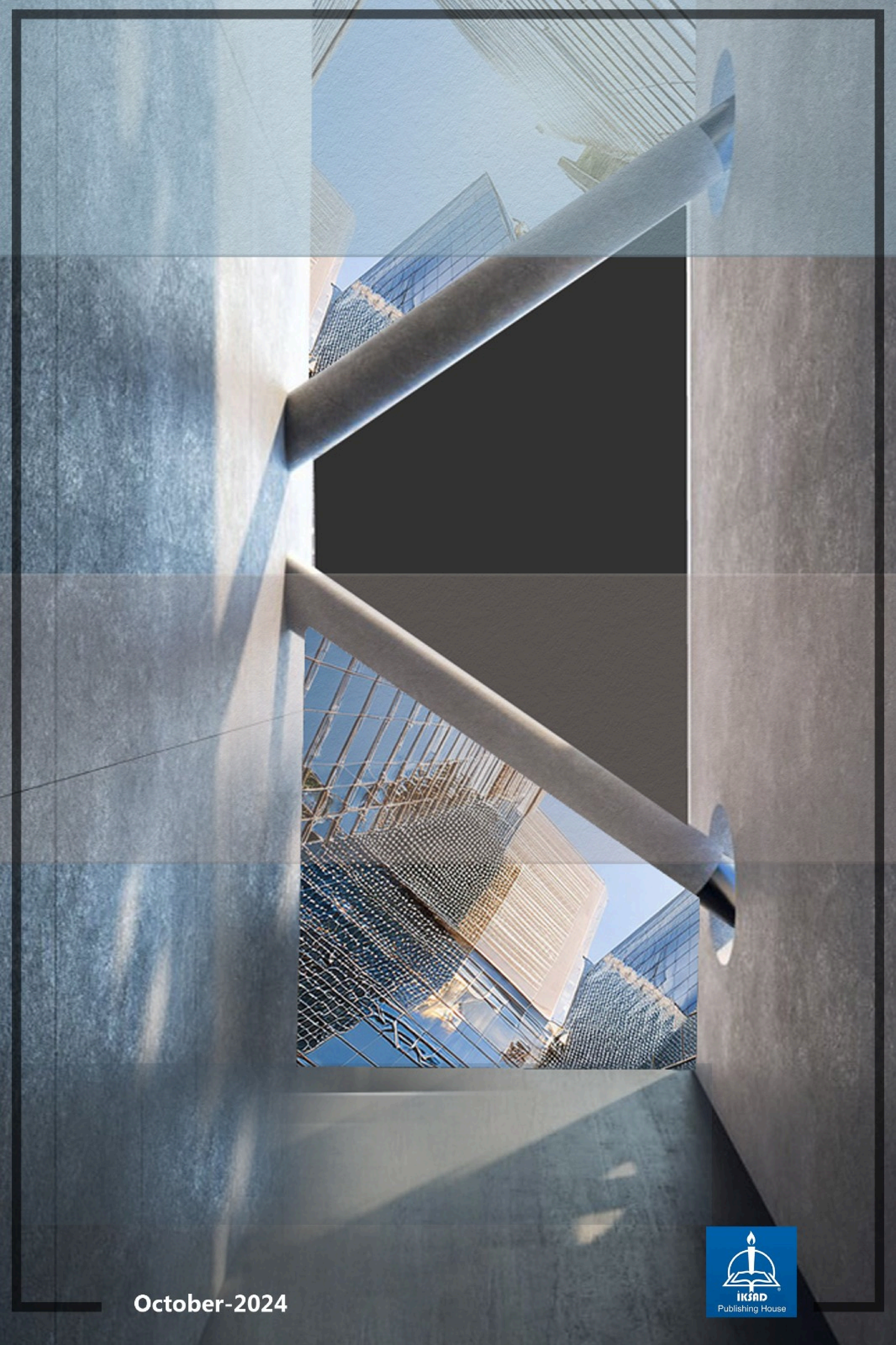

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