Researches on Urban and Architectural Design Studies

Editors

Assoc. Prof. Dr. Betül BEKTAŞ EKİCİ
&
Asst. Prof. Dr. Nihal Arda AKYILDIZ

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PREFACE

Our book, **'Researches on Urban and Architectural Design Studies',** consists of various studies produced in the fields of architecture and urban planning whose titles are given below:

- Examination of Malatya Kernek Square and its Close Surroundings within the Context of the Conservation and Sustainability of the Culture-Space Relationship,
- Sustainable Disaster Management and Urban Transformation: The Case of Elazig Karsiyaka
- Crack Detection with Digital Image Processing,
- Reinforced Concrete Structural Design Failures Related to the Architecture of Buildings: Lessons Learned From The January 24, 2020 Earthquake in Sivrice-Elazıg,
- Evaluation of Wind Velocity Ratio for Changing Aspect Ratios in Urban Areas,
- A Comparative Examination of Early Republic Period Primary School Structures in Anatolia with a Comparison Analysis by Space Syntax Method and Principle Suggestions for Their Conservation,
- Evaluation of Thermal Comfort Models and Energy-Saving Potential in an Office Space in Istanbul.
- Parthenon: A Phenomenological Examination,
- The Contribution of Digital Technology and Modern Methods with Fundamental Approaches to the Conservation of Archeological, Architectural and Cultural Assets,
- The Theoretical Framework of Urban Morphology,

- Landscape Planning Criteria in Historical Environments,
- Determining the Effect of Facade Design in Buildings on Sunlight Reception and Lighting Energy Performance on the BEP-TR Regulation and BEP-BUY Program.

We would like to express our gratitude to the authors who made contributions with their genuine academic studies, to the reviewers who provided guidance for the perfection of the study, and to the staff of 'Livre de Lyon Publishing House', the publisher of our book, for their considerable assistance during the printing phase.

We hope that this book, which addresses important issues in the fields of urban planning and architectural design, will be useful for the reader.

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CHAPTER I

EXAMINATION OF MALATYA KERNEK SQUARE AND ITS CLOSE SURROUNDINGS WITHIN THE CONTEXT OF THE CONSERVATION AND SUSTAINABILITY OF THE CULTURE-SPACE RELATIONSHIP

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1. Introduction

Culture is a multifaceted concept that is closely related to every aspect of life. While tangible data about culture usually have static characteristics; intangible data is dynamic (Akyıldız and Olğun, 2020). In this context, studies aimed at conserving culture and transferring it to future generations are shaped by dynamism and stability (Metin Basat, 2013). One of the important examples of this is the researches on the tangible space and its intangible usage features.

Space, which is closely related to culture, becomes known in architecture when people turn to a physical space and limit a certain part of it (Altan, 1993). Every action that takes place in this area occurs as a reflection of the culture. This situation makes both concepts parts of an inseparable whole.

One of the areas where the culture-space relationship is seen intensely is squares. The square generally refers to a field, standing in the middle, being in the open. Culture, on the other hand, becomes concrete with the square and can be reproduced at any time (Ulutaş, 2019). In this sense, the square is one of the most versatile public spaces, which is an important reflection of culture.

The aim of the study is to emphasize the importance of the relationship between culture and space through Malatya Kernek Square and its immediate surroundings; to contribute to the conservation and sustainability of this relationship. In this context, first of all, the qualities of the concepts of culture and space, and their relations with each other, are conveyed. Then, evaluations about the historical process of Kernek Square, which is the study area, and its close surroundings, and its place and importance in the city are given. The study method consists of researching the relevant literature and observations in the field. With all the data obtained, the transformation of Malatya Kernek Square and its immediate surroundings in the context of cultural values and spatial characteristics was examined and it was aimed to draw attention to the conservation and sustainability of these qualities. As a result, the places of the work done are not only physically; it is thought that it will emphasize conservation with the cultural values it contains and contribute to spatial sustainability in this sense.

2. Conservation and Sustainability of Culture-Space Relationship

Culture, which is a valuable part of human life, is a concept that shapes the places we live in as well as our way of life. Cultural factors, which determine the boundaries of the space, the way and period of use, its physical qualities and many other features, also play a major role in the spatial change and transformation process. In this sense, it is important to examine the qualities of the concepts of culture and space and to reveal their relations with each other in this direction, in terms of detailing the study.

Culture is a long-established and broad concept. The word "culture", which is of Latin origin and which is derived from various words such as cultivating, protecting, processing, repairing, building, training, care, etc; has been used in English since the 15th century with such meanings including farming and observing natural development (Williams, 2005; Oğuz, 2011).

The concept of culture has become more comprehensive since the 15th century and has begun to be used for abstract concepts about human life (Özlem, 2000; Williams, 2005). This situation has been effective in the emergence of expressions such as art culture, literary culture and science culture in the following process (Galley, 2001). As a part of this whole process, the culture of living has also developed and has become a concept used by many disciplines.

There are many factors that make up the culture of living. These include comprehensive concepts such as history and resources (customs), family and kinship, health and nutrition, educational process, settlements (built environment) and lifestyle, economy and technology, sciences and arts, religion and state, personality system and language cultural and historical environment (Güvenç, 1984). It is possible to state that among these concepts, which are closely related to each other, settlements and lifestyles, cultural and historical environments stand out in terms of architectural discipline and space studies. In this sense, culture cannot be evaluated separately from space; can be considered as a concept intertwined with space.

The concept of space, like culture, is intertwined with life and has multifaceted qualities. Space, which has a deep-rooted history, is derived from expressions that mean existence and body in Arabic (Aydıntan, 2001). When considered comprehensively, it is an area that is defined as a space that separates people from their surroundings to a certain extent and allows them to continue their activities related to life and whose borders can be perceived by the observer (Aslan, Aslan, & Atik, 2015).

Space is a phenomenon that we perceive with all our sense organs and compare it with the situations in our minds (Altan, 1993). In this sense, both indoor and outdoor spaces have qualities that shape human life and direct the senses.

Architectural and natural space can be distinguished according to the characteristics of the elements that limit the space. In this context, those limited by natural elements (sky, earth, horizon, trees, bushes, etc.) are natural spaces; those limited by artificial elements (wall, beam, column, ceiling, etc.) can be expressed as artificial space or architectural space. The spaces limited by both natural and artificial elements are considered as mixed spaces (Altan, 1993).

Although the space becomes defined by physical constraints, the perception and senses of the living creature are also important in terms of determining the definition and boundaries of the space. In this context, it is possible to state that space consists of not only tangible but intangible elements.

Culture; environmental images, religious beliefs, family structure, kinship norms and rules, together with various mental and behavioral processes is a multi-faceted concept. These factors, which are closely related to individual and social life, directly affect living spaces and all kinds of places where the individual is located (Turgut, 1990).

The boundaries of spaces are determined by the cultures that shape them (Akın, 2008). In this sense, every society has forms that are shaped according to its cultural values and are against change (Rapoport, 2004). The effect of these forms on space can be clearly seen when the architectural values of different societies are examined. Even the cultures that the same society reflects in different periods can lead to the emergence of many places with different characteristics.

Culture directs the lifestyle and aesthetic understanding of the society. Different styles of different cultures are formed by this orientation process. Spatial elements such as streets, avenues, squares and houses that reflect the characteristics of societies form the cultural and architectural environment. Culture is one of the defining features of space in the relationship of the individual with society and his environment. In

this context, spaces are the most important vital evidence of culture (Çınar, 1996).

Culture and space are two phenomena that interact and reference each other. In this sense, the conservation of space in order to transfer the culture to future generations; in order for the place to continue its existence, it is of great importance to maintain the cultural values of the users.

The effects of the culture-space relationship are seen in many settlements in Turkey. One of them is Malatya. With its deep-rooted history and rich culture, Malatya has qualities that are worth examining from a spatial point of view. In this context, located in Malatya city center; Kernek Square, named after Kernek Waterfall, a natural resource here, is an important area where cultural values are reflected both in the past and today.

3. The Characteristics of Malatya Kernek Square and Its Neighborhood

Malatya is at a strategic point in Anatolia; it is a settlement that stands out with its deep-rooted history and unique geography. Located in the west of the Eastern Anatolia Region, Malatya is located on an area that is mostly covered with mountains (Göğebakan, 2002; Demirbağ, 2013) (Figure 1, Figure 2).

Figure 1. Location and districts of Malatya (Prepared using Malatya Provincial Directorate of Culture and Tourism, 2021)

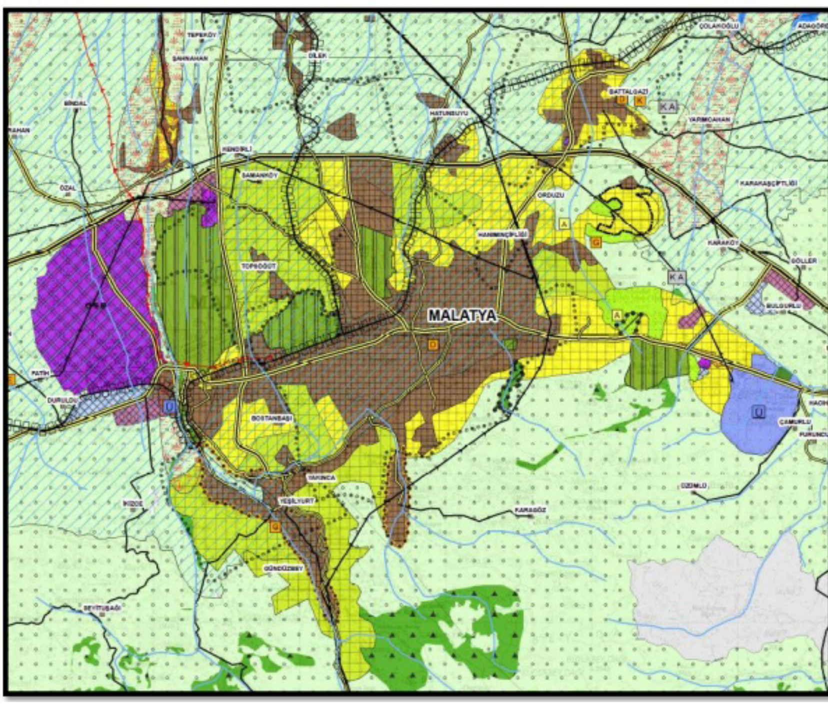


Figure 2. Malatya urban area (Plan Disclosure Report, 2018)

Malatya is located in the Euphrates Basin, the largest water basin in Turkey. However, many water sources coming out of the Beydağı mountains surrounding the settlement make Malatya a rich area in this context (Demirbağ, 2013). The water resources in question have a great impact on the shaping of the city.

Malatya, which is known to have been used as a settlement since the Neolithic Age, has hosted various civilizations in the historical process and in this sense, it has continued to develop under the influence of many cultures (Ağaldağ, 2016). It has been stated that Malatya, which is mentioned as a wetland in various historical sources, had many streams, fountains and public fountains in the past (Çelebi, 2010).

Malatya, which has a unique architectural identity with the effect of its geographical location and historical process, has many historical textures, traditional buildings and public spaces from the past to the present. One of them is the public spaces around Kernek water, which is a natural source, and the square within them.

Kernek Square is an important attraction center due to its location at a central point of the city and its connection with a natural water source. The protection and sustainability of the square and its immediate surroundings, which have been evaluated and organized in different ways from past to present, are important for Malatya's identity and values.

3.1 Historical Formation Process of Kernek Square

Kernek is one of the important focal points in Malatya city center. Kernek Waterfall, which is a natural spring, the immediate surroundings of the waterfall and Kernek Square organized in connection with this spring; it covers an area that also hosts many rituals and stands out with its deep-rooted past.

Kernek Waterfall, located between Kanalboyu Street and Şehit Hamit Fendoğlu Street, which is described as the center of Malatya, and Kernek Square, located to the north of this waterfall; has come to the fore with different uses in the process that has reached the present day (Figure 3, Figure 4). It is known that before the 1950s, when urbanization did not become widespread, the water flow from the source was divided into two and a peninsula-shaped area was formed in between. It is among the information in the relevant sources that it is believed that there is a holy tomb in the area in question and that it was visited by the local people until the 1940s (Arslan, 2013).

Figure 3. The location of Kernek Square (Prepared using Google Earth, 2021)

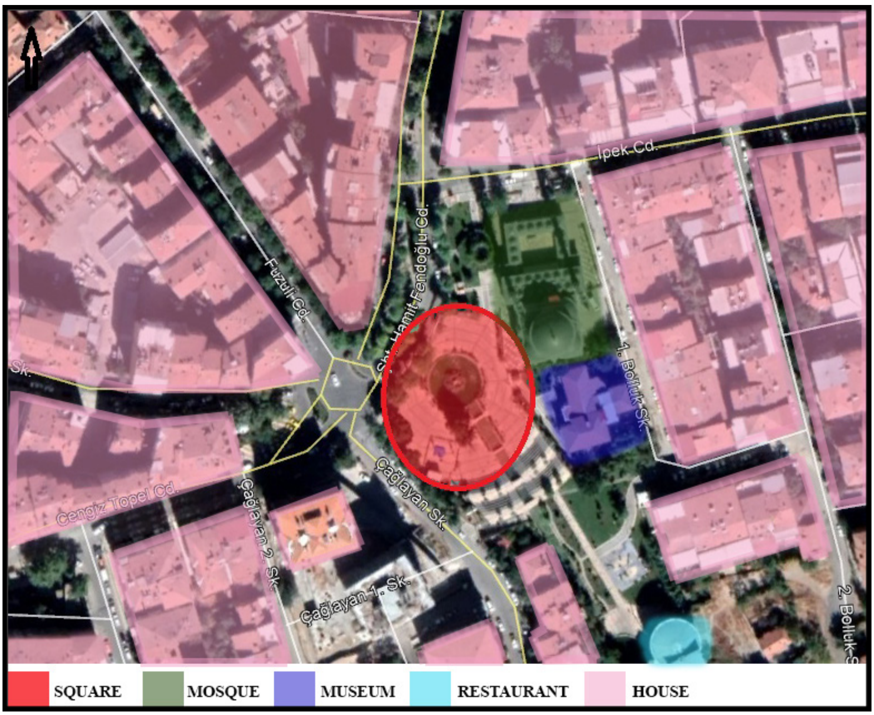


Figure 4. Close vicinity of Kernek Square (Prepared using Google Earth, 2021)

There is no source confirming the holy tomb located at the point where Kernek Waterfall splits into two. However, it is known that it has an important place in the culture of the region for many years. There are also those who do not believe that there is a holy tomb at this point before the 1950s and only use the area for reasons such as resting, having fun and cleaning (Arslan, 2013).

The tradition of praying and making wishes by visiting the holy tomb in Kernek has continued with various activities until recently (Figure 5). The tomb was replaced by a tree believed to represent the sanctuary. However, after the 1950s, when urbanization accelerated, entertainment culture became more prominent in this area (Arslan, 2013). For this reason, Kernek Square, which is close to the waterfall, has been transformed many times and has been made available to the public with new arrangements.

(a)

(b)

(c)

Figure 5. People gathered in Kernek to make wishes and celebrate (a), candles lit for wishes (b) and wish figures hung on a tree believed to be in the place of the holy tomb (c), 2007 (Arslan, 2013)

Kernek Square and its surroundings have become an area where entertainment culture is seen more with the construction of the casino. Before the casino was built, activities such as picnics and rest were common around the waterfall;

along with the casino, musical entertainment has also taken its place in the identity of the area (Figure 6). In this context, Kernek Lake Casino served as one of the two modern entertainment centers of the city, especially between the years 1970-1990 (Arslan, 2013) (Figure 7).

