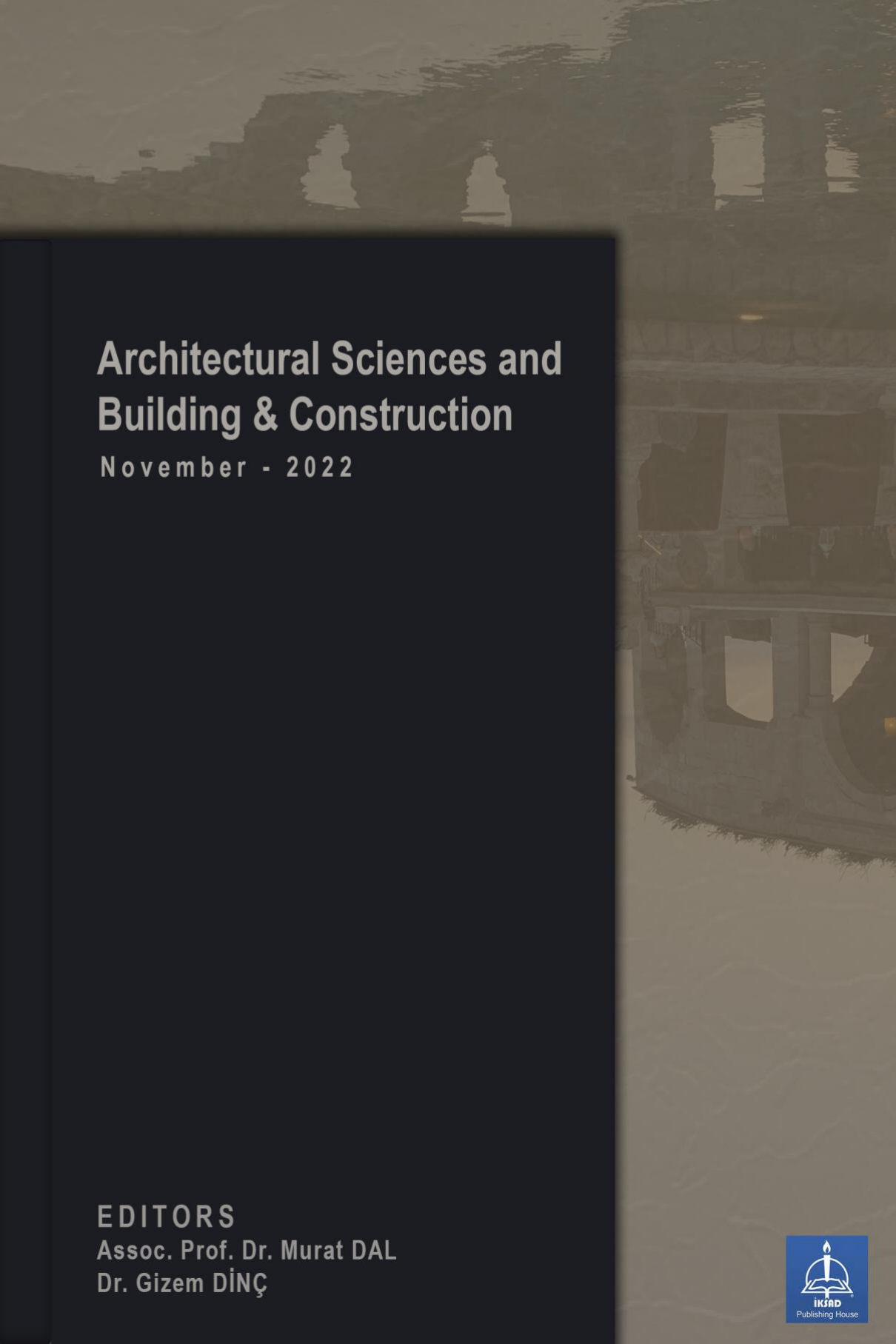

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PREFACE

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. In addition, this book, which is the continuation of the Architectural Sciences series, aims to present important studies on Building and Construction after the book containing two separate volumes, Architectural Sciences, and Protection & Conservation & Preservation and Architectural Sciences and Sustainability, published in December 2021.

This book named “ARCHITECTURAL SCIENCES and BUILDING & CONSTRUCTION” consists of ten chapters. In the book, the topics named “Environmental Impact Assessment Models For The Selection of Building Products; A Framework Approach Recommendation for the Inspection of the Building Usage Phase; A Conceptual Framework for Stages of Regenerative Built Environments; Biomimetic Architecture for Responsive Building Façade; The Use of Urban Space and Spatial Quality for the Elderly People; Structural Problems Caused by User-induced Changes and Transformations in Historical Baths: The Example of Diyarbakır Melik Ahmet Pasha Bath; Traditional Vaults and Techniques; Analysis of Republican Period Civil Architecture Examples' Plan Typologies by Space Syntax Method; Analyze the Public Buildings of the Early Republic Period by the Space Syntax Method: The Case of Rıza Çergel Cultural Center; Renovation of MSGSU Tophane-i Amire Culture and Art Center Guest House” 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 BUILDING & CONSTRUCTION" will be useful to readers.

EDITORS

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Environmental Impact Assessment Models for the Selection of Building Products

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1. Introduction

Today, it is an important decision stage for the people involved in the building design process to choose the material with optimum properties. The increasing environmental impact of building materials has brought with it the necessity of preventing problems such as deterioration of human health, climate changes, depletion of resources, ozone formation and photochemical fog formation. Reducing these negative effects caused by the material is possible as a result of the decision-makers in the material selection process making the right decisions and minimizing the environmental effects throughout the life of the material. Since the 1960s, studies have been carried out at the national and international levels to reduce environmental impacts, conserve resources and lead a healthy life for living things. The focus of the book named Silent Spring on environmental issues, the establishment of the Environmental Protection Agency (EPA), the organization of the United Nations Environment Conference and the establishment of the United Nations Environment Program (SETAC), the discovery of the hole in the ozone layer by scientists in the 1985s and as a result, the Montreal Protocol on Substances that Deplete the Ozone Layer, the publication of the Brundtland Report in 1987, the establishment of the International Institute for Sustainable Development (IISD), the Rio Declaration, the publication of the ISO 14001 Standard, the Kyoto Protocol and the implementation of certification systems such as LEED, DGNB, BREEAM, CASBEE is just a few of the studies carried out for sustainability at the international level. Some of the studies carried out

at the national level are; Environmental Law, Environmental Impact Assessment Regulation, Energy Efficiency Law, Energy Performance Regulation in Buildings, Green Certificate Regulation for Buildings and Settlement, Regulation on Construction Materials, Regulation on Environmentally Responsible Design of Energy-Related Products, Energy Efficiency Law, Excavation Soil Construction and Demolition Waste Control Regulation, TS EN ISO 14000 series, TS EN 15804 + A2 standards and the implementation of certification systems such as B.E.S.T, BUD, SEEB-TR. The main purpose of all these studies is to implement the concept of sustainability, which aims to leave a livable environment for future generations. With this concept; human-based problems such as conservation of resources, correctly directing technology, ensuring economic and social welfare, increasing the quality of life, and reducing biodiversity will be prevented. In addition, the evaluation and selection of material alternatives used in the building will contribute to the reduction of environmental loads by creating a method for everyone.

2. Material and Method

In this chapter; LCA was described, model proposals were created using the LCA method, and models that assess environmental impact were examined. Also, some Life Cycle Assessment models are described and evaluated comparatively. At the end of each chapter, the models were evaluated among themselves

3. Findings and Discussion

3.1. Life Cycle Assessment Method

Life Cycle Assessment (LCA) collects and evaluates the inputs, outputs, and possible environmental impacts of a product system throughout its life (TS EN ISO 14044, 2007). There are many accepted LCA methods today. Organizations such as the Environmental Protection Agency (EPA), the American Society for Testing and Materials (ASTM), the American Institute of Architects (AIA), and the International Organization for Standardization (ISO) work to develop LCA methods (Spiegel, 2012). Since the use of different LCA models in different countries causes confusion and incompatible environmental results, Environmental Management Systems- ISO 14000 Standards were created for the first time in 1997 due to the need for a common language union. Among these standards, two important standards dealing with the LCA method are ISO 14040 LCA-Principles and Framework and ISO 14044 LCA-Requirements and Guidelines. Detailed information about what the LCA stages cover is given in the TS EN ISO 14044 standard. An LCA study consists of four stages (Figure 1).

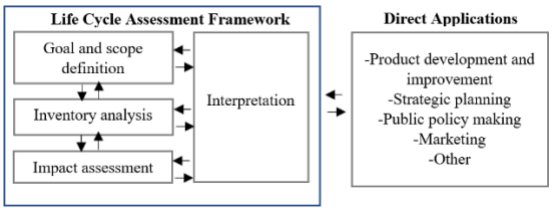

Figure 1. Life Cycle Assessment Framework (TS EN ISO 14044)

3.2. Models Created by using the LCA Method

3.2.1. The Gültekin model

In this study, an open-ended model was produced by using the LCA method to evaluate the environmental loads of building materials and a sample study was made. The relationship between the environmental effects caused by the maintenance and repair of the wallpapers in the usage phase and human health was evaluated quantitatively. In the case study, first of all, the building product system, assumptions, functional unit, system boundaries, distribution methods, and data quality requirements were defined within the scope and purpose; decisions on critical review and report preparation were made. The second phase, the life cycle data analysis phase, covers the creation of data collection methods and calculation methods for the inputs and outputs of the wallpapers, and the finalization of the system boundaries. In this context, a method has been followed in which the data are classified as "data specific to the building products", "data specific to the resource flows", and "data specific to the structure to which the building product will be applied" and "user-specific data". In the third stage, the mandatory and non-mandatory elements considered in the case study element flows were created. The structure of the created model is grouped and subdivided as (a) building products, (b) environmental effects, and (c) life cycle stages (Table 1). In the interpretation phase, important topics (impact classes, class indicators, class endpoints) related to wallpapers were introduced and the results related to these topics were evaluated (Figure 2) (Gültekin, 2006).

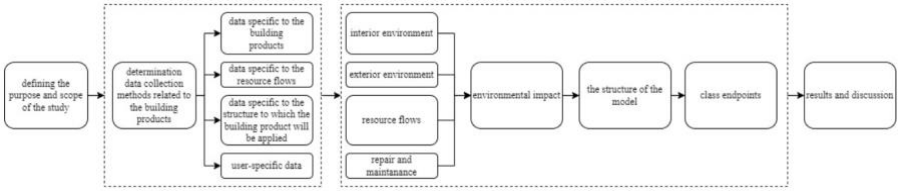

Figure 2. The Structure of the Gültekin Model (Gültekin, 2006).

3.2.2. The Taygun model

In this study, a model has been developed that aims to define the product during the selection stage and to examine and evaluate all life cycle processes. First of all, the relationship of building products with the environment was examined and models for life cycle assessment are described and evaluated. The first step of the model is to arrange the information sheets for the description of the building product. The second step is the determination of the inputs and outputs in each of the life cycle processes of the building product, the information obtained as a result, the outputs in the life cycle processes, and the preparation of the information cards of the affected environmental groups. The third step covers the environmental impact assessment of the outputs. The fourth and fifth steps are the stage in which the life cycle processes of the building product are evaluated (Figure 3). The model created is exemplified by polyvinyl chloride joinery (Taygun, 2005).

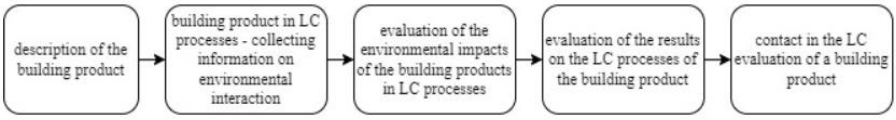

Figure 3. The Structure of the Taygun Model (Taygun, 2005)

3.2.3. The Alptekin model

This study proposes, a mixed material selection model, which compares alternatives and criteria for building products and ranks them with multi-criteria decision-making methods. First of all, the architect, who is in the decision-making position, determines the alternatives that constitute the decision-making problem. Then, the environmental impact class data of the determined alternatives are obtained from a database. After the material alternatives determined by the architect are entered into the program, the importance levels of the environmental impact data of the materials are determined by factor analysis according to their correlation with each other. Local conditions can be effective in determining the degree of importance. Then, each material alternative is evaluated with the degree of importance obtained by TOPSIS, which is one of the multi-criteria decision-making methods. As a result of the evaluation, an environmental impact score is given for each environmental impact class, and material alternatives are ranked from the highest performance to the lowest (Figure 4). In this way, the environmental impact performance of the building can be obtained in a way that is closest to the ideal. The proposed model can be used in all life cycle stages in the evaluation of the environmental impacts of materials. In a sample study carried out within the scope of the model, the environmental effects of the raw material extraction and production stage of the floor finishing materials were examined, and a material selection evaluation was made in line with the obtained environmental data (Alptekin, 2014).

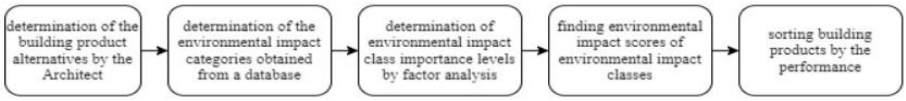

Figure 4. The Structure of the Alptekin Model (Alptekin, 2014)

3.2.4. The Bayraktar model

In this study, a model that evaluates the environmental effects of materials in line with the LCA method is proposed based on considering the current situation of Turkey on environmental issues, in line with the country's possibilities and limitations on environmental impacts. First of all, the properties and environmental effects of building materials were examined, the stages of LCA were defined and the studies on environmental impacts in the world and Turkey were presented. Within the scope of the proposed system, it is aimed to carry out a life cycle impact assessment by taking into account the lower and upper limit values specified in the reviewed regulations after the information regarding the life cycle stages of the product is determined in line with the designed leaflets. Evaluation can be made in three categories: mean value, a value close to the limit, and a value close to 0 (Figure 5). At the last stage of the study, the proposed system is exemplified by cement building material (Bayraktar, 2010).

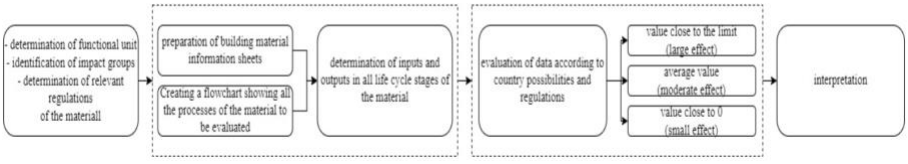

Figure 5. The Structure of the Bayraktar Model (Bayraktar, 2010)

3.2.5. The Paulsen model

One study focused on the link between the choice of a product and the effects that occur during the use phase of the product's service life. For the calculation of environmental loads in the usage process; (1) emissions from products to the indoor environment, (2) emissions from products to the external environment, (3) interference with resource flows in building systems, (4) consumption of auxiliary products and resources for maintenance and (1) LCI data for building products, (2) LCI data for flows in the usage process, (3) the necessity of knowing building-specific data are conveyed (Figure 6). In the study, first of all, the development of sustainability was mentioned, the stages of life cycle assessment were explained, and the problems in the calculation of environmental impacts in the use process were mentioned. In this context, it has been determined that the methodical analysis of the usage phase of floor coverings depends on creating a model for maintenance by making the following generalizations: (1) cleaning and maintenance methods, (2) products and machines used for maintenance, (3) amount of product and resource used for each maintenance method. Using a calculation tool, it is also shown how the environmental impacts of a product can be calculated based on its maintenance characteristics. Maintenance is grouped under 3 subheadings as; frequent maintenance, periodic maintenance and remedial maintenance. It has been mentioned that understanding the service life of the material depends on the economic, aesthetic, ecological service life and additional information. The study also addresses the total energy use of materials. At this point,

3 scenarios were constructed: (1) heat losses from external walls, (2) the effect of the building context, and (3) the importance of heat capacity. To calculate the energy loads of the building, the importance of the information in the usage process and the necessity of considering all information as a whole have been conveyed. In the conclusion, recommendations are made and it is mentioned that the use phase can have more environmental impact than maintenance and the impact on a building's energy use alone (Paulsen, 2001).

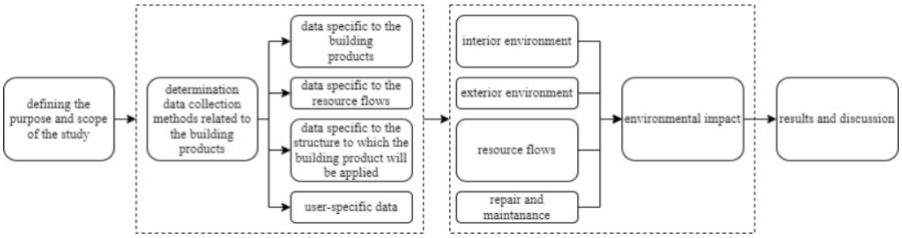

Figure 6. The Structure of the Paulsen Model (Paulsen, 2001).

3.2.6. Evaluation of the models created by using the LCA method

As indicated in the studies, each model can be used for each life cycle stage. The stages that are discussed in detail with the sample study in the models are indicated in Table 1.

Table 1. LC stages covered by the models

	Gültekin	Taygun	Alptekin	Bayraktar	Paulsen
Product stage		x	x	x	
Construction Process Stage		x		x	
Use Stage	x	x		x	x
End of life		x		x	

In Table 2, the environmental impact categories determined in the models are given. Since the Taygun model is for the Life Cycle Assessment process, environmental impact categories are not specified

in the study. Instead, the inputs and outputs of the product are mentioned in each life cycle phase. In addition, since environmental impact categories were not determined in the Paulsen model, they are not given in the table. In this model, it is stated that the impact categories will be chosen according to the user's request.

Table 2. Environmental Impact Categories of the LCA models

	Gültekin	**Alptekin**	**Bayraktar**
Global warming	**x**	**x**	**x**
Depletion of the ozone layer	x	x	x
Acidification	x	x	x
Eutrophication	x	x	x
Photochemical fog formation	x	x	x
Indoor air quality		x	
Fossil fuel consumption		x	x
Resource consumption	x		x
Water consumption		x	
Human toxicity	x	x	x
Ecological toxicity	x	x	
Pollution (air, water, soil)	x		
Damage to biological diversity	x	x	
Air pollution		x	

When the models are evaluated in general, it is seen that there is no limitation on the product to be evaluated, and the models can be used optionally. Among the models, only Gültekin and Alptekin consider environmental impact importance weights. In addition, Alptekin model showed that multi-criteria decision making methods can be used in material life cycle evaluation. Studies have shown that the models produced at national and international level are only theoretical and unused. It is important to put these models into practice in order to reduce the environmental impact of materials.

3.3. Models That Assess The Environmental Impact

3.3.1. The Anderson model

The model, created by BRE based on life cycle assessments, presents the environmental impacts of materials in tables by grouping them according to their usage areas. Each effect has different relative importance. The life cycle evaluation headings are listed as follows, from the most important impact to the least important impact. Materials are evaluated under the headings of climate change, fossil waste consumption, ozone depletion, airborne toxins, waste management, water extraction, acid residue/accumulation, eutrophication, ecotoxicity, summer smoke/mist, and mineral extraction, toxins mixed with water. The value obtained as a result of the total evaluation and the effect levels for each title is expressed with the letters A, B, and C (Figure 7) (Anderson, et.al., 2009).

Loadbearing partitions

Element	Summary Rating	Climate Change	Fossil Fuel Depletion	Ozone Depletion	Human Toxicity to Air and Water	Waste Disposal	Water Extraction	Acid Deposition	Ecotoxicity	Eutrophication	Summer Smog	Minerals Extraction	Cost £/m²	Typical Replacement Interval	Recycled Input	Recyclability	Recycled Currently	Energy Saved by Recycling
Aerated blockwork partition, plasterboard on dabs, paint	A	A	A	A	A	A	A	A	A	A	A	A	41-53	60	B	B	B	B
Brickwork, plaster, paint	B	A	A	A	A	B	A	A	A	A	A	A	45-60	60	C	A	A	A
Dense blockwork, plasterboard on dabs, paint	A	A	A	A	A	B	A	A	A	A	A	A	47-56	60	C	A	A	B
Fairfaced brickwork	A	A	A	A	A	B	A	A	A	A	A	A	26-36	60	C	A	A	A
Fairfaced reinforced concrete	C	A	A	A	B	C	B	A	A	A	A	C	80-95	60	C	A	A	A
Lightweight blockwork partition, plasterboard on dabs, paint	B	B	A	A	A	B	A	A	A	A	A	A	41-53	60	A	A	A	B

Figure 7. Sample Environmental Impact Assessment Charts of the Anderson Model (Anderson et.al., 2009).

3.3.2. The Wooley model

In this book, some evaluations reveal the environmental impact levels with life cycle analysis by classifying building materials on their usage

areas. While making the life cycle assessment, the environmental effects of the materials over the headings in the "production" and "use" processes are compared with materials with similar functions and gain values between 0-4. Environmental impact assessment titles; Under the title of "production"; energy use, consumption of biological resources, consumption of non-biological resources, global warming, ozone depletion, toxins, acid rain, photochemical oxidants, under the title of "use"; energy use, strength/maintenance, recycling/reuse/waste, health. In the tables presenting the environmental impact assessments, visual expressions are used instead of numerical values, with larger dots meaning greater negative impact. At the same time, with written evaluations on each title, designers are provided with tips for choosing a material that will take into account its environmental impact (Figure 8) (Wooley et. al., 2005; Wooley & Kimmins, 2005).

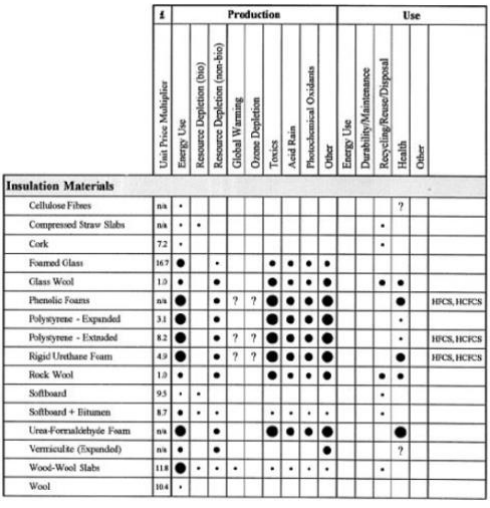

Figure 8. Sample Environmental Impact Assessment Charts of the Wooley Model (Wooley et. al., 2005; Wooley & Kimmins, 2005).

3.3.3. The Demkin model

The Environmental Resource Guide, prepared by the American Institute of Architects (AIA), provides assessments that reveal the environmental impact levels of building materials through life-cycle analysis. The life cycle assessment comparatively reveals the environmental impact levels on a 6-point scale under the headings of “environment and ecosystem”, “health and well-being”, “energy” and “building operation”. Visual expressions are used instead of numerical values in the tables. Environmental impact assessment titles are listed as; under the title of “environment and ecosystem”,air quality/ atmospheric effects, water quality/accessibility, land and soil quality/accessibility, raw material consumption, biodiversity / growing environment, under the title of “health and well-being”, the health of employees, the health of building users public health, under the title of “energy”, production, transportation, use and under the title of “building operation”, it can be listed as service life/durability, maintenance, and repair, reuse/recycling. In addition to the environmental impact assessment tables, the materials are handled under the headings of "supply and preparation of raw materials", "production and fabrication", "construction, use and maintenance" and "reuse, recycling, destruction" based on their origins and detailed evaluations are presented with written explanations and tips (Figure 9) (Demkin, 1998).

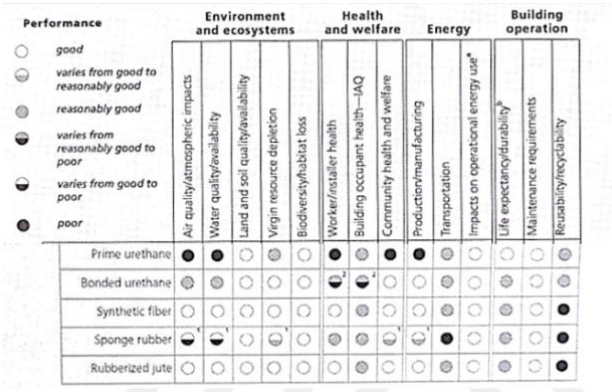

Figure 9. Sample Environmental Impact Assessment Charts for Carpet Cushions of the Demkin Model (Demkin, 1998).

3.3.4. The Curwell model

The model is designed to help designers choose the product that is least harmful to health but remains within the most adequate and logical limits in terms of technique and appearance, in the processes covering the design, construction, maintenance, and changes of the structure.

According to Curwell, the impact of the health risk arising from building products on users depends on the location of the building products in the building, the environmental factors inside the building, and the indoor ventilation. In the model; harmful effects on health caused by building products are determined on a numerical scale from 0 to 3 and in areas qualified as A/B/C (Figure 10). A defines the possible harmful effect of the position of the product in the structure on the health of the user, and B defines the possible harmful effect of the product on the health of the user as a result of maintenance, repair, change or fire and C defines the long-term potential environmental impact of maintenance, repair, replacement, fire and improper disposal

Life Cycle Stage	Resource Consumption	Score
Material Acquisition & Preparation	Betterment in resource use (10% from renewable source). Also, removes ash that is currently landfilled from waste stream for a beneficial use.	+1
Production & Distribution	An extra 2% water required in brick making process. However, this is not considered significant in terms of resource use. Lignosulphate is used, but this is a naturally derived product and assumed to be non-toxic.	0
Construction	No difference in the method of construction.	0
Use & Maintenance	No difference in durability or replacement cycles.	0
Demolition & Disposal	No difference in options for reuse/treatment.	0

Figure 11. Sample Environmental Impact Assessment Chart for Clay Bricks of the Urie Model (Urie & Dagg, 2004)

3.3.6. Evaluation of the models that assess the environmental impact

When the models are examined, it is seen that especially the Anderson, Woolley, Demkin and Curwell model has the characteristics of a material database and allows the comparison of different materials within the model (Table 3).

Table 3. Materials in the databases

	Materials in the database
Anderson	Materials over the area of use; are classified under the headings of exterior walls, roofs, floors and floor coverings, floor constructions, interior partition walls, suspended ceilings, and ceiling coverings, doors, paints, insulations, and landscaping elements.
Wooley	(1st book) thermal insulation materials, meshed systems, wood, composite panels, wood origin, joinery, paints, and stains on joinery, roofing materials, rainwater removal systems, plumbing systems, carpets, and floor coverings, (2nd book) interior decoration, connectors, electrical wiring, glass, flat roofs, ventilation, fences, straw/reed buildings.
Demkin	The materials are presented by classifying them under the following headings, based on their usage areas and origins; lightweight structures, insulations, coatings, wall finishes, elastic floor coverings, architectural finishes, glass, carpet, load-bearing system, metal, and plastic pipes, fabric and paper wall finishes.
Curwell	Building products that are harmful to health are listed as; asbestos and other natural materials, wood, cellulose fiber, calcium silicate board, mineral fiber, vermiculite, natural slate, phosphogypsum, mineral fibers originating from the building industry, metals, aluminum, zinc, iron, steel, copper, lead, chromium, plastics, and toxic chemicals.
Urie	No material database

It has been seen that the models are easy to use and their use is not mandatory. In particular, Anderson, Wooley, Demkin models have shown that environmental impact comparisons of several different materials can be made quickly. In addition, the Curwell model keeps the creation of information tables mandatory in material comparison. In the Urie model, which focuses on each of the material life cycle processes, a more complex selection system based on calculations has been created. The LC stages covered by the models is given in Table 4.

Table 4. LC stages covered by the models

	Anderson	Wooley	Demkin	Curwell	Urie
Product stage	x	x	x		x
Construction Process Stage	x		x		x
Use Stage	x	x	x	x	x
End of life	x		x	x	x

3.4. Life Cycle Impact Assessment (LCIA) Models

3.4.1. The Öztaş model

In this study, an LCIA model that deals with the entire life cycle of building materials produced in Turkey has been developed. Using the ISO 14040 standard, the midpoint approach model is adopted. Considering the environmental issues in Turkey, the EN 15804 standard, and the impact categories mostly used in the current LCIA models, 11 environmental impact categories caused by construction materials were selected. Identification models and category indicators were selected for seven impact categories based on the EN 15804 standard. For the remaining 4 impact categories, identification models and category indicators were determined based on Turkey-specific data. Weighting coefficients for these impact categories were determined using the panel method (Analytical Hierarchy Process). As a result of the weighting, 11 selected environmental impact categories are grouped as high risk, medium risk, and low-risk environmental problems for Turkey. The environmental impact caused by a Turkish citizen is proposed as the normalization reference value. During the model creation phase, many different difficulties were encountered and solution methods were explained. The model was tested on expanded

polystyrene foam material and the results of the model were compared with other LCIA models using Simapro (Karaman Öztaş, 2014).

3.4.2. The ECOHESTIA model

The model evaluates the environmental impact of building materials and components. The system boundary of this model is cradle to gate. All the data it contains is specific to Cyprus. Materials used in the ECOHESTIA database are; aluminum, PVC, float flat glass, brick, plasterboard, tiles, cement, plaster, concrete (c10/ c15, c16, c20/ c25, c35) , thermal insulating materials (EPS, mineral wool), paint (exterior, interior), waterproofing, polyethylene film, plywood, steel. It employs CML 2001 methodology. Normalization and weighting are not possible with this method. (Kylili et. al., 2016).

3.4.3. The BRE (Building Research Establishment) environmental profiles model

This model created by UK BRE, allows for a 'cradle-to-grave' environmental impact assessment of materials using a midpoint approach. BRE LCIA model includes classification, definition, normalization, and weighting steps. It includes energy, mineral consumption, water consumption, waste, water emissions, and air emissions. The service life of the building material is taken as 60 years, and the functional unit is taken as 1 m^2. The model also includes normalization and weighting steps (BRE, 2008).

3.4.4. The BPIC-ICIP (Building Products Innovation Council-Industry Cooperative Innovation Programme) model

The BPIC/ICIP Construction Products Innovation Council and Industry Partnership Innovation Program aimed to establish a model of international construction industry LCA for Australia. The normalization value is based on the annual per capita environmental impact value in Australia (Bengtsson & Howard, 2010a). 11 workshops were conducted in major populated centers covering all climatic zones to calculate the weighting coefficients according to different climatic zones of Australia. The results are Australian averages and Australian demographically adjusted averages. As global effects, resource consumption, ecological impact, sea pollution, air pollution, and global warming are discussed; local effects, local resources, habitat loss, urbanization, water pollution, air pollution, land productivity, and poisoning are discussed. Comfort and health are handled as internal problems. Demographic weighting has been weighted according to age, gender, and income (Bengtsson & Howard, 2010b).

3.4.5. Evaluation of the LCIA models

The models are evaluated according to impact categories (Table 5), category indicators (Table 6), normalization values (Table 7), and weighting values (Table 8).

Table 5. Environmental Impact Categories of the LCIA models

	K. Öztaş	ECOHESTIA	BRE	BPIC-ICIP
Global warming	x	x	x	x
Depletion of the ozone layer	x	x	x	x
Acidification	x	x	x	x
Eutrophication	x	x	x	x
Photochemical fog formation	x	x	x	x
Indoor air quality	x			x
Fossil fuel consumption	x	x	x	x
Mineral resource consumption	x	x	x	x
Water consumption	x		x	x
Waste generation	x		x	
Land use	x			x
Human toxicity		x	x	x
Ecological toxicity			x	x
Ionizing radiation				x
Transport pollution				x

Table 6. Category Indicators of the Models

	K. Öztaş	ECOHESTIA	BRE	BPIC-ICIP
Global warming	kg CO_2 eq.	kg CO_2 eq.	kg CO_2 eq.	kg CO_2 eq.
Depletion of the ozone layer	CFC-11 eq.	kg R11	CFC-11 eq.	CFC-11 eq.
Acidification	kg /SO_2	kg/ SO_2	SO_2 eq.	SO_2 eq.
Eutrophication	kg/PO_4 eq.	kg/PO_4 eq.	PO_4 eq.	PO_4 eq.
Photochemical fog formation	kg/ C_2H_4	kg Ethene	kg.ethane	kg. NMVOC
Indoor air quality	VOC			-
Fossil fuel consumption	TEP	MJ	Toes	MJ
Mineral resource c.	Tonne	Kg Sb-Eq	Tonne	Kg
Water consumption	M^3		Litre	Kilo Litre
Waste generation	Tonne		Tonne	
Land use	m^2 x year			Hectare.year
Human toxicity		Kg DCB-Eq	Kg toxicity	1,4-D Beq. DALY'
Ecological toxicity			kg 1,4-DB	kg.1,4-DB
Ionizing radiation				Kg U235
Transport pollution				-

Table 7. Normalization Values of the Models

Model	Normalization value
K. Öztaş	Total environmental impact of a Turkish citizen
ECOHESTIA	-
BRE	Annual environmental impact created by a British citizen
BPIC-ICIP	The environmental impact per person per year in Australia

Table 8. Weighting Methods of the Models

Model	Weighting method
K. Öztaş	Panel method – Analytic Hierarchy Process
ECOHESTIA	-
BRE	Panel method--Eco-points system
BPIC-ICIP	Panel method--Delphi method

4. Conclusion and Suggestions

Today, building materials have been artificialized by using different techniques and components to meet the performance requirements expected from them. Materials that deviate from naturalness cause the world ecosystem to deteriorate and threaten human health. This situation brought with it the necessity of establishing a systematic model. Some institutions and organizations have started to take measures on the subject and aimed to reduce the environmental burden by developing various models for material selection. In addition, there are studies on the subject prepared on a country basis. Considering that material selection is a multi-criteria process that requires a lot of data, it has been observed that the models examined do not consider the material at every stage of the life cycle process or only consider some aspects. To maintain sustainability awareness and leave a better environment for future generations, models that deal with materials in detail and evaluate them based on country/region/city are needed. In this sense, institutions and organizations should work together, and

laws, regulations, and standards should be established. In this study, some of the environmental impact assessment models created for material selection are discussed. The study revealed the importance of material selection at the design stage and emphasized the necessity of a comprehensive model in this regard.

Author Contribution and Conflict of Interest Disclosure Information

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

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A Framework Approach Recommendation for the Inspection of the Building Usage Phase

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1. Introduction

Like everything that exists in the universe, buildings also have a life cycle. It is a dynamic and long process that continues from the design stage to the demolition of the building and includes many phases in itself (Sey, 1998).

The inspection of the building, on the other hand, covers the entire life cycle process. It is a necessity of the life cycle which is not limited to a certain time and work, and is thought to include all phases of design, construction and use. At this point, it is thought that the main purpose of the inspection is to ensure the continuity of the building safety and since the building safety covers issues such as public health and the protection of the natural environment, and the effective and rational evaluation of the resources used in the construction of the building, it is thought that it would be correct to deal with the issue in a holistic way. The fact that the building inspection cannot be limited to only the design and construction stages and the necessity to carry out the inspection independently of the contractor indicates the requirement of it being a public service that should be emphasized greatly regardless of whether the owner of the building is the state and/or private sector.

The principles and legislation regarding zoning practices in Turkey have been determined by the law number 3194. In the aforementioned law, building inspection was defined under the title of technical responsibility, but after Marmara Earthquake of 1999, detailed inspection of building construction came to the fore and the law number 4708 came into force.

The main problem in the building life cycle process is the illegal various augmentations and additions made during the usage phase of the buildings (Çakır, 2011). Due to the lack of an adequate and effective control mechanism in this regard, a framework approach for inspection has been put forward in this study.

The starting point of the research is that the life span of building-type structures is very short and there is no application in the current system regarding the inspection of buildings in use. Today, in an environment where even motor vehicles are inspected and recorded at regular intervals, not checking the structures during the usage phase has been identified as a deficiency, and eliminating this deficiency has been the main purpose of the research study.

Research; in order to propose a framework building identification and inspection approach (model) for the usage phase of building-type structures, was conducted on the sample of the Turkish construction industry. In the research, as a result of the statistical analysis of the data collected with semi-structured interviews and Delphi method; In addition to the building inspection method, which covers only the design and construction phases in the current system, an inspection model proposal has been created for the usage phase, which is an important part of the life cycle process of the buildings. In this respect, the study also carries the feature of being the first study in the Turkish construction sector literature.

2. Conceptual Framework

2.1. Structure, Building and Building Inspection

Physical masses that are constructed by using various building materials and construction techniques in order for all kinds of living beings in nature to survive are called structures (Ayaz, 2002).

Building is one type of structures and a special application in terms of quality and quantity. According to many variables such as the location and geometry of the land on which the building will be built; building's function, project stakeholders, financial and economic parameters, current legislation, etc. it differs for each building (Güner and Giritli, 2004).

Building inspection is defined as checking the suitability of the building in the project design and construction application processes for the construction of buildings in accordance with the conditions of the zoning plans and construction standards that have come into force for the purpose of ensuring the safety of life and property (http://www.csb.gov.tr).

2.2. Building Life Cycle

The building life cycle is a cycle as shown in Figure 1 that starts with the demand and need for the building, continues with the phases of planning-design, construction, use, and demolition (Metin and Tavil, 2010).

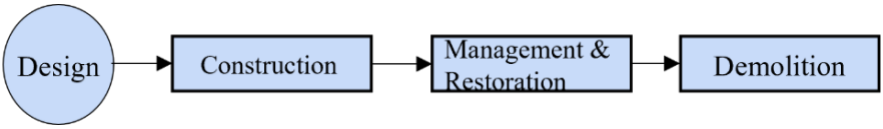

Figure 1. Diagram summary of the building life cycle (Karaaslan, 2011)

The life cycle process of buildings is a long process that includes many different business steps, as shown in Figure 2. Professional management capability is needed and this process should be shaped by a project management discipline.

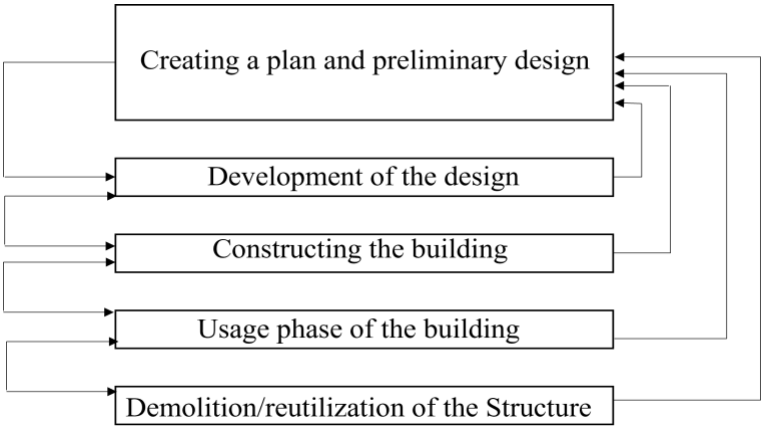

Figure 2. Diagram of relationships between life cycle stages (Özmehmet, 2007)

2.3. Building Usage Phase

In the life cycle of building-type structures, the usage phase comes after planning-design and construction phases. After the construction of the building is completed, the occupancy certificate is issued and the real estate is registered as a building by making the transition to condominium ownership and and use conversion in the land registry offices.

It is a phase where users and building managers remain as stakeholders and public/private auditors do not have a duty. Buildings are exposed to innovative and technological additions within the scope of facility management by its managers (Dayangaç, 2005). In addition, various interventions by each independent section user are observed after the delivery in the buildings. At the core of the problems that lead to user intervention are the inability of the material chosen during the construction phase to fulfill its function, the transformation brought about by the changing living conditions, etc., which are situations that also take place in the physical space. The building, which was designed according to traditional and/or periodical conditions, can go as far as to become completely different in terms of space with time (Erbaş, 2013). However, buildings should provide a healthy and comfortable environment for living things to live in safety. They are also responsible for maintaining the functions expected of them over a long period of time (Dal & Yılmaz, 2015).

3. Methodology of the Study

With this study; the main objective is to actively monitor and rightfully maintain the buildings by drawing an approach framework for the inspection of the building usage phase, and to be cautious against possible disasters. Another point that makes this study important is that the approach framework creates a basis for the creation of sustainable buildings and environments.

3.1. Research Method

In this study, a research was conducted in which qualitative and quantitative data were used together in order to propose a framework approach for the inspection of buildings in the usage phase, based on expert opinions. First, a mass housing project in Beykoz district was evaluated as a case. In the field, the data collected by semi-structured interview method and Delphi method were analyzed and qualifications and standards were tried to be determined. The reason for choosing this technique as a research method is that it is a reliable method that provides consensus in cases where there is no clarity due to time and resource constraints and there is not enough research in the relevant field. At the last stage, the differences and similarities of opinion among the experts participating in the study in line with the standards agreed upon as a result of the Delphi technique were statistically investigated.

3.2. Scope and Limitations of the Research

Considering the time and resource problems, the research was limited to the province of Istanbul. In the research; Civil engineers and architects, who are in the position of technical vice president in charge of development of municipalities, were evaluated as sector experts, and faculty members working in civil engineering and architecture departments of universities were considered as academic experts. At this point, the limitation of the research is that it is limited to the knowledge and experience shared by the sector and academic experts who accepted to participate in the Delphi sessions and whose opinions were sought.

3.3. Determining the Participating Experts and Target Audience

Various researchers with sufficient expertise about the research topic, willingness and interest in research, sufficient time to conduct the research and communication skills were selected (Mead & Moseley, 2001; Skulmoski et al, 2007). A total of 31 participants were determined for the research by choosing the non-probabilistic sampling (Büyüköztürk et al., 2010) approach, which is a probabilistic and non-random sampling method in the selection of experts. At the first stage, a total of 34 people were contacted for the study, 14 of them academic and 20 of them in the sectoral field. 12 of the academic and 19 of the industry experts agreed to participate in the study.

3.4. Determination of Audit Criteria and Data Collection Process

In order to determine the building usage phase inspection criteria, a detailed literature review and case study were carried out simultaneously. With the case study, which is thought to be able to examine the building life cycle phases comprehensively, it is aimed to determine how and on which issues the current needs affect the building during the building usage phase.

These steps formed the basis for the participants to report the importance and opinions. Before starting the Delphi study, the brainstorming method was used as meetings took place with a group of 7 industry and 5 academic experts at different places and times. Regardless of this method, information notices were sent to other industry experts and academics who were requested to participate in the

research to get their opinions on the subject. The aim here is to gather the opinions of the participants freely on the subject without any direction and influence with the brainstorming technique and targeted questions. Although there are various studies in the literature that directly start the research with closed-ended questions, due to the importance of the subject and the lack of a similar study on the subject in Turkey before, determining the raw form of the audit criteria was preferred in the light of the information obtained from the case study by using the brainstorming method with a team of 12 experts.

As a result of the meetings held with the participants participating in the brainstorming method and the questions sent to other interested parties, a Delphi questionnaire consisting of 7 separate sections and a total of 86 questions was conducted.

The Delphi technique is defined as "a systematic, time and cost effective method of achieving consensus among key data sources and a selected group of experts" (Alston & Bowles, 2003). In the Delphi technique, it is aimed to reach a consensus by making use of the opinions of experts who look at the subject from different angles (Şahin, 2001); the experts are not affected by each other when expressing their views (Clayton, 1997). The Delphi method, which is preferred to reach a consensus, is based on obtaining expert opinions on a problem within a system (Rowe and Wright, 2001). As professionalism is sought in Delphi technique participants, this situation creates high motivation in the participants (Sumpsion, 1998).

3.5. Conducting Research with the Delphi Method

The research was completed in three consecutive Delphi studies over a period of 5 months. By asking open-ended questions to the participants through the draft form created in the first round of the study, it was aimed to determine the exact working framework and to benefit from the participants' knowledge and experience about the scope. In the first round (it lasted for 3 months between February to April 2017), those whose frequency percentage was below 50% in the comments from the experts could not be moved to the next round. By trying to measure the level of participation in the questions in the form created in the second (completed in 2 months) and third (completed in 1 month) Delphi rounds, with a 5-point likert type scale; The purpose of reconciliation was aimed by question reduction method according to percentage and frequency, standard deviation, and approximation.

According to the answers given by the participating experts to the 5-point likert-type scale as a consensus criterion, 80% of the participants agreed and the standard deviation of the answer given to each question was (+/-)1 standard.

4. Findings

In order to create a framework approach proposal on the phase of usage of buildings, evaluation forms were sent to the participating experts in the form of three rounds within the scope of Delphi and their opinions were received on the subject; to examine the level of consensus in the results of the Delphi study from the participating experts, Wilcoxon Signed Rank Test was used in the second question in the non-parametric

tests and Kendall's W Concordance Test was used in the other questions.

Kendall's W test is one of the non-parametric tests used to compare more than one sample population. It is also a test that analyzes the level of statistical significance of the ordered data. Kendall's W coefficient of concordance obtained from the test results can be interpreted as seen in Table 1 (Şengür, 2010).

Table 1. Kendall's W Concordance of Coefficient and Degree of Consensus

Rank	Kendall's W coefficient of	Degree of Consensus	Coded
1	0.1	Very weak consensus	VWC
2	0.3	Weak consensus	WC
3	0.5	Moderate consensus	MC
4	0.7	High consensus	HC
5	0.9	Very high consensus	VHC

7 questions were asked within the scope of the research and shared the findings below:

Question 1: What are the Features in the Inspection of the Usage Phase?

In the first round, opinions of the experts on the features that should be emphasized during the inspection of the usage phase of the buildings were taken and grouped. In the second round, they were asked to give a score on a five-point Likert scale. In the third round, the standard deviation and general average values prepared by taking into account the scores of all participants were given and they were sent for them to review their views and make a ranking. The ranking results and the

order of Likert general average scores are in agreement with each other as in Table 2.

Table 2. Results of Question-1

	Usage Phase Inspection Features of Buildings	Rnd. 1		Rnd. 2	
		Frequen	**Pct.**	**Likert Avg.**	**Standard deviation**
ENVIRONMENTAL FEATURES					
1	Positioning of the building within the land	12	%100	4,47	0,82
2	Featues of the building regarding he silhouette	10	%83	4,40	0,72
3	Adequacy of having open (garden) and closed (indoor) parking lots	9	%75	4,40	0,67
4	Features related to building-garden and road level (whether the natural ground levels of the land are disturbed by leveling and filling)	8	%67	4,33	0,84
PHYSICAL FEATURES					
1	Features related to the load-bearing system safety	12	%100	4,87	0,58
2	Fire-related features	12	%100	4,73	0,52
Mechanical features		10	%83	-	-
3	Heating installation adequacy [quantity of building elements (radiator, fancoil, etc.)]	-	-	4,30	0,75
4	Adequacy of cooling inst. [quantity of construction elements (air conditioner, fancoil, etc.)] Adequacy of cooling inst. [quantity of construction elements (air conditioner, fancoil, etc.)]	-	-	4,00	0,87
5	Ventilation installation adequacy [quantity of building elements (pile, grille, fan, etc.)]	-	-	4,27	0,83
6	The quality of the elevator and its adequacy for building use	-	-	4,50	0,68
7	Roof related features	10	%83	4,27	0,58
8	Fatures related to water, moisture and other liquids	9	%75	4,77	0,50

9	Electrical features	9	%75	4,63	0,61
10	Heat-related features	8	%67	4,60	0,67
11	Features related to independent sections*	7	%58	3,97	1,10
12	Features related to indoor common areas	7	%58	4,20	0,85
13	Sound-related features	6	%50	4,27	0,64
SUSTAINABILITY FEATURES					
Electricity usage		12	%100	-	-
1	Lighting (total energy consumed-kWh)	-	-	4,40	0,67
2	Heating	-	-	4,33	0,71
3	Sanitary hot water	-	-	4,23	0,73
4	Cooling	-	-	4,13	0,82
Water usage		12	%100	-	-
5	The use of new systems that minimize water consumption (remote taps, cascading reservoirs, etc.)	-	-	4,33	0,92
6	Collecting and utilizing rain water	-	-	4,03	0,85
7	Evaluation of the amount of CO2 emissions	8	%67	4,17	0,91

*Could not move to the third round.

The Kendall's W concordance test coefficient of the first question, which consists of 23 propositions, was found to be 0.987 and has a high degree of reliability.

Question 2: What Should the Inspection Frequency of the Usage Phase of the Buildings Be?

In the first round, questionnaire were sent to get their opinions on the period of the inspection application in the inspection of the usage phase of the buildings. Participating experts expressed their opinions in 7 categories, between once every 2 years and once every 20 years, and pointed out that the most prominent issue in terms of wear and intervention of buildings is the function of the building. In the second round, the opinions of the participating experts were taken for 7 time periods for 7 functions, including housing, office buildings, shopping malls, accommodation buildings, health buildings, education buildings and public service buildings. In the third round, all was sent to the experts with the participant scores to be evaluated again. The results of the third round, including the results of the second round, are shown in Table 3.

Table 3: Opinions and Results of Participant Experts on Question-2

Rank	Audit Frequency		Frequency Values And Percentages													
			Houses		Office Buildings		Shopping Mall		Accommodt Buildings		Health Buildings		Education Buildings		Public Service Buildings	
			Frequency	Percentage %	Frequency	Percentage %	Frequency	Percentage %	Frequency	Percentage %	Frequency	Percentage %	Frequency	Percentage %	Frequency	Percentage %
1	**every 2 yrs**	**Rnd 2**	1	3	3	10	**18**	**58**	4	13	**16**	**52**	**15**	**48**	**15**	**48**
		Rnd 3	2	6	1	3	**21**	**68**	2	6	**22**	**71**	**19**	**61**	**17**	**55**
2	**every 3 yrs**	**Rnd 2**	5	16	3	10	6	19	1	3	9	29	12	39	9	29
		Rnd 3	6	19	3	10	4	13	2	6	4	13	8	26	8	26
3	**every 5 yrs**	**Rnd 2**	**21**	**68**	**17**	**55**	4	13	**23**	**74**	5	16	4	13	5	16
		Rnd 3	**19**	**61**	**23**	**74**	4	13	**26**	**84**	4	13	3	10	3	10
4	**every 7 yrs**	**Rnd 2**	2	6	5	16	2	6	1	3	1	3	-	-	-	-
		Rnd 3	2	6	2	6	1	3	-	-	1	3	1	3	1	3
5	**every 10 yrs**	**Rnd 2**	2	6	3	10	1	3	2	6	-	-	-	-	2	6
		Rnd 3	2	6	2	6	1	3	1	3	-	-	-	-	2	6

Wilcoxon Signed Rank Test, which is one of the most powerful non-parametric tests that can be used when the assumption of the significance test of the difference between the two correspondances cannot be met, was used to evaluate the second and third round opinions

about the frequency of inspections in the usage phase according to the functions of the buildings.

The Wilcoxon test is a dependent two-sample test. It is the non-parametric alternative test of the paired t test (Akgül & Çevik, 2010). It is used in the analysis of whether there is a random sample drawn from the majority with a median of zero of the difference of two groups obtained from n samples. A hypothesis is established for the proposal: H0: Co-trial results are equal, H1: Co-trial results are not equal, and α: 0.05 significance level was chosen (Daniel, 1990).

According to the test results of the study on inspection frequency, the H0 hypothesis was accepted for each building function. In the light of the findings, there is no statistically significant difference between the opinions of the second and third round expert participants. As seen in Table 4; the result is $p>0.05$ for all building type structures according to their function.

In this case, it is accepted that all the evaluations and opinions that can be received from the expert participants have been recieved, and the answers to Question 2 should be evaluated in the light of these data. Thus, there was no need for a next round of inspection frequency.

Table 4. Third Round of Question 2 Wilcoxon Signed Rank Test

Rank	Building Types by Function	Difference btwn Round 2 and Round 3	
		Z	p
1	Houses	-1,131	0,257899
2	Office Buildings	-0,319	0,749805
3	Shopping Malls	-0,954	0,340084
4	Accommodation Buildings	-0,086	0,931286
5	Health Buildings	-1,552	0,120645
6	Education Buildings	-0,265	0,791153
7	Public Service Buildings	-0,284	0,776205

Question 3: What are the Knowledge, Skills and Features Required in an Auditor Who Will Perform the Building Occupation Inspection?

In the first round, six evaluation items were determined by in-depth interview method. In the second round, participant experts were asked to evaluate on a five-point Likert scale. From the opinions in Table 5, the 6th item with a score below 4 was eliminated and sent to the experts for 5 item rankings in the third round. In the third round, the participant experts were asked to see the values ranked according to the likert average results of the opinions they gave in the second round, and to review their opinions in terms of the knowledge, skills and features sought in the auditor who will carry out the building usage phase inspection and rank them accordingly. Kendall's W test coefficient of concordance value used in the question was found to be 0.890. There is high consensus among the rankings of the participating experts.

Table 5. Results of Question-3

Rank	Knowledge, Skills and Features Required in an Auditor	Rnd. 1		Rnd. 2	
		Frequenct	Pct.	Likert Avg.	Std. deviation
1	Possess technical knowledge (e.g. architecture, engineering) required by the task	12	%100	5	0
2	Acting independently and impartially	12	%100	4,90	0,30
3	Ability to use technology-based audit techniques	10	%83	4	0,58
4	Analytical capabilities	9	%75	4,06	0,57
5	Risk management	9	%75	4,03	0,71
6	Interpersonal communication/conciliation skills*	8	%67	3,52	0,85

*Could not move to the third round.

Question 4: What are the Purposes of the Usage Phase Inspection in the Building?

In the first round, participating experts were asked to express their opinions on 12 items, and in the second round, their opinions were asked on a five-point Likert scale. Kendall's W test was used to test the consensus among the evaluations for the other 11 items except the 12th item in Table 6, and the Kendall's W coefficient of concordance value was found to be 0.883. According to this result, there is a high consensus among the rankings submitted by the participating experts.

Table 6. Results of Question-4

Rank	Purposes of Auditing	Rnd. 1		Rnd. 2	
		Frequance	Pct.	Likert Avg.	Standard Deviation
1	Ensuring building and user safety against possible natural disasters and negative user interventions	12	%100	4,74	0,51
2	Preventing zoning pollution	12	%100	4,74	0,51
3	To ensure the protection and longevity of th building's environmental, structural and economic characteristics	12	%100	4,51	0,51
4	In order to prevent major problems that may occur in buildings, early detection of problems in periodic inspections, taking necessary measures and performing rapid interventions	11	%92	4,45	0,77
5	Providing conscious use awareness in the people living in the building	10	%83	4,29	0,82
6	Ensuring the sustainability of the buildings	10	%83	4,25	0,73
7	Ensuring that the projects produced in the planning and design phase are handled in a way that creates a one-to-one basis for the application.	10	%83	4,23	0,99
8	Bringing the missing phase of building usage inspection into the system	9	%75	4,19	0,83
9	Keeping track of the quality and quantity data of the building in use by recording it in a system document (BKB)	9	%75	4,19	0,83
10	Ensuring the participation of building life cycle stakeholders and the continuity of their responsibilities in the building usage phase	8	%67	4,06	0,77
11	Leading to more careful practices in building life cycle processes	7	%58	4,00	0,58
12	Minimizing the living costs of building users*	7	%58	3,39	1,15

*Could not move to the third round.

Question 5: Who are the Stakeholders who will be included in the Audit Team to Perform the Building Usage Inspection?

In the first round, the 17-item form was asked to the participants to give their views. In the second round, they were asked to give a score according to the five-point Likert scale. In the third round, the participant experts reordered their views as shown in Table 7. Kendall's W test coefficient of concordance, which was used in the evaluation of question 5, was found to be 0.965. There is a very high consensus among the rankings of the participating experts.

Table 7. Results of Question-5

Rank	Audit Team Officers	Rnd. 1		Rnd. 2	
		Frequancy	Pct.	Likert Avg.	Standard Deviation
1	Building-Application Supervisors	12	%100	4,35	0,91
2	Project Owner Staticist	12	%100	4,32	0,83
3	Project Owner Architect	12	%100	4,32	0,94
4	Authority Responsible for Elevator Inspection	10	%83	4,22	0,80
5	Official Admin (Municipal/Governship)	10	%83	4,26	0,73
6	Fire Brigade Officer	9	%75	4,16	0,93
7	Occupational Health and Safety Specialist	8	%67	4,10	0,98
8	Project Owner Mechanical Eng.	8	%67	4,00	0,97
9	Project Owner Electrical Eng.	8	%67	4,00	0,97
10	Sustainability Licensing Specialist	8	%67	4,03	0,75
11	Infrastructure Institutions Officer*	7	%58	3,84	1,10
12	Expert issuing energy perf. certificate*	7	%58	3,65	1,08
13	Relevant Professional Chambers Officer*	7	%58	3,61	1,26
14	Project Owner Ground Engineer*	6	%50	3,59	1,29
15	Contractor*	6	%50	3,54	1,43
16	Building manager*	6	%50	3,45	1,39
17	LİHKAB (Licensed maps and cadastral bureau) official*	6	%50	2,61	1,20

*Could not move to the third round.

Question 6: What should be the sanctions that will be applied in case the negativities caused by the user are not eliminated?

In the first round, a 10-item form was sent. In the second round, these questions were sent to be scored for the five-point Likert rating scale application. When the results of this round were evaluated, the 6th and 7th items in Table 8 were eliminated and a 5-item questionnaire was moved to the third round. Participating experts were asked to reorder the questions in the third round. Kendall's W coefficient of concordance was found to be 0.935 in Question 6, titled sanctions to be applied in case of negativities caused by the user are not eliminated. According to this result, there is a very high consensus among the rankings submitted by the participating experts.

Table 8. Results of Question-6

Rank	Sanctions to be Applied to the User	Rnd. 1		Rnd. 2	
		Frequency	Pct.	Likert Avg.	Standard Deviation
1	Putting a temporary annotation on land registry of the real estate and introducing a "sale ban"	12	%100	4,41	0,81
2	Fines (Accruing more fines for what you did than you earned)	12	%100	4,35	0,88
3	Pulling Infrastructure Usage Costs to a Deterrent Level *Water usage fee ratio increase *Electricity usage fee ratio increase *Natural gas usage fee ratio increase	11	%92	4,13	0,88
4	Reducing the Credibility Ratio	10	%83	4,10	0,94
5	Reducing the Tax Cost to a Deterrent Level * Increased property tax * Increase in environmental and cleaning tax	9	%75	4,13	0,88
6	Evacuating the user*	7	%58	3,61	1,28
7	Imprisonment for the user (in situations that put the safety of the whole building at risk) *	7	%58	3,58	1,46

*Could not move to the third round.

Question 7: What are the Performance Requirements and Degrees of Applicability to the Buildings of the Enforced and Potentially Enforced Mandatory Standards?

In the first round, the questionaire were sent then asked to participants; and in the second round, they were asked to score on a five-point Likert scale. Only 5 of the 13 question items were moved to the third round. In the third round, the experts were asked to rank 5 items by seeing their Likert averages. Kendall's W coefficient of concordance, which was used for the evaluation of question 7, was found to be 0.879. There is a

high consensus among the rankings of the participating experts in the figure in Table 9.

Table 9. Results of Question-7

Rank	Applicability to Buildings and Performance Requirements	Rnd. 1		Rnd. 2	
		Frequenc	Pct.	Likert Avg.	Standard Deviation
1	Improvement of safety performance (Increasing measures against occupational accidents)	12	%100	4,35	0,61
2	Improving water consumption performance	12	%100	4,26	0,63
3	Improvement of the indoor/outdoor area boundaries of the independent section according to the changing needs of the user	12	%100	4,06	0,77
4	Improvement of heating-cooling performance	12	%100	4,03	0,48
5	Improving energy performance	12	%100	4,03	0,31
6	Implementation of fire escape and safety hall standards*	11	%92	3,77	0,72
7	Revision of elevator quality*	9	%75	3,71	0,53
8	Durability of the carrier system for floor editions (Reinforcement) *	9	%75	3,52	0,81
9	Completion of the functional change in accordance with the standards (eg transformation from residence to workplace, workplace transformation into edu. building) *	8	%67	3,52	0,63
10	Improving sustainability performance*	8	%67	3,39	1,02
11	Improving earthquake and disaster resilience performance*	7	%58	3,39	0,56
12	Improvement of contradictions in existing buildings in terms of urban aesthetics with new zoning decisions*	7	%58	3,35	0,88
13	Improving acoustic performance*	7	%58	3,35	0,95

*Could not move to the third round.

5. Conclusion & Recommendations

While the life cycle phases of buildings start at a certain time and end at a certain time; Since the beginning of the usage phase is known and the end date cannot be predicted, it is the longest phase of the cycle. For this reason, an effective building inspection system should be proposed and developed for the building usage phase. By means of this effective system, both the economic life of the buildings will be extended and the risk of loss of life and property in possible disasters will be minimized. Changing needs, requirements and technological developments cause user interventions in buildings. The application of innovations developed by public administrations to buildings is compulsory or sometimes encouraged. Each time a new necessity or user preference intervention comes to the fore, the building should be examined throughly. However, each intervention can create situations that will harm other areas and even cause loss of life and property.

Within the scope of this research, the framework of the building usage phase inspection approach has been tried to be drawn comprehensively. Audit team, auditor knowledge, skills and characteristics; The research questions were determined through in-depth interviews with the participating experts in order to define the targeted issues with the audit, the frequency of the audit, the criteria in the audit and the sanctions to be applied in adverse conditions.

Delphi technique consisting of 3 rounds was used while constructing the building usage phase inspection model proposal. For the scope of the research questions, 7 research questions were created with the Wh-

questions method. Opinions received for each question were evaluated in three rounds, and then high and very high consensus results were obtained according to the Wilcoxon Signed Rank Test (in the second question) and Kendall W Test (in the questions other than the second question). It is possible to summarize the results obtained as follows:

- Building usage phase inspection; It should be done every 5 years in residences, every 5 years in office buildings, every 2 years in shopping centers, every 5 years in accommodation buildings, every 2 years in health-related buildings, every 2 years in education-related buildings, every 2 years in public service buildings.
- Building inspectors, project designers, the authority responsible for the elevator inspection, the relevant public administration, fire department, occupational health and safety specialist and experts who issue sustainability licenses should take part in the building usage phase inspection team.
- Although the auditor has the technical knowledge required by their job at the maximum level; should act impartially and independently during the audit process. Should be able to follow technological developments and use digital bases actively. Must have analytical capabilities and be able to manage potential risk.
- During the building usage inspection, the first of the criteria to be considered is “features related to load-bearing system safety”. Afterwards, a high consensus was reached on the physical, environmental and sustainability features of the building.

- If the negativities detected in the audit are not eliminated within the given time; A high consensus was reached on preventing the change of ownership, accruing and collecting deterrent fines, and imposing sanctions that increase living expenses by registering a sales ban annotation in the land registry.

Using the findings in the study, a model is proposed, which is summarized as shown in the diagram in Figure 3:

The building manager should apply to the Ministry of Environment, Urbanization and Climate Change for an audit when the audit time comes. The Ministry should send the invitation containing the information of the building to be audited and the date of the audit to the main/substitute members of the audit team. Members should examine and inspect the building in detail at the date and time determined within the scope of their field of expertise. Within the scope of the issues agreed upon in the results of the Delphi study "Building usage phase inspection features", the building should be examined in detail and scientifically in terms of "features related to load-bearing system safety etc". Any negativities like discrepancies, omissions etc. threatens the safety of life and property; The building should be evacuated immediately and a demolition decision should be made. As a result of the audit; In cases where the building complies with its project and science and art rules, a visa should be registered and the building should be allowed to be used until the next inspection.

In cases where minor problems are detected, sufficient time should be given to correct the problem. At the end of the period, the problem area

should be re-inspected to see if the problem has been resolved or not. In cases where the problem is resolved, visa registration should be made and the building should be allowed to be used until the next inspection time. In cases where the problem is not resolved, sanctions should be applied for the building.

Building and occupant safety will be ensured against possible natural disasters and negative user interventions when the building usage phase inspection is to be carried out in the light of the findings of this study. In order to prevent major problems that may occur in the buildings, the problems will be detected early with periodical inspections of the usage phase and necessary precautions will be taken; The environmental, structural and economic characteristics of the buildings will be preserved and the buildings will have a sustainable longevity.

It is believed that with the contribution of the model proposal, which is the product of this study, more careful and conscious usage awareness will be created in the building usage phase. In terms of the results obtained from the study, it is thought that it will be a reference and leading research element for all future studies on building usage phase inspection.

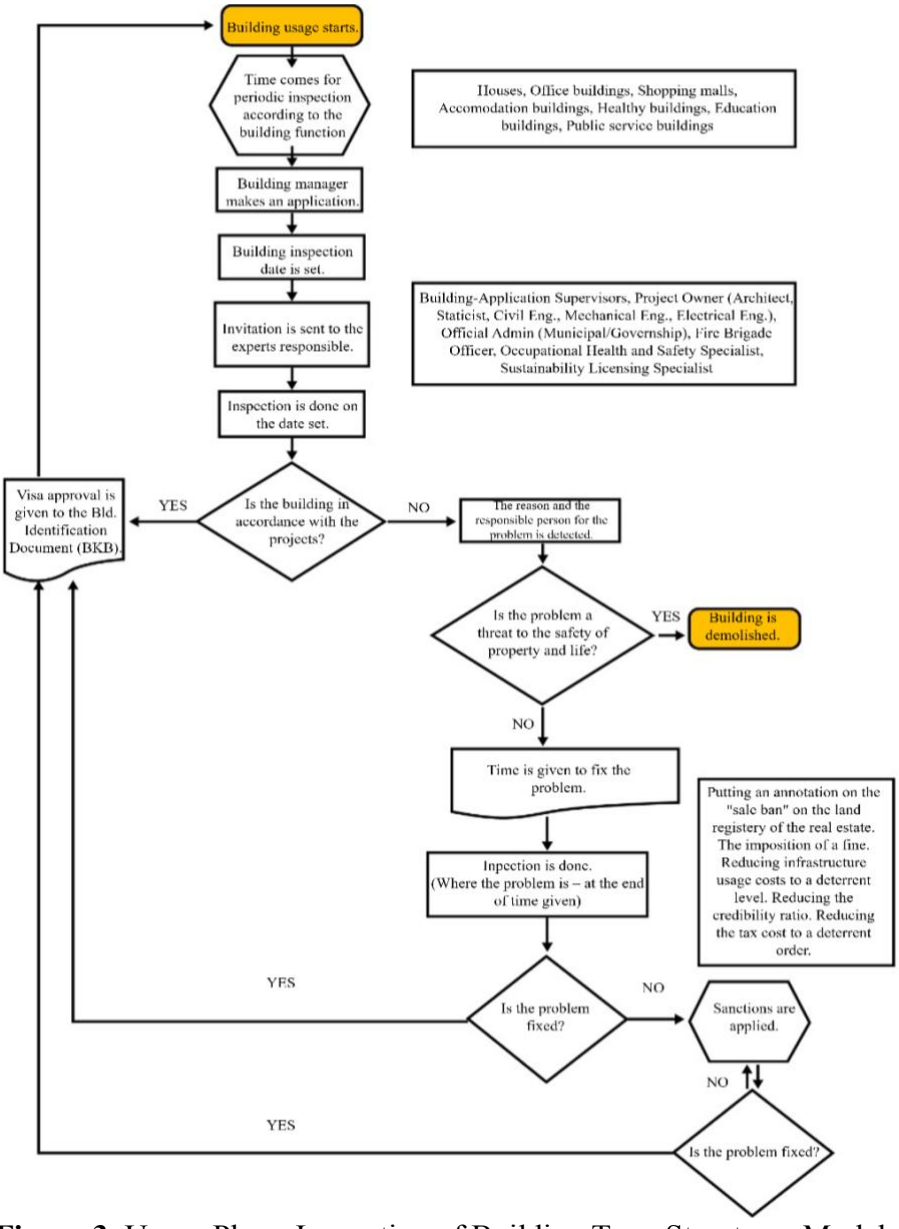

Figure 3. Usage Phase Inspection of Building Type Structures Model Proposal Workflow Diagram

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A Conceptual Framework for Stages of Regenerative Built Environments

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1. Introduction

Humans, unlike other living entities, affect the nature in a distinctive way and can change its properties. Behaviors and endeavors of humankind, shaped by the prevailing paradigms of their communities and adopted worldviews, are widely known for their damage on the ecosystems. Constantly increasing demands along with the burden of their correspondences extremely disorganize ecosystems' functioning and substantially decrease their service provision (Summers et al., 2012) to or beyond critical limits (du Plessis, 2012). Most of these endeavors are related to built environments.

A built environment can be considered as a man-made surrounding, created by re-organizing a part of nature and involves living areas of different scales from a small building to a city or even a region. In accordance with the largely adopted mechanistic worldview that considers humankind over and independent of nature (Cole, 2012a), meeting the needs of humans has been the principal purpose of built environments. Around the world, especially with the predicted rate of urban population increase, many adverse effects on humans and nature are associated with different stages of built environments such as construction and usage.

It is stated that, because human systems are deeply seated in natural systems (Cole et al., 2012) and interdependent to essential life support services supplied by ecosystems (Summers et al., 2012), changes in ecosystems will cause changes in human well-being. Based on this

statement, respecting the biophysical carrying capacity and assisting the recovery of damaged and destroyed ecosystems must be considered among critical priorities.

In order to achieve a balance between humankind's needs with the requirements related to planet's health and to avoid the destruction of its life support systems; substantial changes in built environment become unavoidable. As Haggard et al. (2008) pointed out, realizing the primal need for a shift in values, paradigms and worldviews before changing endeavors or methods is essential because a continued engagement with conditions that cause the crisis, inaccurate assumptions (du Plessis, 2012), deep rooted beliefs and knowledge will keep preventing an evolutionary transform. Building a sustainable future can be managed by moving towards eco-centric concepts instead of mechanistic discourse. This conjuncture, supported by the increase in understanding fundamentally interconnected, complex and systematic structure of nature (du Plessis, 2012), created the regenerative sustainability paradigm.