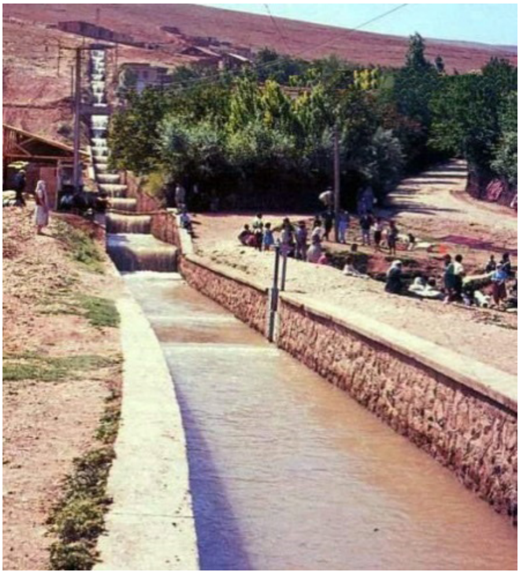
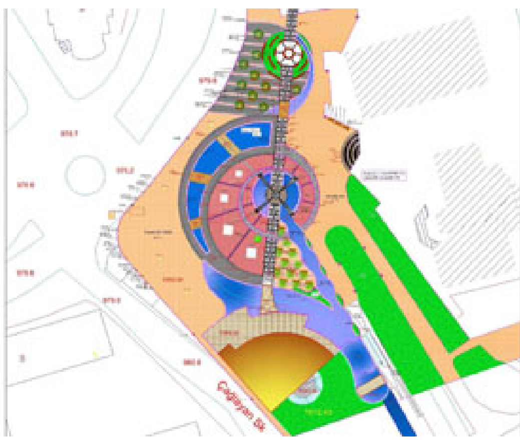


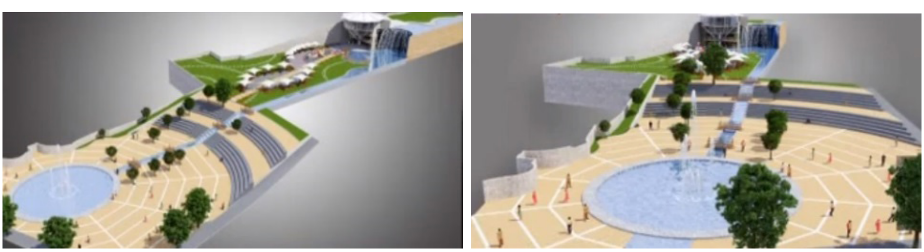
Figure 6. Views from around the waterfall before the casino was built in Kernek, 1940s (Kernek, 2020)

Figure 7. The lake and casino around Kernek Square, 1990s (Kernek, 2020)

Kernek Square and its immediate surroundings, where rituals for faith take place and entertainment culture are reflected in the space, have also been the subject of folk songs and tales identified with Malatya. In this sense, it has an important place in the folklore and art of the city. However, in the area that has undergone radical transformations in the process that has reached the present, the rituals and entertainment culture of the past have been largely abandoned. Kernek has taken on a different identity with the new landscaping made in the vicinity of the square and waterfall, which is mostly used as a resting area. First of all, with the works started in 2012, the surroundings of the waterfall were rearranged and it was envisaged that the square would be handled in connection with the water reaching from the waterfall (Figure 8, Figure 9). However, with the differences in practice, the field continued to undergo transformation. The prepared project was implemented by changing it to a large extent. Changes continued throughout the process. This situation has moved the implementation to a different point than planned. In this context, the windmill-shaped structure, which was placed in the square and used as a cafe, was later removed (Figure 10).



(a)



(b)

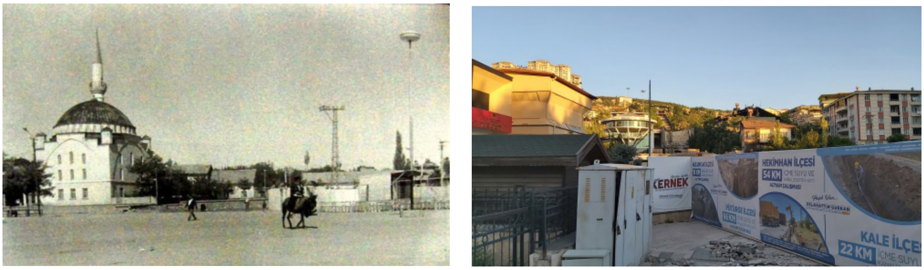
Figure 8. Situation plan (a) and digital images (b) of Kernek Square, the waterfall and its surroundings, which are planned to be implemented in 2012 (Malatya Current, 2012; Malatya Tv, 2012)

Figure 9. General view of Kernek after the regulations in 2012 (Cici, 2020)

Figure 10. The windmill structure placed in Kernek Square,
functioned as a cafe and later removed (Malatya White, 2018; Hazar, 2018)

Kernek Square, after its transformations throughout the historical process and new landscaping; it was brought to the agenda again in 2021, and in this context, studies were resumed in order to restore the area to its original state (Figure 11). In addition, the mosque connected to the square was demolished during the process and a new mosque with a higher capacity was built (Figure 12). Today, the implementation work for the renewal of the square continues.

(a)



(b)

Figure 11. Digital images of the landscaping planned to be completed in 2021 in Kernek Square (a) and images from the implementation works (b) (Malatya News, 2021; personal archive, 2021)

(a) (b)

Figure 12. The old (a) (1970) and new (b) (2021) mosques next to Kernek Square (Malatya Journalists Association, 2020; personal archive, 2021)

3.2 The Importance of Kernek Square for the City of Malatya in the Context of Conservation and Cultural Sustainability

Cities are shaped and gaining identity by means of transportation axes and gathering areas as well as structures. Squares, which are at the forefront of these areas, play an important role in the formation of many Anatolian cities and their processes that have reached the present day. In this context, Kernek Square, which has unique characteristics by integrating with Kernek Waterfall, which is a natural resource in Malatya, stands out in terms of conserving and sustainability of the architectural qualities of the city.

Kernek Waterfall and its immediate surroundings, which consisted of only a natural water source and ritual/resting areas around it in the past, have taken on a different use today with a square and worship structure reached by the waterfall. In the historical process, Kernek Square, which has hosted various religious activities specific to the region, has also come together with places such as casinos and restaurants that reflect the entertainment culture of the city. In this context, the square;

- Natural factors,
- Rituals of faith,
- Entertainment and relaxation activities
- With its many features such as being a reference point in the city, it is of great importance in terms of reflecting the urban development process and cultural characteristics of Malatya.

It can be stated that Kernek Square is worth conserving with its culturally versatile qualities. As an important part of identity, culture develops uniquely for each settlement and is transmitted from generation to generation. In this sense, many cultural features such as belief culture, entertainment culture, recreation and daily life culture are concentrated in Kernek Square, which has strategic importance as it is in the city center of Malatya. This situation is not only due to the gathering function of the square; it is important in terms of making it unique with many different functions.

Kernek Square has become a prominent value with its touristic nature. This area, which is the subject of folk songs and various narratives, is identified with Malatya and has become an important point for the visitors of the city. In this sense, it is of great importance in terms of promoting Malatya, its development and transferring it to future generations.

Kernek Square has gained different features in the process with the recent radical changes and the landscaping that continues today. However, the rapid and unplanned development of the city, the returns of factors such as rent and population growth have also been effective in Kernek Square and its immediate surroundings. Many negativities such as large-sized structures built around the square and incompatible with the general characteristics of the texture, heavy traffic and insufficient parking areas, infrastructure problems; reflecting the urban development process of Malatya intensely, Kernek Square has caused a great change in its original qualities. This is remarkable in the context of the importance of the square for the city.

4. Conclusion

Space characterizes a dynamic concept that is shaped by many factors. One of these factors is culture. It is possible to state that each place emerges by being greatly influenced by the culture it is in. In this context, the relationship between culture and space is an important value that should be considered in terms of architectural preservation and sustainability.

The relationship between culture and space in Anatolia comes to the fore not only in the structural scale but also in the formation of public spaces. In this context, Malatya is worth examining in terms of the relationship between Kernek Square and Kernek Waterfall, which is connected to this area, with the local culture. Kernek Square, which has served different cultural activities such as faith, rest and entertainment in the historical process, has lost many of its original qualities, especially with the great changes it has experienced in the recent past. Today, it is of great importance that the square, which is on the agenda with the new arrangement works, is meticulously evaluated in terms of the conservation and sustainability of the city's culture and that the applications are made accordingly. In this context;

- The history of the square should be revealed in cultural detail. According to the resulting table, the arrangement of both the square and its immediate surroundings can be reconsidered.
- In order to solve the traffic problem of the roads reaching the square, decisions can be taken with the relevant experts at the planning scale. Axles deemed necessary can be closed to vehicle traffic and serve only pedestrians.
- By examining the original situation of Kernek Waterfall, which is a natural resource, projects can be developed to provide these qualities today.
- Efforts can be made to revive the religious rituals/entertainment activities in the square.
- In order to conserve the cultural characteristics of the square, the city should be examined and improved in terms of the culture-space relationship in general. For this reason, it may be beneficial to consider the general cultural situation and change in the city in the decisions to be made for Kernek Square in order to make long-term arrangements.

As a result, it is thought that the study emphasizes the culture-space relationship in Kernek Square and draws attention to the necessity of evaluating conservation within the framework of this relationship.

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CHAPTER II

SUSTAINABLE DISASTER MANAGEMENT AND URBAN TRANSFORMATION: THE CASE OF ELAZIG KARSIYAKA

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1. Introduction

Disasters are natural or man-made events that abruptly interrupt people's daily lives. There is almost no country in the world that is not affected by disasters. The effects of disasters vary depending on the source, the country and its socio-cultural structure and the measures taken to deal with them (Macit, 2018:24). Disasters are either born out of natural causes such as earthquakes, tsunamis, floods, volcanic eruptions, droughts and desertification, or caused by humanbeings, such as fires, nuclear power plant explosions, wars, dam failures, chemical accidents, and mass population movements (Akdur, 2000:1; Sena and Michael, 2016:8; The European Commission's Science and Knowledge Service, 2018; Sarıçam, 2019:3).

Turkey is affected most by earthquakes among other natural disasters due to its geographical location. Existing active fault lines in Turkey are capable of affecting almost the entire country, therefore there is urgent need for pre-disaster planning studies to be undertaken. Earthquakes are considered as inevitable and sudden natural disasters that cannot be prevented: however, with necessary precautions and planning before the earthquake, the potential effects of the earthquake can be reduced. If necessary precautions are taken '*before the earthquake*', '*during the earthquake*' and '*after the earthquake*', the earthquake can be survived with least or no damage in economic, social and physical terms. It is observed that developed countries have better precautions and better planning compared to less developed countries and faster recovery without any major disruptions in the economy or daily lives of people. 'Disaster education' and 'disaster management' also play an important role in minimizing losses and damages. In order for a country to survive an earthquake with the least damage possible, it is crucial to keep the level of awareness of the entire population high in terms of earthquake.

Urban transformation which is an important policy tool for spatial organization and renewal of cities, is also considered an important tool for post-disaster planning studies. Urban transformation is an intervention that aims to solve the economic, physical, social and environmental problems of urban regions that have changed due to unplanned, distorted and unhealthy housing conditions caused by excessive population density (Çiftçi, 2018: 2). Cities are dynamic structures that are in constant change and transformation and urban transformation is a strong tool for restructuring the city. The city is a whole, and the transformation of a part of it should not be considered in isolation. The integrity of the city should be supported by social and environmental sustainability. Considering cities just as physical formations neglecting social and environmental aspects lead to unexpected outcomes. Therefore, urban space should not be seen only as a physical category, but its social, political, economic and cultural dimensions should also be considered (Çiftçi, 2018:16). Urban renewal can be an opportunity for the city to achieve healthy urbanization, yet it should be designed as a planning process which respects the identity elements of the city. Large scale urban redevelopment projects often ignore such given elements and bring out, a different identity. In such cases what is experienced is metamorphosis rather than transformation (Sezik, 2018:601).

Urban settlements can continue to live and acquire sustainable qualities as long as they are used correctly (Olğun, 2021:540). In this context, the study aims to provide information about post-disaster urban transformation practices and inquires how urban sustainability aspect is addressed in the reconstruction process. The study builds on literature review on urban transformation practices and a field study that examines 'Elazığ-Karşıyaka Urban Transformation Project' which had been prepared before Elazığ earthquake on January 24, 2020 and was launched just after the earthquake. Interviews were also undertaken with households and local government in the scope of the field study.

2. Disaster and Disaster Management

The term 'disaster' has various definitions in various sources depending on different perspectives and purposes. Disasters are events that have the potential to destroy normal life together with natural and physical structures (McDonald, 2003; Mızrak, 2018:57). In this regard, destructive events that negatively affect human life due to nature and technology, is called *disaster*. For a natural event to be defined as a disaster, there needs to be death and injury as well as a considerable material loss (Sahin and Üçgül, 2019:44). According to the most general definition accepted by United Nations, a disaster is a *'natural, technological or man-made event that causes physical, economic and social losses and affects society by stopping/disrupting daily life and human activities'* (Kadıoğlu, 2008; Güler, 2018:237).

The magnitude of a disaster is determined by the loss of human life and property, injuries, structural damage, and social and economic losses (Ergünay 2009; Güler, 2018:237). Factors that influence the magnitude of a disaster include;

- The physical size of the event,
- The distance from inhabited settlements,
- The wealth level of the region,
- Population growth rate,
- Uncontrolled urbanization in risk areas,
- Uncontrolled industrialization,
- Degradation or abuse of forest areas and the natural environment,
- Lack of education,
- Level of protection and prevention measures against disasters (Erkal and Değerliyurt 2009; Güler, 2018:237).

In disaster management, '*disaster prevention and mitigation'* '*before, during and after a disaster event'* is a process that needs to be planned, managed and coordinated. This process is a multidisciplinary, comprehensive, multi-actor, dynamic and complex *process* that requires the alignment of all institutional/organizational resources of society towards this common goal (AFAD, 2014:33; Tercan, 2018:103; Şahin and Üçgül, 2019:50-51). Disaster management defines measures for events such as earthquakes, floods, droughts, volcanic eruptions that develop suddenly and have potential to disrupt social and economic lives of people, including;

- Preparation
- Mitigation,
- Prevention, levels of *risk management*,
- Emergency services
- Recovery
- Reconstruction,

All these stages aiming to reduce damage after the disaster, loss of life and accelerate recovery to normal life is called *crisis management* (Kadıoğlu, 2008; Güler, 2008; Limoncu and Atmaca, 2018:135-136) (Figure 1).

Figure 1. Disaster Management (Özkul, 2007; Limoncu and Atmaca, 2018:136).

The goal of *disaster management* is to minimize the risks of loss of life and property from the disaster and to rescue those who are most exposed to the disaster. This also includes restoring social life to normal as soon as possible by protecting the natural environment and cultural and natural assets (Şahin and Üçgül, 2019:51).

In the pre-disaster *risk management phase,* measures are taken against the consequences of possible disasters in order to minimize the damage. In this sense, *'the most important point is what can be done before an earthquake is always more important than what can be done after an earthquake'* (İlhan, 2019:148). This phase is about being able to intervene in time and with the most appropriate and effective organization (Kadıoğlu, 2008; Güler, 2018:239). Risk management consists of the phases of preparation, mitigation and prevention. In this framework:

- *The preparation phase*, is the phase in which the necessary measures are taken to identify the deficiencies that occur during and after the disaster and to be prepared for the hazards that may occur.
- *The mitigation phase,* is the phase in which public institutions and non-governmental organizations work with people. This section identifies the actions that need to be taken to manage the negative impacts of potential disasters throughout the state and the country.
- *The prevention phase*, seeks to prevent possible disasters and secondary hazards that may occur at the time of the disaster through the precautions taken before the disaster (Berg, 2014:282-283; Limoncu and Atmaca, 2018:136).

The post-disaster phase which is *crisis management,* is the phase in which the activities to be carried out during and after the disaster are implemented in the fastest and most effective way within the available resources and capabilities. This phase includes search and rescue activities in the settlements affected by the disaster as well as activities to normalize social life (Ergünay, 1998; Şahin and Üçgül, 2019:54).

- In the *emergency phase,* search and rescue and debris removal activities are carried out immediately after the disaster. This phase also provides emergency shelter for people whose houses have been damaged (Berg, 2014:282-283; Limoncu and Atmaca, 2018:136).
- *The reconstruction phase*, is the process of moving from emergency shelters to permanent residences with the support of reconstruction teams (Limoncu, 2005; Limoncu and Atmaca, 2018:136).
- *During reconstruction*, the damage caused by the disaster is repaired and life begins to return to normal. People whose houses are damaged are resettled in permanent residences (Limoncu and Atmaca, 2018:136).

In this context, the goal of crisis management includes the basic needs of the disaster-affected regions (communication, transportation, electricity, sewerage, education, construction of permanent residences) and the necessary studies so that economic and social life can return to normal (Ergünay, 1996; Şahin and Üçgül, 2019:54).

2.1. Earthquake Risk in Turkey and the Elazığ Earthquake

Earthquake is the shaking of the medium/earth surface where the waves occur as a result of the sudden displacement due to the fracture along the fault plane in the earth's crust (Erkoç, et al, 2000; Şahin and Üçgül, 2019: 46). Turkey is located on the Alpine-Himalaya (Alpid) earthquake belt, which is one of the most active earthquake zones in the world in general (Özey, 2006:27; Orhan, 2019:340). There are three main fault lines in Turkey, namely North Anatolian, East Anatolian and West Anatolian fault lines. Country›s 42% of the surface area is in the first degree earthquake zone (Uslu and Uzun, 2014:1). This creates different rates of earthquake risks all over the country (Atalay, 1997:23; Doğanay and Doğanay, 2014:39-40; Orhan, 2019:340).

International organizations that conduct research on disasters state that 85% of the populations of developing countries are experiencing the effects of natural disaster risks, especially earthquakes and floods (Kuterdem, 2011; Tanrıverdi Kaya vd., 2018:593). Turkey frequently encounters disasters with great loss of life and property due to its geological and topographical features (Limoncu and Bayülgen, 2005:18; Yanılmaz et al, 2019:1115). In this context, many of our cities carry natural risk threats such as earthquakes, floods and landslides. It is reported that 55% of the damages caused by natural disasters in the last 60 years are caused by earthquakes, 21% by landslides and 8% by floods (Istanbul Governorship, 2014; Tanrıverdi Kaya et al., 2018:593). According to the data of the Earthquake Research Institute, 51 earthquakes with a magnitude of 6.0 and above have occurred in Turkey in the last 70 years. Many of these have caused economic and social damage to the country (Limoncu and Atmaca, 2018:135). Elazığ earthquake that occurred a short time ago is one of them.