Nature should not be considered as a simple passive victim against human actions; instead, both must be regarded as equally powerful participants due to the cycle between human activities and the potential of natural environment to provide vital ecosystem services that support these activities (du Plessis and Cole, 2011). Regenerative sustainability guides the process of reforming this new relationship between systems of human and nature (Zhang, 2014). Based on Gabel's (2015) statement

about the possibility to procreate a future of increased ecosystem health and human prosperity by approaching the subject through the lens of regenerative sustainability, it is legitimate to regard the built environment as the key component of this future. Herein, as Zhang (2014) pointed out, it is necessary finding proper ways to engage and relate practitioners to create built environments in pursuance of regenerative sustainability and this can be accomplished by structuring a properly organized way of holistic and systematic thinking.

Robinson and Cole (2015) emphasize the ambiguity in conceptually and practically creating and evaluating a regenerative built environment. Hofstra (2015) underlines that particularly the design stage needs to be focused on due to the fact that the projection of regenerative concept on built environment has not developed commensurately, even if the focus of current agenda is stated to be on the details of how environmental considerations should be included in design by Lützkendorf (2018). Cole (2012b) basically characterized the re-conceptualization of design practice as organizing, structuring and activating it with a larger context, a more holistic approach. Nearly all current approaches concentrate on the reduction of environmental impacts (Robinson & Cole, 2015) of single buildings for only a specific period of building life. Despite this, the consideration of an isolated building is not convenient to be the subject of regenerative thinking. Moffatt and Kohler (2008) argue that this consideration should be expanded over the common ignorance of the impacts through

environments and inadequacy of time limits in terms of patterns and consequences concerning whole life span.

In order to address the necessity of proper support tools, this study aims to constitute and propose a framework for organization of built environments which may have potential regenerative results. The goals of the framework are to outline the importance of the integrity and completeness of the process, considering all stages of built environment through their interrelations among each other and between different scales and to generate consistent principles for particularly design stage in order to reveal some essential steps towards implementable methods for practitioners who want to participate in regenerative sustainability. It is assumed that by aligning design with systems thinking in the direction of consciously structured decision-making tools, it can be easier to move forward for net positive results in spite of the complexity of subject and stagnation tendency of transition. Given the substantial focus is on energy despite the progressive awareness of actors of the sector about their responsibilities to the environment (Lützkendorf, 2018), the potential benefits of studies with stated aim are noticeable.

2. A New Perception for Built Environment and Design

Pursuing and sustaining healthy lives in a certain place are dependent to the quality of interactions between all living entities (Mang & Reed, 2015). Accordingly, instead of regarding humans to be consumers of ecosystems' various services, regeneration discourse posits humans and their constructs as fundamental and interwoven parts of ecosystems

(Girardet, 2010). For that matter, the need for a consideration of an association between ecological and socio-cultural systems becomes essential (du Plessis, 2012). The main aim of this alliance is to reweave them into a co-evolutionary partnership comprised of humans and other living entities, their interrelated activities and physical non-living surroundings (Anderies, Walker & Kinzig, 2006) which targets to add value for the system instead of a managerial diminishment (Cole, 2012b). The persuasion to actualize this aim conceived the regenerative design approach as well as a new definition and mission for built environment.

The 20th century has been depicted with scientifically evidenced environmental degradation, notably because of built environments along with other matters. For the great majority in general practice, there is a tendency to consider a built environment as a piece of private property with building(s), infrastructure and constructed open spaces (Moffat & Kohler, 2008). Furthermore, a linear lifespan, through construction and usage stages generally ending with demolition, is known to be embraced. Despite some discussions searching for adversative opinions (e.g. Vandevyvere & Heynen, 2014), there are plentiful judgments about built environments which have been created in line with the principles of mechanistic Modern Movement and mostly negligent to environmental issues in terms of their past and current adverse effects on humans and nature through abundant improper duplications of Modernist architecture constructed to meet the

requirements of rapid urbanization (du Plessis, 2012). Because of decisions made in design by overlooking impacts of oncoming stages, buildings are considered to account for adverse. As many users are insensibly devoted solely to consume these built environments, many of them eventuate in wastes and are replaced with new ones generally to be the subject of a similar journey.

According to anthropocentric discourse, which sees nature as a resource for consumption, the only meaning of adding value to an ecological system can be making it more beneficial for humans (Mang & Reed, 2015). This effort, accurately defined as 'more welfare from less nature' (WBCSD, 2000), is basically a management tenet aiming to improve the efficiency in consumption (du Plessis, 2012) and can be noticed in the core of today's many popularized design or evaluation approaches on account of their attempts to introduce more responsibility towards reducing the harmful results (Cole, 2015) through buildings that have less negative impacts (Gou & Xie, 2017).

The basic concerns of sustainable discourse include resource use, the level of emissions / wastes and human health / comfort issues. Reduced consumption and negative discharge and improved occupant wellbeing, mostly at an individual building scale and for building's initial performance before occupancy (Cole et al., 2012), are primary aims of these buildings.

A built environment in regenerative design is accepted as a new system with indefinite boundaries, which integrates different systems of nature,

humans, their activities and interactions in interrelated hierarchies, each one is included by a higher level and contains a range of lower ones as depicted in Figure 1.

Figure 1. Interrelated Environments

In spite of many benefits such as success in installing a wide range of environmental tenets, the best level that can be reached by sustainable discourse is net zero (Cole, 2015) because of its aim to sustain the existing situation as it is through decelerating the degeneration, as seen in Figure 2.

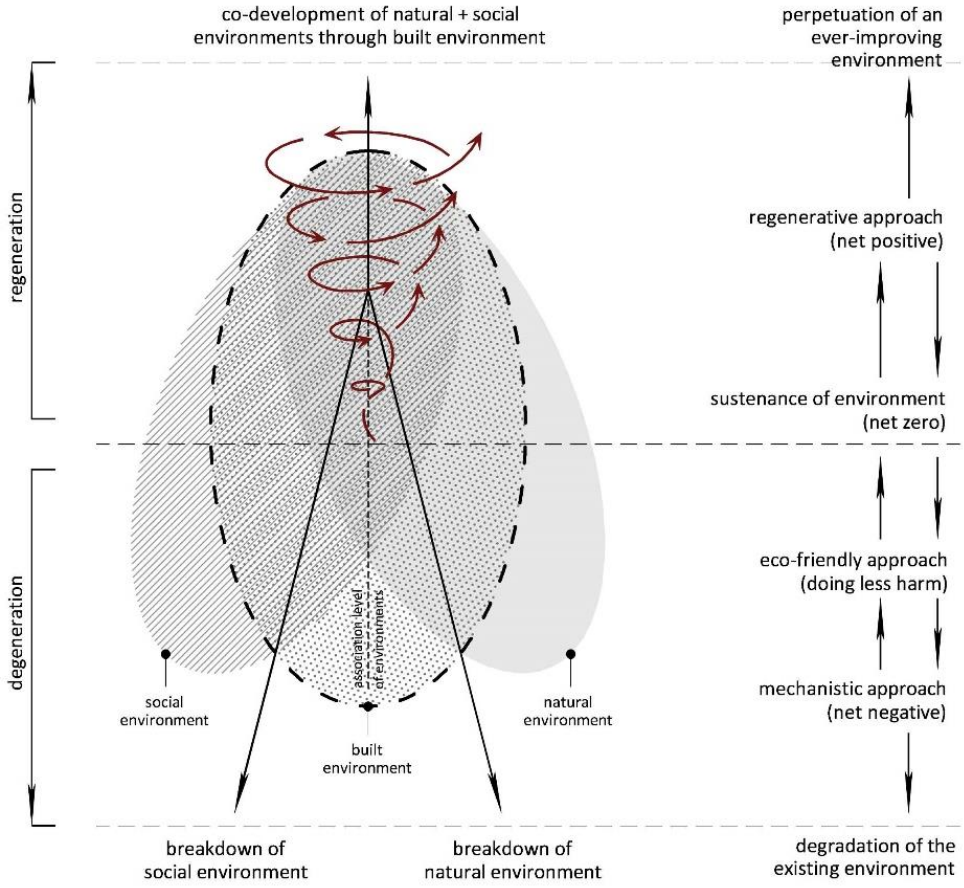

Figure 2. Environments and Approaches (adapted from Darçın, 2014)

Regenerative design targets to overcome the ineffectiveness of approaches that has been guiding green building practice (Cole, 2015): it is not enough simply limiting or stopping negative results (Pedersen Zari, 2012), preserving an entity (Mang & Reed, 2012) or making a local habitat more productive and healthier (Reed, 2007); the work of regeneration means for net positive. In order to accomplish this, it is aimed to create a built environment which exists integrally with natural

and social processes, exerts to transform their relationship and navigate this transformation by serving as a proper medium for their continuous and healthy engagement.

Built environment should produce capacity to heal the current wounds (Clegg, 2012; Cole et al., 2012) in the beginning and after that to develop necessary conditions for sustaining positive evolution in time (Mang & Reed, 2012) by adding value to both systems for vitality and viability (Mang & Reed, 2015) in their smaller and larger scales. By this way, they can evolve towards a continual progressive sustainment without any requisite human management (Pedersen Zari, 2012). Boundaries of regenerative built environments should be consciously blurred, so that they can be inseparably unified with ecological and social environments and become a stimulant for this process within their place of organization (Robinson & Cole, 2015).

For regenerative concept, it is important to design not only with or like nature, but for nature (Hes & du Plessis, 2015) as well. The ways of managing an effective life organization in a particular place can be revealed by examining intact and healthy ecosystems and processes of nature as an aspiration model (Pedersen Zari, 2012). Because the value of a role comes mainly from the pattern of relationships which allows exchanges of value in an ecological system, one species fulfilling its role enables all others to actualize their functions even without a direct connection (Mang & Reed, 2015). Based on this fact, a built environment should provide and integrate to ecosystem services

(Pedersen Zari, 2012) of provisioning, regulating, acculturating and supporting in that particular place through established patterns of multi-scaled relationships (Mang & Reed, 2015).

The practice requires systems thinking in order to focus on the whole rather than fundamental parts, relationships rather than isolated entities, processes rather than structures and quality over quantity. Comprehending the notion of scale creates the main difference; as symbolized in Figure 1, results and effects of a built environment can be experienced not only by its users, but also by various systems (Cole et al., 2012). Based on that, providing connections for individuals to each other as well as to surrounding systems (Svec et al., 2012), reconnecting human activities with nature (Mang & Reed, 2012) and aligning them with natural processes (Plaut, et al., 2012) and instead of embracing a linear mechanism, enrolling in proper flow cycles (Cole et al., 2012) through significant circulation of inputs, outputs and information (Moffatt & Kohler, 2008) up and down concentric scales are the basic requirements. These cycles can be identified between their exit points from ecosystems and entrance conditions to built environment (Moffatt & Kohler, 2008) and vice versa. Receiving, absorbing, filtering and transforming inputs like energy or resources should be enabled through the designed features such as form, space or materiality of this built environment (Gou & Xie, 2017). Generating natural and social capitals by gaining their contribution are the main targets of engagement with flows (Cole et al., 2012).

Arrangement of essential principles and properties related to a regenerative built environment in the way of re-conceptualizing its whole lifespan can be beneficial towards a more favored participation.

3. Built Environment Stages in Regenerative Thinking

The basic targets in regenerative design are transforming the quality of existing systems (Birkeland, 2008), creating new life systems and providing continuous self-renewing (Hofstra, 2015) with the help of built environments. This can be managed by finding proper ways of being useful (Robinson & Cole, 2015) through consciously organized stages of design and operation (Reed, 2007). To continue enhancing wellbeing in time, an interactive adaptability is needed (Robinson & Cole, 2015).

Because of interdisciplinary side of the subject, practicing regenerative design requires participants who are associated with new types of specialties (Robinson & Cole, 2015) such as entomology or social psychology. This alliance is essential for not only different point of views to work in harmony with the aim of activating new potentials (Svec et al., 2012), but also for co-learning (Reed, 2007).

Exploring fundamental stages of a built environment will be contributive for a fruitful organization of investing regenerative capacities. The following sections examine how each step of stages unfolds and integrates to form a developmental progression.

3.1. Pre-Design Stage: Analysis and Interpretations

In regenerative thinking, built environment is not solely for its human users anymore; all existing and future humans and non-human living entities in the context of their socio-cultural and ecological systems inside and around the design area through concentric scales (Figure 3) should be considered as equal users of built environment. In order to create this type of living habitat, which will integrate with and serve as a proper medium for the healthy engagement of these user groups, the character of the place should be deeply understood through a thorough analysis of its all-key elements, their properties, needs, activities and interactions. This analysis should not approach to the elements separately in isolation; all elements are to be comprehended in their associations. Furthermore, not only existing elements are needed to be searched, but especially disenabled entities, activities, relations and flows should be revealed. Additionally, the frame of analysis should not be constrained with some limits in terms of area or time such as site boundaries or the period between design and usage. The focus should be moved beyond, rather on all interrelated environments, their unique history and potential for future lifelong differentiation arising from their inexpungable dynamism of continuous structuring and destroying.

The next step of pre-design stage is to make significant and purposeful interpretations as outcomes of the analysis for to determine the role of the built environment in co-evolutionary partnership of user groups and generate relevant questions for a collective discovery process. All

findings obtained during analysis should be inferred singularly and under various groups so as to develop two main consecutive explorations: adequate samples of healthy functioning of systems and strategies to create an adaptive sustainment coherent to those samples.

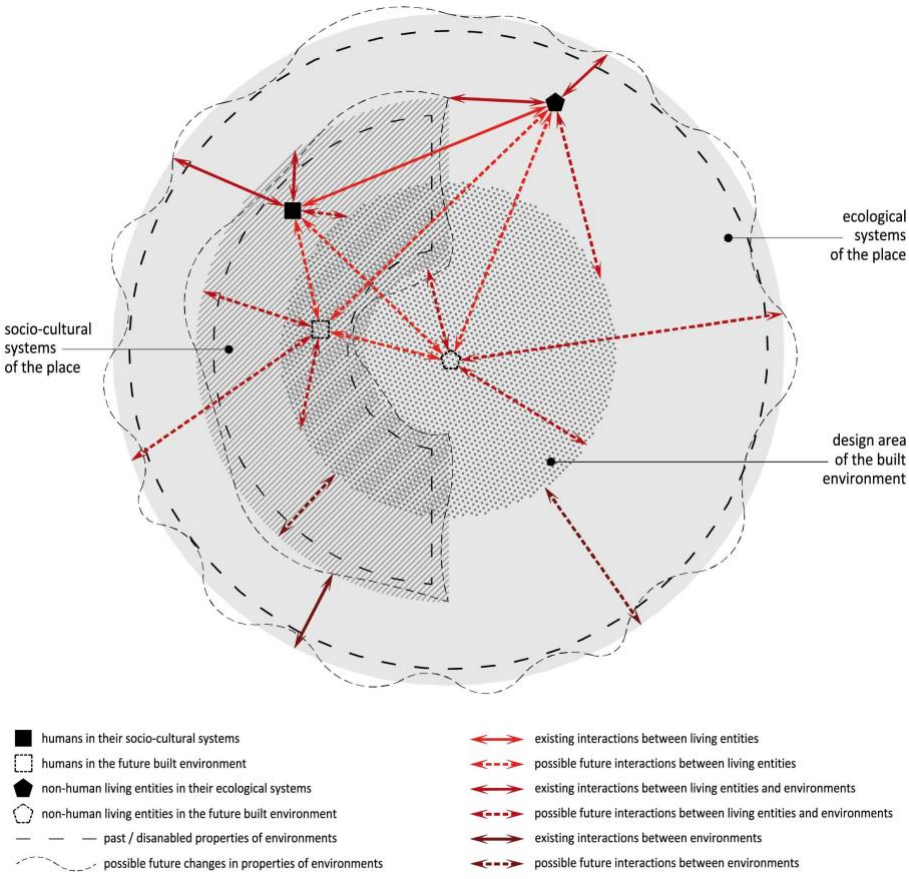

Figure 3. User Groups and Their Interactions

Transforming the user groups into a better state can be possible by questioning how their existing deficiencies and needs can be met, their current properties can be enhanced and how they can be enabled to

function as required. After searching for missing entities, activities, relationships and flows, it will be possible to decide how proper activities can be aligned with which healthy flows of the place. For a mutually beneficial engagement, considerations should be extended towards finding proper support systems that can assist certain functions of user groups and ways of compensating the lacking properties. In this way, it will be possible to find acceptable approaches to strengthen the current relationships.

After initial improving and coalescence, an evolution of the whole system can be achieved with creating new entities, functions, relationships and flows among user groups and between groups and environments. Alternatives can be developed for a new set of explorations to seek and generate for potentials by considering the current and future risks, looking for proper adaptation methods and finding ways of meeting future requirements, enhancing new properties and reinforcing new relationships.

It is not quite possible to generate consistent decisions using insufficient or incomplete findings, because of that the quality and extend of pre-design steps bear a crucial importance for the forthcoming stages.

3.2. Stages of Collaborative Activities: Design, Construction, Usage and After-Use

Establishing an ambience and conditions required for regenerative targets is directly related to the way of creating, using and performing operations at the end of useful lifetime of the system. While deciding

proper ways for these practices, many different determinations, properties and impacts related to the whole system and system's various parts should be synchronously focused on.

In the design stage, one of the major fundaments for developing target-oriented decisions is pre-design outcomes. The role of built environment can be resolved and advanced according to interpretations. In the meantime, it is highly important for regenerative results that not only initial organization should be concentrated on, but these decisions should be produced while conceptualizing is broadened upon construction, usage and after-use stages. Especially, the organization should be executed in a way where the whole system can proceed to evolve with the functioning of its own dynamics after the professional team completed their work. Mang and Reed (2012) prescribe this alliance as transform of passive entities of consumption into active components of responsibility.

A built environment can be intentionally organized in a congruent way an ecosystem functions in the natural inter-web of its associations. All the components of built environment should be structured not only as certain objects with specific properties, but also as processes associated with many impacts on other mechanisms through all stages. Du Plessis and Cole (2011) adduced that rather than fixed functions, flexible operations can be designed. The roles of each component can be designated as an articulation into current patterns and moreover they can create new ones through deciding their directionality and how they

can serve as proper mediums for enhanced fluxion. Every useful input flowing into built environment should be utilized and every degraded load entering the system should be transformed instead of rejection or avoidance. This system of a designed metabolism should produce outputs as net positive values. By potentially adaptive skills invested in the project, a cyclical conversion should be embraced instead of usual linear process. All stated principles should be valid for after-use stage as well. Based on the death and rebirth cycles of ecosystems, built environments can be designed in a similar concept with decisions for possible operations of disposal, transformation or self-renewal. Although the total performance of the whole system is determined by the effectiveness of its parts, the system can become greater than the summation of its components with the help of the synergy created by their mutual work.

3.3. Evaluation Stage: Assessment of Decisions

For a system to adapt and evolve, it is essential to supply extensive feedback by examining and investigating results of the work. Relative to the quality of the structured partnership, the value of each decision can be determined by examining the properties of its possible impacts on this system and natural functioning of entities. This feedback process can provide a potential for better development by producing a stronger interrelation via beneficial criticism between each consecutive stage throughout time.

3.4. The Model for Flow of Processes

Obtaining net positive results can be possible by inducing the conception of methods into a framework which is developed to organize fundamental stages of a built environment in order to embed regenerative principles and to illustrate their relationships as how they can work as a holistic approach (Figure 4).

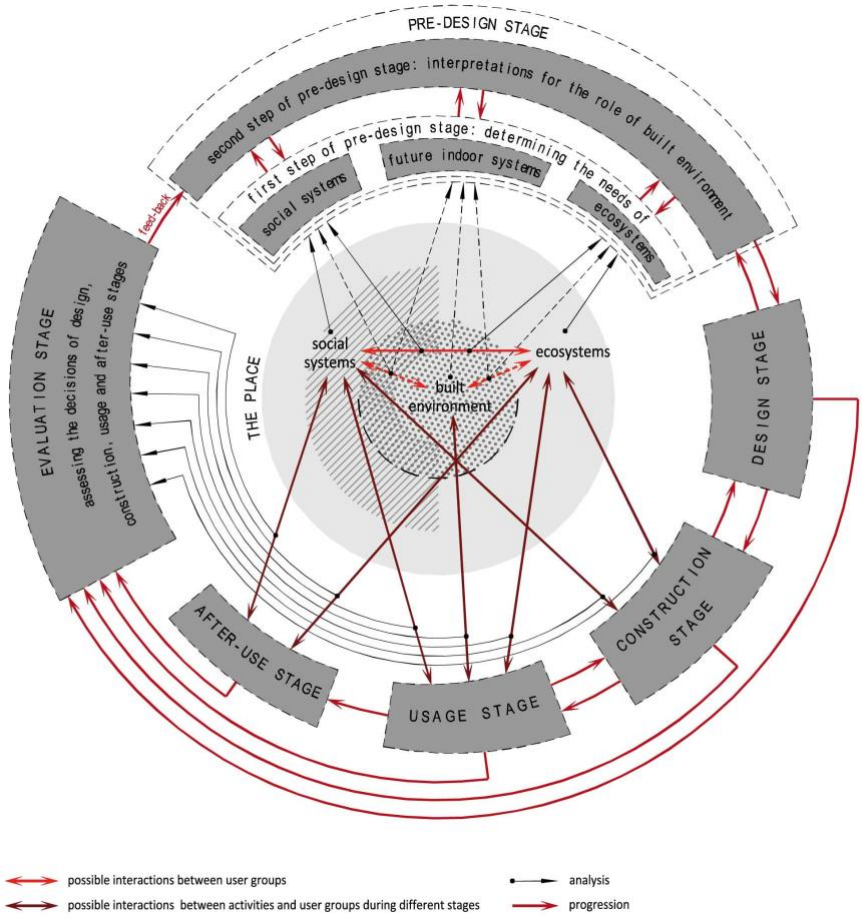

Figure 4. Model of Stage Interrelations

The two consecutive parts: generating life and sustaining self-evolution can be managed by producing sound decisions for all stages. Analysis and the interpretations of findings are positioned as the two steps of pre-design stage, intentionally populated with thought-provoking questions to constitute strategies which can be unique to each project.

Pe-design stage forms a basis for net positive results and constitutes the core of the process while recognizing all users. In addition to interdependent features of this organization, it is possible for each experience to evolve into feed forward loops between different simultaneous or asynchronous projects (Figure 5).

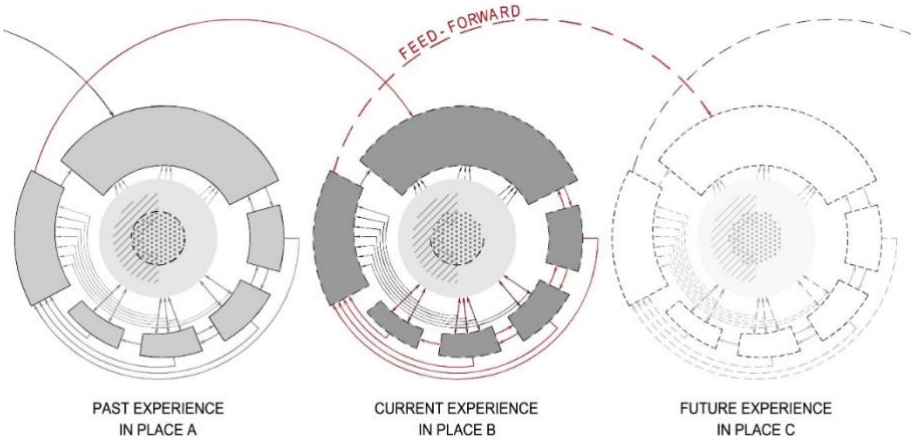

Figure 5. Interrelated Experiences

4. Discussion and Conclusion

In the sense of establishing a co-evolutionary partnership between social and natural systems with the guidance of regenerative sustainability, built environments can be contemplated as proper mediators for this task; they can be organized as healthy ecosystems

which are able to transform all kinds of inputs to net positive outputs. This can be achieved by motivating more practitioners to embrace systemic thinking with the help of consciously designed support tools against the complicacy and intricacy of the mission. As an honest effort to address this deficit, examining the significance of the integrity of the whole process through interactions of hierarchic phases and proposing an approach for their systemic regulation have been the main concerns in this research.

By focusing on the dynamics of human decisions and recognizing the value of process, a framework has been developed as a guidance tool with the intention of assisting participants to procreate reformative decisions. The proposed process begins with a thorough analysis of all key elements in the place with regard to multi-scale nested systems through their entire life span. The findings of this analysis are interpreted to generate outcomes in the form of provocative questions so as to initiate a discovery process in order to establish a built environment that serves as a living habitat for not only its human users, but for also current and future ecological systems and social communities of the place. In design stage accurate decisions for construction, usage and after-use stages, can be produced based on these outcomes for every aspect of built environment with regard to its catalysis role in co-evolutionary partnership of all user groups. To supply a continuous evolution, positive and negative results of each decision are determined in order to generate prosperous critique cycles.

Various existing tools – either process based or otherwise – such as design methods, construction techniques or assessment systems can be embraced in this framework; its structure presents an easy organizational arrangement. Particularly for the decision-making step of design stage Plaut, et al.'s (2012) framework: LENSES will be a very comprehensive tool with its three lenses, triple bottom line and visionary questions. It is also possible to operate each lens separately in different stages as well, such as delegating Flows lens in both analysis and decision-making steps of pre-design and design or utilizing Aspects of Place lens in evaluation. Another consistent example is the integration of Pedersen Zari's (2012) study on ecosystem services and their application to built environments into the proposed framework for especially pre-design and design stages.

To emphasize the integrated functioning, the model is designed to elicit the interactivity of its stages and instead of a linear or closed order it is organized as a cyclical and flexible network. Rather than imposing rigid and normative solutions, the main goal of the framework is to motivate a discovery in the direction of regenerative understanding. It is believed that this framework can create a potential for practitioners to design not only the built environment itself but its whole life and even its afterlife in a supportive manner for intended regeneration. Especially with the pre-design stage being placed to the heart of the process, all existing, disabled and missing elements can be revealed. Here, the practitioners are motivated to incorporate findings beyond the ordinary ways, to

expand thinking over accustomed boundaries of space and time and to concentrate on interrelations of different user groups. Connecting each step with an evaluation stage can transform the process into a developmental cycle through promoting extensive feedbacks and feed forwards. By this way, it can be possible to constitute stronger interrelations between various experiences of different design teams. Participants can also be challenged to re-examine each other's actions to trigger a progressive learning.

Complementary to similar works, advantages of interactive stages are highlighted in this research. It is hoped that aspects of the proposed system will initiate some discussions, instigate an effort for testing its effectiveness and eventually give positive results. In future studies, each stage can be examined in detail, particularly interactive adaptability and articulation to existing flows are considered to be intricate subjects.

Information Note

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

Author Contribution and Conflict of Interest Disclosure Information

There is no conflict of interest.

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Biomimetic Architecture for Responsive Building Façade

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1. Introduction

The main purpose of this book is analysis to develop associate innovative means within which to make new style thinking through a mixture of the biomimetic principles of style that relate to and inform the method of digital and constant quantity style.

In different periods of time, architects have applied natural environment as a source of inspiration for construction shapes and decoration methods. Nature as a Source of Inspiration, Biomimicry allowed architects to use elements described by nature in their buildings, such as sustainability, survival, interaction, energy efficiency, structure and material optimization, and interaction with the environment. According to this, imitation procedure of natural environment has started and has been improved within different chastisements and lately understood by way of "Biomimicry"(Zari & Storey, 2007).

By novelty within recent architectural tendency new techniques of design demanded for achieving difficulty of natural environment geometries, shapes, and forms group procedure, ways would use equipment's that would be applied to match algorithms of natural environment. The presence of digital equipment's claims significantly "Parametric Design Utensils" and great improvement of CAD utensils have been solution to this mission (Skidmore, 2015).

Normally, a considerable part of improvements within architecture is become conceivable through flexible structures. Within the mentioned category, the likelihood of applying flexible and twisting ingredients

have been suggested within the latest years, significantly in elevation. Flexible bending structures are consisting of benefits over normal flexible structures, important of which would be easiness, not being heavy, the demand for less ingredients and potential for returning easier to main shape that has an influence over the elevation (Yao Zheng, Wu & Junhua, 2020). Since the facades of buildings have the greatest impact on the preservation and health of the environment and citizens, and with the integration of the Biomimicry, this impact will have a scientific aspect. Therefore, this book seeks the achievements of this field to date to examine the existing examples, then tries to find methods to update the architectural facades of the ancient buildings to connect with advanced architecture.

Form design process according to natural shapes would be given. For starting, natural shapes and pattern ideas are studied, decided and brief. Next, parametric design discerning is divided to segments: way of thinking, utensil design mode and design style. The movement of planning, utensils, and writings It in addition shows a way to make parametric symbols. The procedure from rule of natural pattern to symbol would be explained via a logarithmic spiral shape through an sample natural pattern examination, shape and color control standards, procedure research and design producing and making a design an algorithmic process monitoring whole of the limitations and objective information fixed within architecture, in addition to possibility for using

this information to improve a smarter device, could be helped through designing a construction façade or elevation structure.

1. Organism Level: this level mentions a special organism such as, a vegetable or a living creature and might include imitating segment or complete and total organism.
2. Behavior Level: great number of creatures face alike environmental trials like people and they should resolve difficulties like what had been mentioned.as it had been mentioned before, these creatures give the idea to behave in a provided place environmentally friendly potential in addition to energy and material existence limits.
3. Ecosystem Level: The repetition of rest of environments in addition to normal standards which allow them for functioning greatly.

1.1. Biology and Architecture

Nature is an endless source of patterns of variability. Changes that occur in the body of animals and creatures for growth, evolution, movement, and adaptation to environmental changes, security, metamorphosis, appearance change, and so on. The source of the formation of these changes was internal, and these events themselves are effective in treating them, but many changes are also caused by external factors, such as changes in the form of force or impact, changes in humidity, heat, or the like. Both types of movements can serve as a source of inspiration for architects and designers. Although the events that

generated these changes were internal, and these events are beneficial in curing them, many changes are also produced by external variables, such as changes in force or impact, changes in humidity, heat, or the like. These models provide different rules for inspiration, but the process of extracting these rules and using them requires a scientific approach that is lacking in knowledge due to the novelty of this knowledge. The analysis for this topic is used to solve the problems in parametric pattern in order to bring back the relation of biology and architecture and combine them together. The pattern of facades according to the biology architecture can solve several functions and aesthetic part of each building.

2. Material and Method

Biomimicry and its dimensions in architecture are studied by a qualitative method, and then, using existing examples around the world, it tries to determine their applicability. Architecture is a complex negotiated culture practices, which includes all of the aesthetics, technical, economic, political issues of social production itself (Bahamon, 2009). Integration of scientific knowledge and design practice can be a challenging activity to define for architects, but it can be the intellectual fuel that drives innovation and progress in their practices. Biomimetic architecture is attempting to advance this design practice by incorporating a theoretical approach that includes modern biological sciences in order to adapt to real-world environmental challenges. Finally, by general classification and analysis of this

example attempts are being made to access a scientific method to use this knowledge to change the design of the facades of existing buildings.

Since Biomimicry has a wide range and is integrated with all aspects of architecture, for the better efficiency of this research, studies are limited to Building facades.

2.1. Nature Strategies and Targets

Nature has long been regarded as a source of inspiration in architecture. There are a variety of movements that can be lumped together under the umbrella term "bioinspired." Biomimetic architecture is attempting to advance this design practice by incorporating a theoretical approach that includes modern biological sciences in order to adapt to real-world environmental challenges. Most people mean to mimic nature by creating aesthetic forms and symbolic associations without considering biological awareness or necessarily long-term growth. From the point of view over the natural environment, it is perfectly visible that natural environment worries about basic purposes and foundation for being attained within creation, development and throughout communication with setting (Li & Su, 2018).

2.1.1. Aesthetics

Aesthetics has worldwide and individual application. Many of people would settle over an eye-catching ratio. But together, one part could ponder an element or a trend for being eye catching and aesthetic though the other one is disgusted with it (Li & Su, 2018).

2.1.2. Efficiency

To be effective has be mentioned through proportion of time and determination used for a job to be accomplished, and natural environment is smart at harmonizing demand with answer. Natural environment matches design answers which neither absorb nor miss energy within procedure of development (Li & Su, 2018).

2.1.3. Ethics

Within natural environment, ethics is not considered as good or bad. Natural environment does not get absorbed within decision. Its ethic would be to only accomplish the "feasible thing". Whatsoever is greatest practical and sustainable (Li & Su, 2018).

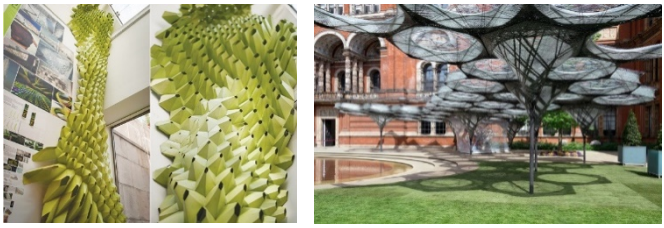

Figure 1. a. Pattern **b.** Pattern (Kolarevic, 2004).

2.2. Biomimicry Levels

The 3 steps of biomimicry which might be used for a design issue are normally provided as shape or form, procedure and ecosystem (Aksamija et al., 2012). The steps and levels are, Organism, Behavior, Ecosystem steps and levels.

Organism step and level mentions a special organism such as a tree or living creature and might include mimicking section or total organism.

Second level points at mimicking behavior and might involve interpreting the way an organism perform feature, or narrates to a greater setting.

The next or third level is mimicking of all the ecosystems and normal and ordinary rules which lets them to positively behave.

2.3. Organism Level

The resource biomimicry at organism step, in outward of insect has been evaluated and imitated for being applied for other possible requests, like, clearing fog from land fields in airports and progress removing humidity tools (Aksamija et al., 2012).

Design Architecture within Environmental science is a most of time, systems are greatly organized. It encourages people for mimicking them for making new products or discover solutions for issues (Marignani et al., 2017).

Neural Networks have been descriptive examples. Systems and Genetic Procedures have been two kinds of algorithms which fall in similar group a kind of revolutionary computing method which efforts for recreating an organic development or data movement within terms of ordinary problems (like forecasting) the financial market and business incomes) (Zari & Storey, 2007). Development of economy complex resources which have been multi task and functionally classified materials (honeycomb, hydrophobic resources.) and in the end improvement of lots of substances which mimic biotic systems (Skidmore, 2015). The methods to biomimetic, thoughts of using

biology for encouraging thoughts, in addition to a chastisement summary from modeling for operating at two of the Nano and macro size. The bonds which tie many different biological encouraged methods to improve design and other delinquent solving kinds answers provide a great impression of setting of biomimetic which explains attractive objects and procedures discovered within natural environment, along with claims within improvement (Aksamija et al., 2012).

2.4. Behavior Level

Huge amount of living creatures faces similar environmental situation which people organize and demand for resolving same problems which mankind encounter. By way of being mentioned, the considered living creatures be inclined to behave in environmentally friendly capacity of special area and in restrictions of energy and resources existence. The mentioned restrictions in addition to forces which make ecological position overcoming within bionetworks mean not just perfectly modified creatures continue for changing, but likewise decently adjusted creature reactions and connection patterns among creatures or species (Marignani et al., 2017).

2.5. Ecosystem Level

The ecosystems imitating can be considered as an essential biomimicry part. The benefit of designing within this stage of biomimicry would be that it could be applied within combination with rest of 2 stages of biomimicry, as well the values of sustainability. The mentioned stage

undergrowth out more interested in “Circular Economy”; that would be necessarily mentioning there could be no consequence. Later, ecological system educations are truly big aimed at human (Ravilious, 2007).

3. Findings, Discussion and Evaluation of Nature in Parametric Pattern of Façade Design

The program of computational practices to design procedure is understood by way of parametric design over elevation and face of the buildings. Instead of depending on perception and understanding for tackling hard design trials, computational design works to develop procedure through programming design decisions applying computer strength and language. Flexible structures have been in charge for huge architectural alterations part. Within recent years, usage of flexible and twisting ingredients has been made conceivable within mentioned method, special over building elevations (Kolarevic, 2004). Flexible winding structures give many benefits over old kind of flexible structures, the greatest protuberant of which have been easiness, not being heavy, the demand for less ingredients and potential for returning to first form much easier, that has influence elevations. The innovation of mentioned kind of structure has required innovative evaluations and research for lecturing a variability of difficulties connected to equipment’s, a considerable necessary of which would be the appropriate apparatuses for their changeability (Garcia, 2009*)*.

3.1. Parametric Design

Determined through new digital construction equipment's, architectural designs which have been being created are moving borders of shape, specialization and constructing. Moved through performs demanding for making innovation, CAD systems have been progressively parametric which is the signify designs which develop by their contribution (Bar-Cohen, 2006).

The digital architecture applies computer shaping, program writing, imitation, and imaging for making two of the simulated shapes and physical constructions. It depends on "groups of numbers kept within electromagnetic format" used for making representations and simulating which resemble to resource function and for working out created objects digital architecture lets complicated scheming which define architects and let an assorted variety of compound shapes for being made by decent comfort by computer processes (Garcia, 2009*).*

Figure 2. **a.** Design Pattern **b**. Design Pattern (Körner et al., 2017)

4. Examples of Digital Patterns

In used pattern: for Frog Queen, the constructions facade has been cladded by silkscreen drawn through a pixilated pattern of square boards, that made through unlike scales of points positions and placements by different images, like flowers or gear wheels. The building façade had been planned and produced for creating moving views of masses and textures, against closed place (Körner et al., 2017). Fritted glass for Ryerson University, concrete structure had been cladded in printed glass by computer and in digital manner, by irregular forms, had been determined for framing perspectives of town, decrease solar temperature absorption, bring about variable light situations in building, and provide another kind of perception each time go to see the building (Benjamin, 2020). Eberswalde, Herzog & de Meuron in a project School Library, ideas had been exposed photos through artist Thomas Ruff within his personal assortment, which associated the old, cultural, earthly, and emblematic setting of library. Through organizing those within horizontal ties moving around the elevation, within an identical manner for observing like patterns (Garcia, 2009*)*. Examples of Digital Patterns Types on Building Façade (Ripley & Bhushan, 2016).

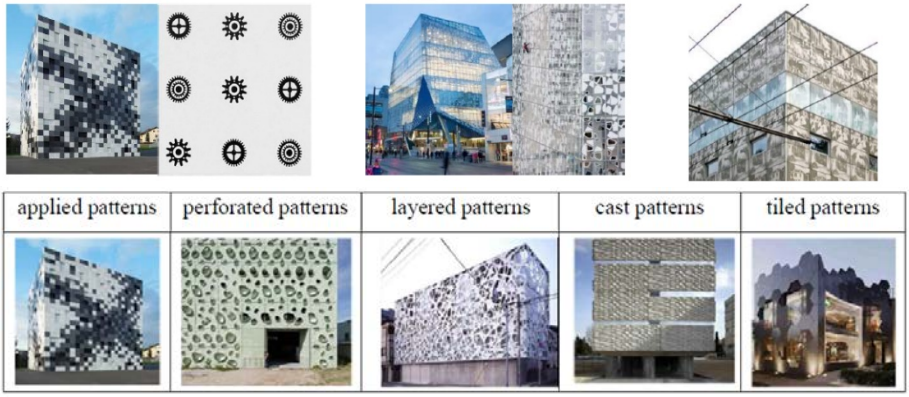

Figure 3. Irregular forms in facades (Ripley & Bhushan, 2016).

5. Influenced Factors on Pattern Design's Architectural Performance

5.1. Structural Performance Pattern

Concept: the mentioned structure technique might affect elevations shape. Various architects may apply the mentioned structure system alone either a basic structure or infrastructure, that accomplished a special appearance of elevation and building shell pattern design.

Examples: by way of a fundamental structure the TOD'S Omotesando Building had exterior façade functioned by way of both visual pattern and structure functional scheme, and has been made of 3cm concrete and flush mounted frameless glass. In this example trees are living species which appear just themselves, consequently it made of meeting tree outlines, so form of the trees has an essential structural reasonableness (Ripley & Bhushan, 2016) as an infrastructure.

Zero Tower office building elevations altered by each angle. The elevation has been a modular curtain wall created of white aluminum

sheets and further transparent glass followed by white ceramic, due to upright pattern which strengthened the thinness of building, it provides dispersion of sun light and control the interior glare for creating interiors perceiving decent quality (Sivagami et al., 2020) 4a Advance Material Effect, 4b Symbolic Effect requires a visual support with related figures.

Figure 4. a. TOD'S Omotesando (Davidov, 2019). **b.** Zero Zero Tower (Benjamin, 2020).

5.2. Lighting Effect

Concept: Light can be considered as a presentation feature which enabled optical assessment to study the influence of skin shape and form and also the size location over light diffusion (Davidov, 2019). Which provided new senses and images to constructions. Lighting wanted for being ambient or guiding by aptitude for alternating within day providing various patterns (Benjamin, 2020). There are many lighting or sources types: public lighting {for social and non-private areas}, object lighting {detecting architecture of construction, announcement, light of window displays in historical center} (Byrne, Subramanian, & Pillai, 2018). So, the plane would be delicate to two of

the altering light situations and altering perceiving angles (Xie et al., 2020) By way of outcome, through lighting tools improvement, lighting planning used color capriciousness, by way of the construction and structure elevation appearance made a changed result from outside than from interior (Byrne, Subramanian, & Pillai, 2018).

Examples: In Guzzini lighting via Mias Architects, the balloon formed shop seemed for being detached in air, by philosophical lighting idea assisted for making new evening scenery, and at same elevation, but through night the harsh influences had been acted in detail, for example in London 2012 Games, Basketball Stadium (Byrne, Subramanian, & Pillai, 2018). Maison Folie building had partly translucent façade creates changing patterns by way of single move along it. This lively show of illumination was a main performative angle. In Kunsthaus Graz, illumination and media adjustment designed through authenticities was introduced in arrears the acrylic glass for producing a "outgoing preprogrammed {single-minded} or in answer to environmental fluctuations {unknown, interactive} skin".

5.3. Kinetic Solar Shading Effect

Concept: combined shading system applied for stopping sun heat absorption and decrease energy usage for (Vrana & Meppelink, 2011). Performative architecture within moving properties was producing vision architecture, which building's façade would adapt energetically its form within reply to numerous environmental effects.

Examples: In SDU university Kolding, is a 3D alteration within elevation pattern through adapting weather alteration, by active sun shading accustomed to available weather situations through the elevation (Schumacher, 2009).

5.4. Color Effect

Concept: elevation day and night color variety shown a stress over architecture producing its fundamental personality and every building skin unit groups of allowed decision (Byrne, Subramanian, & Pillai, 2018). Examples: LED color scheme had been creating active patterns by way of in water cube (Byrne, Subramanian, & Pillai, 2018).

Figure 5. Color Effect (Byrne, Subramanian, & Pillai, 2018).

5.5. Advance Materials Effect

Concept: existing resources and computer helped materials construction machines engaged within a similarly dynamic side over design techniques, what's more old-style ones, like brick, cloth and glass or new kinds by way of ETFE. Such as, applying of textile skins and foils in construction façade was getting extra famous. With many novel methods

Figure 6. a. Material effects (Vrana, & Meppelink, 2011). **b.** Material effects (Körner et al., 2017). **c.** Material effects (Vrana, & Meppelink, 2011).

Through the realization of pressure and patterns that improved form was applied for transferring weight and designing very complicated surfaces (Schumacher, 2009). Also, flexible base of fabrics is applied within elevations for making items which moved for suggesting sun shading (Körner et al., 2017).

Examples: according to Studio House designed with CC-Studio, PTFE Teflon layered fiberglass material has been cut to tiles and arranged by way of overlapping grits and sticked over reinforced boards, which moved by wind, producing an active appearance (Vrana & Meppelink, 2011).

5.6. Symbolic Effect

Concept: various features caused on building's façade idea, aided the architect for providing construction its individual factors through applying specific expressions achieved from buildingbehaviour and personality, close surrounding culture.

Examples: the Hazza Bin Zayed Stadion Al Ain, exterior elevation made of a steel simple structure by sheath boards positioned separately, providing the elevation face of palm bole sections (Andersen & Salomon, 2010).

4. Results and Discussions

Results: through studying face and elevation design pattern result over architecture act, bearing in mind its advantages over the construction shape, and focusing over its numerous factors which provided the façade design basic concept, it gives the impression which there were adjustable colorations among 5 kinds of digital pattern by three stages of architecture action. It is not just one appearance of purpose of elevation designed pattern but in addition an influence over the constructionact (Table 1).

Table 1. The arose colorings among pattern and act stages

			Digital Patterns				
			Applied Patterns	Perforated Patterns	Layered Patterns	Cast Patterns	Tiled patterns
Architectural Performance Levels	**Structural Performance**	Main structure					
		Sub-structure					
	Physical Environment Performance	Light					
		Kinetic					
	Aesthetic and Cultural Performance	Color					
		Advanced material					
		Symbolic					

Through comparison of basic architectural acts stages by digital pattern kinds, there have been numerous connections arises. From pattern type

perspective, the cast pattern consists of an obvious result on each of the three stages of act, significantly within structural presentation. Trailed through punctured pattern which attained whole segments among two of physical setting presentation and artistic and culture act issues. At that time the layered one has only achieved two issues within two of physical and artistic routine correspondingly. The same has been within tiled pattern, though used pattern was consisting of a result just over artistic and beautiful performance.

Instead, from the architectural act perspective, the artistic and culture function was extra performance would be reached through whole 5 patterns, significantly by figurative and cutting-edge materials issues correspondingly. Trailed through the tangible surrounding act would be obtained through just 3 patterns, perforated, layered, and cast patterns correspondingly. Though the structural presentation would be accomplished just through cast pattern.

The pattern kinds would be organized within a descendent instruction, on the word of its influence over architecture action stages. Begins by cast, punctured, later cultivated, layered, and finally applied pattern. Similarly, the three stages of architecture action might be organized in connection to its influence through digital design kinds, artistic and cultural action formerly surrounding action and at last structural action and performance.

6. Conclusion

The improving middle of biological language within architecture setting brings new points of view by novelty within architecture and its design procedure. Furthermore, bionic architecture concept, wherein buildings contain an ecological friendly method, starts for improving to resolve the amplified issues of human town and cities. By observing and studying natural environment and living creatures some values might be excluded for making a natural environment imitation design within architecture. Patterns establish and describe connections within natural environment and would be combined to design for verifying and sustenance visual communiqué. Since design's aim is for producing a connection by the observer, pattern literature assistances for shaping what the mentioned connection was previously the communication was intentionally managed. Be removed for producing a natural environment imitation design within architecture. Architectural design probable has been evaluating shapes and the way to create a main concept for elevation pattern producing a pattern which sheltered the whole building elevations constructional, ecological, and artistic demands. The connection among shape, concept and action made new design procedures significantly over elevations and facades pattern.

Specific resources let complicated architectural patterns which might influence physical and ecological behaviors, like material shaped tensile structure appearances, that behaved like an artistic job within whole day, create buildings among repeatedly wave or concrete within

molded pattern, both were consist an obvious influence over light issues. Also, indistinguishable, or different separate segments are mixed into a greater and bigger compound and shells or patterns. design pattern might provide a changed understanding of resources such which of stiff materials look soft like many forms of concrete or mixtures.

Thanks and Information Note

Ethics Committee approval was not required for the study.

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The Use of Urban Space and Spatial Quality for the Elderly People

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1. Introduction

People aged 65 and over are called the elderly according to the World Health Organization (WHO, 1989). The aging of the world population has increased since the second half of the 20th century. Similarly, demographic data show that the number of elderly people is increasing rapidly in Turkey. While the population aged 65 and over, which is considered the elderly population, was 6 million 651 thousand 503 people in Turkey in 2016, it increased by 24% in the last five years and reached 8 million 245 thousand 124 people in 2021 (TUIK, 2022). The rapid increase in the proportion of the elderly population in Turkey indicates that aging is an important issue for our country as well. This situation concerns many disciplines such as medicine, sociology, psychology, economy, politics, industrial design, interior architecture, architecture, urban design, and city planning.

There have been many studies (Booth, 2000; Orsega-Smith et al., 2004) emphasizing the importance of elderly spaces. Some studies have revealed that elderly spaces should be designed by the wishes and needs of the elderly (Howell, 1980; McKee et al., 2002). However, scientific data on how spaces for the elderly should be designed are limited. In this respect, the study aims to reveal design criteria for urban open spaces suitable for the elderly, to investigate the participation of the elderly in urban life and the use of urban open spaces. The study examines the use of urban space by the elderly from the perspective of urban design and urban planning and aims to reveal various parameters of space quality for the elderly.

1.1. Old Age

Aging refers to the late period of the life process and related changes in the individual. Old age is one of the natural and inevitable stages of life such as childhood, youth and adulthood (Emiroğlu, 1995; Yerli, 2017). The aging process can be classified according to age or situations/events. According to the World Health Organization, people aged 65 and over are considered elderly. In addition, 65-74 years old is called young old age, 75-84 years old is old age, and 85 years and over are called very advanced old age. However, old age indicators may change depending on the living standards of people (Yılmazer, 2013).

When old age is classified according to situations/events, it can be examined from various perspectives. Various deteriorations are observed in physiological processes during the aging phase. In other words, functional deficiencies occur in all systems that make up the body. Changes occur in the sense organs (like sight, hearing, etc.) in the form of a decrease in abilities. There are some deteriorations in the skin system with the decrease of cell renewal rate and skin sagging; in the musculoskeletal system with bone reduction, muscle loss, decreased strength, fractures, slowing of movement; in the digestive system with the slowdown of digestive and metabolic activities, deterioration of dental health; in the neurological (nervous) system with the deterioration of nerve cells and in the immune system with being open to infections and diseases due to aging (Hablemitoğlu & Özmete, 2010; Yerli, 2017). This is called physiological aging.

In psychological aging, behavioral changes occur due to the increase in experience, retirement, the necessity of changing life habits due to physiological deficiencies, the losses experienced and the psychological burdens of diseases. With aging, perception, memory and creativity abilities, in general, begin to decline. In addition, fear, anxiety, and sadness arising from insecurity in the future can also cause psychological depression (Tümerdem, 2006). Socio-cultural aging is the change of one's social role, status and expectations. In economic aging, on the other hand, with the onset of the retirement period, income decreases and the usual social status gradually disappears. In short, the old age period can be defined as a period of loss with unique problems. With the onset of losses and deprivation in all areas of life, poverty begins, which can reduce the self-esteem and life satisfaction of the elderly (Hablemitoğlu & Özmete, 2010; Yerli, 2017).

Old age is a period in which physical strength and resistance decrease, the body's adaptation to the external environment weakens susceptibility to diseases increases, the individual withdraws from production, experiences role-status losses and increases the risk of addiction and accident.

In general, it is the period when the ability of organisms to establish balance decreases with the combination and interaction of psychological, biological, social and economic factors that cause a decrease in the potential to adapt to changing environmental conditions over time. For these reasons, it is a phenomenon that concerns many disciplines such as medicine, sociology, psychology, economics,

politics, industrial design, interior architecture, architecture, urban design and city planning (Kitwood & Bredin, 1992; McKee et al., 2002). Human lifespan is increasing due to the developments in the field of medicine and the increase in the quality and standards of life in other disciplines. Due to this situation, the proportion of the elderly in the general population is increasing rapidly in the world. Accordingly, some important needs such as meeting the social and spatial needs specific to the elderly arise (Emiroğlu, 1995; Yerli, 2017).

1.2. Age and Quality of Urban Space

Cities are living organisms. Today, as a result of globalization and liberalization processes, the city is turning into a place of rent. Urban open spaces and especially green spaces are disappearing in urban environments that have turned into concrete piles. This situation brings along various physical problems for the citizens and especially the elderly who can not find the opportunity to move in the urban open space. In addition, the multi-storey and detached housing blocks built create sterile and artificial urban environments, breaking the connection between people and the elderly with the street; it creates various disadvantages, especially in terms of socialization, neighborliness, and friendship relations (Barlas, 2014). The elderly are trying to adapt to the constantly changing and transforming urban dynamics and urban spaces with the physical, socio-economic and psychological changes they go through (Düzenli & Alpak, 2017).

The quality of urban open spaces consisting of areas outside the buildings within the urban fabric is very important for the elderly (Şahin

& Dostoğlu, 2007). Spending time in suitable urban spaces, taking air, walking, moving, and socializing with other people helps the elderly to adapt to society by reducing their physical and psychological problems. It is an undeniable fact that elderly people's breathing, walking and movement in urban open spaces contribute to almost every system of the body, especially the musculoskeletal system and to general health. While gatherings in the urban space increase participation in society, which decreases after retirement, it reduces the role-status and social environment losses and depression. Maintaining the bonds established with people and social roles in urban open spaces significantly affects the happiness of the elderly, meeting social needs increases the level of satisfaction with the living environment, and a sustainable relationship with the city is ensured (Harel, 1981).

Urban spaces provide quality of life to the extent that they meet the physical, social and psychological needs of the user and support activities suitable for these needs. Different space users such as children, young people, adults and the elderly have different needs. Factors such as the usability, purpose and frequency of use of the spaces vary depending on the needs of the users. While the behavioral patterns, habits and physical conditions of the individual that are changed and shaped throughout life affect the use of space, the organization of the space also affects the way the individual uses the space. Spaces should be designed for everyone. And, of course, places should also be addressed in line with the needs, skills and needs of older people. (Düzenli & Alpak, 2017). In addition, the characteristics and quality of

the space and the suitability of these parameters for the elderly are important. For this, it is important that concepts such as activities in urban space, quality of space, and user satisfaction are examined and that it is aimed at the elderly.

Quality is the level of suitability of a product or service to meet the user's needs and use (Juran, 1974). It is a subjective concept, but objective indicators can be used to measure quality (Das, 2008; Uzgören & Erdönmez, 2017). Whyte (2000) examines the quality of urban space through the concepts of accessibility, variety of activities, comfort, image and social interaction. Planning, design and training organization PPS (2003) defines the quality of space with four main parameters: sociability, use and activities, comfort and image, access and connections. According to Lynch (1984), liveliness, sense of space/identity, access and control are important concepts for space quality and Appleyard (1981) defines spatial quality as safety, cleaning, being free from traffic jams and suitability for children. Gehl (1996) suggested an activity-type-dependent approach to space quality. According to Gehl (1996), there are three types of activities in urban space: necessary activities, optional activities and social activities. Presence, diversity and quality of elective and social activities are important for the quality of the space. Rapoport (1982) considers space quality as diversity and distinctive differences. Similarly, İnceoğlu and Aytuğ (2009) define the quality of space with functional features as well as features specific to the space, defining the space and making it meaningful. Halu (2019) also defines spatial quality through the

parameters of safety, accessibility, usability, physical comfort and social environment.

There is a direct correlation between the quality of living environments and the health of the elderly. In old age, compulsory occupations decrease, free time increases and if they do not spend this free time in the right places, the elderly are exposed to conflicts and material-spiritual crises. There are many studies examining the effects of urban open space use and the quality of these spaces on the physical and psychosocial structure of elderly individuals. Older people participate more in physical activities when they spend time in environments that provide for their needs. Participating in more activities allows one to spend time with other elderly people and to be involved in social life. Many studies have shown that natural landscape elements in urban spaces have healing and regenerative effects on people's physical and mental health (Kaplan et al., 1998; Düzenli & Alpak, 2017). It has been revealed by researchers that elderly individuals who spend time in open spaces improve their sleep patterns, complain less pain, decrease their physical discomfort and slow down the symptoms of dementia and Alzheimer's. For this reason, the elderly should be directed to the use of open spaces such as parks, because the activities in these spaces increase the quality of life and help active aging (Fujita et al., 2006; Selekler, 2007). There are important factors in directing the elderly to outdoor use. First, they need to be safe when accessing open urban spaces. Therefore, the urban environment must have low traffic density and traffic speed.

In addition, walkability is very important both during access and in urban open spaces. For this, the pedestrian ways must be wide enough, their integration is high, the pavement heights and ramp solutions are found and the necessary arrangements are made for the disabled. Safety is an important issue for the elderly in this period when they are more vulnerable to the environment and more open to the dangers of the environment. In terms of safety, besides the design of traffic and physical space elements suitable for the elderly, it is also very important to develop belonging, ownership of the place, face-to-face relations and neighborly relations. Another significant parameter is cleanliness, which has both physical and psychological effects. The variety of activities, shopping opportunities and easy access to various services are also very important for the elderly (Kaplan & Kaplan, 1989; Düzenli & Alpak, 2017).

In addition to this, the level of perception decreases in the old age period and there is a loss of sense of place and direction. For this reason, the identity elements offered by the urban space are significant. Moreover, access to various areas of the city by public transport, the comfort, diversity, frequency and integration of public transport are important for the elderly. Access to health services is also very important for the elderly in this period when various health problems are more intense (Düzenli & Alpak, 2017). When the reasons for the elderly to go to urban open spaces are questioned; naturalness, accessibility and safety factors were determined. Generally, the elderly prefer environments that contain natural elements such as water and plants and natural

environments make people feel good (Kaplan & Kaplan, 1989; Düzenli & Alpak, 2017). Herzog (1989) revealed in his study that natural environments have a high percentage of healing and resting. For this reason, parks and urban open spaces are preferred by the elderly (Herzog, 1989; Düzenli & Alpak, 2017).

2. Material and Method

Bakırköy district of Istanbul, the most populous city in Turkey, was chosen for the study area. Istanbul is a city where traffic, transportation and access problems are quite intense. In addition, it can be said that security problems are seen intensely due to its crowded and cosmopolitan structure. Also, Istanbul is one of the cities where there are cleaning and hygiene problems, vertical construction and concretization are very high, open green areas and urban open spaces are few, technical and social infrastructure is insufficient, and the cost of living is the most noticeable. All these negatively affect the elderly physically, psychologically and economically. However, Bakırköy is one of the most preferred districts in Istanbul by the elderly. For this reason, examining Bakırköy with the advantages and disadvantages it offers to the elderly will shed light on the studies on the relationship between the elderly and urban space. There are E-5 Highway, Güngören and Bahçelievler districts in the north; the Marmara Sea in the south, Çırpıcı Stream and Zeytinburnu district in the east, and Küçükçekmece district in the west and northwest of Bakırköy. In the study, Zeytinlik, Cevizlik and Zuhuratbaba Neighborhoods, which are located in the center of Bakırköy and offer the opportunity to examine in detail due to

the diversity of land use and spatial elements, were selected since the analysis of the elderly-spatial quality will be carried out at the scale of urban design. The study was carried out on weekdays and weekends, on days without precipitation, in May 2022.

In the study, the on-site observation method, one of the qualitative data collection methods, was used. The on-site observations were made with various parameters in terms of elderly-spatial quality. The on-site observation was constructed in two stages. First of all, the urban spaces where the elderly spend more time were determined and their characteristics were examined. In the second stage, concrete quality measurement indicators obtained from the conceptual and theoretical framework were used. In the study area; access to other areas of the city, access to health services, traffic density and speed, walkability parameters in the context of transportation and accessibility; safety, cleanliness and hygiene, perceptibility, naturalness and silence and resting parameters in the context of comfort and image; land use diversity parameter in the context of land use; parameters such as neighborhood relations and neighborhood phenomenon, being able to come together with peers and other people, and street animals in the context of socialization were examined in terms of elderly-space quality.

3. Findings and Discussion

Bakırköy, on the west side of Istanbul, M.S. It was founded in 384 by Constantine as an entertainment and summer resort. Today, Bakırköy District is located between the E-5 Highway, Güngören and

Bahçelievler Districts in the north, the Marmara Sea in the south, Çırpıcı Stream and Zeytinburnu District in the east, and Küçükçekmece District in the west and northwest. Bakırköy, one of the big and important districts of Istanbul, is also an important sub-center serving Istanbul. Social facilities and shopping opportunities are quite developed. The housing texture is in the form of 5-6 storey reinforced concrete blocks.

It can be said that the existence of green areas is positive compared to many districts of Istanbul. It is also possible to say that there is a recreational green axis with Bakırköy, Florya, Yeşilköy, Yeşilyurt and Ataköy coastlines, coastal cafeterias and promenades. In the center of Bakırköy, the elevation is 20-30 meters. Due to the diversity of land use and spatial elements, Cevizlik, Zeytinlik and Zuhuratbaba Neighborhoods of Bakırköy were chosen as the study area (Figure 1). When the demographic structure of Cevizlik, Zeytinlik and Zuhuratbaba Neighborhoods is examined, the population of Cevizlik District is 5,495, the population of Zeytinlik District is 5,387, and the population of Zuhuratbaba District is 21,353. Elderly population rates are 24% in Zeytinlik District and 23% in Cevizlik and Zuhuratbaba Districts (TÜİK, 2020).

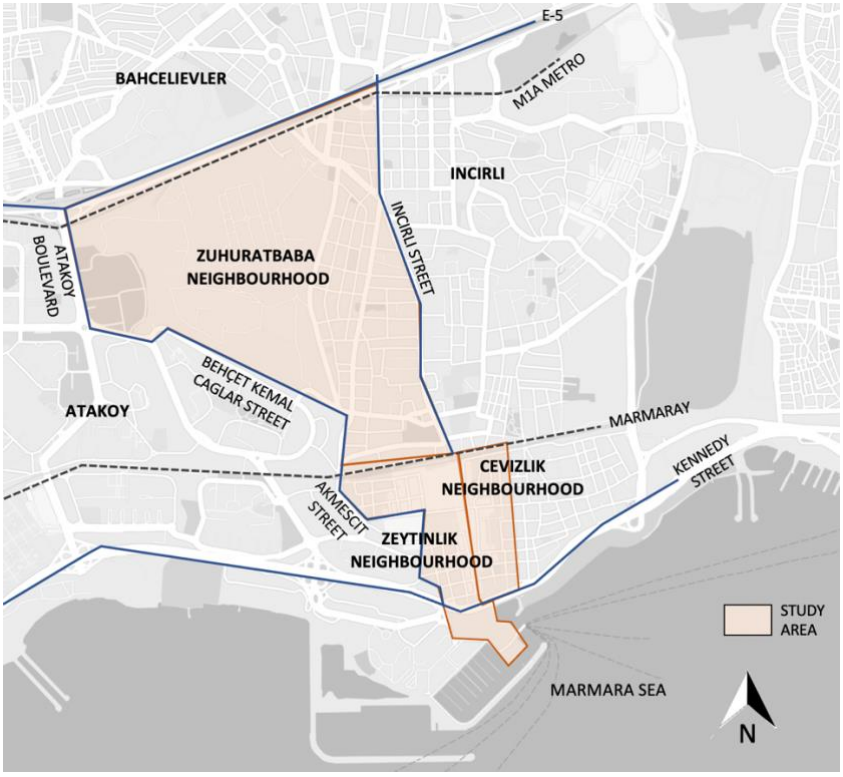

Figure 1. Study Area (Google Maps base map is used.)

3.1. Using of Urban Open Space and Activities

Within the boundaries of the study area, there are many parks such as Gençler Road Park Gathering Area, Democracy Park, İsmail Akyüz Park, Çamlık Atatürk Park, Bilal Bozkaya Park and Hüdaverdi Park. As a result of the observations, it has been seen that the elderly mostly prefer parks on weekdays and weekends. It is possible to say that the open spaces in Bakırköy Çarşı (and the seating elements in these spaces) follow the parks on weekdays. However, it is seen that the elderly do not prefer the places in Bakırköy Çarşı at the weekend. In this case, the crowd is thought to be an important factor. In addition, the

elderly use the street and the open spaces around the residence and the coast. When the reasons for the elderly to go to urban open spaces are questioned; naturalness, accessibility and safety factors were determined. When the activities of the elderly are observed in the urban open spaces, it can be said that they mostly talk with other elderly people, sit and rest. Watching the environment, walking, reading newspapers and books, taking care of grandchildren, knitting, playing games such as backgammon are also among the activities that the elderly often do.

3.2. Spatial Quality of Urban Open Spaces

There are important factors in directing the elderly to outdoor use. First, they need to be safe when accessing open urban spaces. Therefore, it is important that the urban environment has low traffic density and traffic speed. In addition, walkability is very significant both during access and in urban open spaces. For this, it is very important that the pedestrian ways are wide enough, their integration is high, the pavement heights and ramp solutions are found and the necessary arrangements are made for the disabled. Safety is a significant issue for the elderly in this period when they are more vulnerable to the environment and more open to the dangers from the environment. In terms of safety, besides the design of traffic and physical space elements suitable for the elderly, it is also very important to develop belonging, ownership of the place, face-to-face relations and neighborly relations. Another prominent parameter is cleanliness, which has both physical and psychological effects. The variety of activities, shopping opportunities, and easy access to various

services are also very important for the elderly. Moreover, the level of perception decreases in the old age period and there is a loss of sense of place and direction. For this reason, the urban image elements offered by the urban space are important. In addition, access to various areas of the city by public transport, the comfort, diversity and frequency of transportation and integration of public transport with other transport modes are important for the elderly. Access to health services is also very necessary for the elderly in this period when various health problems are more intense (Düzenli& Alpak, 2017).

In the next part of the study, concrete quality measurement indicators obtained from the conceptual and theoretical framework are examined in the study area. These are the parameters of access to other areas of the city, access to health services, traffic density and speed, walkability in the context of transportation and accessibility; parameters of safety, cleanliness and hygiene, perceptibility, naturalness and silence and rest in the context of comfort and image; land use diversity parameter in the context of land use; parameters such as neighborhood relations and the phenomenon of neighborliness, being able to get together with peers and other people, stray animals in the context of socialization.

3.2.1. Transportation and accessibility

When the study area is examined in terms of transportation and accessibility, the presence of the Bakırköy stop of Marmaray, a suburban train system serving between Istanbul/Halkalı and Kocaeli/Gebze, facilitates transportation and increases accessibility considerably. Marmaray, which has 43 stations in total, provides

service every 8 minutes between Ataköy and Pendik, where Bakırköy stop is located, and every 15 minutes between Halkalı and Gebze. In addition, Marmaray is integrated with many metro and metrobus lines such as Yenikapı-Atatürk Airport Metro Line, Yenikapı-Kirazlı Metro Line, Yenikapı-Seyrantepe-Hacıosman Metro Line, Üsküdar-Çekmeköy Metro Line and Söğütlüçeşme-Beylikdüzü Metrobus Line. In addition, it can be said that public transportation is highly developed thanks to the bus and minibus stops, sea, metro and metrobus located nearby. Yenikapı-Atatürk Airport metro line and Söğütlüçeşme-Beylikdüzü Metrobus Line İncirli Stations are approximately 2 kilometers from the study area. The development and high integration of public transport is very important in the old age, when the use of private vehicles is considerably reduced due to physical and psychological reasons. It is very positive for the elderly, especially because the rail system is developed, eliminates the traffic problem and is comfortable.

In addition, Bakırköy Pier is located at Ataköy Marina, which is separated from the study area by Kennedy Caddesi. There are Istanbul Sea Bus (Bostancı-Kadıköy-Yenikapı-Bakırköy-Avcılar) and Turyol Expeditions (Islands) at Bakırköy Pier. However, access from the study area to the pier is not good due to the multi-lane coastal road (Kennedy Street) and high-speed traffic. There are underpasses and overpasses on Kennedy Street to ensure the integration of the coast. The presence of a ramp in the underpass and an elevator in the overpass increases the access of the elderly.

Streets in residential areas are open to vehicular traffic. In some streets, it is seen that the pavement widths are not sufficient and the pavement texture is broken. In addition, regulations such as lanes and ramps for the disabled are not common. These factors can make walkability difficult for the elderly. However, it is positive that the traffic speed and density on the vehicle roads are low. In Bakırköy Bazaar, on the other hand, many streets are pedestrianized and the traffic speed and density are low on the streets that are not pedestrianized. However, there is heavy traffic on Fişekhane Street in front of the shopping malls (Capacity and Carousel). Traffic density makes it difficult for pedestrians to cross the street. It is seen that the pavement texture is broken, similar to the residential areas. Similarly, regulations such as lanes and ramps for the disabled are not common, too. In addition, the overcrowding of the bazaar (especially on weekends and evenings) makes walkability difficult (Figure 2).

Figure 2. Spatial Elements Affecting Walkability

When the access to health services is examined, it is seen that there are many health units in the study area. There are many hospitals, medical centers, polyclinics, clinics and dentists like Dr. Sadi Konuk Training and Research Hospital, Bakırköy Psychiatric and Neurological Diseases Hospital, Istanbul Leprosy Skin and Venereal Diseases Hospital, Professor Dr. Mashar Osman Oral and Dental Health Clinic, Private Çamlık Hospital. The mentioned facilities can be reached by public transport, private vehicle or walking.

3.2.2. Comfort and image

When the study area is examined in terms of security, it can be said that there is a positive perception of security. The residents of Bakırköy have a high level of education, are sensitive to the events around them, and have a high sense of belonging. For this reason, it can be said that there are people who raise their voices in the face of any negative situation and strive for a solution. Abandoned buildings or spaces, destroyed/damaged buildings and broken urban furniture, uninhabited areas, poorly illuminated areas and idle ground floors are almost nonexistent as urban elements that can create a feeling of insecurity in urban space. Therefore, it can be said that spatial security is positive. As an exception, the floor coverings of some streets in the study area are very neglected, broken and displaced. This can cause various problems such as tripping and falling for the elderly. In addition, as many people from outside Bakırköy come here for various purposes and create crowd, the crowd formed on certain streets and avenues (İncirli Caddesi, Kennedy Caddesi, Fişekhane Caddesi) both creates traffic and

increases the risks such as theft and pickpocketing. In addition, the crowd of people or cars in the bazaar causes serious noise pollution as an important negative situation for the elderly.

When the study area is examined in terms of cleanliness and hygiene, it can be said that the biggest problem is the garbage that is thrown on the ground or not collected/accumulated especially in Bakırköy Bazaar. The perceptibility, which is another factor, which is especially important in the old age because of the gradual decrease of the sense of place and direction, depends on the existence, density and power of urban images. In this respect, the existence of different land uses and landmarks (trade, health, education, worship, park, Marmaray etc.) is important.