The Elazığ earthquake, which occurred at 20:55 on local time on January 24, 2020 in Turkey's Elazığ province, affected the entire Eastern Anatolia region, especially Elazığ and Malatya. The earthquake, the epicenter of which was the Çevrimtaş village of the Sivrice district of Elazığ, lasted for about 22 seconds and caused many damages. The earthquake occurred at the boundary between the Anatolian and Eurasian plates on the Eastern Anatolian Fault Line. The Elazığ earthquake was felt in many cities such as Adıyaman, Adana, Batman, Bingöl, Çorum, Diyarbakır, Gaziantep, Hatay, Kahramanmaraş, Malatya, Mardin, Osmaniye, Samsun, Sivas, Siirt, Şanlıurfa, Şırnak, Tokat and Tunceli. It was also felt in many countries such as Iraq, Iran, Israel, Lebanon and Syria (URL-1).

During the 6 months after the earthquake, around 4650 aftershocks occurred with magnitudes ranging from 0.8 to 5.1. It was stated that 50 buildings were destroyed in Elazığ, 308 buildings were severely damaged and 150 buildings were moderately damaged (Figure 2). In Malatya, it was stated that 155 buildings were destroyed and 1278 buildings were severely damaged. It was stated that 8 buildings were destroyed by the same earthquake in Diyarbakır and 16 buildings were severely damaged (URL-2).

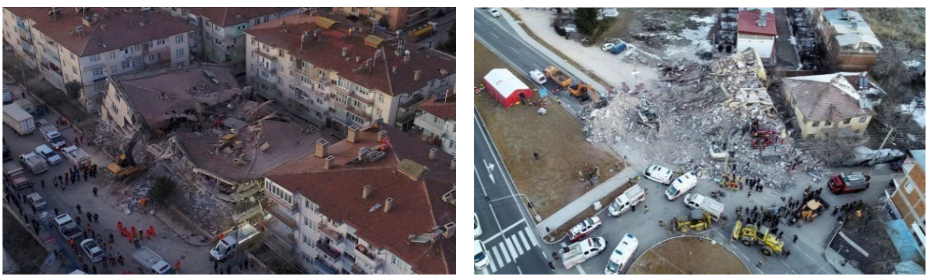

Figure 2. Debris areas after Elazığ Earthquake (URL-3).

Karşıyaka settlement, which is the subject of the study, had been declared as urban transformation area before the Elazığ earthquake, however, it had not been evacuated before the 24th of January, when the earthquake took place. Due to the heavy damage of the settlement after the earthquake, the implementation of the transformation project was accelerated.

3. Post Disaster Spatial Solution Pratices in Turkey: Urban Transformation Projects

Urban transformation is one of the recovery tools used after the disaster. Urban transformation appears in different sources with different definitions according to different perspectives and purposes. According to the Turkish Language Association, the word transformation is defined as *taking another form, taking another state, changing shape*. Urban transformation is defined as *demolishing* *unlicensed buildings that do not comply with the city's zoning plan and creating mass settlement areas in accordance with the plans* (URL-4; Ertaş and Bayındır, 2019:2).

Urban transformation practices are the reintroduction of slumped, run-down and low standard of living areas to the city. It has also become a method used to improve the economic, physical and environmental conditions of these areas (Çiftçi, 2018:15). The definition of urban transformation was handled in Turkey with its differences as following;

- Projects that create all kinds of social reinforcement areas such as residential areas, industrial areas, commercial areas,
- Projects that rebuild the old parts of the city and preserve the historical and cultural texture of the city,
- Projects that include not only transformation but also development projects (Ünal, 2018:20),
- The implementation of the urban transformation projects (Uslu and Uzun, 2014:2) used for reconstruction after the disaster.

The most important factor that made urban transformation compulsory in the country was earthquakes (Uslu and Uzun, 2014:2). Damage assessment studies are carried out after the disaster, the heavily damaged areas are demolished and urban transformation practices are initiated.

The first application of urban transformation in the world was implemented after the productivity of workers living in unsuitable conditions in industrial cities decreased and factory owners suffered losses. The factory owners had settlement areas built near the factory in order to get more benefits from the workforce. Industrial development is the reason of not to have healthy social development. It triggered the unplanning urban development and caused many other problems in the cities (Ergen and Ergen, 2018). However, due to the high costs of construction and maintenance, these areas have become neglected and abandoned. In order to regain these areas, the state had to realize high-cost projects such as new infrastructure and housing, as well as rehabilitation and urban transportation network (Tekeli, 2010: 30; Ünal, 2018: 22). Due to the Great Depression in the world in 1929, housing construction increased along with the economy and unemployment in industrialized countries. Investments in housing construction brought along transportation and infrastructure investments. These developments have been decisive in urban transformation and the crisis has been tried to be surmounted (Tekeli, 2010:43-45; Ünal, 2018:22-23).

Following the Second World War, a planned urban transformation policy approach was adopted and social housing programs were emphasized. In the 1950's, redevelopment programs were emphasized by the emergence of capitalist industry. Transformations were implemented with the aim of protecting historical areas and cities in 1960 and improving the tourism sector and urban empty spaces in 1970 (Üstün, 2009:11; Aktaş Polat, 2015:189). The private sector took over while the transformation projects were being implemented in the 1980's. Public lands were sold to the private sector during the same years, and investors were requested to produce housing (to a small extent) for the lower income group. During this period, empty buildings were demolished and new buildings were started to be built. This period in history is known as *urban renewal by demolition period* (Üstün, 2009:27; Ünal, 2018:23). It is possible to divide the development of urban transformation in the world into four periods to considering a periodic basis such as:

1. Reconstruction of cities and the period of industrialization,
2. The period of reconstruction of cities and decentralization of industry after the Second World War,
3. The period of physical interventions,
4. Finally the urban renewal period (Demirkıran, 2008:12-13; Kayan, 2019:761-762).

The urban transformation process in Turkey started with economic growth and migration exceeding expectations from the village to the city between the years 1950-1980. In this period, the opening of new factories in cities triggered migration. Thus, slum areas were formed in the immediate vicinity of the city, but on empty lands near the factories. In this period, urban transformation was carried out in the form of apartment building according to different population groups by restructuring the slums around the city (Ataöv and Osmay, 2007; Ertaş and Bayındır, 2019:3). Urban transformation applications have been carried out under different names since the end of 1990. The definition of urban transformation is also usable for our country according to the lessons and experiences learned as a result of these applications (Ertaş and Bayındır, 2019:3). After the 2000's, in parallel with the local government reforms, urban transformation has been frequently discussed in the legal and institutional restructuring processes. Especially the 1999 Marmara earthquake drew attention to the importance of transformation. Participatory approach and participation tools, which were previously implemented with local initiatives, have also started to be discussed in the urban planning agenda.

Figure 3.Major Earthquakes in Turkey (URL-5).

The frequent use of the concept of urban transformation, which is an effective tool after a disaster in our country, emerged after the 1999 Marmara earthquake (Uslu and Uzun, 2014:10). Many major earthquakes have occurred in Turkey (Figure 3). These earthquakes caused great losses and damages. Due to the damages in the provinces such as İzmit, Kocaeli, Yalova, Gölcük, Zonguldak, Düzce, Van, Erzincan, Elazığ, urban transformation projects were implemented after the disasters and the cities were tried to be restored. *Transformation projects, which are important urban renewal projects* apart from earthquakes, are carried out with many practices such as socio-economic rehabilitation, revitalization for tourism purposes, transformation of slum areas into qualified housing areas (Polat and Dostoğlu, 2007; Ataöv and Osmay, 2007; Yıldız et al, 2015:497). In large projects that change and transform the entire city, such as urban transformation, it is important to include users as well as NGO's, local governments, technical participants in the planning-implementation sector. In this context, the main objectives of the urban transformation projects to be realized is:

- The gain obtained with urban transformation should not limited to density increase or renewal,
- Considering the social, environmental, cultural and spatial sustainability of the transformation projects aiming the construction and revitalization of the post-disaster region during the reconstruction of the collapsed areas that endanger the social and physical areas,
- The region undergoing transformation should be a part of the city, feeding the city and providing added value, since the city should be considered as a whole,
- Transformation practices that take into account the needs of urban users and aim to offer them a better quality of life should be accepted *as the new dynamics of the city*.

In this sense, it is important to integrate the newly built urban areas with the urban transformation into the whole city through services such as healthy transportation and infrastructure. Healthier practices that add value to environmental and social sustainability are expected in urban transformation practices. Considering the demands of city users who will benefit from transformation practices and ensuring their active participation in the process is the basic need for healthier cities.

4. Material and Method - Elazığ Karşıyaka Urban Transformation Example

Elazığ province is located in the southwest of the Eastern Anatolia Region, in the Upper Euphrates section. Elazığ province, thought to have been founded in 3000 BC, is the continuation of the city Harput on the plain. Therefore, it was called Harput for years. Elazığ has a historical value as it is home to many civilizations. Elazığ province is a city on the Eastern Anatolian fault line and located in the second degree earthquake zone (URL-6).

Many residential areas of the city of Elazığ were affected by the earthquake that took place on January 24. Urban transformation decisions were taken in many places such as Sürsürü, Mustafa Paşa, Abdullahpaşa and Karşıyaka with the damage assessments after the earthquake. Before the January 24 Elazığ earthquake, the buildings in the Karşıyaka settlement area, whose urban transformation was decided and designed, were not yet evacuated during the earthquake.

Karşıyaka Urban Transformation Project gained momentum and its construction was started due to the areas determined as heavily damaged after the investigations made following the Elazığ earthquake. In this sense, the study examines the area, which was designed before the earthquake in Karşıyaka neighborhood and whose transformation was initiated faster due to the damages received after the earthquake. (Figure 4).

Figure 4. Satellite image of Karşıyaka Urban Transformation Area (prepared by using Google Earth).

The industrialization movement in the 1960s caused population growth and unplanned urban development in Elazig. Thus, the city grew along the railroad track and, from the 1960s, expanded unplanned to the city's periphery. This growth has started to accommodate new population groups in the city edges like Karşıyaka (Ardıçoğlu, 2019). Karşıyaka Urban Transformation project is a project implemented in the Karşıyaka district of the Central district of Elazığ, in cooperation with the Municipality of Elazığ and the Mass Housing Administration. Demolition works of 331 residences were carried out in Karşıyaka neighborhood, and new residences and workplaces were built on an area of 6 hectares. In the project, which consists of 24 blocks, 468 residences and 31 workplaces were built (URL 7) (Figure 5). 402 of the 468 residences are planned as 2+1 and 66 of them are planned as 3+1 residences. 2+1 residences are 77 m^2, 3+1 residences are 119 m^2.

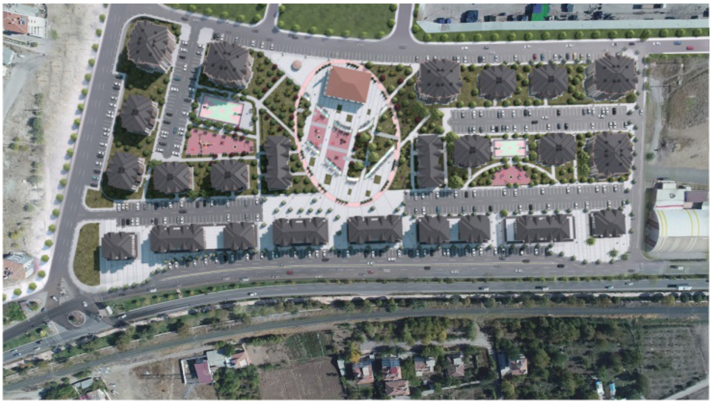

Figure 5. Karşıyaka Urban Transformation Project Layout Plan (URL-7).

This transformation project is designed not only for the renewal of the old residential areas, but also for the revitalization of the collapsed area that threatens the physical and social areas of the city. It is known that the transformation project planned before the earthquake was made for this purpose. It was aimed to increase the urban welfare and quality of life with the transformation application. Preventing the city to spread onto an unnecessarily large area, development of low and middle income city dwellers' housing strategies that are defined as *urban transformation goals* (Kayan, 2019:777-778) were also targeted for this project.

(a) (b) (c)

Figure 6. Karşıyaka Urban Transformation Project Construction Phases (URL-7).

While Elazığ Karşıyaka Urban Transformation Project was being carried out, it was put forward with a three-step management approach used in urban transformation studies. These steps are:

- *At the stage of Urban Renewal, which is the first step,* the old understanding that urban transformation is perceived as the transformation of individual parcels or buildings has been abandoned. Instead, it was tried to be developed as plans that take into account the island, streets and neighborhoods at the upper scale of the parcel (Figure 6-a).
- *At the stage of Urban Rehabilitation, which is the second step,* studies were conducted in which idle areas were effectively evaluated at the neighborhood scale, and infrastructure, transportation and cleaning services were considered together (Figure 6-b).

Figure 7. Karşıyaka Urban Transformation Project 3D Images (URL-7).

- *In the Urban Revitalization phase, which is the third step,* it was aimed to bring social, cultural and economic vitality to the region where the works were carried out with the projects of urban renewal and urban rehabilitation. It has been tried to benefit the citizens living in the region from the economic and social gains that are created fairly (Figure 6-c) (URL-7).

Figure 8. Karşıyaka Urban Transformation
Project Completed Housing Images (URL-7).

The fact that the social dimension generally stays in the background in urban transformation projects causes incompatibility between the spatial structure and the social structure causing the transformation to become unadopted. In this project, a similar process was left incomplete since it was a project that needed to be implemented quickly after the earthquake. However, for the transformation projects to be successful, the envisaged spatial and economic change must be integrated with the sustainability of the social fabric (Korkmaz et al, 2019:37). In this context, urban transformation applications, which are actually ideal, should be carried out for the following five main purposes:

- Establishing a direct relationship between the physical structure of the city and its social problems and developing these projects in a way that basically prevents social deterioration (Görün and Kara, 2010:153; Kayan, 2019:762),
- Transformation projects should aim to protect the rapidly growing, changing and deteriorating texture of the city and should meet the need for change that develops according to new economic, social, physical, environmental and infrastructural needs (Şişman and Kibaroğlu, 2009:9; Kayan, 2019:762-763),
- Transformation practices should be aimed at revitalizing the depressed areas of cities (which threaten physical and social areas), developing strategies that will bring economic mobility, increasing urban welfare and quality of life (Şişman and Kibaroğlu, 2009:2; Kayan, 2019:763),
- Developing projects that will reveal strategies for the effective use of urban areas and avoiding unnecessary urban expansion with urban transformation (Gümüşboğa, 2009:3; Kayan, 2019:763),
- Urban transformation, as a product of social structure and policy actors, has to meet the need to shape urban policies and should be carried out with a multi-participant planning/design process (Yaman, 2014:14; Kayan, 2019:763).

It has been designed and tried to be implemented in order to serve the aforementioned purposes in the urban transformation projects carried out after the Elazığ earthquake. It can be said that the project serves the purpose of urban transformation, since it is aimed to revitalize the heavily damaged areas and to increase the quality of life (URL-7) (Figure 7, Figure 8). The urban transformation project implemented in the Karşıyaka residential area of Elazığ has served to create more livable and sustainable spaces that are compatible with today's needs, safe against earthquakes.

5. Conclusion and Evaluation

Intense and uncontrolled urbanization is one of the problems that a significant part of today's world geography frequently encounters. In this context, urban transformation is the process of ameliorating the economic, physical, social and environmental deteriorations in the city by protecting the interests of urban dwellers and developing a solution to the urbanization problem, whose boundaries are narrowing day by day and human risks are diversifying. Especially in countries like Turkey where the rate of urbanization is high and its control is problematic, urban transformation practices are an important opportunity for the city user to have a healthier and higher quality living environment. In this context, these applications which should be seen as *an urban renewal*, are the planning/implementation processes that support the social, cultural and economic development of the city users, while ensuring the improvement and development of the cities.

Karşıyaka district, where the urban transformation project is implemented, has an important symbolic value as it is located at the entrance point of the city of Elazığ. In this sense, the success of the application directly affects the silhouette of the city. In the Karşıyaka Urban Transformation Project, which was examined within the scope of the study, many differences are striking between the old version and the state after the transformation. In the light of the results of the interviews with the users and the data:

- A healthier physical environment is provided to city users through the new houses built,
- The old houses in Karşıyaka neighborhood and the region without any social reinforcement area was built with sufficient social and recreational equipment areas after the transformation,
- Contribution to the social and spatial sustainability of the region was provided with the urban transformation,
- The new settlement area realized with the transformation has achieved a safer, healthier and planned physical environment design,
- The cultural, social and transportation opportunities of the users in the settlement area are increased and visible improvements in the living standards are provided,
- In the implemented urban transformation project (albeit in small numbers), it has been determined that some of the residents are not satisfied with the flats that they own, since specified flats are below their expectations (m^2/ number of residences). However, it is an important gain for users to be able to accommodate safely in their new buildings built after the earthquake,

- After the urban transformation, the majority of the users are satisfied with the new housing, living environments and the recreational green spaces provided,
- It was stated that all the needs of the residents, that had problems such as lighting and natural gas before the transformation, were met without any problems after the new planning.