There are historical and aesthetic landmarks such as Taş Mektep, Kadro High School and Surp Asdvadzadzin Armenian Church in the bazaar. When the naturalness, which is an important factor affecting the spatial preferences of the elderly, is examined, it is positive that there are green areas, parks and trees, the coast and the water element in the study area. Although it is a completely urbanized place, the fact that the buildings do not exceed 5-6 floors allows the protection of human scale and ensures that it is not like artificial, mechanical housing environments. Another important issue for the elderly is the availability of recreational opportunities in urban open spaces. The need for rest met by green areas in residential areas, benches in parks and sitting elements in in the bazaar (Figure 3).

Figure 3. Spatial Elements Affecting Comfort and Image

3.2.3. Land use

When the Zeytinlik, Cevizlik and Zuhuratbaba Districts selected as the study area are examined, it is seen that the Zeytinlik and Cevizlik Districts have intensive commercial use. There is a wide variety of land uses such as accommodation units, cafes, restaurants, supermarket chains, clothing stores, hairdressers, law offices, banks, jewelers, courses (language, sports, dance, handicraft, theatre, painting, music, etc.), education units, theater, cinema and health units in Bakırköy Çarşı (a part of Zeytinlik and Cevizlik Districts). It can be said that the land use in Zuhuratbaba District is mostly residential. Apart from housing, there are many markets, grocery stores, pharmacies, florists, parks (Gencler Caddesi Park Gathering Area, Democracy Park, İsmail Akyüz Park, Çamlık Atatürk Park, Bilal Bozkaya Park, Hüdaverdi Park, Bakırköy Hospital Running Track), Zuhuratbaba Cemetery, mosque,

health units (Dr.Sadi Konuk Training and Research Hospital, Bakırköy Psychiatric and Neurological Diseases Hospital, Istanbul Leprosy Skin and Venereal Diseases Hospital, Professor Dr. Mashar Osman Oral and Dental Health Clinic, Private Çamlık Hospital, many hospitals, medical centers, polyclinic, practice and dentist), school, Sinan Erdem Sports Hall, course (yoga-sports-dance course-theatre-painting-music course etc.) (Figure 4). In this respect, it can be said that it offers a wide variety of land uses to its users. The elderly can easily meet their shopping needs from the residential neighborhood or the bazaar, and being close to health units and parks is an important advantage. However, the availability of different types of courses, sports and art activities for important in meeting the physical and psychological needs of the elderly.

Figure 4. Land Use Diversity

3.2.4. Socialization

During the observations made in the study area, it was observed that the residents knew each other and the shopkeepers by name. For this reason, it is possible to say that face-to-face relations continue and

neighbor relations exist. Seating units in parks and bazaars are among the most common spatial elements used by the elderly. While sitting here, they find the opportunity to get together with other elderly people and have a long conversation. Although cafes and restaurants, especially concentrated in the bazaar, provide the opportunity to come together and socialize, it is seen that the elderly do not prefer these places. The reason for this is thought to be lifestyle and cost. However, it can be said that patisseries are mostly preferred for socializing. In addition to these, the coast is in demand by the elderly. In addition, it can be said that painting, music and handicraft courses are places that have the potential to bring the elderly together. When stray animals, another parameter, were examined, it was seen that the elderly loved stray animals and fed them frequently. This relationship with animals is very valuable for the psychological health of the elderly (Figure 5).

Figure 5. Spatial Elements Affecting Socialization

4. Conclusion and Suggestions

Being one of the natural and inevitable stages of life, old age is a period that brings with it many physical, psychological, social and economic changes and difficulties. With the developments in the field of medicine and the increase in the quality of life, the proportion of the elderly

population has increased rapidly in Turkey and in the world and has become an important issue. For a good quality of life in old age, it is important that the elderly live in a quality urban environment and that urban open spaces meet the needs and expectations of the elderly. For this reason, it is necessary to reveal the urban open space quality parameters for the elderly. However, studies and data on this subject are limited. In this respect, the study aims to reveal the participation of the elderly in urban life, their use of urban open spaces and design criteria for urban open spaces suitable for the elderly. In Istanbul, which is a difficult city for the elderly to live in, Bakırköy is one of the most preferred districts of the elderly. For this reason, examining Bakırköy in terms of the advantages and disadvantages it offers to the elderly will shed light on the studies on the relationship between the elderly and urban space.

In the observations made in the field, it has been seen that the elderly mostly use the parks and spend time with other elderly people. The reason for this is that naturalness is an important criterion for the elderly and being with peers plays a decisive role in the life satisfaction of the elderly. Concrete quality measurement indicators obtained from the conceptual and theoretical framework were used in the study. Accordingly, access to other areas of the city, access to health services, traffic density and speed, walkability parameters in the context of transportation and accessibility; safety, cleanliness and hygiene, perceptibility, rest parameters in the context of comfort and image; land use diversity parameter in the context of land use; neighborhood

relations and neighborhood phenomenon, being able to come together with peers and other people and stray animals in the context of socialization were examined in terms of elderly-space quality.

As a result of the examinations, it can be said that the study area is positive in terms of access to other areas of the city, access to health services, traffic density and speed, walkability, safety, perceptibility, rest, land use diversity, neighborhood relations and neighborhood phenomenon, meeting with peers and other people and stray animals. However, various spatial arrangements can be made to improve walkability, safety and perceptibility, such as pavement widening, pedestrianization, improvement of floor coverings and enhancement of image elements. Especially in Bakırköy Bazaar, which is within the boundaries of the study area (a part of Cevizlik and Zeytinlik Districts), the important problems that become apparent are cleaning-hygiene and noise. For this, it can be recommended to collect garbage regularly and frequently, increase cleaning services, and make noise-reducing landscaping. As a result; accessible urban open spaces should be designed, allowing the elderly to do peaceful, natural, safe, different activities and spend time with their peers.

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Structural Problems Caused by User-induced Changes and Transformations in Historical Baths: The Example of Diyarbakır Melik Ahmet Pasha Bath

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1. Introduction

Historical baths are social and commercial structures located in different locations in cities and where people's bathing activities were carried out in the past.

The architectural forms of the baths built in historical cities vary. The first examples of baths were discovered during excavations in Tel Amarnah and Zincirli regions of Egypt (Aru, 1941:10).

Bath is a place of cleaning that people have often preferred and used in the past. These spaces are heated by circulating the hot water pipes passing through the walls and floors. The word “hamam” originally came from Arabic and was used as “hamm” and in Persian as “germâbe” and used to mean “warming, keeping warm” (Ülgen, 1950:174; Ertuğrul, 2009:241).

1.1. The Development Process and General Characteristics of Historical Baths

The bath culture, which started from the Roman and Byzantine periods, was used as places where purification from sins was carried out in Egypt, China, Iran, and the Hittites. In the Islamic period, it was seen that cleaning and cleaning became more important and the construction of baths in the cities became widespread (Çelik, 2018:1).

The baths, which were used for cleaning and bathing from the Romans to the Seljuk and Ottoman periods, reflect the architecture and style of the civilizations in which they were built (Say & Kula, 2007). In many cities of Anatolia, where the Ottoman Empire ruled, the construction of

baths continued between 1299-1453. Anatolian Turkish baths, with their unique style and architecture, social culture, and social mobility, have become structures that are preferred and preferred. In Anatolian Turkish baths, after the cold section (soğukluk) and tepid section (ılıklık) area at the entrance, it is passed to the warm and hot section. There are bathing niches (iwan) in the hot section (sıcaklık) and "halvet" in the form of cells called private rooms in the corner cells. (Önge, 1988:404) (Figure 1).

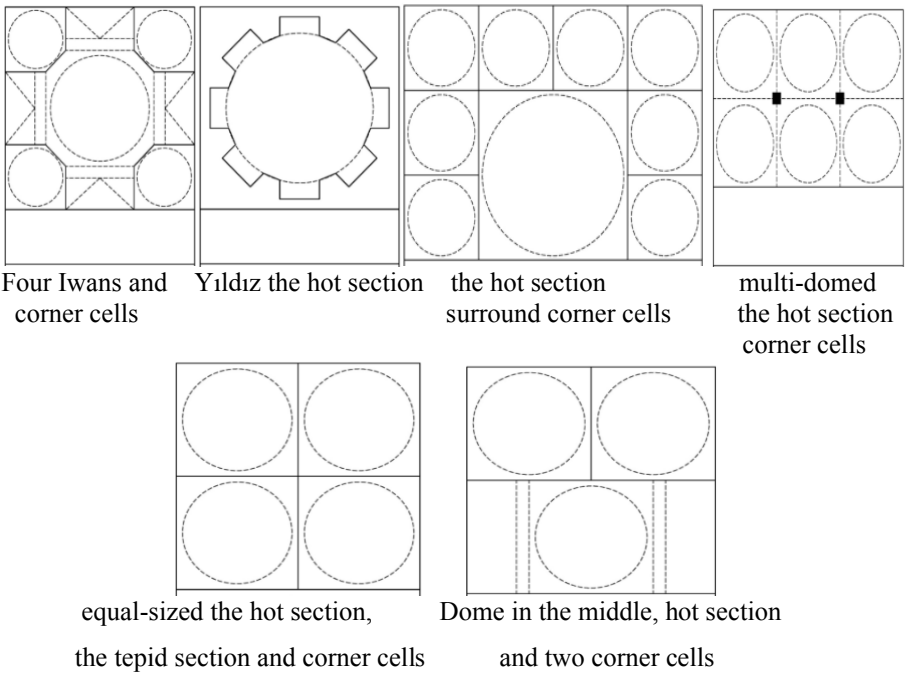


Figure 1. Schematic classification of Turkish baths according to their the hot section divisions (Ertuğrul, 2009)

The bath structures consist of places with different functions and as a plan layout, a glazing (entrance), the cold section (soğukluk), tepidity (ılıklık), toilet (WC), shaving section (traşlık), felting section (keçelik)

pad in some baths, the hot section (sıcaklık), the furnace (külhan) and water tank.

In general, the entrances of men and women are arranged separately in the plan layout of the baths. However, the use of some baths for men and women is divided according to days.

The disrobing (soyunmalık, soğukluk) room is one of the biggest spaces of the bath. There are pool and dressing niches in the middle of some disrobing rooms.

There are two-storey examples of the dressing rooms with wooden floors and wooden stairs. Instead of a direct transition from the cold section (soyunmalık, soğukluk) to the hot section (sıcaklık), transition is provided through intermediate spaces called “tepidity” (ılıklık).

The dimensions of the hot section, the cold section and other spaces in the bath vary, and the sizes of the spaces form the original plan order.

They are spaces covered with rectangular vaults located between the tepidity (ılıklık), the cold section (soğukluk) and hot sections (sıcaklık). In this section, there are marble or stone benches where the users rest, at a height of approximately 45-50 cm from the ground, in the inner parts of the wall. There are transitions from the warm section to the shaved and toilet areas.

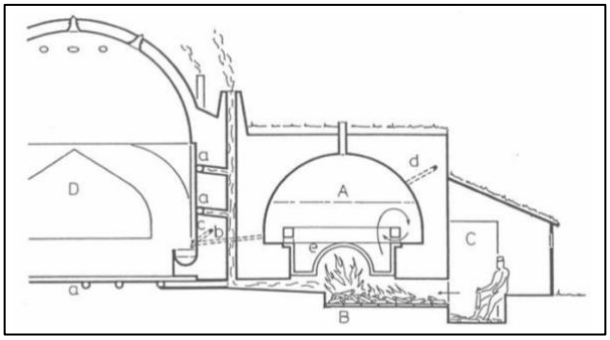
The hot section is the hottest and steamy part of the bath, which is heated by earth pipes on the floor and walls and where the bathing action takes place. There are niches called “iwan” (eyvan) in the section with the “navel stone” in the middle, and private corner cells (halvet)

located at the corners of the hot section. The hot section is usually passed with a dome made of brick material, and in this section, there are holes called "ceramic smoke pipes" (tüteklik) and glass-enclosed openings called "fil gözü" often found in domes glass that provide steam outlet.

Ceramic smoke pipes (tüteklik) are pipes made of terracotta placed vertically inside the walls, which are used to discharge the hot water vapor in the channels in the hellish section from the bath (Bursa olgunlaştırma, 2022). There are lighting windows in the sections close to the dome drum.

The hot water heated in the furnace section is circulated through special galleries called the hypocaust (cehennemlik) (Kuban, 1976;199) and pipes on the walls under the floor raised by stone feet, thus heating the hot section (Figure 2).

Although the materials used in the baths differed according to the period and regions in which they were built, stone material was generally used as the main construction material for the walls. The cold section (soğukluk) was replaced by a hipped roof using Turkish style tiles, and the hot section by a dome made of brick material. In addition, the tepidity section (ılıklık) and private corner cells (halvet) of the baths are covered with vaults and domes.



A hot water tanks
B the furnace
C service place
D hot section
a heating pipes
b hot water line
c cold water line
d boiler cold water line
e copper boiler

Figure 2. Heating System in Turkish Baths (Klinghardt, 1927; Aru, 1941)

2. Material and Method

In this study, the current conditions of 6 baths in Diyarbakır Suriçi Region that have survived to the present day were evaluated, and a field study was carried out to determine the structural problems that occurred in the Melik Ahmet Pasha Bath. In the field study, the current situation and structural problems of the Melik Ahmet Pasha Bath were determined, and the identified problems were documented with photographs.

The structural problems of today's Melik Ahmet Pasha Bath, which is under the ownership of the Melik Ahmet Pasha Mosque Foundation and whose construction system was changed due to faulty interventions, were examined in detail, and suggestions were presented for the elimination of the identified structural problems.

Limitations: In this study, the evaluations are limited to a single building scale by determining the structural problems in the coldness section of Melik Ahmet Pasha Bath, which is one of the historical baths

in Diyarbakır Suriçi Region and presenting suggestions for these problems.

2.1. The Location and General Characteristics of the Baths in the Suriçi Region of Diyarbakır

16th-17th centuries in Diyarbakir. Between the periods, many baths were built in the historical Suriçi Region. Some of the baths built close to the four gates (Urfa Gate, Mardin Gate, Yeni Gate, Dag Gate) of the Suriçi Region that open outside the city walls were damaged over time, and some of them did not reach the present day as they were destroyed. In the southwestern part of the Historical Suriçi Region, there is the Deva Bath, which is defined as the largest bath of the city in the sources, close to Mardin Gate on Gazi Street. Vahap Ağa Bath and Kadı Bath are in the northwest of the region, Çardaklı Bath in the northeast, Paşa Bath in the southeast part and Melik Ahmet Pasha Bath on Melik Ahmet Street around Urfa Gate.

Cimşit Bey and Cıncıklı Baths, one of the historical baths of the city, were destroyed, and 6 (six) baths have survived to the present day. It is stated in the year books of Diyarbakır that there were 12-13 baths in 1870 and 1875, and 8 in 1900 (Palalı, 1999; Korkusuz, 2003:62, Payaslı, 2018:122) (Figure 3).

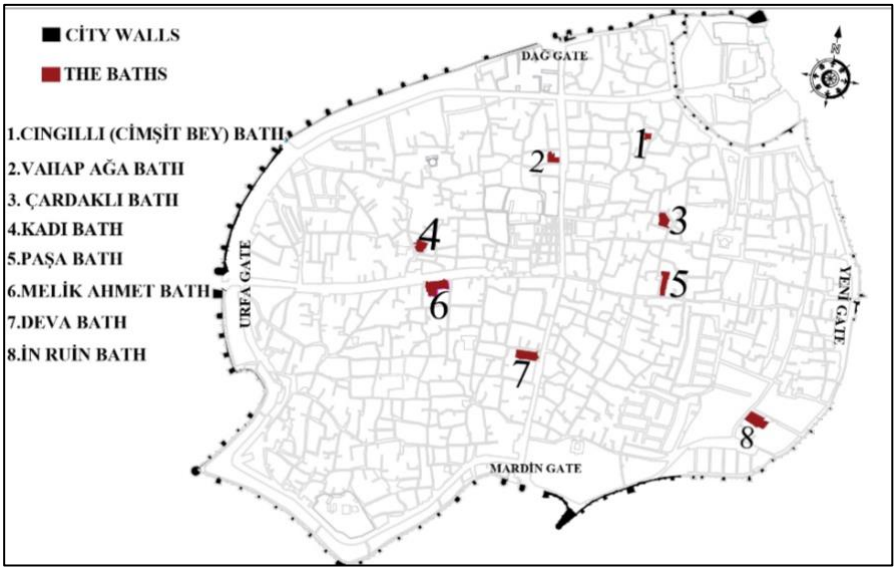


Figure 3. The locations of the baths that have survived in Diyarbakır Suriçi Region (KAİP, 2012)

The baths that have survived in the Suriçi Region are the Melik Ahmet Pasha Bath, the Deva Bath, the Çardaklı Bath, the Kadı Bath, the Vahap Ağa Bath, and the Pasha Bath. Not all the baths are used with their original function today. Among these baths, Vahap Ağa Bath, Deva Bath, and Melik Ahmet Pasha Bath are either foundation or privately owned. Restoration works were not carried out in the Deva Baths and Melik Ahmet Pasha Baths, which are the largest baths in the city, and partial damages and structural problems occurred in these structures (Halifeoğlu et al., 2019; Halifeoğlu et. al., 2020).

Unqualified and faulty interventions by the users in these privately owned baths, which are used with different functions, have led to an increase in the existing problems (Figure 4).

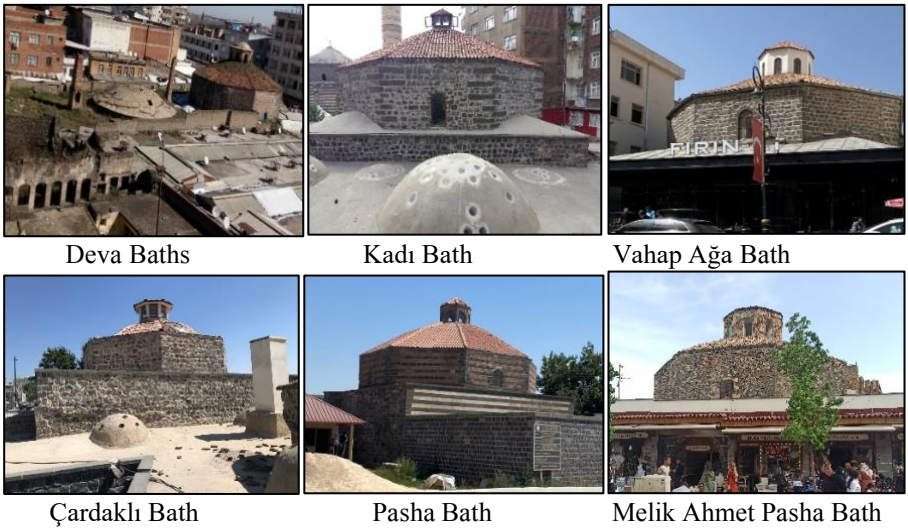


Figure 4. Examples of historical baths in the Suriçi Region (2022)

The restorations of Çardaklı Bath and Pasha Bath in the northeast of the Suriçi Region and the Kadı Bath in the northwest were made by the Regional Directorate of Foundations and are now closed. The restoration work of the privately owned Vahap Ağa Bath has been completed and it has been used as a commercial space (restaurant).

Deva Bath and Melik Ahmet Pasha Bath are other privately owned baths. No restoration work was carried out in the Deva Bath until recently, only plaster scraping was done in the cold room and the existing paint and coatings were removed. Today, the cold section (soğukluk) has been converted into a cafeteria, the other parts of the Deva Bath are empty and unused.

Melik Ahmet Pasha Bath, located on Melik Ahmet Street, has survived to the present day. Other parts of the bath hot section (sıcaklık), the tepidity (ılıklık) section, the water tank (su deposu), the furnace

(külhan), etc.) were demolished and the construction system was partially changed by making user-based changes and transformations in the bath.

In this study, the structural problems in the Melik Ahmet Pasha Bath, where damaged and user-induced changes and interventions were made, were examined. Structural problems determined observationally by fieldwork and the current state of the bath were documented with photographs. General evaluations were made about the structural problems, change and transformation in the bath. After the evaluations, the study was completed by presenting suggestions for the structural problems in the bath.

2.1. The Location and Architectural Features of the Melik Ahmet Pasha Bath in the Suriçi Region

Melik Ahmet Pasha Bath, located in the southwest of the Suriçi Region, the first historical settlement of Diyarbakir, was built by Melik Ahmet Pasha, who was the Governor of Diyarbakir, in the 16th century (1564-1568) (Beysanoğlu, 1998;642, Paköz,2018). Since Melik Ahmet Pasha Mosque is located on the same street, it has been called Melik (Melek) Ahmet Pasha Street since 1800 (Yılmazçelik, 1995: 40).

According to sources, 19th century. It is stated that an extensive repair was made in the bath between (1832-1846) (Yılmazçelik, 1995: 84) (Figure 5).

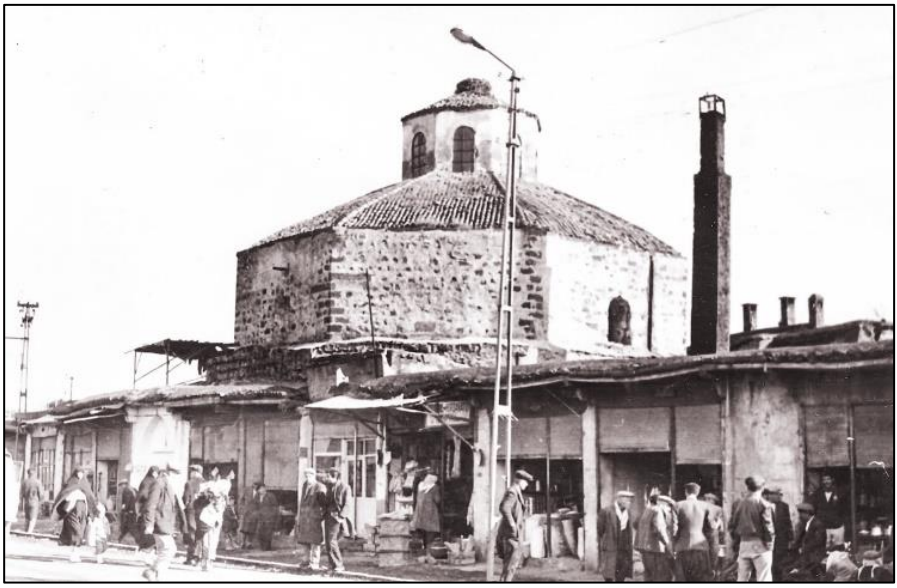


Figure 5. The cold section (soğukluk), hot section and furnace sections of Melik Ahmet Pasha Bath, which was actively used in 1967 (Editör, 2022)

Only the cold section of the bath, which was built with the masonry technique on Melik Ahmet Paşa Street, has survived and the other sections have been destroyed.

The bath has a total of three entrances, two on the north (men's entrance) and two on the east (women's entrance). Today, since the whole of the bath and its surroundings are surrounded by commercial spaces, the men's entrance is in one of these spaces. The women's entrance to the east of the bath was blocked, and the original structure of the bath was damaged by faulty interventions (Figure 6).

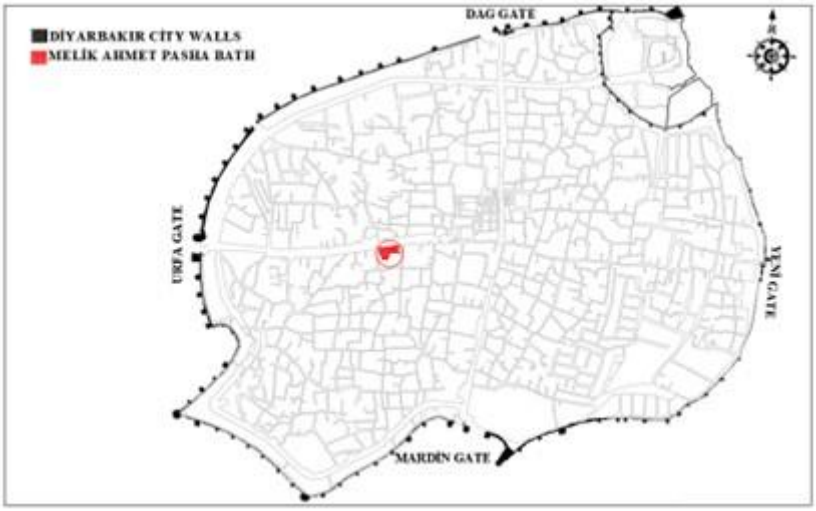


Figure 6. Location of Melik Ahmet Pasha Bath in the Suriçi Region.

Melik Ahmet Pasha Bath consists of four pointed arches on an octagonal pulley and a dome carried with squinches. There is an octagonal shaped lighting lantern in the disrobing (soğukluk) dome. There are windows in each corner of the lighting lantern.

The original door of the men's entrance and the entrance vault of the bath remain inside the commercial space today. Local basalt stone was used on the walls of the baths. The cold section and the top of the lighting lantern are covered with a Turkish style tiled hipped roof. On the north façade, there is a window close to the drum of the dome. Located on Melik Ahmet Street, the bath and its surroundings have been converted into commercial spaces (Figure 7).

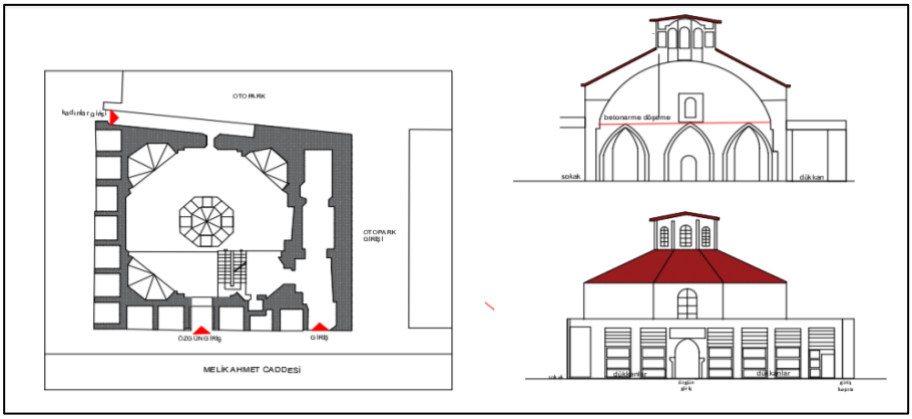


Figure 7. Plan, section and view of Melik Ahmet Pasha Bath [1]

3. Findings and Discussion

Melik Ahmet Pasha Bath, located in the southwest of Diyarbakir Suriçi Region, is on the commercial axis on Melik Ahmet Street. Melik Ahmet Pasha Bath belongs to the Melik Ahmet Pasha Mosque Foundation, and it is stated in the sources that the bath was repaired in 1832 and 1846 (Yılmazçelik, 1995; 84, Paköz, A.E, 2018, 90).

The bath has not been extensively repaired and restored since the 19th century, and it has survived only with the cold section (soğukluk). The parcel containing the demolished parts of the bath, which does not have all other parts except the cold section (soğukluk) is operated as a parking lot. The most important factor that accelerates the formation of structural problems in the bath is the faulty repairs and interventions made by the users. Structural problems continued to increase over time

[1] Melik Ahmet Pasha Bath, plan, section, and views were taken from Dağtekin, E. 2007 PhD thesis and rearranged.

due to faulty repairs and interventions made in the cold section (soğukluk) of the bath.

3.1. Structural Problems Identified Due to Usage in Melik Ahmet Pasha Bath

Melik Ahmet Pasha Bath, one of the historical baths in the Suriçi Region, was built with the masonry construction technique. Over time, the hot section, the tepidity section, the furnace, toilet, and warehouses of the bath were destroyed, and only the cold section (soğukluk) has survived to the present day. The cold section (soğukluk) of the privately owned bath is used outside of its original function today.

As a result of faulty and unqualified interventions of the users, the construction technique of the bath was transformed from a masonry system to a semi-carcass system.

In the street rehabilitation and façade arrangement works of Melik Ahmet Paşa Street, which was initiated by Diyarbakır Metropolitan Municipality in 2018, unqualified additions in commercial spaces were removed and the vaulted section with the men's entrance was revealed. The section where the men's entrance of the bath is located is used as a commercial space (cheese sales place) (Figure 8).

2016 2022

Figure 8. Melik Ahmet Pasha Bath before and after the repair of the northern façade

The main construction material of the bath is basalt stone, rough cut and rubble stone was used on the walls and brick material was used on the dome. The top of the basalt stone material used in the walls, floors and arches was covered with plaster and paint by the users. In addition, the construction system was partially changed by making a direct intervention in the construction technique, which is not found in the original architecture of the cold section (soğukluk).

Apart from the pointed arches in the wall and iwan sections in the cold section (soğukluk), which are covered with plaster and paint, a reinforced concrete floor and stairs that divide it into two horizontally have been added to this section at high elevation. Reinforced concrete slabs, beams, and columns, which were constructed contrary to the construction technique, were supported by adding (Figure 9).

Figure 9. Floor, column and beam added to the cold section (2022)

Wrong interventions made by the users (addition of columns, beams, and reinforced concrete slabs) caused the walls of the bath to be under excessive and uneven load, and the external walls of the coldness caused segregation due to loss of mortar. The mortars between the decomposed walls were completed in 2021, and existing problems were resolved with temporary solutions (Figure 10).

Figure 10. Reinforced concrete slabs and beams added to the bath (2022)

The commercial spaces under the bath were rearranged during the façade arrangement works carried out in 2018. In the commercial space where the vaulted section of the men's entrance is located, apart from the existing walls, separating walls made of cut basalt stone were added. In some places, unqualified interventions were made by adding

columns and beams to the construction technique and to increase the structural problems (Figure 11).

Figure 11. User interventions at the men's entrance in the cold section (2022)

The dome of the cold section is carried by four pointed arches and squinches that include the iwan sections. However, the beams added later by the users caused uneven load transfer on the columns and reinforced concrete slab facade walls, the dome, and the arches (Figure 12).

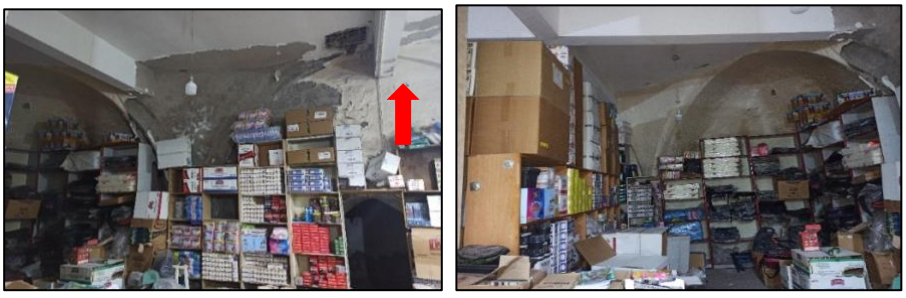


Figure 12. Faulty interventions in the cold section (2022)

Moisture-related deterioration occurred on the plaster and paint covered walls of the cold section of the bath and the surrounding commercial spaces. In the areas where the toilets in the cold room are located, completions were made with unqualified materials. There is

deterioration and mold formation due to humidity around the entrances to the toilets and around the lighthouse (Figure 13).

Figure 13. Moisture-related deterioration in the transition to the toilets in the cold section (2022)

The luminous lantern walls of the bath are octagonal in shape, made of brick material. Due to material losses in the brick material and mortars on the walls of the lighthouse, deterioration due to weathering occurred in the lighthouse wall. Except for one window in the luminous lighthouse, all windows have no joinery or glass. The open window openings and the lantern area were vulnerable to outdoor conditions. In this section, there are material losses due to moisture. In the interior of the illuminated lantern, some windows were covered with unqualified (plastic) materials (Figure 14).

Figure 14. Moisture-related deterioration in the luminous light and its walls (2022)

There are partial losses in the stone material and binding mortars on the outer walls of the cold section. With the decrease of the binding mortars on the walls, separations occurred on the dome walls. The segregation damage on the facade walls of the bath, which was built with the masonry construction technique, increased with the addition of reinforced concrete slab columns and beams added by the users. Contrary to its original architecture, the existing mortars on the walls were poured and lost their binding properties due to the discontinuity and irregular load increase created by the reinforced concrete slabs, columns and beams added later. On the outer walls of the dome, where there are mortar losses, the losses in the stone material were completed by the users with brick material, and the load-bearing feature of the wall was deteriorated.

There are moisture problems due to water leakage from the brick material on the wall of the lantern and the damaged tiles on the roof of the coldness dome to the inside of the lantern. Partial and temporary interventions and completions made by the users in the roof and lantern

section were insufficient and the existing problems could not be resolved today (Figure 15).

Figure 15. Material losses in the cold section and the lantern walls and roof tiles (2022)

The south wall of the cold section was completed with unqualified materials and converted into commercial spaces (Figure 16).

Figure 16. Commercial spaces added to the south and east walls of the cold section (2022)

The women's entrance to the east of the bath has been closed, and today this area is used as a warehouse. The stone walls and arches in this section were covered with plaster and paint, and the walls and ceiling were damaged due to moisture. Also in this area, a toilet was added with unqualified walls, columns, and beams by the users (Figure 17).

Figure 17. Closing the women's entrance of the bath by the users and unqualified additions and interventions (2022)

4. Conclusion and Suggestions

Diyarbakır Suriçi Region is an important settlement center with many monumental and traditional buildings. Historical baths have an important place in social and cultural life in the region where religious, social and cultural structures are located.

Restoration and repair work of historical baths belonging to public property were carried out in different periods, but interventions in baths owned by private or foundation property were limited to temporary and unqualified interventions made by users.

Restoration works of Çardaklı Bath, Kadı Bath, Vahap Ağa Bath and Pasha Bath in the Suriçi Region have been completed recently. One of these structures, Vahap Ağa Bath, is privately owned and has been used as a commercial space (restaurant) after restoration. Other baths whose restoration has been completed are closed and have not been put into use yet.

Since the Deva Baths and Melik Ahmet Pasha Baths, which are the largest baths in the city, are privately owned, extensive repairs and

interventions have not been made except for the unqualified and temporary interventions of the users. The cold section of the Deva bath is used as a cafe, and the Melik Ahmet Pasha Bath is used as a commercial space (plastic material sales place). In the baths that have been converted into commercial spaces, the original architecture and functions of the spaces have been changed with unqualified interventions by the users.

Melik Ahmet Pasha Bath, which has an important place in the city architecture and is owned by a private foundation, is one of the social and commercial structures whose cold section has survived. The original entrance of the bath, which has three entrances in its original architecture, is used as a commercial space today, while the other two entrances have been closed.

Simple and unqualified interventions were made in the cold section of the bath and the commercial spaces around it, in line with the needs of the users. The bath, which was built in the masonry system, was transformed into a semi-carcass system by adding a reinforced concrete floor to the cold section.

Structural problems have occurred due to the interventions made to change the construction system and the original architecture of the bath has been changed. In the bath, where extensive restoration and repair has not been carried out today, the interventions made over time caused the existing problems and losses to increase. For this reason, transforming the bath into its original architecture and function is very

important in terms of ensuring its sustainability in social and cultural life.