The settlement area, which was reorganized with the implemented urban transformation, supported the formation of a safer environment in the post-earthquake life. It is seen that the consciousness and awareness of all Elazığ residents (in the process experienced with the ongoing aftershocks) about the safety of buildings increased after the earthquake. The implemented urban transformation project has focused on both the renewal of the buildings and the reconstruction of a safer and livable living environment considering the effect of the earthquake, supporting the sense of belonging as well as urbanization. The urban transformation project that was accelerated after the earthquake in Elazığ, not only physically renovated the old buildings but also strengthened the social and cultural relations of the inhabitants.

It should be noted that Karşıyaka Urban Transformation Project started before the earthquake, that the transformation project was implemented quickly after the disaster and that the ideas of the people of the region were not included in the process. Based on the sample analyzed within the scope of the study, it should be noted that more participatory processes are needed in urban transformation applications. Nevertheless, it can be said that expectations are met according to the positive feedbacks for the process that took place without disturbing the social structure of the households living in the transformed region.

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CHAPTER III

CRACK DETECTION WITH DIGITAL IMAGE PROCESSING

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1. Introduction

A large part of our daily lives is spent in buildings. These structures, which serve a variety of purposes, are designed to ensure that the people they house can continue their lives in a healthy and comfortable manner and that suitable environments are created for the activities they perform (URL-1). Although the goal in building design is to create comfortable spaces, the opposite results may appear due to some environmental conditions and situations that are ignored during the design/construction phases of the building (Güler et al., 2010). Factors that affect user comfort and/or damage the structure are referred to as building physical problems. In some cases, these problems deprive users of living a healthy life and meeting their needs.

It is known that much of the energy and money consumed in the world is used to build and repair structures that are used for various purposes (Santamouris, 2001). Therefore, the structural problems that occur in the buildings not only increase the energy that must be spent to meet the comfort conditions, but also create problems for the users and the economy of the country with the maintenance and repairs that must be done constantly. From this point of view, every step that is taken to prevent or eliminate the problems related to building physics is very important. If these problems cannot be eliminated, they will affect the health and life of the building and threaten our sustainable future.

Building physics problems are often attempted to be seen with the naked eye. However, this has subjective consequences. In this case, when the building physics problem is not defined correctly, it causes an increase in repair costs and time loss. Destructive methods used to diagnose the problem can damage the building surfaces to which they are applied and/or parts of the building that require repair. If not applied correctly, destructive testing can also cause serious damage to the building structure (Ergün & Kürklü, 2005). With the developing technology, X-ray examination, ultrasonic examination and liquid penetrant methods etc. are generally used as an alternative to destructive testing methods in detecting structural problems. These methods, which do not disturb the structural behavior and do not cause damage to the structure are referred to as non-destructive testing methods (Arıöz, 2004). In addition to these methods, studies using artificial intelligence have been frequently found in the literature recently (Perez et al., 2019; Martini et al., 2021; Su et al., 2021). Some of the applications where successful results are obtained in the field of artificial intelligence are performed with image processing.

Image processing applications and methods are one of the most important areas of computer and digital sciences. Since the 1960s, the applications of image processing have been expanding day by day. With the development of technology, computer software and hardware have increased the interest in this subject and made it easier to work on images that can be used as data. As a result, image processing applications have found an environment to be used in various fields of daily life. Image processing methods are used in defense industry, medicine, education, military, industry, art, geography, agriculture, astronomy, fingerprint recognition, character recognition, biology, blood sampling, archeology, physics, X-ray machines as well as concrete engineering (Gönen et al., 2006; Demir, 2006). Another function of image processing methods is to take samples and use them in inaccessible parts of buildings. Image processing methods provide information about damage detection and structure in a faster and more economical way. At the same time, they provide a clear result without subjective judgments and dilemmas of experts.

Great progress has been made in the literature in the field of architecture and urban design. Improvement and feature extraction from the images taken from the buildings are especially used areas. Başyiğit et al. (2012), estimated concrete classes using image processing method. Water absorption, specific gravity, void ratio and compressive strength tests were performed on concrete specimens with 3 different strength classes. Then, the images captured from the specimens were analyzed using the image processing method and the relationship between them and the initial tests were compared. As a result, it was found that the proportions of aggregate and cement in the concrete specimens could be estimated using the image processing technique and the compressive strengths were highly consistent with the initial tests. Kaçın & Aydın (2020), determined the time-dependent displacements of reinforced concrete beams subjected to bending test by classical methods and image processing method. In their study, it has been observed that the beam surface tensions can be visualized by the image processing method. As a result, they stated that the results obtained from both methods were very close to each other. Paiva et al. (2018), proposed the use of images captured by unmanned aerial vehicles (UAVs) for the conservation and rehabilitation of historic buildings. According to the results obtained, they stated that the method performed satisfactorily in terms of precision, recall and accuracy. He et al. (2021), proposed a hybrid method that can be used in the early stages of sustainable building design using image processing. The developed method integrates image processing and machine learning with CFD (General Computational Fluid Dynamics) simulations used to model the behavior of buildings under the influence of wind. It was found that the study modeling the low wind speed areas around rectangular shaped buildings provides a time saving of 78.15% compared to manual applications in the tests. There are also many studies using visual processing techniques for building/damaged building detection and edge removal in urban areas, especially during disaster periods (Ekici, 2021; Chen et al. 2021; Cai, 2019).

In this study, the usability of image processing in "*crack detection*", which is one of the problems related to building physics, is discussed based on literature applications. The aim is to determine the cracks that occur on the concrete surface using image processing methods. For this purpose, the detectability of cracks on the structure was studied by applying the convolutional architecture of artificial neural network, which is one of the image processing methods, to a dataset compiled from different sources. The dataset subjected to machine learning by running it through different processes was finally tested and the results were compared.

2. Building Physics Problems and Cracking in Buildings

The first of the two basic issues of building physics is to determine the environmental conditions according to the purpose of use and the current situation, and the second is to provide esthetic and economic solutions together with these conditions. However, buildings are subjected to negative influences due to reasons such as wind, sun, humidity, natural disasters and water under the influence of climatic conditions based on the environments in which they are located. These influences cause severe damage to the structures over time.

In the design of the building, considering these criteria, it is necessary to take constructive measures to minimize the effects of possible damage and to make appropriate detailed solutions (Güler et al., 2010). In this section, the effects that can lead to cracking in structures are discussed.

Cracks are deformations that occur as a result of deterioration of thermal balance, water-moisture effect, indoor-outdoor temperature difference, and physical and chemical reactions in the structural system or building materials of the building. Cracking can occur as a result of long-term use of the structures as well as in the early stages of construction. Although these deformations affect the structure only visually, it can go as far as the collapse of the structure if the effects of the crack are not brought to light.

2.1. Mechanical Effects

The deformations that occur in the internal structures of the materials subjected to the force can cause displacements between molecules and atoms when the value of the force is increased after a certain limit. As a result, the material breaks and cracking becomes inevitable (Eriç, 1994). Cracks that occur in reinforced concrete structures due to the action of various loads are called structural cracks. Various cracks that may occur in a structural reinforced concrete element are shown in Figure 1. The high number of cracks in the load bearing elements indicates that the overload or design decisions are not smooth. The size of the cracks varies depending on parameters such as cover thickness, concrete-reinforcement bond and reinforcement spacing.

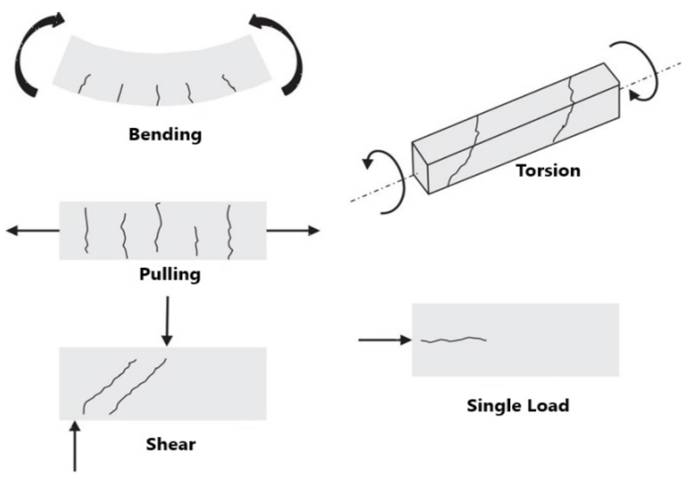

Figure 1. Structural cracks that may occur in reinforced concrete elements

2.2. Thermal Effects

Exterior walls expand when exposed to direct sunlight due to thermal expansion coefficients, which is one of their characteristic features. These expansions are limited by structural elements such as partitions, floors, foundations and lintels, which do not heat up and expand as much as they do. For this reason, there will be some compressive stress inside the wall. This compressive stress will be higher for windows because the area of the wall is comparatively smaller (URL-2).

The compressed wall expands and reaches its original state when the temperature of the wall decreases at night. In this process, the tensile stress develops in the brick wall and the tensile stress becomes maximum in the same window as the compressive stress. When the wall is exposed to direct sunlight and cold at night, compressive and tensile stresses develop in the wall every day. When the tensile stress is greater than the tensile strength of the wall, the wall will crack due to the thermal effects it is exposed to in the process. As can be seen in Figure 2, these cracks usually occur in the upper areas of the building walls that are exposed to direct sunlight. The use of different materials with thermal expansion differences in these areas will increase the cracking.

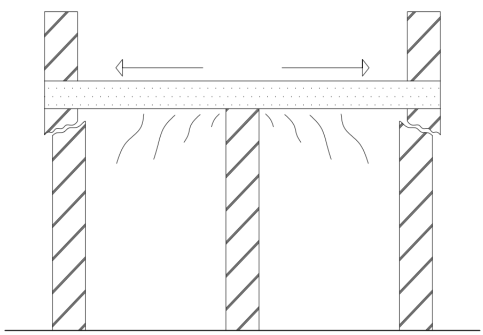

Figure 2. Cracks due to thermal expansion

2.3. Effects of Water and Humidity

The humidity in the environment should be at a certain level (35-70%) so that the users of the building can live in a better environment. The movement of moisture in the materials and elements used in the construction of the building is seen in three forms as capillary effect, vapor diffusion and infiltration (Ertaş, 2001). The water vapor, which moves according to the partial pressure, moves from the place where the pressure is high to the place where it is lower. For this reason, moisture pressure differences occur within the building material. As a result, moisture and water not only cause damage to the structure such as rotting and swelling (Figure 3), but also lead to unhealthy conditions with mold, and these negativities significantly reduce the strength and durability of the structure (Güler et al., 2010).

Figure 3. Historical building with flooded walls

2.4. Physico-Chemical Effects

Physico-chemical problems that cause the destruction of structures over time can be caused by various chemical effects such as fire, flowering, corrosion, and sun. Although fire is also included in this class of problems, it is not a situation that develops over time. Solar radiation causes damage such as discoloration and thermal stress cracking in the structure (Figure 4a). In addition, physicochemical events such as shock, mechanical fatigue, and vibration that develop over time cause wear in the concrete and cause microscopic cracks. The resulting cracks grow and lead to the leakage of smoke and fumes into the air, moisture, carbon dioxide and corrosive substances into the internal environment. Due to the corrosive effect of the leaks and oxygen, the reinforcement starts to corrode, i.e. it starts to rust, reducing its cross-section and decreasing its strength (Figure 4b).

(a) (b)

Figure 4. Some physico-chemical deformations

3. Arti icial Intelligence and Architecture

Technology is one of the biggest factors influencing architecture. Artificial intelligence, which is at the cutting edge of technology today, is constantly evolving (Penrose, 1997). The use of artificial intelligence in architecture can be discussed in two parts. First, the use of artificial intelligence in a phenomenon, and second, the use of artificial intelligence by architects. The use of artificial intelligence in architectural phenomena can be studied under the name of smart building (Yalkı, 2001). On the other hand, the use of artificial intelligence programs for designing architecture can be mentioned. These are the programs that enable making changes to a created phenomenon or creating an architectural phenomenon. After the architect's workspace is defined, she starts generating ideas. Architectural history, building programming, building production, typological studies, building physics and material selection can be examples of these work areas. Programs created with artificial intelligence can be used in these areas of study (Yalkı, 2001).

3.1. Image Processing

Attempting to perform the operations of human eye structure in the computer environment is made possible by image processing technology (Akkoyun, 2010; Yılmaz, 2007). In studies conducted by evaluating image processing methods, images are first captured using a camera. Image processing methods include many functions such as acquisition, segmentation, classification, retrieval, enhancement and digitization of the obtained image. Pre-processing is applied to the obtained images and features are extracted from the desired objects. The most important step in feature extraction is the proper identification of the objects in their environment. Various methods are used in the studies dealing with object recognition or detection. Studies on effective and fast identification of objects by using simple features specific to the object, detection with complex background; methods like color detection, corner and edge detection, pattern matching, pattern and shape recognition are used (Viola & Jones, 2001; Hussin et al. 2012; Sonka, 2014).

3.2. Convolutional Neural Networks (CNN)

Artificial neural network structures have been inspired by the movements of neurons in the human brain. In the biological structure of the nervous system, the soma corresponds to neurons, dendrites to inputs, axons to outputs, and finally synapses to weights in neural network systems. Signals connect neurons with weighted connections (Figure 5a). Synapses establish connections between neurons. Artificial neural networks (ANNs) are computer software that mimic biological neural networks and perform basic functions such as generating new data from data collected by the brain through learning, remembering, and generalizing by applying the learning pathway of the human brain (Öztürk & Şahin, 2018). ANNs produce a specific output by passing the information transmitted to neurons through the specified functions and parameters. When the structure of neurons is studied, it is seen that the nodes in which the inputs are obtained, the weights with these inputs, the sum of the inputs and the addition function that is created by processing the weights, the activation function that generates results by processing the values obtained from this function, and the outputs (Gülcü & Kuş, 2019). Multi-layer ANN systems consist of at least three layers. These layers, shown in Figure 5b, are the input layer where the data is introduced, the hidden layers (intermediate layers) where the output is produced by processing the data after the input layer, and the output layer where the results are produced from the hidden layers (Sinecen et al, 2017).

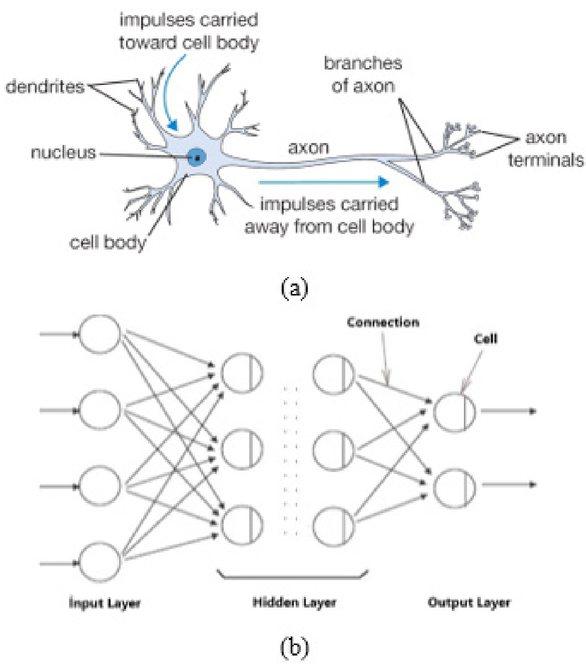

Figure 5. (a) Biological nerve cell-(URL-3)
(b) ANN structure

ANNs are used in many fields, such as pattern recognition, prediction, and classification, and achieve successful results. Since the problems are different, there is no unified model of ANNs in applications. Special cases such as the inputs of the problem data, the types of inputs, the desired outputs, the form of the outputs cause ANNs to be in different models and change the difficulty of the problems.

Convolutional Neural Networks (CNNs) are deep neural networks that are mainly used for image classification (e.g. naming what is seen), clustering by similarity (photo search) and object recognition in scenes. For the results to be successful especially for CNNs, the hyper-parameters must be chosen correctly. Evaluating and optimizing the hyper-parameter values for all possibilities is practically difficult as it requires high computational power (Gülcü & Kuş, 2019). The number of layers in the main layer and the operations vary depending on the application content. The content of the general architecture of CNNs is shown in Figure 6.

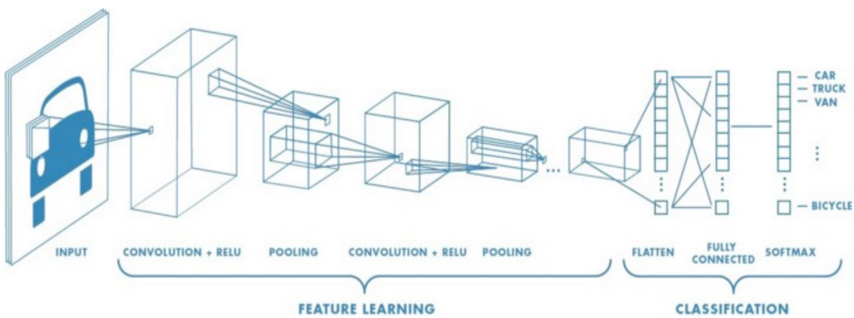

Figure 6. Convolutional Neural Network Architecture (URL-4)

The distinctive feature of the CNN is the use of convolutional layers. The reason for choosing this convolutional network among multilayer artificial neural networks is that it ignores information without content by reducing the density with other layers it contains deeper than learning and feature extraction. The layers of convolutional neural network and the operations performed in each layer are explained below.

- **Convolution Layer**

  The convolution layer is the basis of deep neural networks. This layer works by sliding filters of different sizes (e.g. 2 x 2, 3 x 3, 5 x 5) over the input image. A new image is created by extracting the attributes from the input image (Kizrak & Bolat, 2018; İnik & Ülker, 2017). As shown in Figure

7, a 3 x 3 filter was applied to the 5 x 5 sized image and the output image was displayed. Here, the 3 x 3 dimensional filter moves right-left and top-bottom on the entire input image. The filter coefficients are calculated by multiplying and summing the same size windows in the input image. As a result, a new image with high-rank discriminative features is generated (Türkoğlu et al, 2020).

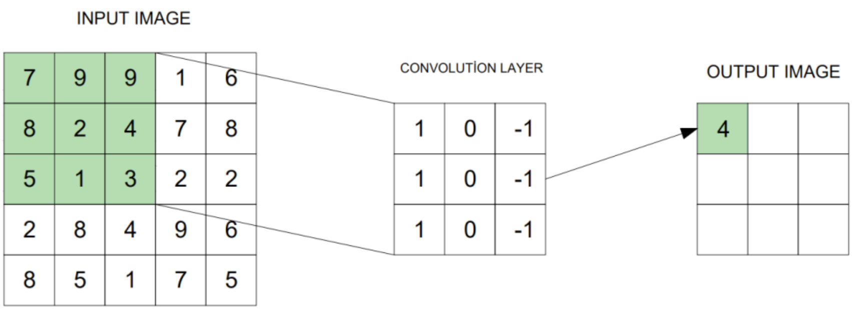

Figure 7. Convolution application

- **Pooling Layer**

  This layer is the process performed to reduce the size in deep learning applications. The pooling process is used to reduce the computational load and to take advantage of the fact that the model cannot memorize. By moving the filters over the image, the pooling process is performed by taking the minimum, average or maximum values of the pixels on the image (İnik & Ülker, 2017). Figure 8 shows an example of the pooling process on the input image of the 2 x 2 filter.

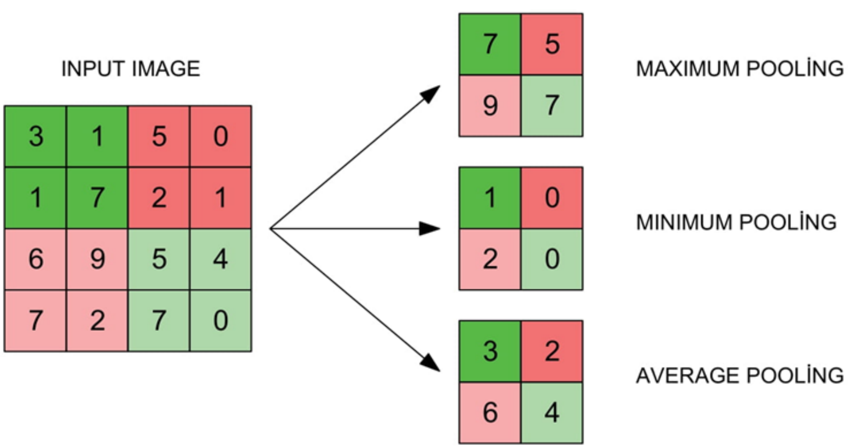

Figure 8. Pooling Process Example

*** Relu Layer**

Activation functions are a very important function for convolutional neural networks. Among them, the most commonly used is Relu function. The most important feature of this function is that it makes the network learn easier and faster by making the negative values in the processed data zero at the input.

*** Normalization Layer**

This layer improves the performance of the network by ensuring that the data obtained from the layers in the convolutional neural network is ordered and the input data is within a certain range (Türkoğlu et al, 2020).

*** Fully Connected Layer**

This layer, which is a one-dimensional matrix, is connected to all neurons in the previous layer. This layer is generally located towards the end of the neural network architecture and optimizes the class values. Depending on dep learning, the number of fully connected layers may vary (İnik & Ülker, 2017; Doğan & Türkoğlu, 2018).

*** Dropout Layer**

In the fully connected layers in convolutional neural networks, the dropout layer is used to prevent the network from remembering and overlearning data. It ensures that some nodes are not formed by using certain thresholds. It also increases the performance of the network by forgetting weak and unnecessary information (Çarkacı, 2018).

*** Classification Layer**

It is the last layer of network architecture where classification is performed in CNNs. Depending on the deep learning architecture, the softmax classifier is usually used in this layer. The softmax classifier produces probabilistic values in the range of 0 - 1 for each class. The highest probability value indicates the class predicted by the convolutional neural network model (Kizrak & Bolat, 2018; Doğan & Türkoğlu, 2018).

4. Application Study

The aim of this study is to evaluate the applicability of structural damage observation as a non-destructive method by detecting cracks on concrete with a digital image processing system using a freely available dataset. In practice, the type of network chosen from the artificial neural networks was "Convolutional Artificial Neural Network", which is a subset of the discipline "Deep Learning". The application study was carried out by creating an artificial neural network on the program Matlab R2020. The structure of the convolutional neural network used is shown in Figure 9.

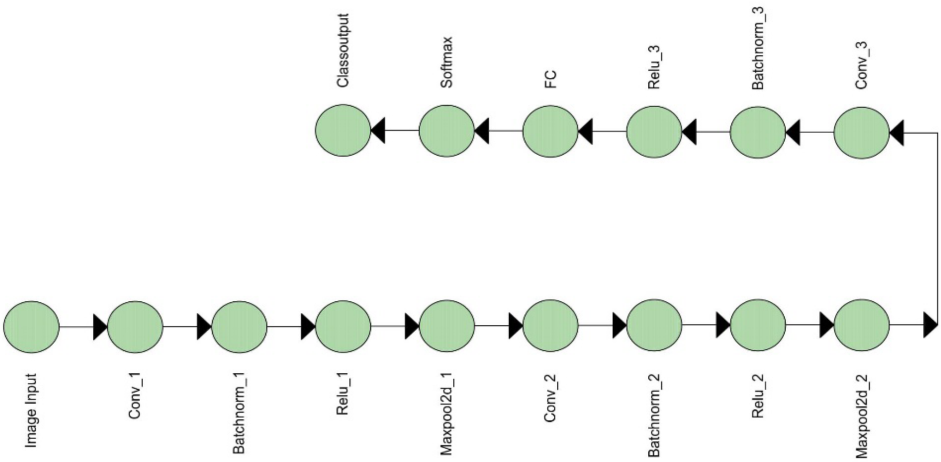

Figure 9. General view of the CNN architecture used in the study

4.1. Dataset

Images of concrete were used as the dataset, consisting of a total of 40k images obtained from the Internet (URL-5). 20k of these images have cracks and the other 20k are images without cracks. The images used have dimensions of 227 x 227 x 3. While 227 x 227 represents the dimensions of the data matrix, the last 3 indicates that the data is colored. Although the image sizes used in the application pose a challenge to the performance of the neural network, the size, namely the pixels, was not manipulated to achieve high learning ability. In other words, the images were not converted to black and white format by applying any filter and taken in 2 dimensions. The data with different types of cracks on it are fed to the model as 2 separate class files in one file. Necessary codes were entered to read the data and dimensional analysis was performed. Figure 10 shows 10 randomly selected data from 40k samples.

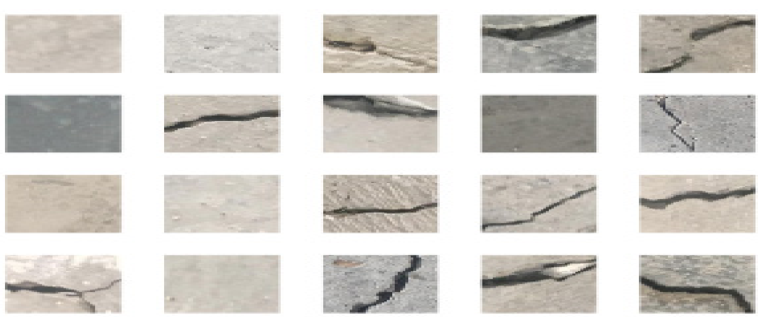

Figure 10. Randomly selected images among the dataset

5. Results

In this model, the data is first divided into negative and positive classes. Negative data denotes images without cracks, and positive data denotes images with cracks. A part of the data in these two classes was used for training. The data to be used for training was set to 80% of the total data. The remaining 20% is reserved for testing. After the necessary preprocessing was done with the codes, the architecture of the artificial neural network was created. The artificial neural network architecture consists of 3 convolutional layers, as illustrated above (Figure 9). The data is trained with certain iterations. After the training phase, the convolutional neural network is learned. Then the validation phase was started. After testing, the classification was performed with the softmax layer and the accuracy rate was determined.

The confusion matrix of the CNN is given in Figure 11. As it is seen from the figure, 19 of the images without cracks were predicted as cracked among 4000 images. And 93 of the cracked images among 4000 samples were misclassified as images without cracks. This means that our CNN classifier could not classify 112 images among 8000 mixed samples correctly.

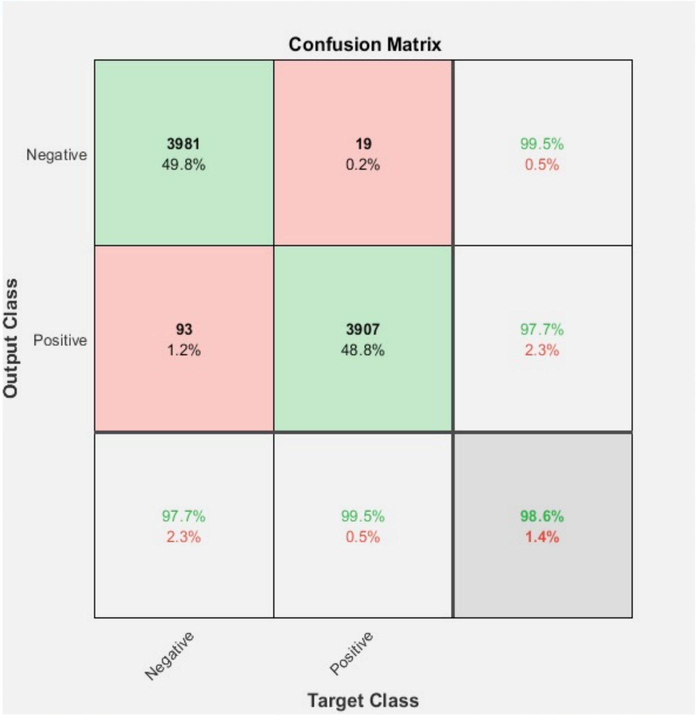

Figure 11. The confusion matrix of the CNN

To evaluate the success of the CNN the performance measures employed in this study are given below. While TP, TN, FP and FN are the True Positive, True Negative, False Positive and False Negative numbers in the confusion matrix respectively the *overall accuracy* which shows the amount of correctly predicted cracked and without cracked images can be calculated with the equation given below.

$$\text{Accuracy} = \frac{(TP + TN)}{(TP + TN + FP + FN)} \tag{1}$$

The rate of incorrectly classified images expressed with the following formula *error* equation.

$$\text{Error} = \frac{(FP + FN)}{(TP + TN + FP + FN)} \tag{2}$$

The ratio of correctly classified cracked images by the CNN to all cracked images is stated as *sensitivity*, and it can be calculated with the 3rd equation.

$$\text{Sensitivity} = \frac{TP}{(TP + FN)} \tag{3}$$

Similarly, the ratio of incorrectly labeled crack images to all non-cracked images is called *specificity* and is obtained as in formula 4.

$$\text{Specificity} = \frac{TP}{(TP + FP)} \tag{4}$$

And as a last performance measure *precision* is expressed as correctly classified cracked images to all cracked tagged samples by the CNN.

$$\text{Pr ecision} = \frac{TP}{(TP + FP)} \tag{5}$$

In terms of the criteria stated above, the performance of CNN is as given in Table 1.

Table 1. Statistical measures of the CNN

Accuracy	**Error**	**Sensitivity**	**Specificity**	**Precision**
98.600	1.4	99.525	97.675	97.717

The comparison of the CNN model with some previous models in literature is given in Table 2. Although the data set used is not the same, when the success rate is considered, it is seen that the result is satisfactory.

Table 2. Comparison of the Model with some previous works

Reference	Number of Images	Accuracy (%)
Yang et.al, 2019	3000	95.54
Ali et al, 2021	25000	96.7
Dorafshan et. Al, 2018	18000	97
This study	8000	98.6

6. Conclusion

Although structural problems reduce the life of the structure, it is well known that improperly performed repairs lead to greater problems. Various methods are used to identify the problems and in some cases severe damage to the structure occurs. For this reason, the use of non-destructive methods is an indispensable option for construction. It should be used especially in the inspection and detection processes to be carried out in historical buildings. In addition, the clear identification of the problem in the building and the repair of the building on site, not for the entire building, will significantly reduce the time and repair costs.

In the study, a convolutional neural network model was created and image data related to crack detection was introduced into this network and the network was trained. Considering the result of the application, it was found that convolutional neural networks can be trained on structural images and as a result of the validation tests, a high success rate (98.6%) was obtained. Changes were made to the parameters of the artificial neural network and it was observed that the accuracy changed only slightly as a result of these changes. As a result, it is clearly seen that the proposed CNN architecture can be used as an alternative to the existing non-destructive methods in the detection of cracks, which is one of the structural problems in architectural field. As a preliminary study, the proposed method can be applied to the further studies of classification and determination of other building physics problems by generating appropriate dataset.

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CHAPTER IV

REINFORCED CONCRETE STRUCTURAL DESIGN FAILURES RELATED TO THE ARCHITECTURE OF BUILDINGS: LESSONS LEARNED FROM THE JANUARY 24, 2020 EARTHQUAKE IN SIVRICE-ELAZIG

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1. Introduction

An earthquake with a magnitude of 6.8 on January 24, 2020, occurred in Sivrice district of Elazig city in Turkey. This earthquake, which caused heavy loss of life and property, also severely damaged many reinforced concrete (RC) structures in the region. After the earthquake, the damages to the residential and commercial RC buildings in the epicentral region were determined during the investigations carried out by Şahin and co-workers. The findings have been presented in a detailed report (Şahin et al., 2020). According to this report, the structures in Elazig were heavily damaged even in this earthquake of which magnitude was below their design earthquake (Şahin et al., 2020).

The deficiencies arising from the structural design of RC systems significantly affected the heavy damage to the buildings. These deficiencies were largely caused by the engineers and architects responsible for the technical part of the design. Structural irregularities caused by considering architectural usability rather than earthquake safety in RC building design vitally contributed to damage in buildings (Şahin et al., 2020). Although there are various standards and regulations (TS500, 2000; TS EN 1992-1-1, 2009; TBEC2018, 2018; TEC1975, 1975; TEC1998, 1998; TEC2007, 2007) for the design of RC structure systems, there was no true design made according to these regulations, especially before 2000 (Şahin et al., 2020). For this reason, the faults made in the design of RC structural systems played a vital role in the heavy damage of the buildings in the Sivrice-Elazig earthquake.

In this study, the structure plans of many RC buildings damaged during the Sivrice-Elazig earthquake have been examined. The defects in the structural system designs of 11 different RC buildings built between 1983 and 2001 have been evaluated. In addition, earthquake damages caused by material quality and manufacturing defects have also been mentioned. The lessons to be learned from these failures, which are thought to have been made by keeping architectural concerns in the foreground, are very important for both architects and engineers who design buildings in areas with high earthquake risk. The efficient structural design of the RC structures to be built in risky disaster areas, like Elazig, carries vital importance.

2. Failures of Reinforced Concrete Structural Designs

The stability behavior of the structures has been an issue of the structural design. The structural design is aimed to produce a structure efficient for resisting all applied loads including lateral loads without failure during its planned life span. If a structure is not properly designed or manufactured, or if presently applied loads exceed the design loads, the building would fail with heavy consequences (Mrema, Gumbe, Chepete, & Agullo, 2011).