Suggestions for the functionalization of the Melik Ahmet Pasha Bath in accordance with its original architecture:

• In order to ensure that the Melik Ahmet Pasha bath, which has structural problems due to faulty interventions by the users, can be used with its original function, restoration and repair works should be started immediately.

• After the determination of the current survey and damage analysis of the bath, which is owned by a private foundation, comprehensive restitution and restoration projects and a strengthening project should be prepared.

• To ensure the follow-up of the prepared projects during the implementation phase, a scientific committee consisting of relevant experts and academicians should be established.

• Public participation in the cultural inventory should be ensured by expropriating the privately owned bath for qualified repair and restoration works.

• Before the restoration and strengthening works of the expropriated bath are started, the evacuation of the bath and its surrounding commercial spaces should be ensured.

• A security boundary should be established against external interventions by creating safe areas in and around the bathhouse.

• In the restoration works to be carried out for the bath and its surroundings, the construction system of which has been changed by the users and which has structural problems, parts that are destroyed and do not exist today (hot section, tendity section, furnace, etc.) should be added in accordance with their projects under the supervision of relevant experts, and the bath should be transformed into its original architecture.

• Existing material losses should be eliminated by using sustainable materials and techniques in the bath, whose projects suitable for its original function are prepared under the supervision of relevant experts.

• In the repair and restoration phase of the bath, interventions should be allowed within the criteria allowed by the relevant statute (Venice Regulation, ICOMOS etc.) and rules for the protection of historical buildings.

• After the restoration, the bath sections, and its surroundings, which were completed with annexes, should be arranged, and brought back to the city architecture with its original function.

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Traditional Vaults and Techniques

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1. Introduction

The vault structure has been derived from the arch by means of its extension in depth. It has been used as a roof cover in buildings since ancient times (Erten, 2018), (Babita, 2020) and due to its geometry it can cover relatively bigger spans with a decrease in the amount of building materials. It can be made of various materials such as brick, stone, earth (adobe), wood, concrete (Roman Vault) in accordance with the material used in the construction of the building.

In the 1-2. century the vaulted tombs in Mylasa, were built as a barrel vault from the inside and in the form of a slightly inclined flat roof from the outside. During the excavations in Mylasa, it was determined that the vault thickness of the tombs was 30-35 cm and the wall thickness was 90-110 cm in general. These types of tombs were frequently used during the Roman Imperial period. Limestone and khorasan, which can be found in the immediate vicinity, were used in the tombs (Kızıl, 2018). The vault, which was made as a semi-circle in the early ages, has been developed over the years and has reached a more durable and refined design with the use of different techniques. The vault, which was first produced with the corbel technique, later began to be produced as a barrel vault. After the development of this technique in arched barrel vaults, highly developed examples have been reached with the arches used. Some of them were able to carry the characteristics of both the previous and the developed example by carrying the transition feature. For example, although it is stated that the Kimisis Teodoku Greek Orthodox Church in Bozcaada was built between 1598-610, it is

thought to date back to much older times (Ekiz Barış, 2018). And in this example, both barrel vault and cross vault features are used. In the next process, variations of these two properties were developed much more in terms of getting light, creating form and increasing strength. In Europe, especially during the Roman Empire, during the period between the High Middle Ages and the Renaissance, very beautiful examples of vaults emerged, both technologically and aesthetically (Gaetani et al., 2017).

The subject of the study is a brief retrace of the evolution of vaultings from the first ever built examples to Renaissance; discussed in terms of the structural qualities of the vaults, as well as the developments in their forms in general. In this process, it is aimed to monitor the development process of the vaults in terms of construction geometry and techniques and to see the level they have reached from the beginning of the traditional process.

2. Material and Method

In this study, vault types are discussed in the historical development process as material. In this historic process, the vaults started to be made with the simplest form, then they were developed day by day both aesthetically and structurally in terms of form and technical additions.

In the study, as a method, the development stages in the vault construction process and the definitions and literature in this process were researched. In this context, articles, lecture notes, thesis, promotional web pages and publications of various structures were used, the development of the vault was discussed in historical order.

3. Vault Types and Technologies in the Historical Process

In this section, the types of vaults and their technologies in terms of their historical development process are discussed.

3.1. Corbel Vaults

The corbel method was developed in search for a better way to bear loads with wider spans since a regular beam requires many vertical load bearing elements. The gradual overlap of the brick bonding allows the crossing of spans as a means of roof coverings (Figure 1 a). The corbel vaults of vernacular architecture can be seen all throughout the Mediterranean region dating back to the Bronze ages (Fraddosio, Lepore & Piccioni, 2019). About 6000 B.C. one of the oldest applications of corbel vaulting ever to be detected is found in the Tall Halaf (5900-5300 BC) in Tall Arpachiyah as domed tombs and another in 4500-4000 BCE de Royal Cemetery of Ur (Sumerian settlement) (Figure 1b) (Akdeniz, 2016). Some prehistoric vaulting examples can be found in the ancient cultures of the regions of the rivers Nile, Tigris and Euphrates. Examples of clay brick arc-vaulted storehouses from 3400 years ago can be found in Luxor, Egypt (Sandaker, Eggen & Cruvellier, 2011). Other examples from the Babylonian era during the reign of Nebukadnezer (605-562 BC) have been discovered (Usanmaz, 2022).

Figure 1a. Example of a Trulla vault (Corbel) (Fraddosio, Lepore and Piccioni, 2019).

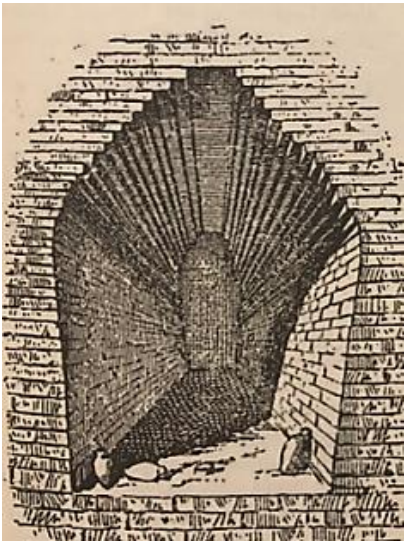


Figure 1b. Burial chamber in the city of Ur (Corbel (Akdeniz, 2016).

One of the most famous examples of this type of vaulting is The Lion Gate in the citadel of Mycenae with a massive triangular relieved disc and corbelled architrave beam with corbelled stone false-arch, (1200-1299 B.C.) (Figure 2a) and the corbelled tunnel in ancient Tiryns located on the Peloponnese peninsula 2000-1600 B.C. (Figure 2b). The corbelled stone false-arches Near East have been commonly used for mortuary, temples, and palaces (Maślak & Partov, 2018).

Figure 2a. Lion Gate in the citadel of Mycenae (Maślak & Partov, 2018)

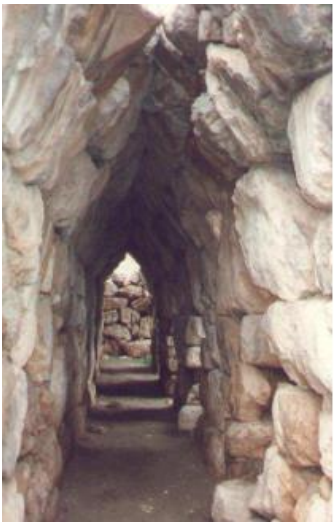


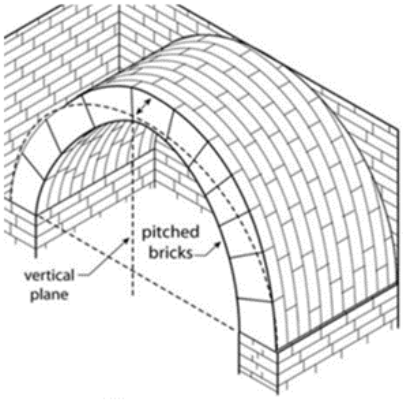
Figure 2b. Corbel structure (Maślak & Partov, 2018)

3.2. Types of Barrel Vaults

An easier and more advanced method that was developed is the barrel type vaulting where the locks are placed at an angle following a semi-circular from (parabolic/elliptic/pointed arched examples can be found). A good example is the Tomb of Ka'a's Necropolis of Sakkara in Egypt (early 3rd millennium B.C.). By the 16th to early 15th centuries B.C. the use of vaultings reached the Mesopotamia/Anatolia and used in the grain silo complexes of Hattusa (Usanmaz, 2022). In Olympus after the 2nd century A.D. vaulted mortuaries were constructed with this barrel technique and with the help of mortar as bonding element between the stone blocks (Figure 3).

Figure 3. West-Necropolis, vaulted tomb, Olympos Excavation Archive 2006 (Özer, 2013).

The applications and forms of vaultings evolved over time using different methods such as pitched bricks, vertical bricks and radial bricks (Roman empire). In this method, the joint gaps of the brick or stone were made according to the lines extended radially from the center of the arch and the blocks themselves (brick, stone, soil) were cut with this angle (Figure 4 a,b). Due to the curved geometry of vaultings, they transfer vertical loads at an angle to the supporting element (usually a wall). As a result, the thickness of the supporting "wall" should to be thicker and also heavier to avoid collapse and carry loads (Figure 5a) (Erten, 2018; Como, 2017). Such an example can be seen for the horizontal earthquake load in Iran by means of thickening the side walls in order to increase the earthquake resistance of the vaults (Figure 5b).



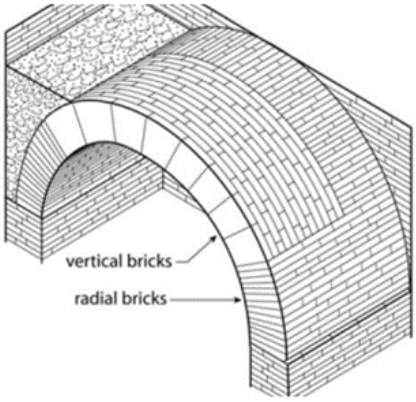


Figure 4a. Pitched bricks, **Figure 4b.** Vertical bricks and radial bricks (URL 1)

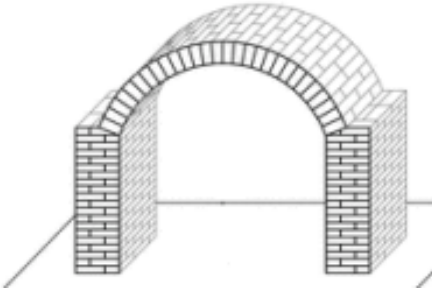


Figure 5a. Thick sidewall application (URL 2)

Figure 5b. Adobe vault Bam, Iran (Hejazi, 2020)

The supporting of walls using buttresses is one of the methods used to reinforce the load bearing structures and prevent the collapse of the barrel or ribbed vault by supporting and keeping the abutments in place (Figure 6a) (Hejazi, 2020). In addition, steel tensioning elements are another alternative in this type of reinforcements for keeping the abutments in place (Figure 6b) (Ak, 2019).

Figure 6a. buttresses usage. Strengthening mud brick barrel and ribbed vaults with buttresses, Bam Citadel, Iran (Hejazi, 2020)

Figure 6b. Edirne Alipaşa Bazaar use of steel tensioning elements (URL 3)

3.2.1. Barrel vaults

In 300 B.C. Greece, real vaulting examples are not commonly found but still exist and one of them is the Didyma temple (Figure 7 a) (Dirlik, 2017). Where barrel vaults can be found under the sanctuary and the stones in the vaulting were used to transfer loads to each other and down to the "foundations" (Figure 7b).

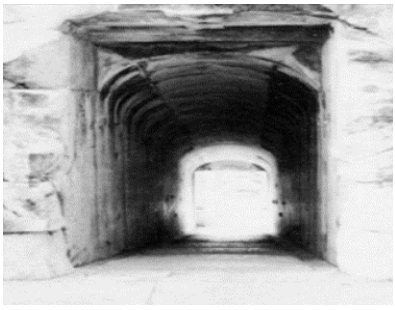


Figure 7a. B.C. 3rd Century Didyma Apollon Temple (Dirlik, 2017)

Figure 7b. Didyma Apollon temple corridor (URL 4)

In 133 B.C. the ancient city of Aizanoi came under the rule of the Roman Empire and the temple of Zeus was built in the Ionic order (117-138 A.D.). The use of the vault in the lower section of the Zeus temple is seen in Figure 8 a,b (Kalburcu, 2017).

Figure 8a. Zeus Temple vaulting (T.C. Kütahya Valiliği)

Figure 8b. Zeus Temple (Kalburcu, 2017)

This ancient barrel vault structure, was used in Roman times and later on in the Romanesque architecture (Como, 2017).

3.2.2. Pre-romanesque era – archivolted barrel vaults

The Archivolts were developed in order to reinforce and articulate the barrel surface. In this technique the "beams" support this surface allowing for bigger spans. An example for this method would be the Church of Cedofeita, Porto, Portugal (eleventh century) (Figure 9a) and Santa Maria del Naranco 842 (Figure 9b). The building was built by Ramino I, initially as a part of the palace, and was converted into a church in the 12th century (URL 5).

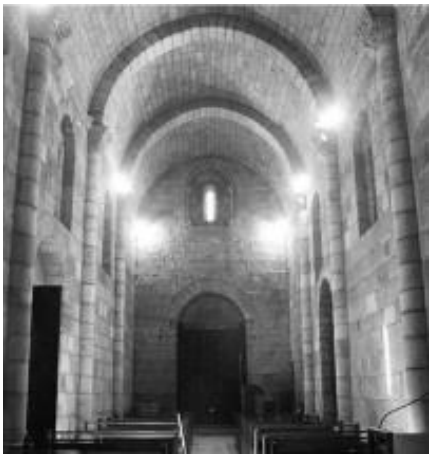


Figure 9a. Archivolted barrel vaults example in the Church of Cedofeita (Alexakis and Makris, 2017)

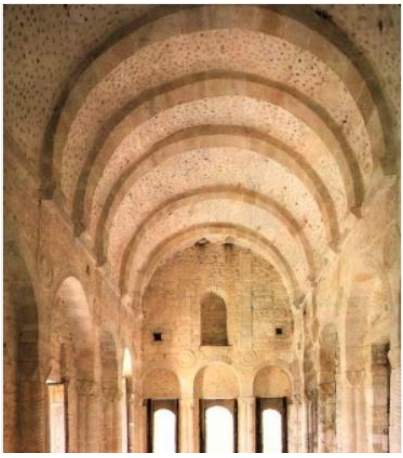


Figure 9b. Santa Maria del Naranco interior view (URL 6)

3.2.3. Pointed-arch barrel vaults

This vaulting type evolved from the semi-circular barrel vault where the peak of the vaulting is elevated even higher in order to obtain a well distributed loading scheme and resulting in the pointed-arch form. The Cluniac architecture can be characterized by the pointed arch barrel vaults. (Cambré, 2022). In this type of vaulting the body of the barrel and the archivolts are broken at the major axis. The first building that was built with the pointed arch was used is the Cluny III Benedictine Abbey Church of Fontenay (1139-1147) one of the first examples of it in the world; built during byzantine times at the end of 11th century. (Figure 10) (URL7).

Figure 10. The use of pointed barrel vaults in the Abbey Church (Cambré, 2022)

3.2.4. Archivolted barrel + transversal smaller barrels for reinforcing the whole structure

Underpitched vaults - Welsh vault; used in 16.-18. Century Europe; Bosa Cathedral is an example of this type of vault. Bosa is a Roman Catholic cathedral located in Sardinia, Italy. The Cathedral, which was built in the 12th century, has undergone great changes in the 15th century. Restored from 1803 and completed in the 19th century (Figure 11) (URL 8).

Figure 11. Underpitched vaults, Bosa Cathedral (URL 9)

3.3. Types of Roman Cross Vaults / Groin Vaults

Groin vault originates from the intersection of two-barrel vaults and due to this geometry two ridges are formed that increase the support and enhance the load distribution (Gaetani, et al. 2016).

3.3.1. Roman cross vaults / groin vaults

The first example of this type of vault was built by Attalos I, king of Pergamon (Bergama) between the years 241-197 B.C. This type of vault was later widely used in ancient Roman architecture. Groin vault is also more advantageous than barrel vault in terms of lighting (Figure 12 a) (URL 10). 11th century, France, in Tournus, the vault construction of St. Philibert church can be given as a good example of the Groin vault type (Figure 12 b).

Figure 12 a. Groin vault in the church of Sant Miquel - Terrassa, 9th/10th century, Spain (URL 11)

Figure 12 b. Groin vault in St. Philibert in Tournus (URL 11)

3.3.2. Romanesque cross vaults

In the early Gothic period architecture, the groin vault was replaced by the more advanced rib vault (URL 12). The Romanesque cross vault is made up of semi-circular arches on all sides and diagonals of a rectangle

or square base. The arches at the diagonals are higher than the sides resulting in a better distribution/support of the loads, increasing the vertical component of the forces the structure becomes more stable. In the Romanesque cross vault used in the Basilica St Denis-France (1135), the ribs at the intersections are built together with the vaultings (Figure 13 a). In Carolingian times and initially constructed between, (800-888 CE) the monastery and basilica were partially rebuilt in 1135 under the direction of Abbot Suger. It was also rebuilt again in 1219 and 1837 (URL 13). Another good example is St Martin's Cathedral (in Bratislava, Slovakia, 1430-1440). Construction continued in the second half of the 14th century and between 17th-18th centuries (Figure 13b) (URL 14).

Figure 13a. Basilica St Denis, cross vault (URL 15)

Figure 13b. View of nave, St. Martin Cathedral (URL 16)

3.4. Romanesque Sexpartite Cross Vaults (6 Parted)

Later on an extra rib was added to the Romanesque Cross Vault creating a six parted ribbed system. It is sometimes considered to be the first ribbed system because the typical vault is a surface structure and the

bays are supporting each other whereas in the sexpartite cross vault surfaces are supported by the skeleton ribs and archivolts transfer the loads to the shoulders and basement/foundation.

3.4.1. Early gothic sexpartite vaults

Sexpartite was an important vault construction system at the beginning of Gothic architecture. Lyon Cathedral is an example of this construction technique (Figure 14). The construction of the building, which is a Roman Catholic church, began in 1180 and was completed in 1476 (URL 17).

Figure 14. Example of sexpartite vaulting Lyon Cathedral (URL 18)

3.4.2. Gothic pointed arched cross vaults

This type of vaulting is a cross vault transformed to use the pointed arch and was an advancement for some of the previous obstacles. The rib transversal line that split the base rectangle in half is halved again but this time with a ridge. This type of vault emerged to make decorative windows and doorways of Indian and Islamic architecture, but it began to be used as an important structural element in France and England in

the 12th century. Elements such as rib vault and flying buttress are also included in this use (URL 19).

An example of this type of vault is the St Etienne of Bourges Cathedral (France). The Cathedral of St Etienne of Bourges is an important example of Gothic architecture, built in the late 12th and 13th Centuries (URL 20). Gothic Bourges Cathedral (1195) Bourges is the last gothic church with the largest and highest sexpartite vaulting (Figure 15) (Taylor and Mark, 1982).

Figures 15. Bourges Cathedral, view of sexpartite and Pointed Arched Cross vault (URL 21)

3.5. Net Vaults

Through time the supporting structure of the vaultings advanced to a point where individual development of vaultings became possible to create much more complex and unique designs. What enabled this was the usage of net vaultings. In the mid 14th century a special type of this net vaulting was produced; the Net (Parler) vaulting where the ribs are composed of Y- shape crossing of the ribs and its elongations becoming a normal rib.

St Vitus Cathedral in Prague is an important example of Gothic architecture. The construction of the building began in 1344 and the building has some various repairs until 1929. The St. Wenceslaus chapel of the cathedral was designed with a ribbed vault by Peter Parler between 1356-1364 (Figure 16) (Gajdošová, 2016; URL 22).

Figure 16. Prague, St Vitus' Cathedral (Gajdošová, 2016)

3.6. Stellar Vaults

A stellar vault is a specific kind of Gothic ribbed vault that can be considered as an evolution of the traditional cross vault, characterized by a more complex geometry and by a system 21 of supporting ribs. It emerged during the late gothic period of 13-14th centuries and it continued its evolution with additional secondary ribs resulting in further subdivisions of bays for the purpose of wider spans and higher heights (Grillanda et al., 2021). After the beginning of the Middle Ages and throughout the Renaissance, arch constructions were created with combinations of parabola and ellipse forms (Sandaker, 2011).

One of the most important examples of European gothic style is Amiens Cathedral. The construction of the building started in 1220 and lasted for many years. Some additions were made after 1260. The view of the central vault above the nave and vaults above the side aisles that form the cross section of a main corridor and the opposite corridor in the plan of the building is given in Figure 17 a, b. The Aimens vaulting is a type with 2 curvatures that enhance the strength and as a result the vault is been considered as a rib vault whit horizontal ridge ribs (Angelillo, Fernandez and Piracci, 2019-2020).

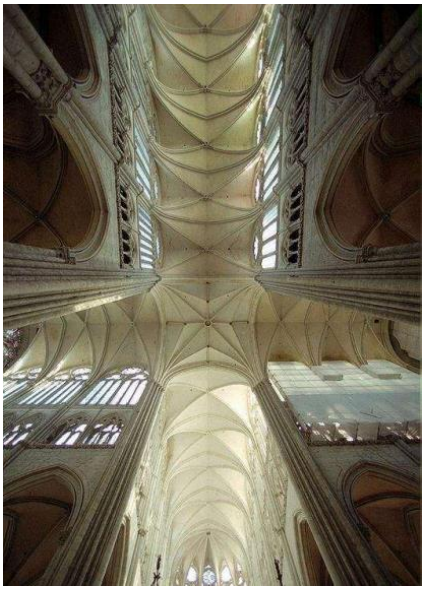


Figure 17a. Amiens Cathedral interior view of the vaultings. (Angelillo, Fernandez and Piracci, 2019-2020)

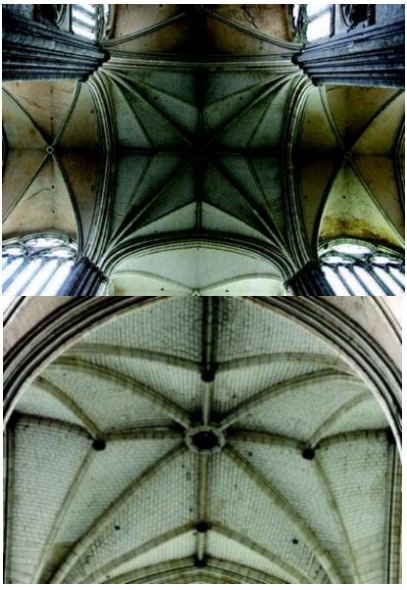


Figure 17b. The five bosstone vault of the transept vault of Amiens' cathedral, Lateral view of the vault showing the ridge line (Palacios. 2018).

4. Findings and Discussion

Dating back to approximately 8000 years ago the vault construction has been an integral part of the structures as the cover of many types of structures for thousands of years. In this study, vault construction techniques and forms are discussed in terms of their development. The developmental stages of the examined vaults are listed below, and their developmental characteristics are shown schematically in Table 1.

- Corbel Vault; it is the first vault type that has been in use since BC 6000. In this brick/block bonding method is just like a regular wall but the blocks are gradually shifted towards the main axis until their intersection and the apex.

- Barrel vault; the next vaulting technique to appear was the barrel vaults in 3000 BC. In this technique, the vault is constructed by placing of the stones radially from the center in the form of a semicircle. Thus, it was possible to pass a greater opening. This new development made a significant impact.

To improve this method even further it was necessary to implement a kind of reinforcement, which lead to the construction of the;

- Pre Romanesque Era - Archivolted Barrel Vaults. As a result the strength of the vault has been increased by adding "beams" to the vault.

- Pointed-Arched Barrel Vault; the height of the vault has been increased by the use of pointed vaultings, thus reducing the horizontal load and making the system more stable.

- Archivolted Barrel + Transversal Smaller Barrel; enabled the main vault to receive support from the sides which strengthened the structure.

It became possible to make openings for windows and provide natural light. This development created the possibility of motions on the top of the vault, making further improvements.

- Roman Cross Vault / Groin Vault; intersects two vaults; the intersection lines work as a reinforcement to increase the strength.

- Romanesque Cross Vault; a beam like structure; ribs were added to the intersection lines of the previous technique and the structure was strengthened even further.

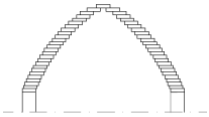
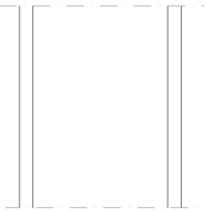
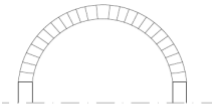
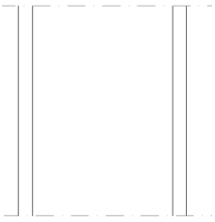
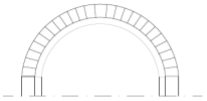
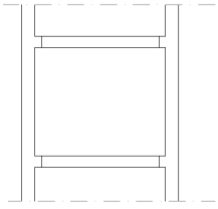
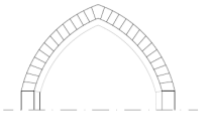
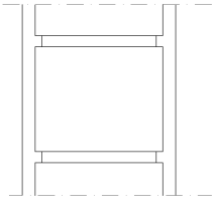
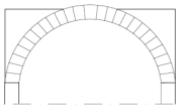
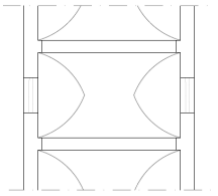
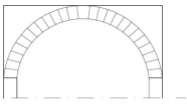
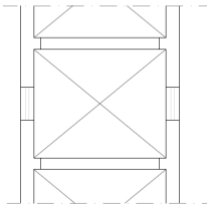
- Romanesque Sexpartite Cross Vault (6 Parted) - Early Gothic Sexpartite Vaults; the number of beams previously added diagonally has been increased by the addition of another and the vault has been divided into smaller pieces, reinforcing the structure.

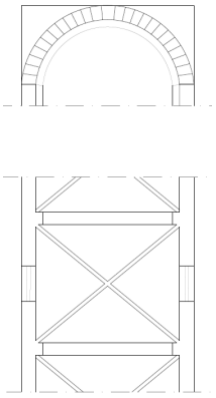
- **Gothic Pointed Arched Cross Vault;** the height of the previous vault type has been increased significantly even enhanced further with implementation of buttresses and it has been made easier to transfer the load to the foundations.

- Net Vault; the number of partitions by "beams" in the vaults increased resulting a much more optimized load distribution and transfer. These elements can also be decorated with different ornaments.

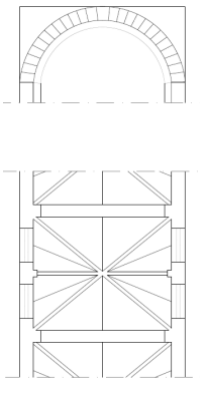
- Stellar Vault; increase in the number of beams has been achieved by creating a star form, a very different form and aesthetic approach is achieved.

Table 1. Developmental phase schemes of vault construction in the historical process

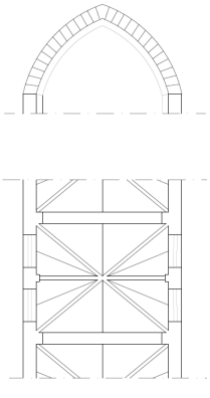
Vault Types		
  Corbel vault	  Barrel vault	  Pre Romanesque Era-Archivolted Barrel Vault
  Pointed-Arch Barrel Vault	  Archivolted Barrel + Transversal Smaller Barrels	  Roman Cross Vault / Groin Vault



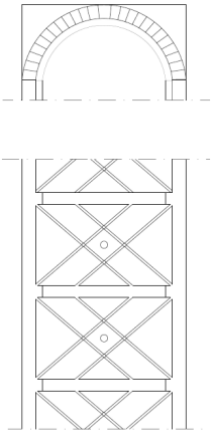
Romanesque Cross Vault



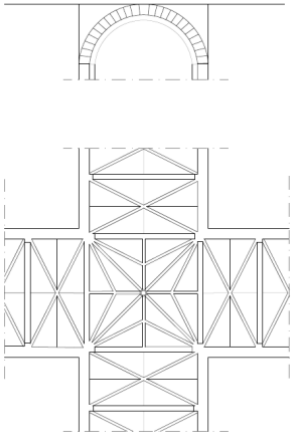
Romanesque Sexpartite Cross Vault (6 Parted) - Early Gothic Sexpartite Vaults



Gothic Pointed Arched Cross Vault



Net Vault



Stellar Vault

The vault, which started with the construction type of Corbel was the first vault type to be obtained by placing stones on top of each other, built for the purpose of covering the building. Continuing developments provided many structural advantages in terms of strength, form and aesthetics and increasing heights/spans to better suit functions. And at

the point of development, the rib (beam-like elements) were used as load bearing methods in the vault increasing the strength and bringing great visual varieties.

5. Conclusion

Examining the development of the vault construction technique, which has survived from ancient times to the present, is very important in terms of recognizing the progress. During the process that started with the Corbel technique, the transition to the barrel technique has been a great step and this method has been expanded by being very diversified. The vault, which was first supported by arches, then the cross vault allowed to break within itself. After this stage, the fracture lines are supported by beams and made more complex by using both the fracture and the beam support. By dividing this complex structure into smaller parts and supporting these parts with arches, a multi-surface and beam system was developed. At the last point reached, it has been possible to produce the vault in desired forms with almost as many fracture planes and arches as desired.

In this study, the vault development process is discussed and conveyed through important examples. It has been tried to increase awareness in the perspective of traditional structures by considering how the vault construction technique was developed in the historical process and how its visual feature evolved.

Author Contribution and Conflict of Interest Disclosure Information

All authors contributed equally to the article

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Analysis of Republican Period Civil Architecture Examples' Plan Typologies by Space Syntax Method

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1. Introduction

With the proclamation of the Republic in 1923, many innovations and changes were experienced in Anatolia in the political, social, economic and structural context. These changes and developments have also been reflected in the field of architecture and have taken their place in architectural practice over time. The social order that started to change and the lifestyle that moved away from the traditional building brought along the search for new places. Especially with the change in the life style of the Turkish family structure; New architectural approaches have started to be seen in the plan schemes of the houses. Due to both these changes and developments and the different architectural movements that emerged in this period, the formation of architectural works has changed. (1.National architectural movement, rational-functionalist movement, cubism etc.). Naturally, the effects of these changes and currents were mostly seen in residential architecture.

In this context; In the period between 1923-1940, which is expressed as the Republican period, through the plan schemes of the houses, which are the product of the changing and developing architectural practice; spatial organizations were analyzed by the spatial configuration and space syntax method. In this context, three types of residences belonging to private individuals, which were built at different times (1923, 1930, 1938) in Ankara, Afyonkarahisar and Istanbul, with different plan typologies (interior sofa, central sofa) were selected. The plan schemes of the selected houses were analyzed using the “Agraph”

program with the space syntax method, and the spatial configurations and spatial relations of the houses were evaluated.

1.1. Evaluation of Civil Architecture Examples in the Republican Period of 1923-1940

Changes and developments in the world and in our country in the historical process have led to the emergence of different housing types and plans in different cultures, societies, climates and geographies. (Dilaver, 2018). The segregation in social status, the change in the function of the house and the enactment of new laws on settlements have caused the house to enter a new formation process as a unit. The changing life order in our country with the proclamation of the Republic has paved the way for the houses to break away from the traditional understanding and undergo multiple changes in the architectural field (Dilaver, 2018).

On July 23, 1908, With the II. declaration of the Constitutional Monarchy, as a result of political and social change, very important effects were seen in the field of architecture, and this effect lasted until the 1930s. In these years, there was a two-way development, namely the National Architecture Style and the Style Based on International Movements. The First National Architecture movement is often referred to as National Architecture, National Architectural Renaissance or Neo-Classical (Yalvaç, 2019). In the context of the first national architectural movement, the methods of the Ottoman and partially Seljuk periods and contemporary architectural techniques were used together. According to Güneş (2013), the buildings of the

period are quite different from the previous periods. In purpose-built buildings, the façade has a completely plain design concept. In the buildings, the reinforced concrete skeleton system came to the fore, and applications such as cubic mass design concept, facades with wide glasses, free design layout and flat roofs were seen. The changes and developments experienced in the Republican Period changed the house plan, construction technique, structure and materials used, and materials such as wood, adobe used in traditional house architecture were replaced by stone, brick and reinforced concrete.

In addition, the transition from the traditional extended family order to the nuclear family structure, which started to settle with the Republic, strengthened the reflections of the developments in architecture in the space. According to Bozdoğan (1996), the changing upper-class house culture and family life, starting with the Tanzimat, mostly changed the houses of the elites dealing with bureaucracy and commerce.

The new houses are programmed according to the nuclear family structure, unlike the traditional house type designed in accordance with the traditional family structure. Previously, as “The Room”, it replaced the multi-functional spaces that responded to all actions; It has taken a space layout that started to be used depending on its functions such as "Living Room", "Bedroom". Rooms in residences are no longer a house on their own, serving all functions, and each room is assigned a single function. The volumes defined as “Sofa” in the old order have left their place to the holes and corridors. (Bozdogan, 1996). The ghuslhane, located in the cupboards inside the rooms, has now been transformed

into a separate place called the bathroom, and the toilet located outside the houses has been taken into the houses. These changes have actually emerged as the necessities of the new lifestyle.

1.2. Plan Typologies of Civil Architecture Examples

"Type" and "typology", which have different meanings according to the periods they were used in the discipline of architecture, have also found a place for themselves conceptually outside the field of architecture. According to Yılmaz (2018), typology is a conceptual process that can also be defined as the division of a subject into sections in the form of series of types, in accordance with the criteria determined by the person conducting the study.

Buildings are examined and classified with this approach, and their definitions are made in this context, and their "types" are determined. Different results can be obtained according to different criteria, different components and different factors in classifying housing types. The parts of the house are formed by grouping the actions in the house according to their functions. If we look at the formation of the parts of the house in terms of functions; actions constitute action areas, action areas spaces, spaces sections and sections constitute residences (Yılmaz, 2018).

When we look at the housing development process in our country, the understanding of shelter from the tent culture has left its place to a settled order over time. The historical process of the houses, on the other hand, started in the Seljuk period and followed the Ottoman period and developed from the Republican period to the present day.

Traditional Turkish houses form the basis of our architecture. The distribution of space in traditional Turkish houses has been shaped within the framework of two main elements, rooms and sofas. The rooms function not only as a unit of the residence, but also as an independent living unit. (Eldem, 1984) On the basis of this arrangement, the effect of the lifestyle shaped as an extended family is great. According to Eldem (1987), while the rooms in the Turkish House meet all the needs of the families living in a house, the "sofa" is the place that allows all members of the family to come together and spend time together. Sofas are large spaces that provide access to the rooms and open the doors of the rooms. Sofa, in other words, is defined as the common space between rooms. In the beginning, the sofas only provided the circulation between the rooms, but over time they were used for sitting, resting, gathering etc. Special corners are formed for functions. In this context, sofas have become the basic element of the Turkish House plan scheme. According to Eldem (1986), the plan type of the Turkish House is classified depending on the location of the sofa, its shape and its relations with other spaces. Houses without sofa constitute the first phase of Turkish traditional house after tent.