A large number of RC structures were heavily damaged during the 6.8 magnitude earthquake that struck Sivrice-Elazığ in Turkey on January 24, 2020. As a result of the investigations, it has been seen that there were significant design errors in the structural systems of RC buildings. The plans of these buildings, which were heavily damaged in this earthquake, have been examined below. While some of these buildings were collapsed during the earthquake, the others were demolished later due to the heavy damages they received. All RC structure plans discussed in this study have been drawn to scale to fit on the page. In this way, the dimensions of the carrier system elements can be understood compared to each other. Black solid-hatched elements on the plans show the columns. Elements drawn with two parallel lines represent beams. Since almost all of the plans belong to buildings used for residential purposes, it can be said that there were infill wall loads on almost all the beams.

The most important of the design errors made in RC structural system plans have been heavy overhangs. These overhangs were designed to expand the space on the second floor level of the buildings. Moreover, there were generally infill walls above the beams in these overhangs of the buildings that are carried to the cantilever beams. Thus, the infill walls increased the dead load on cantilever beams and were adversely affected by the lateral movements that occurred during the earthquake (Dogan, Ünlüoğlu, & Özbaşaran, 2007; Donduren, 2012). Figure 1 shows the cracks that occurred in the infill wall in the overhang of a building in Elazig. Since this damage did not occur in the RC structural system, it was not statically disadvantageous. However, this failure was both costly and prevented residents from using the building for a long time (Şahin et al., 2020).

Figure 1: Infill Wall Damage in the Overhang (Şahin et al., 2020)

An example of the appearance of the overhang in the structure plan is given in Figures 2a and 2b. The structure plan in Figure 2a shows the first-floor structural plan of the building. There has been a heavy overhang 1.4 m long on one side of this building. While the beam-column (moment resisting) frame system in the red circle with number 1 in Figure 2a has been on a straight axis, at the second-floor plan (Figure 2b), the beams have been brought out 1.4 m and built as a cantilever. Above these cantilever beams, there have been infill walls that increased the load of the overhang. The opposite columns carrying the cantilever beams have not been connected to each other with a beam. This has been inconvenient in terms of transmission of lateral earthquake loads to the foundation of the building (Doğangün, 2005). In this plan, the beam spans have varied between 2.2 to 5 m. In addition, in this structure plan, as in many examples that have been the subject of this study, no shear wall has been designed to resist lateral earthquake loads (Figure 2). On the other hand, the designed beam-column frame systems have not been continuous in the plan. This situation can be seen in the blue circle number 2 in Figure 2b. The problems of discontinuities in the beam-column frames and the absence of shear walls in the structure adversely affect the ductile seismic behavior of the RC building. Thus, the earthquake resistance of the structure decreases (Doğangün, 2005; Doğangün, 2004). In this example in Figure 2, these RC beam-column frames behaved poorly during the Sivrice-Elazig earthquake. Also, all the mistakes made in the design of this RC structure caused the building to be damaged seriously by the earthquake.

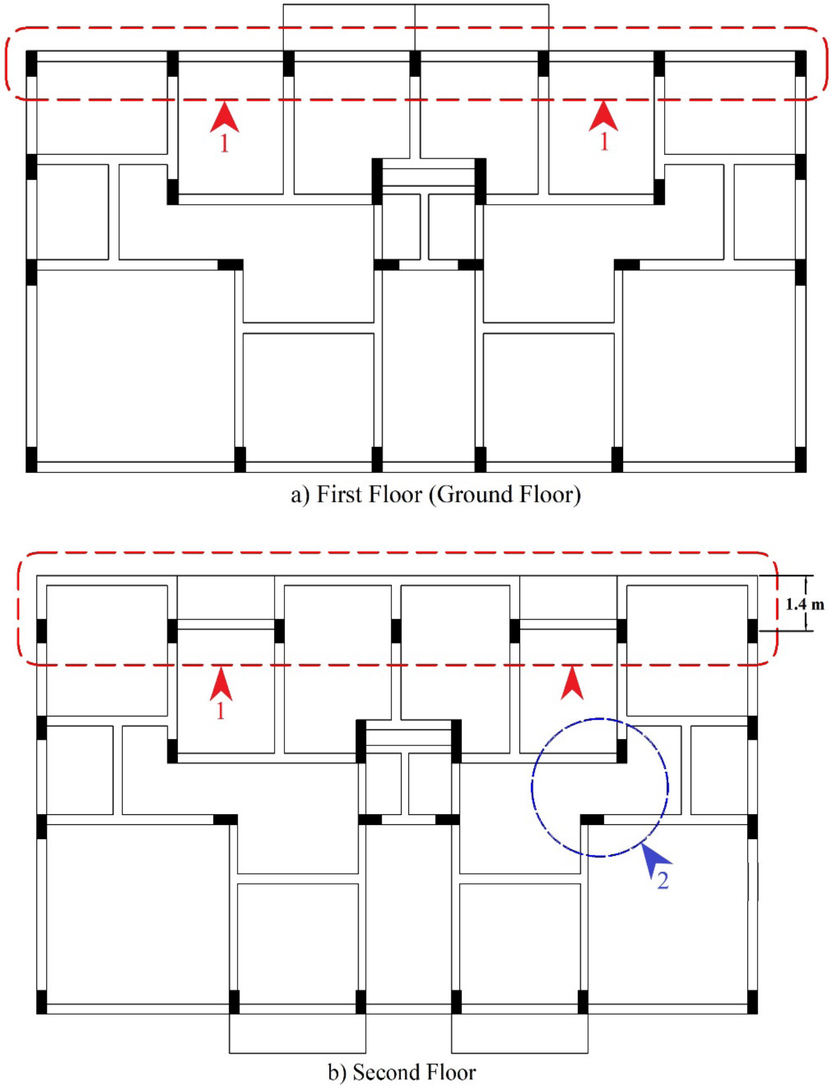


Figure 2: An Example of an Overhang, a) First, and b) Second Floor Plan

In Figure 3, the structure plan of another building that collapsed during the Sivrice-Elazig earthquake is shown. Beam spans in this building have varied from 1.4 to 5.5 m. In this plan, a heavy overhang has been enframed in area number 1. In addition, the irregular facade design in area number 2 has drawn attention (Figure 3). Due to the irregular shape of the land, the designed beam-column frames failed to resist the lateral earthquake loads. Also, the discontinuity of the frames has contributed to this failure. The irregularity of the spaces has led to complexity in RC beam-column frame design. It is known that the irregularity of the frame axes in the plan has adversely affected the transmission of lateral loads to the foundation (Şahin et al., 2020). Moreover, a large number of sub-beams have been designed as shown in circle 3 in Figure 3. Sub-beams transfer their load to another beam called the main beam rather than directly to the columns. Thus, the vertical loads of the structure circulate between the beams horizontally instead of being transferred directly to the columns. There has been a serious sub-beam design error in area 3 in Figure 3. The sub-beam has been supported by another sub-beam while it should have transferred its load to the main beam in a beam-column frame. In this case, the normal vertical load has been circulated too much horizontally at the floor level. The sub-beams designed in this way cannot be expected to succeed in transmitting lateral dynamic earthquake loads, and they also increase the static bending moment of the main beam (Şahin et al., 2020; Yüksel, 2008).

The complexity of sub-beams has been one of the most common design failures in RC structure plans in Elazig. According to Sahin et al. (2020), the reason for designing multiple sub-beams in RC structural systems is the idea that each infill wall should be supported by a beam. This application has caused shear damage in the main beams on which the sub-beams were supported in the RC structures in the Elazig. Moreover, contrary to the intention of this application, the infill walls could not be prevented to have damage (Şahin et al., 2020).

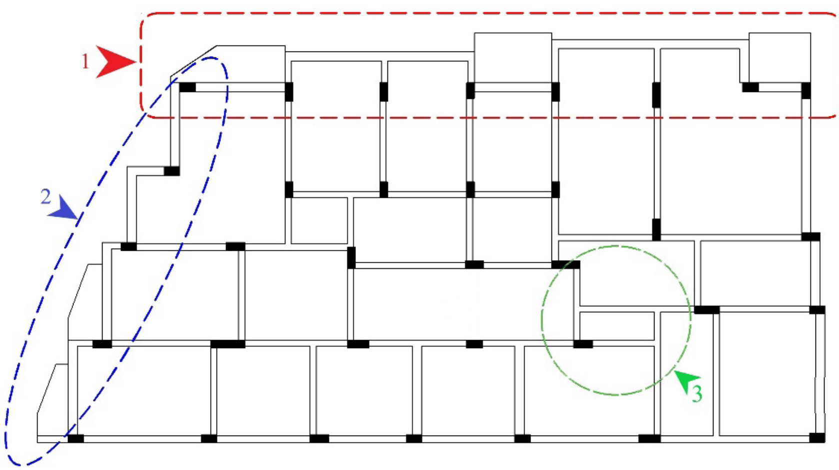


Figure 3: A Structure Plan with an Irregular Facade (Şahin et al., 2020)

Another example of a design of multiple complex RC sub-beam is seen in Figure 4 in the red frame. This RC structure built in 1993 had 5 floors. At first view, a beam designed with a span length of 7.7 m is thought to transfer the load that it received from other sub-beams to the main beams on which it was supported. It can not be unclear which beam was the sub-beam and which was the main beam. RC structural design defect made here has been vitally inconvenient since the load transfer between the sub-beam and the main beam might be easily disturbed during the earthquake. The avoidance of column construction due to dividing the space or due to cost concerns has failed this structure to provide life and property safety in the Sivrice-Elazig Earthquake. In addition, heavy overhangs of the building which are signed in blue circles have been another outstanding structural design fail in the plan.

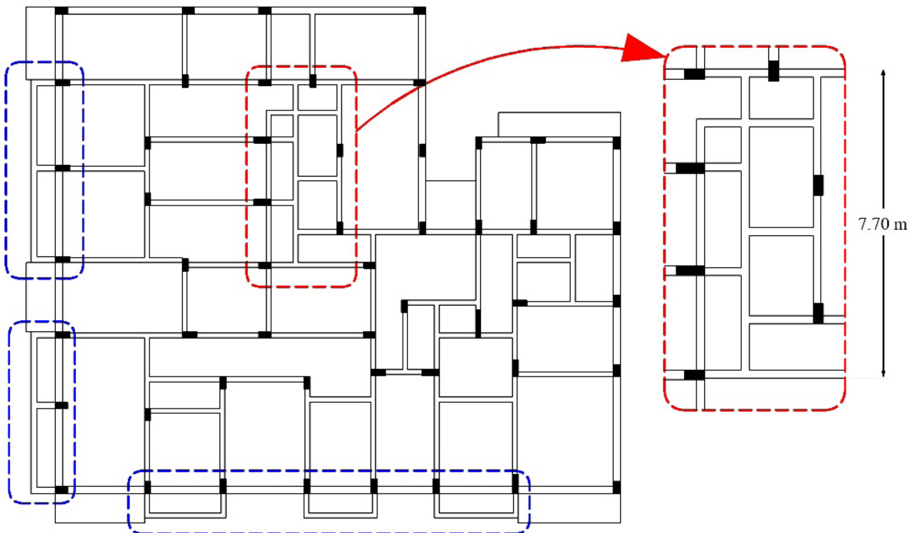


Figure 4: An RC Structure Designed in the Year of 1993 (Şahin et al., 2020)

Figure 5 shows the plan of another 5-storey RC structure built in the year of 1993. Beam spans in the structure have been 2.7 ~ 6.3 m. Many design errors have stood out in the plan. In Figure 5, the error number 1 has been columns that did not form a beam-column frame, although they were opposed. It is known that connecting the columns with beams and designing continuous frames in two directions in the plan contributes positively to the ductile behavior of the RC structure against lateral earthquake loads (Doğangün, 2005). Error number 2 has been that the beams have not been fully supported on the columns (Figure 5). In such a case, it is clear that beam loads could not be safely transferred to the columns. This situation has been unfavorable in terms of both vertical static loads and lateral loads such as earthquakes on the building. Errors indicated by numbers 3 and 4 have led to the generation of extra sub-beams. Error 3 could have been corrected by expanding the column dimensions and error number 4 by moving the column to the nearest corner point (Figure 5).

Finally, at the point indicated by number 5, it has been unclear which of the large span beams was the sub-beam and which was the main beam. Designing a column at that point would have cleared this situation (Figure 5).

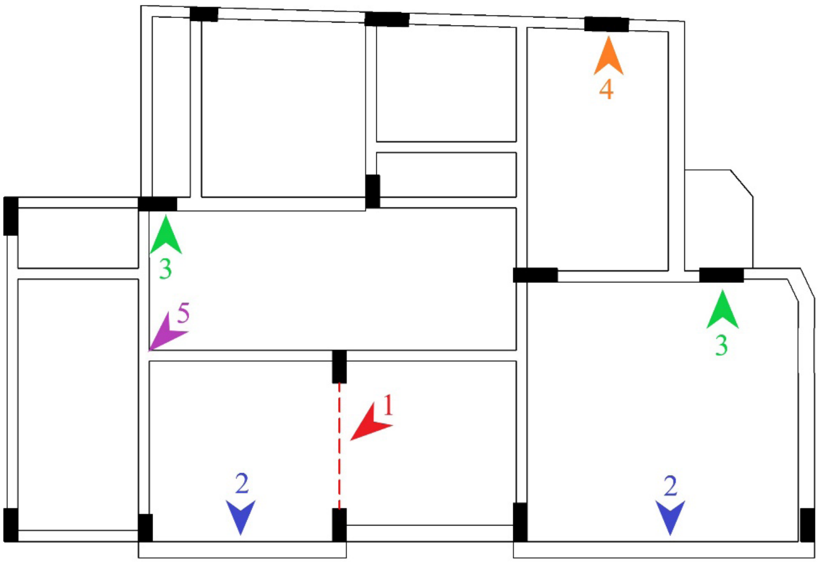


Figure 5: An RC Structural Design from the Year of 1993

In another example, there is an 8-storey RC structure plan designed in 1995 (Figure 6). In this example, the beam spans have ranged from 1.4 to 5 m. Frames have become discontinuous as a result of columns not connected with beams in area 1 marked in the plan seen in Figure 6. Also, for this reason, the shape of the slab in area 1 has become an irregular polygon. It might have been difficult to ensure the stability of this slab during the earthquake. In addition, there have been columns in places where they were not needed in this plan. Some examples of these columns have been indicated with the areas number 2. Why were not the columns in areas numbered 2 placed at the nearest corners? Architectural requirements such as a building entrance or a window may have caused this defect. In Figure 6, a sub-beam problem has been seen in circle number 3. The sub-beam has been connected very close to the beam-column joint region of the main beam, which is known as the most stressed RC element during the earthquake. As it is known, the sub-beam causes extra bending stresses at this point of the main beam. Thus, the probability of damage to the main beam at this point has increased (Şahin et al., 2020; Sezen, Whittaker, Elwood, & Mosalam, 2003; Yüksel, 2008). This problem could have been eliminated by increasing the column size.

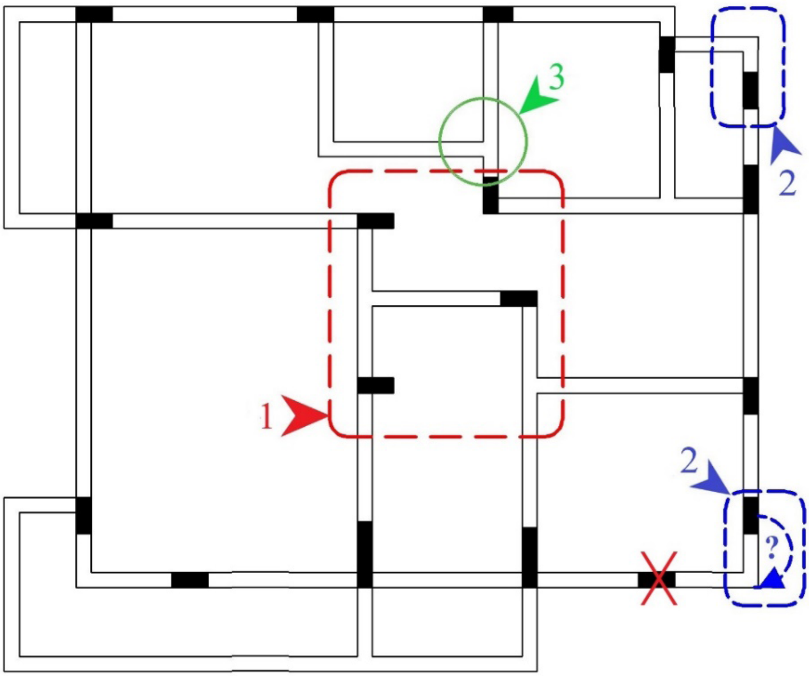


Figure 6: An RC Structure Plan from the Year of 1995

The plan is given in Figure 7 belonged to an RC structure built in 1983. The structure was an 8-storey building and the beam spans have varied between 1.2 to 5.5 m. Another multiple complex sub-beam problem has also appeared in Figure 7. Areas 1 and 2 have addressed this issue. In addition, heavy overhangs indicated by the number 3 have posed another defect in the plan (Figure 7). The other important failure in this design has been the column directions. The column and shear walls to be oriented symmetrically in both the horizontal and vertical directions of the plan contribute to the ductile behavior of the RC structure in both directions against lateral earthquake loads. Thus, the rigidity of the building in both directions is equalized as much as possible and torsional irregularity is prevented (Doğangün, 2005; Şahin et al., 2020; TBEC2018, 2018). Keeping aside there has been no shear wall in the structural design given in Figure 7, the columns have only been aligned horizontally. This has weakened the earthquake resistance of the structure in the y-axis direction, and might have caused torsion in the building and increased the damage to the columns. According to Şahin et al. (2020), the design of the column directions in the plan (Figure 7) in this way has indicated that the architectural usability criteria were taken into account rather than the earthquake-resistant structural design approach.

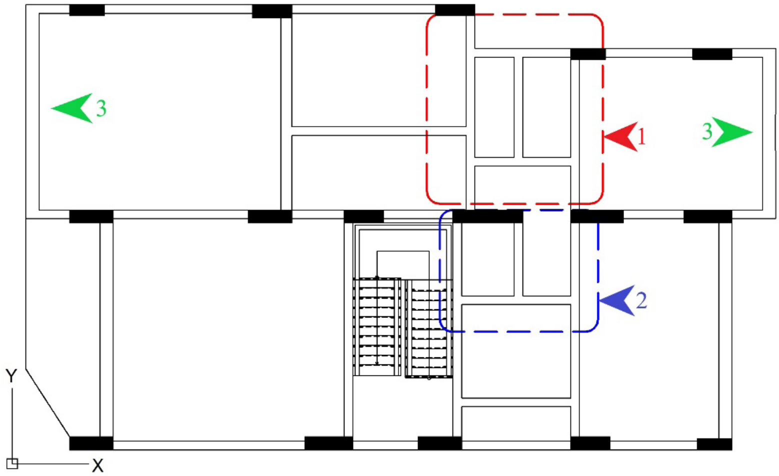


Figure 7: An RC Building Plan with All Columns Aligned in the Same Direction (Şahin et al., 2020)

Another complex sub-beam design has been demonstrated in Figure 8. As firstly noticed in area 1, the load of one sub-beam has been transferred to another sub-beam. Therefore, in this example, it could not be unclear which of the beams was the sub-beam and which was the main beam, especially during the earthquake. The sub-beams seen in area 2 have been bonded very close to the beam-column joint region of the main beam.

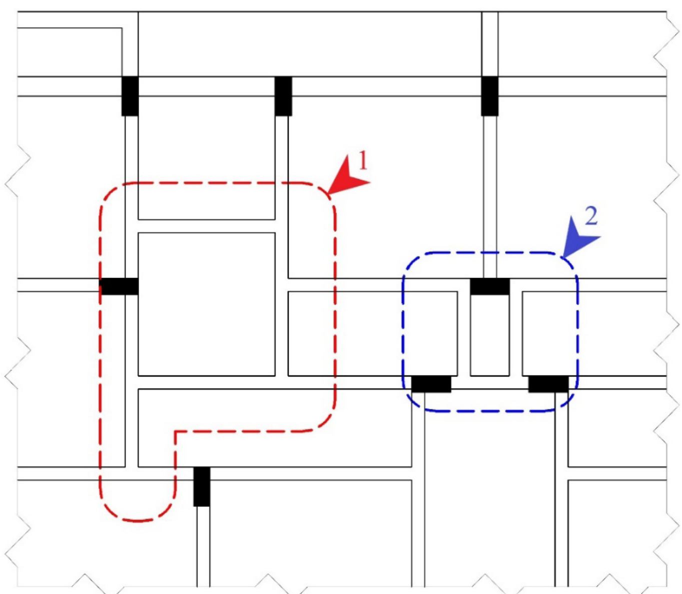


Figure 8: A 4-storey RC Structural Design from the Year of 1995

Figure 9 shows a 5-storey structure built in 1990. In this plan, of which beam spans have ranged from 1 to 5.2 m, the problem of sub-beams in areas 1 has attracted attention. In addition, there has been a non-orthogonal frame problem in area 2. The beam-column frame, which was not arranged orthogonally in the plan, cannot be expected to transfer lateral earthquake loads properly (Doğangün, 2005).

In the plan of another 5-storey building built in 1991 (Figure 10), it is seen that an RC beam with a very large span length has carried 4 sub-beams. A very large bending moment would take place in this main beam. For the beams in this example, it can be said that the static balance can easily be disturbed.

It is also noteworthy that none of the RC structural designs given so far have had shear walls (Figures 2 to 10). Shear walls are extremely essential elements in terms of the earthquake safety of the structure.

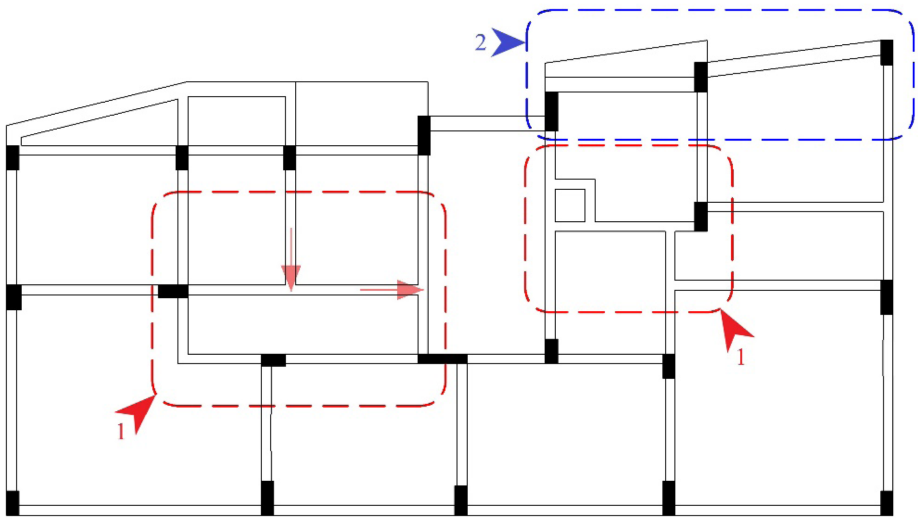


Figure 9: An RC Structural Design from the Year of 1990

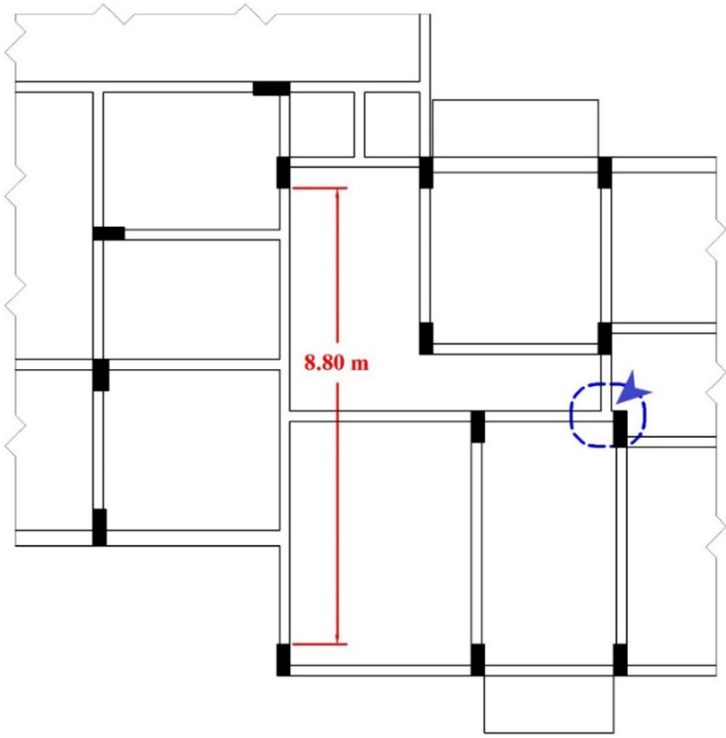


Figure 10: A Serious Complex Sub-Beam Design (Şahin et al., 2020)

In the design of an RC structure made in 1989 given in Figure 11 shear walls have been included in the plan. In Figure 11, RC shear wall (SW) elements have been indicated by green solid hatching. In this 5-storey RC building, the performance of the shear walls was insufficient during the Sivrice-Elazig earthquake, and the building has been demolished due to the serious damage it had. This has been because the beam-column frames with shear walls have been discontinuous in the plan. For example, shear wall number 3 (SW3) has not even been placed within a beam-column (moment resisting) frame. In addition, heavy overhangs have also drawn attention in this structural design where the beam spans varied between 1 and 5.5 m (in areas number 1 in Figure 11). In Figure 11, the non-orthogonal frame problem has been demonstrated in area number 2 framed by the blue line. Non-orthogonal frames are also among the designs that are found to be defective in transmitting lateral earthquake loads (Doğangün, 2005). Şahin et al. (2020), on the other hand, drew attention to the polygonal cross-section columns, seen in area 2, and said that this design was an application that makes uncertain the seismic behavior of the RC column and column-beam joint elements under earthquake. They also have commented that architectural aesthetics have been taken into account rather than earthquake-safe design in this building.

All the structures shown in Figures 2 to 11 were either collapsed during the Sivrice-Elazig earthquake or have demolished later as they got heavily damaged. None of these RC structures were designed in accordance with the necessary earthquake regulations in their time.

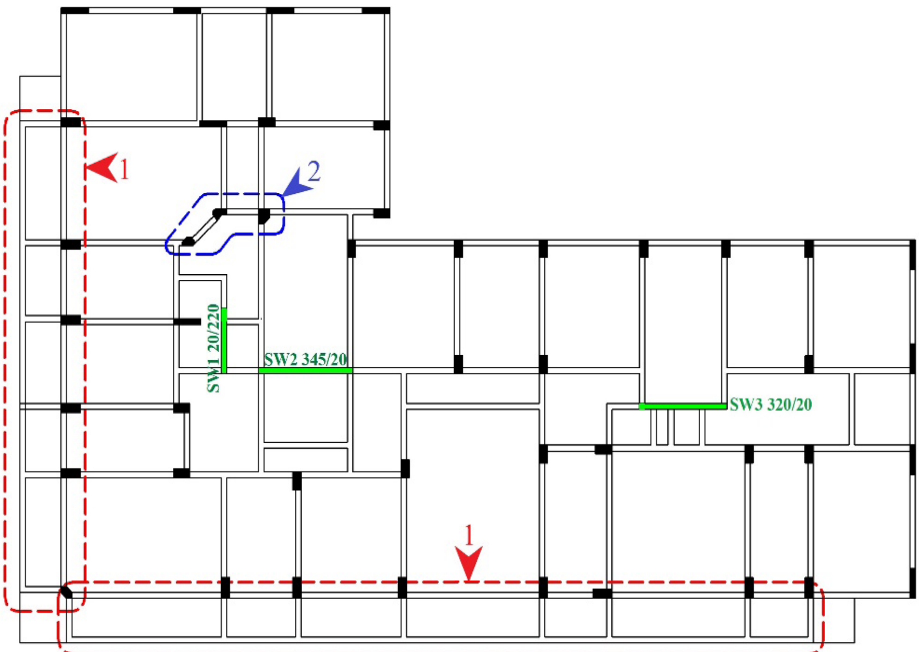


Figure 11: Design of an RC Structure with Shear Walls from the Year of 1989 (Şahin et al., 2020)

According to the report presented by Şahin et al. (2020), shear walls have started to be included in RC structural designs after 2000. Figure 12 also demonstrates a structural design with shear walls. This building has been built in 2001 and had 8 floors. Beam spans have ranged from 1.5 to 5 m. The plan in Figure 12, which has been the half of the building, has been symmetrical with respect to the axis indicated by number 1. Elements shown with green solid hatching in the plan have been shear walls. Shear walls have generally been located in the interior axes of the plan. it would have been more beneficial for the earthquake resistance of the structure if the shear walls had been located on the outer axes of the plan (Doğangün, 2005). Since it prevented architectural elements such as windows, shear walls have been preferred to be made on interior axes. Nonetheless, this building has been able to survive the earthquake with infill wall damage, unlike the other examples in the study. Thanks to its shear walls, the structural system has not been damaged. Even so, almost all the infill walls were cracked. Due to this costly infill wall damage (Figure 13), the residents had to leave the building for a while.

In addition, in Figure 12, there has been a heavy overhang in the area framed by the blue dashed line. This heavy overhang was not found in the building's officially approved plans, it has been discovered only during an on-site inspection of the building. This situation also has revealed the lack of official inspection. Figure 13 shows the infill wall damage that appeared in this heavy overhang.

As in the example in Figure 11, there have been polygonal columns (PC) in this plan in Figure 12. Another cantilever beam supported by these polygonal columns (PC1 and PC2) has been a beam coded B6. B6 has been a curvilinear beam with a width of 25 cm and a height of 60 cm in cross-section. The length of the console in this heavy overhang of the structure has been up to 1.5 m. Also, there was damage to the infill wall above this curvilinear beam (B6). In order to increase the stability in this overhang region in the structural design, another beam coded B4 connecting PC1 and PC2 has been created. It is seen that the cross-sectional height of the B4 beam has been the same as the slab depth (15 cm), and the cross-section width of the B4 has been larger (70 cm) than the other beams. By hiding the beam inside the slab, these cross-section dimensions have been chosen in order to make the ceiling of the space appear uniform for architectural use. These hidden beams, which are found to be unfavorable by the literature, are constructed by enriching the reinforcement in a certain line embedded in the slab. Hidden beams can never reach the performance of conventional RC beams, expectedly (Özbek et al., 2020). Hidden beam application has generally been used to connect the columns supporting cantilever beams of an overhang, as in this example.

As explained before, transferring the load of one sub-beam to another sub-beam instead of the main beam is inconvenient in terms of stability. The plan in Figure 12 has also included a complex sub-beam design. As seen in Figure 12, B7 coded beam has transferred its load to B8 coded beam, and B8 has transferred its load to another beam coded B9 instead of a column.

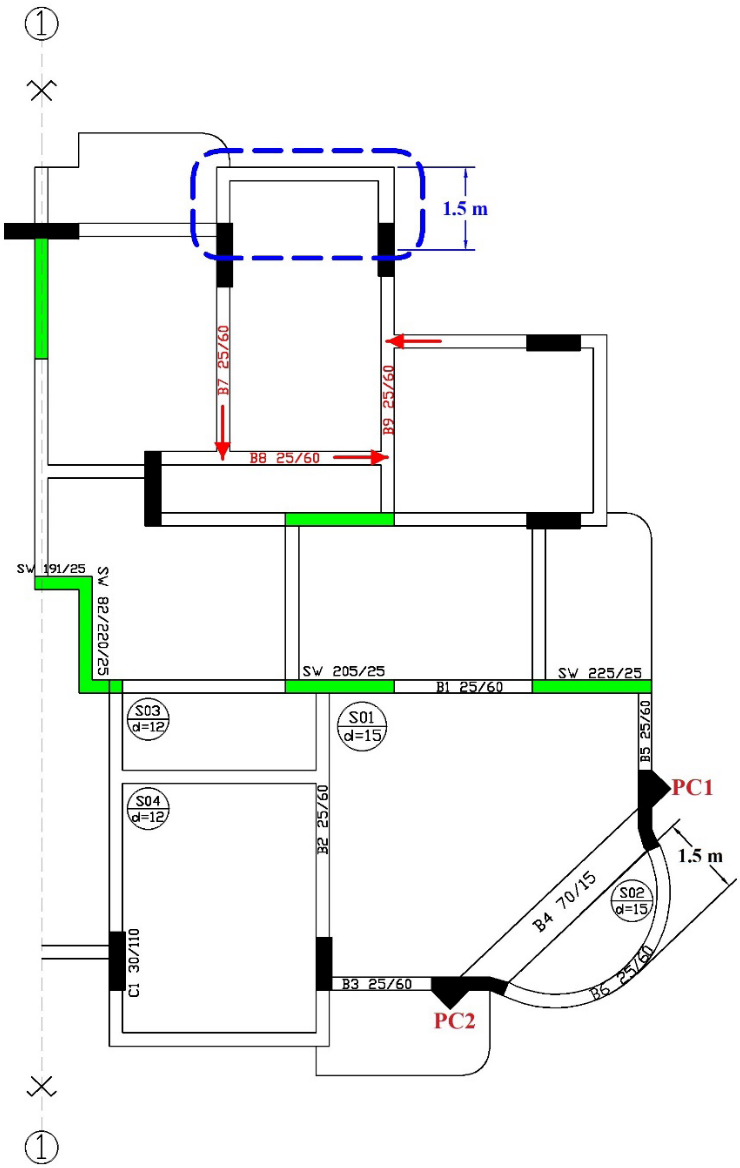


Figure 12: An 8-storey RC structural Design from the Year of 2001

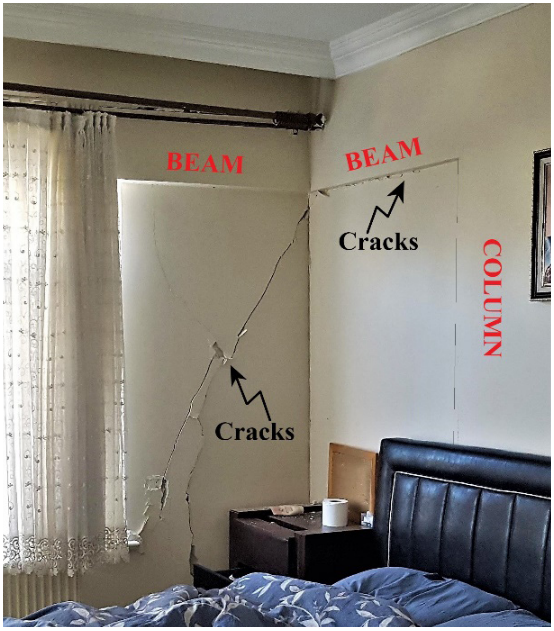


Figure 13: Infill Wall Damage Caused by Heavy Overhang

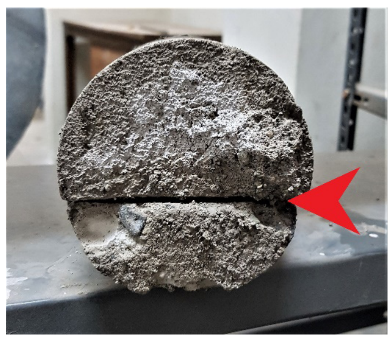
3. Materials Quality and Manufacturing Defects