Open spaces are used to connect the rooms with each other. Houses with outer sofas are another phase that follows houses without sofas. The covered common use area can remain open on two or three sides as well as surrounded by rooms, with only one side open, depending on the shape of the plan schemes. However, the houses with inner sofas are the phases in which a protected common use area is formed by

closing the open side of the outer sofa with windows and placing it between the rooms in such a way that maximum two faces can see light. Houses with a central sofa are the last stage in the evolution of Turkish traditional housing (Faiz, 2012). Traditional Turkish house plan schemes; It consists of four main schemes as plan schemes without sofa, with outer sofa, with inner sofa and with central sofa (Eldem, 1954).

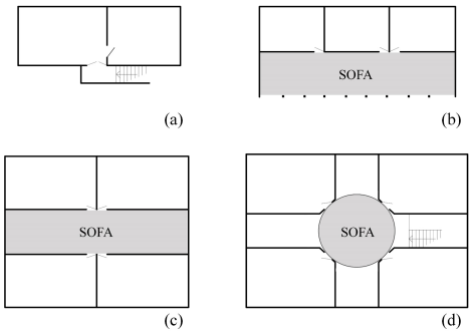


Figure 1. Representation of the plan schemes of traditional Turkish houses a) without sofa b) with outer sofa c) with inner sofa d) with central sofa (Usma, 2021)

These plan types are also divided into subgroups within themselves. The buildings built in plan type without a sofa are single storey and access to and from the rooms is provided via the courtyard. Rooms with windows and doors on the same facade are also open to the negative effects of weather conditions (Kuban, 1975). For this reason, it is seen that the plan scheme without sofa is generally preferred in regions where the climate is warm (Bektaş, 1996). There is not much difference in the arrangement of spaces in the plan type with outer sofa. The most important innovation that emerged is the transition to a two-storey arrangement and the addition of a sofa to the setup for the purpose of

accessing the rooms. This scheme, which has developed examples of "I", "L" and "U" type, is mostly preferred in rural areas. In the plan type with inner sofa, the main setup is the plan type formed by arranging the rooms on the opposite sides of the sofa. In this type, there are rooms on the long sides of the sofa, which takes on a full distribution space, and the short sides are closed with windows opening outwards. These applications, which are also called the karnıyarık plan type, are among the house types that are frequently encountered. In the plan type with central sofa, as can be guessed from the group name, there are the sofa located in the center and the rooms placed on the four corners of this sofa (Eldem, 1954).

2. Material and Method

Within the scope of the study, in order to analyze the spatial configurations and spatial relations of the houses with different plan typologies built in different times in the Republican Period (1923-1940), which the aim of the study, firstly the housing samples to be discussed have been introduced based on the literature. In the next stage, space syntax analysis was made on the plan schemes of the houses in question and their spatial relations were analyzed comparatively.

Space syntax analysis, by Hillier and Hanson in the 1970s, aims to describe spatial models with the help of organizational structures and express them in a graphical language (Hillier and Hanson, 1984). The analysis basically tries to explain the relationship between human form, function-space concepts (Gündoğdu & Çıracı, 2006). The method has

been used in many research and design applications all over the world, and recently it has also been used to measure the design styles of buildings and their readability from the eyes of the user or designer. The most important feature of the method is that it is a method that can define and analyze the relationship between interior and exterior space fiction and social structure in the discipline of architecture (Hillier and Hanson, 1984). In distinguishing the method from other approaches introduced in the same period; It is stated that the techniques used while describing the space directly focus on people's spatial experiences are effective (Seamon, 2007).

With the space syntax theory, rather than the features of spaces such as design, form, quality and scale, the situation of the space in its entirety and its connection with other spaces are discussed, and the desired data are listed as follows (Hillier & Hanson, 1984; Şişman, 2015):

• To reveal all the variations of human spatial organizations,

• Finding the most basic structures of the system and presenting them with graphical expressions instead of verbal expressions,

• To reveal how these structures are in harmony with each other,

• Express how these structures come together to form more complex structures.

According to Penn (2003); space syntax analysis allows to compare spaces because it analyzes different forms of space on the same quantitative basis. Space syntax, which is a morphological analysis method, evaluates each part that makes up the whole depending on the whole system and creates quantitative values. At this point, it defines

the spatial configuration through connections and nodes within the configuration. While explaining the relationships between the nodes, concepts such as mean depth, integration, and connectivity are used (Menderes, 2014). The depth value is related to the number of places passed to reach a place, and it enables us to access information about privacy in the system. The depth value is inversely proportional to the integration value. The integration value is high in the spaces that are passed through a lot, that is, those spaces are described as integrated spaces (Gündoğdu, 2014). Variable space, which is expressed by depth in transition graphics, is called the integration value in a numerical form (Şanlı, 2009, Hillier and Hanson, 1984). The integration value is always between 0 and 1, and maximum integration is seen in the spaces closest to the 0 value (Yıldırım, 2002). Spaces with low integration value are integrated spaces with a lot of social interaction. On the other hand, the depth value and the integration value are high in the places where there is less social interaction. (Ünlü et al., 2001). According to Klarqvist (1993); the definition of space parts as independent nodes, the analysis of what kind of connectivity they are with each other, presents the connectivity value of the space, this value changes according to the relationship of a space with its neighboring spaces. The higher the connectivity value of a space, the higher the potential for direct access from that space to the neighboring spaces.

In this study, assuming that the space syntax theory is a method that shows the social relationship of spaces by considering the physical relations of the space; Three houses with different plan typologies built

at different times during the Republican Period (1923-1940), determined within the scope of the study, were analyzed with the space syntax method.

At this stage, the "Agraph" program developed by Bendik Manum's friends Espen Rusten and Paul Benze was used, and the digital identity of the houses was revealed with the help of the transition graphics obtained from the program (Manum et al., 2006). The Agraph program, developed by Manum et al., measures control value (CV), total depth value (TD), average depth value (MD), relative asymmetry (RA) and integration value (i), which are basic spatial syntax analysis parameters (Şen, 2014).

Access graphs obtained in the Agraph program are expressed with colors. While the most integrated spaces are shown in red, the decreasing integration value is respectively red, orange, yellow, green, blue and dark blue. While each space is represented by a circle in the program, spaces related to each other in the system are connected with their names and numbers, and access graphics are created (Manum et al., 2006).

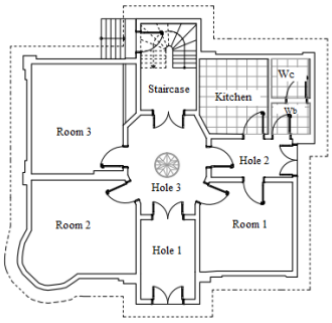
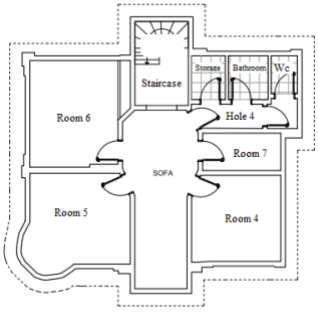
3. Findings and Discussion

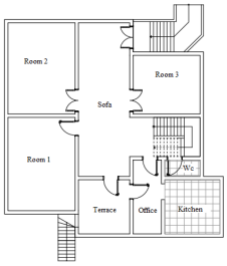
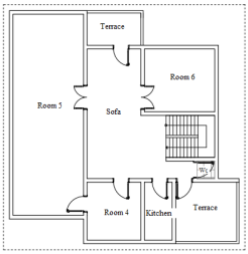
3.1. Introduction of the Case

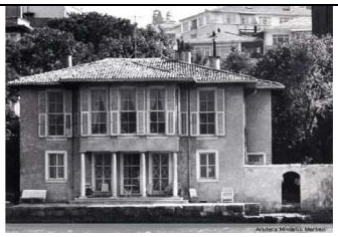
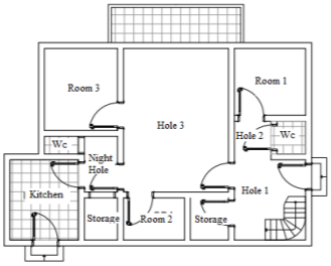
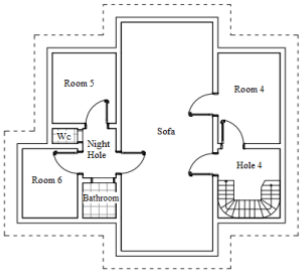
In order to be analyzed within the scope of the study, three housing samples with different plan types from different regions, built in the Republican Period (1923-1940), were included in the study. The selection of the houses was based on the criteria of their existence today and their construction on different dates. In this direction, to be

analyzed in the study; Mehmet Aga Mansion (1923/Ankara), Kırlıoğlu Mansion (1930/Afyonkarahisar), Ayaslı Mansion (1938/Istanbul) were included in the study. First of all, tables containing information about the houses, architectural drawings and visuals were created.

Table 1. Mehmet Aga Mansion, Kırlıoğlu Mansion, Ayaslı Mansion figures, floor plans and presentations

<table>
<tr><td rowspan="5">Mehmet Aga Mansion</td><td colspan="2">  </td></tr>
<tr><td colspan="2">General view of the building</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Ground floor plan</td><td>First floor plan</td></tr>
<tr><td colspan="2">The building is located in Hallaçlı Village of Gölbaşı District of Ankara. The building, which consists of a total of three floors, the basement, the ground and the first floor, was built with stone and brick materials and in the masonry technique. It is stated that the plans of the building, the construction of which began in 1923, were prepared by a Swiss architect and it was built by Greek masters. It is revealed that the building was registered by the Ankara Cultural and Natural Heritage Preservation Board in 1994 and was named Atatürk House in the registration slip. There is a cylindrical corner tower with a dome on the southeast corner of the building. There is a cihannüma on the east side of the building, and a cantilever on the first floor. In the</td></tr>
</table>

	building, which shows the feature of plan type with a central sofa, the corridors where the rooms and service areas are opened open to the sofa spaces. The main living units of the building are the spaces on the ground and first floors. On the ground floor, there are three holes where the entrance doors open, the room, the kitchen, the washbasin, the toilet and the interior sofa where all the rooms and holes are opened. On the first floor, there is a stair hole, four rooms, a bathroom, a storage room, a washbasin, a toilet and an interior sofa (Yalvaç, 2019).
Kırlıoglu Mansion	 
	General view of the building
	 
	Ground floor plan First floor plan
	The building is located in the Dumlupınar Neighborhood of the Central District of Afyonkarahisar. The building, which consists of a total of three floors, a basement, ground and first floor, was built in masonry concrete masonry style as a basement floor stone wall and the other two floors brick walls. It is stated that the building, the construction of which began in 1930, was built by Bulgarian masters. The building has two entrances. In the building, which shows the plan type feature with an inner sofa, the rooms open to the sofa spaces. The main living units of the building are the spaces on the ground and first floors. On the ground floor, there is the kitchen, wet area, four rooms and a sofa, and on the first floor; kitchen, wet area, three rooms and a sofa (Abi, 2020; p.345-348).

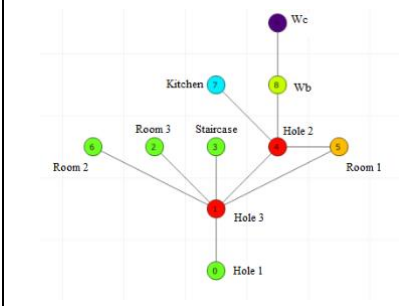
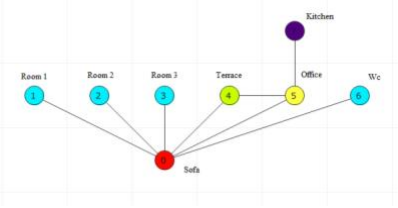
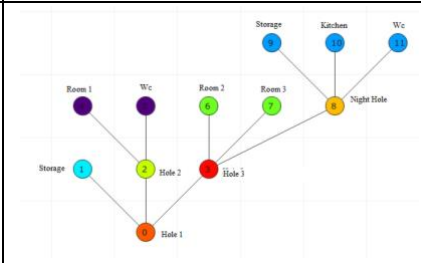
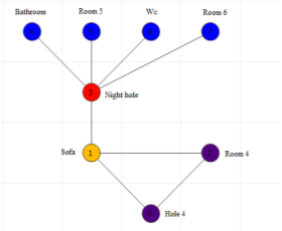
<table>
<tr><td rowspan="5">Ayaslı Mansion</td><td>  </td><td>  </td></tr>
<tr><td colspan="2">General view of the building</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Ground floor plan</td><td>First floor plan</td></tr>
<tr><td colspan="2">The building is located in the Beylerbeyi District of Istanbul. The building, which consists of a total of three floors, the basement, the ground and the first floor, was built with stone and brick materials and masonry wall technique. The architect of the building, whose construction started in 1938, is Sedad Hakkı Eldem. Its plan categorically belongs to the traditional karnıyarık, two-sided sofa type. On the ground floor of the building, the kitchen, storage, three rooms and the entrance hole, where the wet area and the staircase are located. On the first floor of the building; there are three rooms, the hole where the stairs are located, the wet areas and the sofa where the rooms and holes are opened. On the first floor of the building, the sofa opens to the outside at the front and back. The sofa was enlarged with a closed cantilever on the first floor, and the closed cantilever was supported by columns on the ground floor. This area is used as a terrace on the ground floor (Özakbaş, 2007).</td></tr>
</table>

3.2. Analyse

The spatial organization of the houses with two different plan typologies, defined as Mehmet Aga Mansion (1923/Ankara), Kırlıoğlu

Mansion (1930/Afyonkarahisar), Ayaslı Mansion (1938/Istanbul), was analyzed using the "Agraph" program with the space syntax method.

Table 2. Mehmet Aga Mansion, Kırlıoğlu Mansion, Ayaslı Mansion graph analyses

	Ground Floor Transition Graphic	First Floor Transition Graphic
Mehmet Aga Mansion		
Kırlıoglu Mansion		
Ayaslı Mansion		

In Mehmet Aga Mansion; the place where the depth and integration value is the highest on the ground floor; “toilet” space, the space with the lowest depth and integration value is the “hole 3” space. On the first floor; the space with the highest depth and integration value; "toilet"

space, the space with the lowest depth and integration value is the "sofa" space.

In Kırlıoglu Mansion; the place where the depth and integration value is the highest on the ground floor; "kitchen" space, the space with the lowest depth and integration value is the "sofa" space. On the first floor; spaces with the highest depth and integration value; “toilet”, “kitchen”, “room 6” and “terrace” are spaces, the space with the lowest depth and integration value is the “sofa” space.

In Ayaslı Mansion; spaces with the highest depth and integration value on the ground floor; “room 1” and “toilet” are spaces, the space with the lowest depth and integration value is “hole 3” space. On the first floor; spaces with the highest depth and integration value; “room 4” and “hole 4” are their spaces, the space with the lowest depth and integration value is the “night hole”.

Table 3. Mehmet Aga Mansion, Kırlıoglu Mansion, Ayaslı Mansion average depth and integration values according to the spaces

Ground Floor		**Space**	**Average Depth**	**Integration Value (Ra)**
Mehmet Aga Mansion	Max.	Wc	3,11	0,52
	Min.	Hole 3	1,44	0,11
Kırlıoglu Mansion	Max.	Kitchen	1,14	0,47
	Min.	Sofa	2,42	0,04
Ayaşlı Mansion	Max.	Room 1, Wc	3,45	0,49
	Min.	Hole 3	1,81	0,16
First Floor		**Space**	**Average Depth**	**Integration Value (Ra)**
Mehmet Aga Mansion	Max.	Wc	3,20	0,48
	Min.	Sofa	1,50	0,11
Kırlıoglu Mansion	Max.	Room 6, Wc, Kitchen, Terace	1,85	0,28
	Min.	Sofa	1,00	0,00
	Max.	Room 4, Hole 4	2,28	0,42

Ayaşlı Mansion	Min.	Night Hole	1,28	0,09

4. Conclusion and Suggestions

As a result of the study, according to the numerical data obtained; In Mehmet Aga Mansion, the construction of which was started in 1923, the high integration value in the hole and sofa spaces; It is an indication that these spaces meet the functions of gathering and dispersal within the dwelling. The fact that the place with the lowest integration value is the toilet area shows that it coincides with the functional counterpart of the space.

In Kırlıoğlu Mansion built in 1930, as in Mehmet Aga Mansion, the integration value of the sofa space is the highest; It shows that the space meets the function. In Mehmet Aga Mansion, which has a central sofa plan type, the entrance hole connected to the sofa is lost in Kırlıoğlu Mansion, which has an inner sofa plan type; It has been seen that the sofa is the most integrated space in both houses. The integration value has been low since the kitchen space on the ground floor is reached by passing through a different space. On the first floor, the spaces have equal integration values, since all spaces can be accessed from the hole.

In Ayaslı Mansion built in 1938, the most integrated space on the ground floor is the hole, as in the other residences. On the first floor, It has been observed that the integrated space has turned into a night hole. The night hole space, which is not found in traditional houses, has taken its place as a space connecting the sofa and bedrooms in the housing typology that developed with the proclamation of the Republic. This shows that over the years, the rooms where all functions are fulfilled

have been replaced by rooms that serve a single function. It is seen that the most disjointed spaces on the first floor are the rooms.

When the three housing examples are compared, it has been observed that the spaces have responded to a single function over the years, therefore the integration value of the spaces used as bedrooms has increased. As a result; With the proclamation of the Republic, it has been observed that the changing lifestyle has also shown its effect on traditional housing types, the spaces in the plan typologies continue to exist, but their functions differ. The room, which is one of the most important spaces of the house and serves many functions, responds to a single function with the changing lifestyle; caused a change in the intensity of use of the rooms.

The resulting depth and integration values are important parameters in plan types with inner sofa and plan with central sofa, and the results are not accidental; It has been seen that it is a result of spatial relations in the whole. In plan types, “depth and integration values” describe the relationships that cause the form change in the whole.

Author Contribution and Conflict of Interest Disclosure Information

All authors contributed equally to the article contributed. There is no conflict of interest Ş. Ebru Okuyucu or Gamze Çoban.

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Analyze the Public Buildings of the Early Republic Period by the Space Syntax Method: The Case of Riza Çerçel Cultural Center

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1. Introduction

The reforms that took place with the proclamation of the Republic brought about developments in public institutions. With the newly established state entering into a formation process on educating and developing the society, the concept of the halkevi, which is one of these institutions, emerged. These building groups, which have the characteristics of Turkish Architecture in the Republican Period, are covered by 9 branches (1. Language, History and Literature, 2. Fine Arts, 3. Representation 'Theatre and Navigational Plays', 4. Sports, 5. Social Assistance, 6. Public Courses and Courses, 7. Library and Publication, 8. Peasantism, 9. Museums and Exhibitions) have been important cultural and social development centers for cities. Halkevleri which is one of the important examples of modernization with its architectural understanding has a new style not only in social sense but also in architectural sense. The Afyon Halkevi building, which is one of the Halkevi opened on February 19, 1932 in 14 provincial centers, was built with the function of the Türk Ocağı and brought to the function of the Halkevi based on the change of function of the Türk Ocakları throughout the country. This building functionally undertook a transformation role as a modern building for educational and cultural programs, where the effects of the period were seen in the architectural sense.

In this context, the building, which has functioned as the Türk Ocağı, Halkevi, Revenue Office Building, Rectorate Building and finally Rıza

Çerçel Cultural Center is handled with the space syntax method in terms of its spatial functions. The spatial characteristics of the new functions assigned to this structure, which has historical qualities, in the construction of the original space were analyzed through the plan diagrams and evaluated through the parameters of connectivity, depth and integration with the space syntax method. How the relations between private/public spaces that make up the historical building setup are shaped, how the spatial configuration changes, are the main factors that shape the work axis.

Through the plan setups of the historical building; it is aimed to measure the potential of the user to use the space during the cultural and artistic activity by numerical methods such as space syntax. This study is important in the context of calculating and measuring quantitative values over the spatial configuration of re-functioned historical buildings where cultural and artistic activities are organized.

1.1. Evaluation of the Architectural Features of the Halkevi in the Republican Period

The Turkish people faced the danger of extinction within the framework of the social, political and economic conditions they were in at the beginning of the last century. Under these conditions, the priority has been to ensure the survival of the nation and the state. After this struggle, in order for the newly established state to survive and survive, there was a need for a popular understanding that embraced the Republic and its values, was educated, conscious and lived in social

welfare. In order to realize this basic phenomenon, the establishment and dissemination of Halkevi has become the main goal (Gökce, 2019). The concept of Halkevi serves a purpose that focuses on social solidarity for the unity and solidarity of the society together with cultural activities. When the activities and operations of the Türk Ocakları that emerged in the Ottoman Period are examined, it can be interpreted that they were the first institutions to lay the foundation of this idea because they are similar to the Halkevleri.

With the adoption of the Republican regime, an all-encompassing modernization project begins with the establishment of new state-owned institutions. With decisions in the cultural, political and economic spheres, the definition and structural establishment of the new regime has been completed to a considerable extent. At this point, spatial formations, which correspond to the various institutional formations realized with the Republic, are quickly put into practice in Early Republican Turkey (Durukan, 2006). this process, many constructions that will leave the traces of the period with a unique style have been active. This structure is designed to include the public, educational, military... etc. Although it is seen that it is in the field, the Halkevi, which have a period-specific understanding and activity, are an important movement.

Halkevleri; The adoption of Atatürk's Revolutions was established in 1931 in the place of the Türk Ocağı in order to carry out the cultural activities of the Republic alongside National Education. Halkevleri,

which were opened on February 19, 1932, have an important place with their original structures within the cultural breakthroughs, secularization and modernization policies of the Young Republic. In the first stage, Halkevleri are located in 14 city centers; In the second phase (June 1932) it began to operate in 20 provincial centers. By 1950, there were 478 Halkevi and 4332 Halkodası (Özacun,1996; Kara. 2018). As of its opening, it has taken its place in Turkish cultural history with its branches that were put into service in 14 centers on the same day. These are Adana, Afyon, Ankara, Aydın, Bursa, Canakkale, Denizli, Diyarbakır, Eskişehir, İstanbul, İzmir, Konya, Samsun and Van Halkevi. (Gökçe, 2019).

The project productions of the Halkevi, buildings were made in different ways through the competition, by architects from private architectural offices and governorships and by the Ministry of Public Works. Since it is aimed to increase the number of Halkevi, buildings rapidly, it has been designed with four types of plan schemes as "L, I, T and U" over time. The function-based mass understanding of modern architecture is the criterion based on the plans of the Halkevi, Buildings. The sections in the plan consist of a hall, an administration department, a library, and classrooms and classrooms. They come together in different ways to form various plans. Especially the "L" plan sky is the most typical plan setup encountered in the Halkevi Buildings. The masses, one of which consists of the hall and the other of the

administration part, together define an inner garden (Arslan & Alagöz, 2015).

Considering that these project productions are focused on new construction, Çeçen (1990) states that Halkevi, can also benefit from buildings with historical value to solve the building problem. The government also attaches importance to the preservation of buildings of historical value and supports their use as Halkevleri. Among these buildings with historical value are the Türk Ocakları. In fact, with the closure of the Türk Ocakları and the transfer of their properties to the Halkevleri, it is seen that some of their buildings were also transferred (Durukan, 2006).

In order for a Halkevleri to be opened, it is a condition that at least three of the nine branches of work specified in the directive must be established, that it must have a conference hall with a capacity of not less than 200 people, a library, a study room, a building, a courtyard sufficient to perform gymnastics, and a budget that can give the salary of a chamberlain and civil servant (Halkevleri Directive, 1932; Kara, 2018)

In terms of the architectural style of the Halkevleri, it is seen that they exhibit a classical approach by showing similarity with other public buildings under the influence of westernization. They have a simple understanding of the plan, which is often solved in symmetrical order, and especially the entrance facades gain movement, away from the ornament. Apart from the Ankara Halkevi building, it is seen that other

Halkevi buildings throughout Turkey carry the classical form of public buildings (Arslan & Alagöz, 2015) (Figure 1).

Figure 1. Ankara Halkevi (URL1), İzmir Halkevi (URL 2)

Halkevleri, which have important traces of identity in the development process of public buildings, have also affected the spatial formations with their requirements in the understanding that will serve cultural and social values. It is seen that many of these institutions, which were closed as of the 1940s, have been brought to the cities with different functions that their spatial qualities allow. In this context, within the scope of the study, the building, which was first built as a Türk Ocağı and then given the function of a Halkevi, will be discussed and today it is used as the Rıza Çerçel Cultural Center building.

1.1.1. Rıza Cercel Cultural Center

Afyonkarahisar spent the first years of the transition to the Republican period very troubled and experienced two consecutive occupations. It is one of the provinces most affected by the destruction of war; the tried to heal his wounds by closing in on the long term and to relieve the tiredness of history. A few state investments during this period had an economy dominated by traditional agriculture in isolation other than new factories and buildings. Despite this, new constructions have

started in the city. Halkevi building was one of the main works built in this period (Yelken, 2001; Ulugun& Ortak. 2006).

It was used as the Türk Ocağı building for the branch of the Halkevi in Afyon, which was opened on February 19, 1932. According to its statute, the Türk Ocağı was opened in order to ensure the scientific and intellectual development of the people of Karahisar-ı Sahip. In other words, its aim has been to educate the people by organizing conversation meetings, by opening day and night schools, and to eliminate ignorance with the light of knowledge (Ilgar, 2001) (Figure, 2).

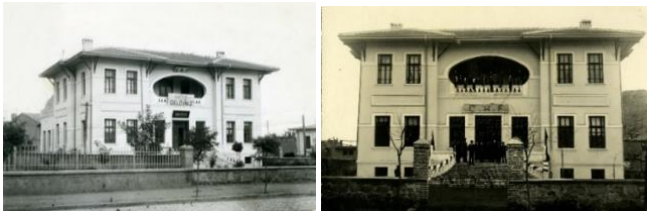


Figure 2 Afyon Halkevi (URL3), (URL4)

From the Foundations Administration in order to build a building that can meet all kinds of needs of the quarry; It was decided to provide a large land with a garden, and the 1907.50 m2 land of the place where the current AKÜ Rıza Cercel Cultural Center is located was taken from the Foundations Administration. Under the coordination of Haji Mülazım's Tahir Bey, the head of Ocak, the 'Constructive Association Committee' started its work and the internal materials of the building, which was appreciated with a value of 50.000 TL, were met from the treasury. With the outstanding efforts of Afyonkarahisar Prison Director Tahsin Bey and the work of the inmate masters and workers in

the prison, the labor was completed without paying the labor fee. Projects of the building; The project author of the Ankara Türk Ocakları service building was built by Architect Arif Hikmet Koyunoğlu. When Atatürk came to Afyonkarahisar on March 2, 1931, he visited this building. On the way up the stairs, Dr. Resat Galib Pasha this building was beautiful. But when he said 'this place should be made a Halkevi, Atatürk said, 'Yes, there should be a Halkevi, a Halkevi. Thus, the Türk Ocağı turned into a Halkevi (Ilgar, 2001; Abi, 2021).

The building was used as the Revenue Office building under the Ministry of Finance until 1993, when it was allocated to Kocatepe University after the Halkevleri and Halk Party (1951-52). (Özpınar, 2014). Since the establishment of Afyon Kocatepe University, the building, which has been used as the Rectorate building, has been serving as a new function cultural center since 2020.

2. Material and Method

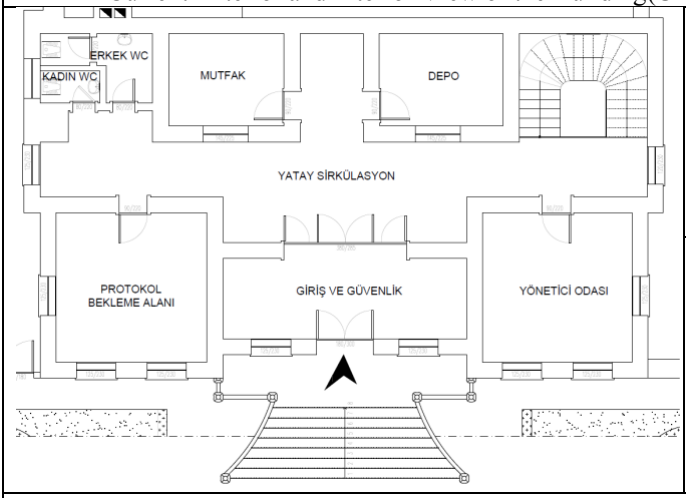
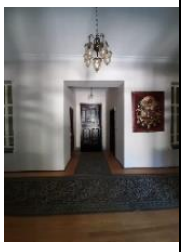
2.1. Material

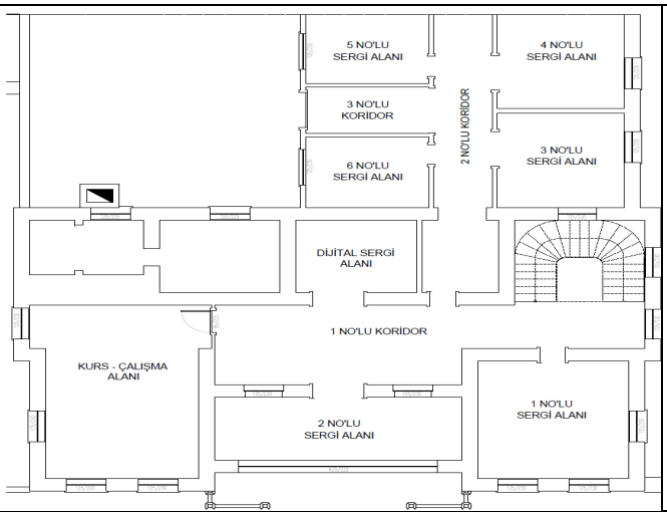
Within the scope of the study; The spatial structure of the historical building, which served many different functions in the historical process and finally started to be used as the "M. Rıza Çerçel Cultural Center", was analyzed by the space syntax method.

In order to analyze the spatial fiction of the historical building, which was designed by Architect Arif Hikmet Koyunoğlu in the Early Republican Period and used as a Halkevi, party building, revenue

office, rectorate and cultural center respectively, the M. Rıza Çerçel Cultural Center was introduced based on literature (Table 1).

Table 1. Plan Diagrams and Visuals of M. Rıza Cercel Cultural Center

M. Rıza Cercel Cultural Center	
	
Current Exterior and Interior View of the Building(URL 5/ 6)	
	 
Ground Floor Plan	
	



First Floor Plan

The building is located on Ordu Boulevard, which is one of the important axes of Afyonkarahisar province and provides a connection with the city center. The building, which consists of three floors in total, namely the basement, the ground and the first floor, was built in the masonry technique with stone material. It is known that its construction started in 1928 and was delivered in about two years. It was determined that the building design was undertaken by Architect Arif Hikmet KOYUNOĞLU as a result of the literature reviews.

It is known that the building was used in the functions of Türk Ocağı , Afyon Halkevi, Republican Halk Party Building, Revenue Office, Rectorate and affiliated units respectively. In 2020, it was transformed into a culture and art center under the Rectorate of Afyon Kocatepe University Social Facilities Operations Directorate. In this context, it is known that functional changes have been made in order to strengthen the university-art bond of the city. On the basement floor there is a warehouse, heating center and technical room, on the ground floor there is security, wet volumes, kitchen, warehouse, executive room, protocol waiting area and conference room. On the first floor, there are temporary exhibition areas, corridors, work-shop / working area, digital exhibition area, terrace and storage.

2.2. Method

In the next stage, the spatial configuration of the historical building is read through the plan diagrams; The relationship of indoor and outdoor

space organization with social structure was analyzed by space constellation method.

The Space Syntax analysis method, which is accepted as a "space reading" method, was started to be studied theoretically in the fields of architecture and urbanism by Bill Hillier and his team at the University College of London (UCL) in the early 1970s in order to reveal the effects of "spatial appearance" in buildings and built environments and their interactions in social structure (Hillier et al., 1983). According to Gündoğdu and Çıracı (2006), spatial sequence analysis is a model developed on the shaping properties of space. Gündoğdu, (2014) uses the spatial sequence analysis method; It is a method used to define the spatial models of cities, built environments, building groups at different scales, the organization of space within the building and their interactions with the social structure. According to the definition in Hillier and Hanson (1984) in their book "Social Logic of Space"; space syntax defines it as a method for understanding the social logic that makes up the urban fabric, in other words, reading about the potential to bring people together. The most important feature of this method is that it provides the opportunity to analyze the relationship of interior and exterior organization with social structure in architectural practice. The theory of spatial constellation, which aims to create quantitative values by evaluating each part (local) that makes up the whole (local) depending on the whole of the system (global), defines the spatial configuration in its mathematical fiction through the nodes that describe

the connections and the intersections of routes within this configuration. While explaining the relationships between these nodes, concepts such as mean depth, connectivity, integration, and Isovist were used. While reading the relations between spaces in the plane of the plan within the scope of the theory, the concept of convex space (Bafna, 2003), which is the most considered, is based on the logic of reducing the areas in the plane of the plan, which have different sizes from each other, to cellular partitions in order to be able to read them in relation to each other. In this context, in the analysis of convex space, which forms the periphery of the spatial space whose boundaries it defines and which can be defined as the space that opens outwards, the relationship of each cellular grid to each other gives rise to these concepts that will open the spatial configuration such as integration, connectedness and depth to interpretation (Menderes, 2014).

1. Integration Value: Integration value refers to the depth/shallowness value of a space depending on the other spaces in the plan diagram. The high level of the integration value of a space is a factor that increases the integration of that space with other spaces, and the low integration value is a factor that reduces the integration of that space with other spaces. In other words, spaces with high integration value are expressed as shallow and low spaces are expressed as deep (Hillier and Hanson, 1984). According to the integration value, in the spatial pattern colored from red to purple, the red areas describe the areas with the highest potential to be used, while the areas towards the

purple refer to the segrated areas. Areas with high integration value indicate the movement routes that have the most potential to be used. In this context, while evaluating the M. Rıza Çerçel Cultural Center, which will be analyzed in the context of public relations, it was determined that the areas with high integration value were determined as the routes that the public could use intensively.

2. Depth Value: Depth is one of the analysis methods that reflect the configurational characteristics of the space sequencing method. Hillier and Hanson (1984) express depth as the total number of spaces that must be passed through in order to reach the space. The differences that govern behavior within a spatial system can vary greatly with the average depth of a configuration. Too deep space involves little movement, and less deep spaces contain a lot of movement (Hillier, 2001). In the graphs obtained as a result of the software used for deep spaces, spatial constellation analysis, cold colors - from blue to green - and shallow spaces are expressed in warm colors - from orange to red.

3. Connectivity Value: Connectivity value is the value that shows how much space has access to it, that shows its relationship with adjacent spaces. When the connectivity value is high, it can be inferred that the accessibility value of the space is high (Hillier, 1984). In the space constellation researches carried out at the building scale, the space to be analyzed within the scope of any study is evaluated as a environment consisting of the composition of different convex space parts in the plan plane. Defining the parts of the space as independent

nodes and examining what kind of connectivity state they are in with each other provides the connectivity data of the space. to Klarqvist (1993), this value is a value that varies depending on the relationship between a space and the spaces it neighbors close to itself. In other words, Haq and Luo, (2012) show that the higher the connectivity value of a space, the greater the potential to directly reach the neighboring spaces from that space.

As stated by Penn (2003), the sequence of spaces makes it convenient to read the spaces comparatively, in order to analyze the different formations of space on the same quantitative basis. This situation reveals the relationship of the method with the research in terms of examining the M. Rıza Çerçel Cultural Center building to be investigated.

In this context, the plan diagrams of the M. Rıza Çerçel Cultural Center were obtained as a result of literature-based research and transferred to the Syntax 2D program. Space constellation analysis was performed on the plan diagrams grouped according to different floors, and the obtained connectivity, depth and integration parameter values and graphs were interpreted. For the plan of the M. Rıza Çerçel Cultural Center, which was discussed within the scope of the analysis, the connectivity, depth and integration values of each cell (grid) were taken and average data were obtained.

3. Findings and Discussion

The space setup of Afyonkarahisar M. Rıza Çerçel Cultural Center was analyzed using Syntax 2D program with space constellation method. The connectivity, depth and integration values and graphs obtained from the Syntax 2D program were transferred to the tables. In the context of the space configuration of the M. Rıza Çerçel Cultural Center, the connectivity, depth and integration values of each space were calculated and average data were obtained. By interpreting the color equivalents of the connectivity, depth and integration values obtained from the Syntax 2D program in the plan diagrams; the relations between the spaces are read in the plane of the plan.

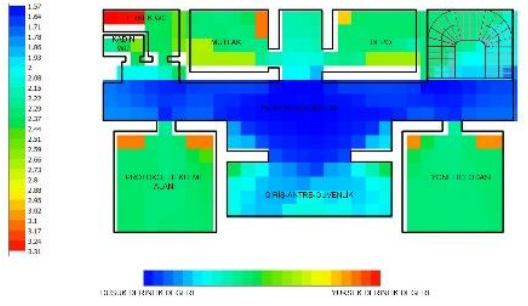
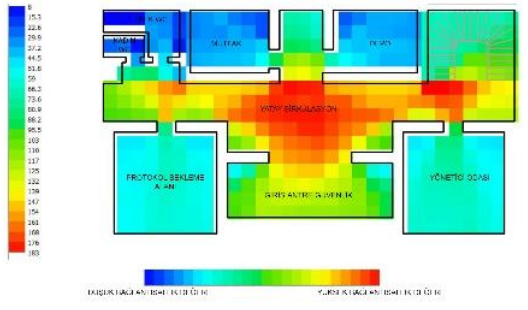
3.1. M. Rıza Çerçel Ground Floor Average Depth Connectivity Integration Values

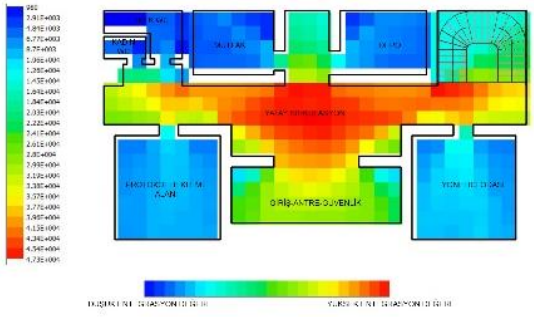
The spatial relationships and spatial syntactic data of the ground floor, which were analyzed through the Syntax 2D Program of the M. Rıza Çerçel Cultural Center, are shown in Table 2 and Table 3. In the table, the highest and lowest values are expressed in bold.

Table 2. M. Rıza Çerçel Culture and Art Center Ground Floor Depth-Connectivity and Integration Average Values

	Places	Average Depth	Average Connectivity	Average Integration
GROUND FLOOR	**Entry-Security**	1,94	116	6169
	Protocol Waiting Area	2,50	65	6142
	Executive Room	2,31	56	5735
	Horizontal Circulation	**1,77**	**135**	**8397**
	Kitchen	2,52	37	4237
	Depo	2,55	38	5415
	Woman WC	2,40	32	3476
	Man WC	**2,60**	**25**	**2915**

Table 3. Graphical expressions of Ground Floor Depth, Connectivity and Integrity.

Depth Value	
Connectivity Value	

Integration Value	

Within the scope of the space sequence analysis made with the Syntax 2D program; The integration value of the horizontal circulation area, defined on the entrance axis of the cultural center on the ground floor, remains at the highest value in the context of the whole plan. The reason for the high integration value of this area is attributed to the relationship of the building with the city and the fact that it has a high value in square meters. In addition, it is seen that the building has a high integration value in the reception / entrance area. This situation integrates the entrance area with the garden and the building, defining an entrance axis with high integrated value. The reason why the horizontal circulation area has the highest connectivity value is evidence that its accessibility is of high value in the context of physical accessibility. It is seen that the wet volume areas on the ground floor remain as very deep spaces. The low integrated value of wet volume areas is an indication that they correspond to their function. The fact that the integration, connectivity and depth values of the protocol waiting area and the executive room on the ground floor are at an average value shows that the spaces are located in the right place due to their

functions. The fact that the depth values of the kitchen and storage areas are high compared to other spaces is proof that they are isolated spaces and that accessibility is controlled.

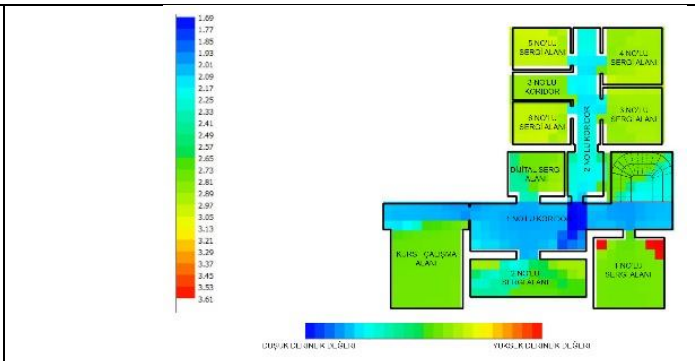
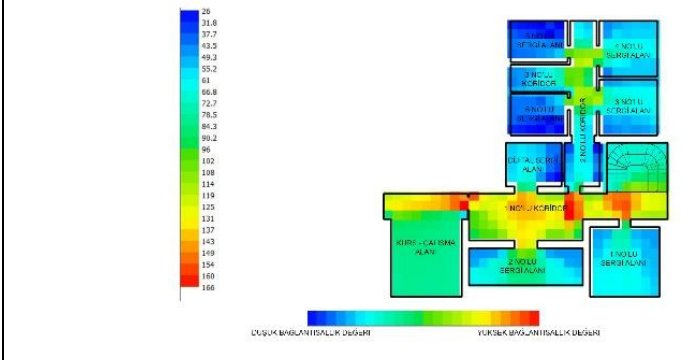
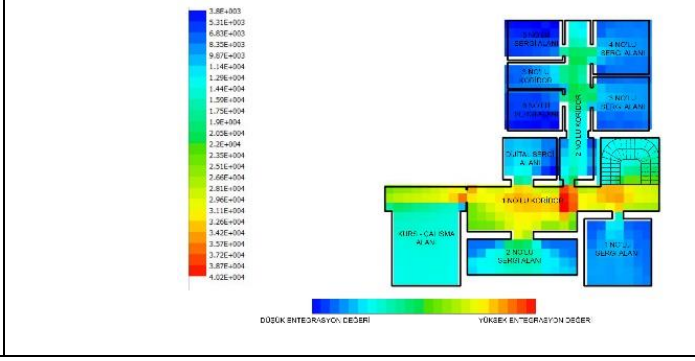
3.2. M. Rıza Çerçel First Floor Average Depth Connectivity Integration Values

The spatial relationships and numerical spatial syntactic data of the first floor, which were analyzed through the Syntax 2D Program of the M. Rıza Çerçel Cultural Center, are shown in Table 4 and Table 5. In the table, the highest and lowest values are expressed in bold.

Tablo 4. M. Rıza Çerçel Culture and Art Center First Floor Depth-Connectivity and Integration Average Values

	Spaces	Average Depth	Average Connectivity	Average Integration
FIRST FLOOR	**Hallway No. 1**	**1,97**	**137**	**6711**
	Exhibition Area No. 1	2,73	61	5330
	Exhibition Area No. 2	2,40	76	6394
	Course-Study Area	2,19	112	6686
	Digital Exhibition Area	2,68	62	5454
	Hallway No. 2	2,63	70	5601
	Hallway No. 3	2,90	51	3218
	Exhibition Area No. 3	2,84	58	4700
	Exhibition Area No. 4	2,89	57	4235
	Exhibition Area No. 5	**3,00**	**37**	**1593**
	Exhibition Area No. 6	2,96	38	2231

Table 5. Graphical expressions of the First Floor Depth, Connectivity, and Integration values.

Depth Value	
Connectivity Value	
Integration Value	

According to the spatial constellation analysis of the first floor of the cultural center; The integral value of corridor 1 remains at its highest in the context of the entire plan. The high level of integration and

connectivity of this space depends on the physical access to all spaces from this area and being an accessible space. The integration value of corridor 2 is relatively lower. This shows that the corridor area no. 1 in the plan plane functions as a more integrated area. However, it is seen that the average integration values of corridor no. 1, no. 2 and no. 3, which can be defined as a distribution area within the building, are quite low compared to the average of the entrance horizontal circulation, which is the general reception area. The place with the lowest and deepest integration value is exhibition area 5. Exhibition areas 3, 4 and 6 also have a high depth value. This configuration within the plan structure caused the exhibition areas to remain in a very deep space compared to the circulation zones. The high depth value of the exhibition areas shows that accessibility to these spaces is difficult. This configuration within the first floor plan has resulted in low public accessibility of the exhibition spaces. The low integration value of the exhibition hall 1, which should be fully accessible to the public, strengthened its inability to respond to its function. The high depth value of the digital exhibition area shows that its accessibility is low in the context of physical accessibility. This circumstance is not suitable for the function of the exhibition area. Starting with corridor 1, it can be taken as a data that supports the argument that accessibility is gradually decreasing. Although the integration, connectivity and depth values of the course and study area are average; The fact that the average integration value is higher than the average integration value of

the floor and the depth value is lower shows that the course and study area function as a more integrated space in the plan structure compared to the exhibition areas.

4. Conclusion and Suggestions

The refunctionalized "M. Rıza Çerçel Cultural Center" has been evaluated on the basis of numerical data and space organization. In the study, in which the relationship between the user and the space was questioned, mathematical data and space utilization potentials were measured and analyzed.

For each plan considered within the scope of the analysis, the connection, depth and integration values of each cell (grid) were taken and average data were obtained. These obtained numerical data were interpreted separately for each space in the context of the space configuration. It was determined which space was the most integrated and which space was the deepest, and the functional equivalents were evaluated.

As a result; Although the horizontal circulation section, which is the first encounter area after the entrance area of the cultural center, shows that the department defines a strong public accessibility with a high integration value, it provides poor accessibility due to the relatively low integration values on the ground and first floor at the points where the public is accepted into the building. Exhibition spaces, which should be the most integrated spaces, have remained at the deepest and have not been able to respond to the concept of public accessibility. In this

context, it is seen that all kinds of interventions to the historical building are directly related to the accessibility limits of the space.

As stated by Arslan & Alagöz, (2015) and Kara (2018); All of the places that should be found in the community centers are available in the M. Rıza Çerçel Cultural Center. However, the historical building, which has been converted into a culture and art center today, is deep and not accessible; It is an indication that the function cannot be found. This is seen as a major problem for the new function of the historic building. In this context, it is thought that in historical buildings that will be re-functionalized as culture and art centers, the places where events and exhibitions are held, which are used intensively, should be more integrated and accessible, while management offices, warehouses and libraries should be more isolated spaces.

The analysis method created using the Space 2D program has revealed very positive results in order to bring a different perspective and reveal the spatial syntactic reflections of a cultural center in perceiving the limits of public accessibility.

In this sense, although it is a study focusing on the accessibility limits of historical buildings repurposed as culture and art centers, it also contributes to the literature of space syntax theory, as well as being an example for other studies to be made in the context of spatial fiction and accessibility in repurposed historical buildings is expected.

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Renovation of MSGSU Tophane-i Amire Culture and Art Centre Guest House

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1. Introduction

Historical places, structures and objects, which are cultural, artistic and vital bridges between the past and the present, are of great importance in terms of preserving, keeping alive and transferring the moral and material values they carry to future generations.

Today, the need for infrastructure and service areas in the conservation, restoration, refunctioning, rehabilitation and reuse works of traditional buildings has brought the concept of additional building construction.

The necessity of preserving and keeping alive not only the physical but also the semantic value of the traditional structure brings the requirement that the practices be carried out in line with highly sensitive multi-disciplinary approaches. Additionally, contemporary conservation regulations advise a technology, a material and stylistic difference in the annexes to emphasize the time interval between the old and the new, while emphasizing the necessity of not harming the identity of the historical building and making it compatible with the spirit of the place (International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter, 1964; Charter on the built Vernacular Heritage, 1999).

In this study, the project and implementation of transforming the workers' dormitory built in the 1990s into a university guesthouse in the Tophane-i Amire building complex in the context of spatial identity and landscape interaction is described. The design and application were carried out in accordance with the decision of the Ministry of Culture,

Regional Boards for the Protection of Cultural Assets, Istanbul No. 2 Board, dated May 14th 2009 -139 and numbered 744.

1.1. Definition of Historic Building

Historical buildings can be defined as places with aesthetic, historical, scientific, social, and spiritual values that form emotional and physical bonds with societies from past times and are a source of inspiration for shaping new lifestyles (The Australia ICOMOS Burra Charter, 2013). According to Feilden, the historical building has architectural, aesthetic, historical, documentary, archaeological, social, political, spiritual and symbolic values, and the first value it carries in terms of being a symbol of cultural identity and continuity is emotionality (Feilden, 1997).

However, as specified in contemporary conservation regulations, it is stated that the historical building includes not only a single architectural work, but also an urban or rural settlement witnessing a certain civilization, an important development, a historical event, not only great works of art, but also simpler ones that have gained cultural meaning over time (The Venice Charter, 1964; Charter on the built Vernacular Heritage, 1999).

1.2. Renovation and Reuse of Historic Buildings

The living spaces of humans are also the reflection of their production and lifestyles from the past to the present (Kuban, 2000). For this reason, prolonging the life span of historical buildings and places is a social and cultural necessity to ensure their cultural sustainability. However, time-dependent changes in the way of living of society,

inevitably prevent traditional structures from continuing their functions (Ahunbay, 2004).

For this reason, it is necessary for historical buildings that have lost their function to be restored or rehabilitated and evaluated with other functions to save them from being ruined and demolished. In Article 5 of the Venice Charter, it is mentioned that the renovation practices must necessarily include social benefits and that the interventions to be made in this direction should be kept at a minimum level without disturbing the originality of the building (The Venice Charter, 1964). This approach is important in terms of preservation of the social economy at the same time.

1.3. Contemporary Additions in Renovation and Reuse

The structural needs arising from re-functioning of historic buildings brings the construction of annexes such as bathrooms, salesrooms, social service areas.

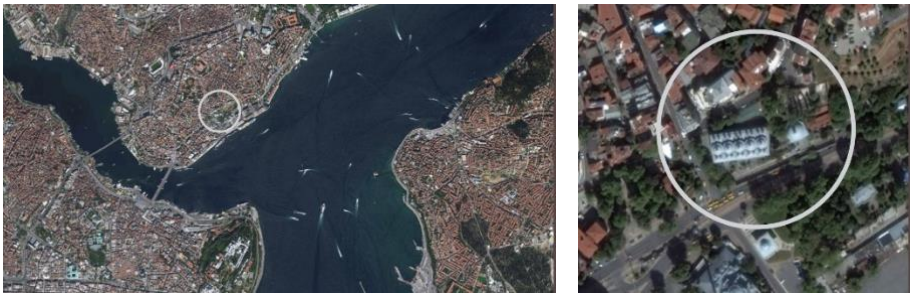
Additions should be designed with a contemporary approach and constructed with contemporary materials without competing with the architecture of the historic building or damaging its architectural integrity. Many decisions taken by international protection boards contain sections on additional building construction criteria.

Article 13 of the Venice Charter states that traditional building additions may be permitted in cases where the interesting parts of the building, its traditional location, composition, balance and connection with its surroundings are not detracted from (The Venice Charter, 1964). It is emphasised that the making of new designs that will enrich the

environment while the historical buildings are re-functioned are not disallowed (The Nara Document on Authenticity, 1994) and the additions should be understandable and an imitation of the original structure should be avoided in practice (Burra Charter, 2013).

2. The History of the Tophane-i Amire Building Complex

The Tophane-i Amire building complex, located in the Beyoğlu Urban Heritage Site and registered as immovable cultural assets, included the first cannon foundry buildings of the Ottoman Empire in the period of Fatih Sultan Mehmed in Istanbul near the Bosphorus Strait (Figures 1a, 1b). The name of the region was Metopon in Byzantine times.



a) **b)**

Figure 1. a) The Location of Tophane-i Amire on the Bosphorus, **b)** Aerial View of Tophane-i Amire Buildings

The mention in the Fatih Vakfıye dated 1465 that the Galata Kapıiçi Hammam among the revenues of the Hagia Sophia Mosque, is located near the Tophane Gate, indicates that there was a cannon casting structure here. According to the Travel Book of Evliya Çelebi, the cannon casting buildings here are reached through the Tophane Gate in the North which is one of the eleven gates on the walls surrounding the Galata Tower (Evliya Çelebi, 2011). In the 1867 State Yearbook, the places in the Tophane-i Amire were listed as: Cannon foundry,

steamboat machine, carpentry, ironworks, gear wheel, saddlery and embroidery etching workshops, tool, tailor, sword, rifle, case and model shops (Çoruhlu, 1994).

The Tophane-i Amire building complex, which gives an extremely important visual contribution to the silhouette of the city of Istanbul, consists of five domes, a single dome and cisterns (Figure 2). The buildings have been demolished and rebuilt again by Sinan, the chief architect of the Empire in the period of Süleyman the Magnificent (1520-1566). Only the single dome part remains original today.

Figure 2. Tophane-i Amire Five Domes, Single Dome and Cistern Buildings, (Photo: Dışkaya, H.)

The buildings were transferred to Mimar Sinan University in 1992 by the Ministry of National Defence to be used as a Culture and Art Centre. The phases of the Tophane-i Amire buildings, which have reached the present through many stages, are given in Table 1.

Table 1. Chronology of Historical Change of Tophane-i Amire Buildings (Çoruhlu, 1994), (Edit: Dışkaya, H.)

Period	Architectural process
Fatih Sultan Mehmed 1465	It is mentioned for the first time in the Fatih Foundation (Vakfıye).
II. Bayezid (1481-1512)	A military barracks is added.
Kanuni Sultan Süleyman (1520-1566)	Buildings are demolished and rebuilt by Architect Sinan.
1719	The building with two domes demolishes in fire.
1745	The two-section part is redesigned as five domes by Commander of Artillery Architect Mustafa Ağa.
1764	Buildings are damaged by fire.
III. Mustafa (1757-1774)	Buildings are repaired, barracks, kitchen and masjid are added. Baron de Tott, invited from France, makes changes in the military artillery school.
III. Selim (1789-1807) (1791-1792)	The armoury is rearranged. Modernization begins, Western engineers are invited, French J. B. Lepére is invited to project and build the cannon foundry. Artillery barracks are built on the land side, and cannon charioteer barracks are built on the seaside.
1 Mach 1823 Firuzağa Fire	Artillery barracks, cannon charioteer barracks, a part of casting house, Arabacılar Kışlası Mosque is completely burned.
II. Mahmud 6 March 1823-1824	Fire damage is repaired with zoning works in one year, Nusretiye Mosque is built in place of Kışla Mosque. A masonry steamboat machine factory and a material factory are added.
Abdülmecid 1847	A carpentry shop is added to the building.

I. Abdülaziz 1863-1864 1866	The Topçubaşı building, which was built by Selim III, is burned down, and the Tophane Marshalship building is constructed by combining the location of the building and the Artillery School's land. Various buildings are added.
1955	It is to be used as a military museum, but it is given up and used as a military museum warehouse.
1956	Due to the construction of the Tophane Salıpazarı road, all structures except the foundries are demolished. A reinforced concrete terrace is built in front of Tophane-i Amire and shops are built under it.
1972	Considering the establishment of a museum where the cannons were displayed, restoration works, and repair of the walls are started. Due to the high cost of restoration, this idea has been abandoned.
1992	It is transferred to Mimar Sinan University Fine Arts Faculty by the TR Ministry of National Defence to be built as a Culture and Art Centre (Ceylan, 2003).
1995-1996	Restoration works are carried out in accordance with the decisions taken by Mimar Sinan University's Restoration Department (Güngören Gönen, 1995).
2013	Conversion of dormitories for workers of former restoration applications into a guest house for artists is begun (Renovation project, environmental design and control: Dr. Hülya Dışkaya).
2014	The concrete terrace and shops on the side of Meclis-i Mebusan Street are demolished by the municipality.

2.1. History and Reuse Decisions of Guest House Building

The additional building, renovation project and implementation carried out for reuse was designed as a dormitory building for the workers who would work on the restoration of the Tophane-i Amire buildings in the

mid 1990s. The building was leaning against the retaining wall behind the roof level of the cisterns. Due to the great need for accommodation for international artists and curators who would hold exhibitions at the centre, the Rectorate of Mimar Sinan Fine Arts University requested an adaptation project, environmental design and implementation for the rehabilitation and reuse of the existing workers' dormitory as a social service aimed guest house.

The initial design decisions of the building in the mid 1990s were not changed and its adaptive use was aimed in line with the needs of the new function according to national and international conservation principles even though the building did not have a historical value. The renovation design and implementation phases were carried out in accordance with the decision of the Ministry of Culture, Regional Boards for the Protection of Cultural Assets, Istanbul No. 2 Board, dated May 14th 2009 -139 and numbered 744.

The material selection, technical application, and lighting design decisions were guided by using natural materials and energy efficiency principles in line with the spatial spirit of cannon casting buildings.

Although many details had to be resolved during the construction because of having a short time for the design process, main restoration decision principles can be listed as follows:

- The unity and the clarity of the internal and external spaces,
- Transparency,
- Minimalist design,
- Natural material use,

- Minimum intervention,
- Contemporary interpretation of traditional design,
- Contemporary interpretation of traditional materials,
- Reversibility,
- Energy efficiency,
- Low cost for implementation and maintenance,
- Innovative lighting.

Thus, natural materials such as wood and copper were preferred in the construction in terms of sustainability of conservation. The roofs, posts, beams and rafters, balustrades, floor coverings are designed with solid or laminated wood. The stone material was used for the cladding of the outer walls of the building. Travertine marble was used on the floors and walls of the bathroom up to a certain level. Khorasan mortar was used in the bathrooms between the retaining walls on which the building is based and the shower section.

3. Design and Implementation Decisions

The additional building is located on the embankment behind the cistern buildings, which can be reached by passing through the West facade of the five domes and the single dome buildings, where the previous workers' dormitory was located (Figure 3).

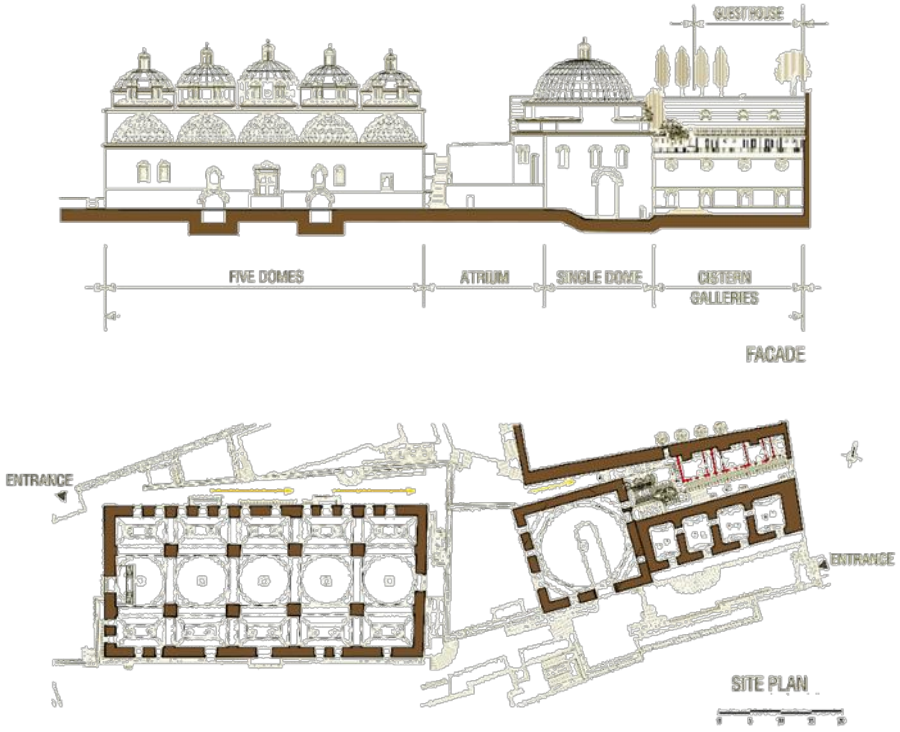
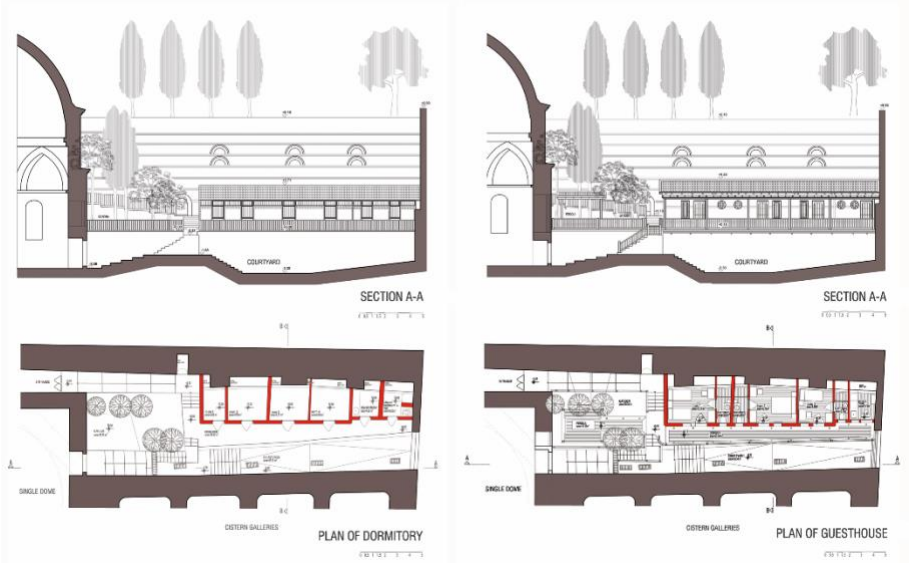


Figure 3. Location of the Guest House in the Site Plan and Facade of Tophane-i Amire Culture and Art Centre (Archive of MSGSÜ Rectorate, Drawing: Dışkaya, H., Graphic Design: Eroğlu, İ.)

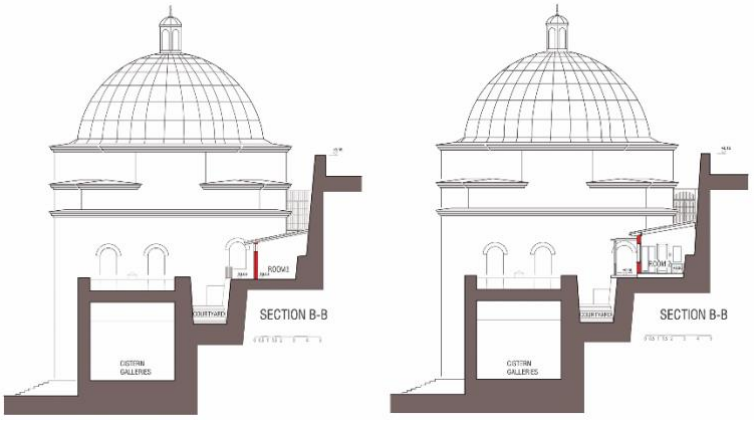
The dormitory of the workers consisted of four rooms with a shared kitchen and a bathroom. It is transformed into three bedrooms with private bathroom and a service room for the laundry and storage with the new requirement programme (Figures 4a, 4b).



a) b)

Figure 4. a) Plan and Facade of Workers' Dormitory **b)** Plan and Facade of Guest House (Archive of MSGSÜ Rectorate, Drawing: Dışkaya, H, Graphic Design: Eroğlu, İ.)

The main design decisions for the new building were mostly influenced by the accessibility point of the wastewater drain connection with the city sewer network's being located in the last room technically. Therefore, to add a space for toilets and shower in each room, the first-floor level of the corridor, and later the rooms, has been elevated up to 15 cm due to the requirement of the slope for the piping system of the building. Thus, the ground level of the building was raised a total of 30 cm elevated from ground level of the retaining wall (Figures 5a,b).



a) b)

Figure 5. a) Section of Worker's Dormitory **b)** Section of Guest House (Archive of MSGSÜ Rectorate, Drawing: Dışkaya, H., Graphic Design: Eroğlu, İ.)

The front wall of the workers' dormitory was also offset 30 cm outwards through the corridor due to the requirements of the architectural needs for the design of bedrooms and bathrooms. In this way, the width of the existing masonry gallery was considerably narrowed. To create a transition area of sufficient width, wooden consoles were used along the corridor, gradually widening from the beginning up to 60 cm. Therefore, while creating the necessary space, a vibrant visual effect was achieved when viewed from the courtyard behind the Cistern Galleries (Figure 6).

Figure 6. View of the Corridor from the Back Wall of the Cisterns and from Below (Photo: Dışkaya, H.)

However, a wooden pergola and a sitting area designed for the study and meetings in the open space, located in the north of the single dome, next to the entrance that overlooks to the Bosphorus as do the rooms (Figure 4b, Figure 8, Figure 9).

It is aimed to achieve a recyclable but also sustainable integrity in the design between the transition elements with the use of wooden beams on the ceilings, timber coverings of the floor and ceilings of the guest house' rooms (Figures 7a,b). The rafters of the aisle and gazebo design were also shaped with the same idea (Figure 8).

a) **b)**

Figure 7. a) Interior View of Twin Room **b)** Interior View of Double Room (Photo: Dışkaya, H.)

a) **b)**

Figure 8. a) View of the Guest House and the Roof of the Cistern Galleries from the Gazebo, **b)** View from Aisle (Photo: Dışkaya, H.)

The technical infrastructure of the building has been modified for the satisfaction of the users. Consequently, the air conditioning, heating, plumbing, electricity, telecommunication, and infrastructure of

innovative lighting that were non-existent before were designed and implemented.

Decisions regarding the lighting design and applications of the annex and its environment have been taken in a way that will be distinguished without disturbing the historical atmosphere (Dışkaya, 2016). The aim was to keep the design in a spiritual dimension that would coincide with the identity of the historical building, to reach structural traces, to be recyclable and to prevent redundancy (Zevi, 2001; Brandi, 2005; *Burra Charter,* 2013).

In this way, it is desired to create an almost hidden but at the same time subtle and dramatic effect in indoor and outdoor lighting in order to preserve and emphasise the cultural and architectural identity of the original spaces by making maximum use of daylight rather than using lighting fixtures (Historic England, 2007) (Figure 7, Figure 9).

Raising the floor with wooden joists also allowed for easy movement of electrical installations for outdoor lighting. In favour of energy consumption, LED systems were preferred. Natural materials such as wood and copper were chosen for the design of the lighting fixtures with a clear, simple, and original design combined with the historical atmosphere was aesthetically aimed for (Figure 9).

Figure 9. View of the Single Dome, Gazebo and Entrance from the Guest House (Photo: Dışkaya, H.)

To achieve an integrated design with an environmental green texture the preservation of the trees in the space was a very important factor in the design. For this reason, the poplar trees, which are inside the gazebo roof and make a great impact on the silhouette, were saved. However, since the roof tiles are dispersed by 30 cm of oscillation of the trees under strong wind, they were fixed to the retaining wall by three steel bars in order to minimize the wind effect (Figure 10).

Figure 10. Use of Steel Bars for Resistance to Wind Force (Photo: Dışkaya, H.)

4. Conclusion

In today's conservation codes and standards, it has been determined as a very important element in the design to reflect the present while preserving the traditional in the additional building applications of historical buildings, thus emphasising the time difference between the past and the present.

In this direction, the preservation of the identity of the original space and the reflection of its values have been the main determinant in the design of an annex and its environment located in the Tophane-i Amire building complex, with its high moral values in the historical and visual sense. For this reason, while preserving the historical material and structural character, the minimalist and contemporary expression of the traditional material in a linear sense has been aimed for.

Functioning the building as an artist's guesthouse also formed the main idea of the design with an approach that is more abstract, unpretentious

and integrated with the spirit of the place. In addition, the design principles of the previous dormitory building were not ignored, but the contemporary interpretation of the traditional lines and details in the Tophane-i Amire buildings gained importance (Figure 11).

Figure 11. View from Cistern Galleries to the Guest House and Single Dome (Photo: Ertuğrul, M.)

It can also be said that the new space and landscaping, designed and produced with minimal intervention and recyclable practices and a multidisciplinary approach, aims to include a spatial integrity compatible with the use of natural materials in terms of the sustainability of conservation (Figure 12).

Figure 12. View from the Courtyard to the Guest House (Photo: Dışkaya, H.)

Thanks and Information Note

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The construction process and contributors of the guest house can be listed as follows:

Ownership of the building: Mimar Sinan Fine Arts University (MSGSU), Rectorship responsible: Prof. Caner Karavit (Vice Rector) Start – finish dates of the construction: October 12th 2012 - March 4th 2013, Environmental design area: 214 m^2, Guest House area: 94 m^2, Architectural & interior design: Ing. Arch. Dr. Hülya Dışkaya, Lighting & lighting fixtures design: Ing. Arch. Dr. Hülya Dışkaya, Coordination: MSGSU Directorate of Construction, Site management: Ing. Arch. Dr. Hülya Dışkaya, Site management assistants: Int. Arch. Hakan Ercan, Int. Arch. Mert Ertuğrul, Contractor: Hasan Şatıroğlu, Mimari Grup Construction and Design (*Masonry construction, mechanical and electrical installations, roofing application, iron works, furniture and fine structure applications*), Timber works: Ahmet Demirel Forest Products (*Timber production and application works, production of timber lighting fixtures*), Fire alarm project and application: Electrical Engineer Osman Celasun, YANMAR Industry and Trade Inc., Production of lighting fixtures: Novalux Lighting Industry & Ahmet Demirel Forest Products, Production responsible for the lighting fixtures: Cengiz Büşlü.

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