Most of the structures examined in the previous section were old buildings and also poor in terms of materials and workmanship. Therefore, it has been not sufficient to consider the causes of damage to these structures during the earthquake as only RC structural system designs. In this section, in addition to structural design failures, material and production defects encountered in these structures are discussed. In the on-site investigations by Şahin et al. (2020), it has been revealed that the concrete quality of the buildings that were heavily damaged in the earthquake was quite low. As a result of the tests, it was seen that the concrete compressive strength class of these structures varied between 7 and 10 MPa (Şahin et al., 2020). These values have not complied with any standard (TS 500, 2000; TS EN 1992-1-1, 2009; TS 802, 2016) defining the concrete strength classes in Turkey. The reason why the concrete quality was so weak might be the unsuitable materials in the concrete composition, manufacturing defects, and lack of inspection (Şahin et al., 2020). Figure 14 shows the manufacturing defect in the cantilever beam of an RC structure that was demolished later. Since the concrete was completely segregated, the steel reinforcement bar could not be surrounded properly by the concrete (Figure 14). Because the steel reinforcement bar was not fully protected by the concrete, it was started to rust (Figure 14). In addition, as seen in Figures 14 and 15, flat surface steel reinforcement bars were used in these structures, not ribbed.

Figure 14. Poor Concrete Placement of an Old RC Structure

Figure 15. Flat Surface Steel Reinforcement Bars Used in Reinforced Concrete Column

During the production, the discontinuous surface formed between the two casting layers of the concrete as a result of a long pause in the concrete casting process is defined as the cold joint. The performance of the RC structures is adversely affected by the presence of a cold joint (Bekem Kara, 2021; Kahn & Mitchell, 2002). Figure 16 gives a cold joint discovery in an RC shear wall. This cold joint has been detected during the core drilling process. Figure 16a shows the place where the core sample was taken from the RC shear wall. The red arrow points out where the cold joint was formed. Figure 16b demonstrates the core sample. Without any mechanical impact, this concrete core sample was easily split into two parts from the point where the cold joint was formed within the concrete. Figure 16c shows the cold joint surfaces in the core sample. As can be seen, the surfaces were almost smooth, and no aggregate appeared on the surfaces. If a fracture here had occurred as a result of a mechanical load, aggregates in the concrete could have been observed on the fracture surfaces. Thus, the reason why the core sample was divided in this way has been the cold joint created within the concrete during the manufacturing process. The cold joint in the shear wall of the building adversely affected the earthquake performance of this RC structure, surely.



(b)

(a) (c)

Figure 16. Sample of a Cold Joint: (a) Location of the Core Drilling Process, (b) Core Sample with Cold Joint, and (c) Surfaces of the Cold Joint

4. Conclusions

The earthquake with a magnitude of 6.8 that occurred in Sivrice-Elazig on January 24, 2020, caused serious damages to many of the RC structures in the region. In this study, the structural system plans of some of the heavily damaged RC structures designed between 1983 and 2001 have been examined. It is thought that the design defects seen in the structural system plans of these RC buildings have played an important role in the heavy damage to the structures. It can be concluded that the concerns regarding the architectural usability of the structures have been prioritized and earthquake safety has also been ignored for these RC structural designs, which have not been well-engineered.

The conclusions drawn from this study can be summarized as follows: Heavy overhangs have been one of the most common defects of RC structural system design. These heavy overhangs, which were built to expand the space, have caused costly infill wall failures during the Sivrice-Elazig earthquake. In addition, by designing the beam-column frames as discontinuous in the structural system, the ductile seismic behavior of the structure against the earthquake has been adversely affected. Another common design mistake has been multiple complex sub-beam creations. The avoidance of column construction due to dividing the space or due to cost concerns has resulted in too many sub-beams in the structural system. Transferring the load of one sub-beam to another sub-beam has led to the formation of multiple sub-beams, and they have been very inconvenient designs that create chaos in terms of transmission of the loads. In addition, no shear wall designs have been found in the plans of the structures that were heavily damaged in the Sivrice-Elazig earthquake. All these have been vital design failures that endanger the earthquake safety of the buildings. Also, considering material and manufacturing defects added to these design failures, it was inevitable for these structures to be damaged during the earthquake.

As a result, the RC structural designs examined in the study could not ensure the safety of the buildings during the Sivrice-Elazig earthquake. Thus, the conclusions drawn from the examples in this study are important in terms of raising the awareness of people working in and training in both architecture and engineering milieus about earthquake-safe RC structural design.

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CHAPTER V

EVALUATION OF WIND VELOCITY RATIO FOR CHANGING ASPECT RATIOS IN URBAN AREAS

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1. Introduction

The urban heat island, which is defined as the warmer urban areas than the surrounding rural areas, is the most important problem of today's cities. In cities with dense and high-rise buildings, building surfaces are getting hotter. Increasing traffic pollution, irregular urbanization, thermophysical properties of coating materials used on building facades and narrow street spaces prevent the cooling of heated surfaces. Another important event that causes the warming of cities is the decrease in the effect of wind on urban surfaces due to dense construction (Givoni,1998). For this reason, the difficulty of the cooling process of urban surfaces is directly related to the ventilation performance of the cities. Natural ventilation in urban areas is an important criterion to be considered in order to improve air quality and provide thermal comfort (Merlier et al, 2018). In cases where the aim is to improve air quality, the evaluation parameter is flow rate, while the rate of wind speed should be taken into account to ensure thermal comfort in the outdoor environment (Gülten& Öztop, 2020).

Wind Velocity Ratio (V_{WR}) is a parameter that is frequently used to analyze the natural ventilation performance of an urban area on a micro scale. Studies evaluating natural ventilation performance in urban areas over V_{WR} and using computational fluid dynamics-based programs for this purpose, generally made simulations for different building configurations, taking into account different wind speeds and directions. As a result of the studies, building density (floor coverage ratio) is considered the most important criterion for good ventilation, while homogeneous distribution of building masses and differences between building heights are stated as important parameters affecting urban ventilation (Ng, 2009).

Aspect ratio which is another parameter that will be get used of in this study and it is calculated by dividing building height to street width in an urban canyon. Urban block height and the widths of adjunct roads were found to be two main factors that affect wind pressure differences in urban areas (Azizia&Javanmardi, 2017). It is also a known fact that urban areas exposure less wind effect than a rural area.

The uncontrollable growth of cities adversely affects, in particular, the ventilation performance of urban districts and causes an increase in cooling and heating loads. Many cities have unappropriate H/W ratios in city centers especially for old settlements. This work focuses on ventilation performance of urban areas based on wind velocity ratio in relation with aspect ratio. This is useful to being able to evaluate the relation between parameters of wind velocity ratio and aspect ratio.

2. Method

In this study, simulations were made to analyze the relationship between V_{WR} and building surface temperatures using a computational fluid dynamics-based program for different building arrangements considering different aspect ratios. The building regulations that can be encountered in the province of Elazig are parametrically diversified. One of the regulations has been used for parametric simulations. Since the structured model of surrounding buildings should be taken into account for an accurate wind flow prediction with a CFD simulation (Liu et al, 2018), the wind velocity ratio values were calculated for the points determined in the regulations. Then the relation between V_{WR} and aspect ratios calculated by dividing building height to street width for different variations was evaluated

For 20 x 20 m square building forms, building configurations with horizontal spacings of 10 m, 15 m, 20 m and building heights of 6 m, 15 m, 20 m for each interval were determined (Fig.1). Street widths are increased for horizontal axles only. The street widths on the vertical axis are kept constant as 10

m. As the wind effect decreases with the effect of urban elements, analyzes were made on a target area determined in the model. The facade surface temperatures of the four identified buildings were measured at 2 m along the facade and were indicated as C1, C2, C3, C4. Wind speed ratios were also calculated for 6 points (N1-N6) within the same target area and their arithmetic averages were taken.

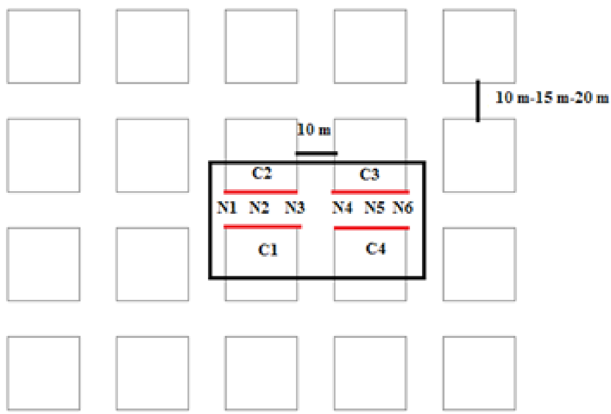


Figure 1. The overall dimensions for the building arrangements modeled in the simulations and the points determined for the wind velocity ratio.

2.1. Solution Methodology

Ansys Fluent 18.2 program was used for simulations. Urban areas are modeled with the Geometry tool in Ansys Workbench and meshed with the Meshing tool. Boundary conditions were defined in the fluent solver and simulations were performed in the steady regime.

The velocity profile (U) of inlet, the turbulent kinetic energy profile (k), and the turbulent dissipation rate profile (ε) are calculated by equations (1) – (3)

$$U_0 = U_{ref}\left(\frac{z}{H}\right)^{0.25} \tag{1}$$

$$k(z) = u_*^2/\sqrt{C_\mu} \tag{2}$$

$$\varepsilon(z) = C_\mu^{\frac{3}{4}} k^{\frac{3}{2}} / (k_v z) \tag{3}$$

Where z presents the height coordinate (m), z is the aerodynamic roughness length (m), k is the Von Karman constant, and u_ is the atmospheric boundary layer friction velocity (m/s) (Bouhacinaa et al, 2013). The governing equations of Fluent could be found in the references (Ansys Fluent Users's Guide, 2019) and have not been presented here in order to summarize the paper. The governing equations are solved as discrete using the control volume method and converted to numerically solvable algebraic equations (Bouhacinaa et al, 2013).

2.2. Boundary Conditions

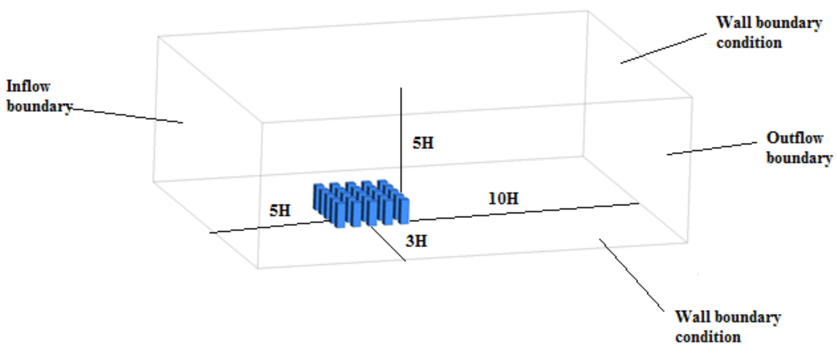


Figure 2. Domain of the study.

The height of the working volume is modeled as 5 times the height valid for the urban configuration, and the wind entry and exit limits are 5 and 10 times this height, respectively (Fig. 2). The wind entry speed was accepted as 3 m/s and the direction was taken as NW. Meteorological data valid in Elazig province were used for the calculated heat transfer coefficients and air temperature values (Government Meteorological Office of Turkey, 2019). Accordingly, in the initial boundary conditions, the wind inlet temperature is 298.15 K and the temperature for the surfaces is defined as 308.15 K. A skewness ratio of 0.83 is provided for the network quality. The standard k-ε turbulence model was used in the simulations.

2.3. Spatially Averaged Wind Velocity Ratio

Wind velocity ratio (V_{WR}) is an indicator to assess the wind's availability at pedestrian level in an urban area. It is defined as the ratio of wind velocity at the top of the boundary layer to the wind velocity at the pedestrian level which is 2 m above ground. Since its value is affected by the arrangement of buildings in a district, the higher the value of , the better the natural ventilation in urban area (Ng, 2009). It can be calculated by equation (4)

$$V_{WR} = V_p / V_{ref} \tag{4}$$

V_p presents the wind velocity at 2 m above the ground level (pedestrian level) while V_{ref} is the inlet velocity of the wind.

2.4. Aspect Ratios

Aspect Ratio (AR) is a parameter that is calculated by dividing building height to street width in an urban canyon. In this study building heights accepted as 6, 15 and 24 m while street widths varied as 10, 15 and 20 m (Fig. 3). Table 1 presents the AR values for changing building heights and street widths that are used in the study. AR value calculated as 2.4 for the narrowest street width and highest building while it is calculated as 0.3 for the widest street and shortest building variation.

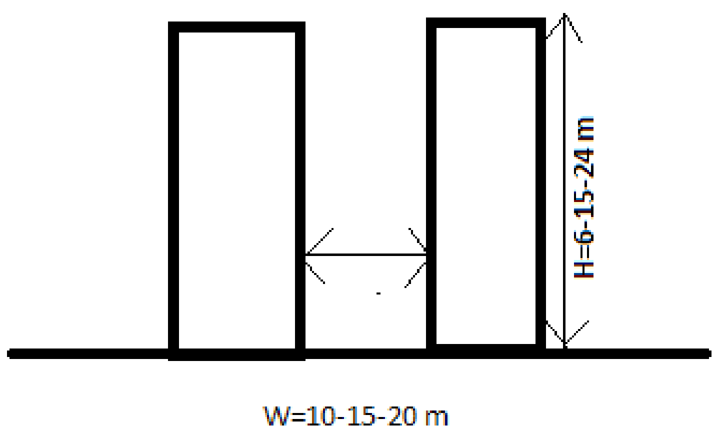


Figure 3. Building heights and street widths used in the study.

Table 1. Aspect Ratio values for changing building heights and street widths.

Building Height (H)	6 m	15 m	24 m
Street Width (W)		**Aspect Ratio (H/W)**	
10	0.6	1.5	2.4
15	0.4	1	1.6
20	0.3	0.75	1.2

2.5. Validation Study

It is obviously necessary to provide the validation of a study done by computational fluid systems with a set of observational data (Hussain &Oosthuizen, 2012). An observational study was performed in order to validate the code. For this purpose, wind velocity measurements were done for the points N2, N3 and N5 for generic configuration that exists in Elazığ. Measurements were done by a mobile CEM DT-619 model thermo-anemometer (CEM Instruments, 2019) and taken on 14th September 2018 at 16.00 pm.

Table 2. Comparison of simulated and measured wind velocities for N2, N3 and N5 points.

	N2	N3	N5
Simulated Wind Velocity (m/s)	2.24	2.67	3.28
Measured Wind Velocity (m/s)	2.20 (NW)	2.60 (NNW)	(3.20 NW)
Convergence(%)	1.78	2.62	2.43

Due to measured wind direction (NW) and velocities (2-3 m/s) for the assessed points, results for $\varphi = 45^{o}$ and V=3 m/s simulation were used for validation study. Measured and simulated data are listed in Table 2. According to Table 2, 1.78%, 2.62% and 2.43% convergences were obtained for N2, N3 and N5 points, respectively.

3. Results

In this study it is aimed to analyze the relation between parameters of wind velocity ratio and aspect ratio. Cfd analyses were performed for a parametric urban area that refers to the old city center in Elazığ, Turkey. Wind velocity ratios calculated for the assessed points in the target area while different aspect ratios for changing street widths and building heights have been taken into account.

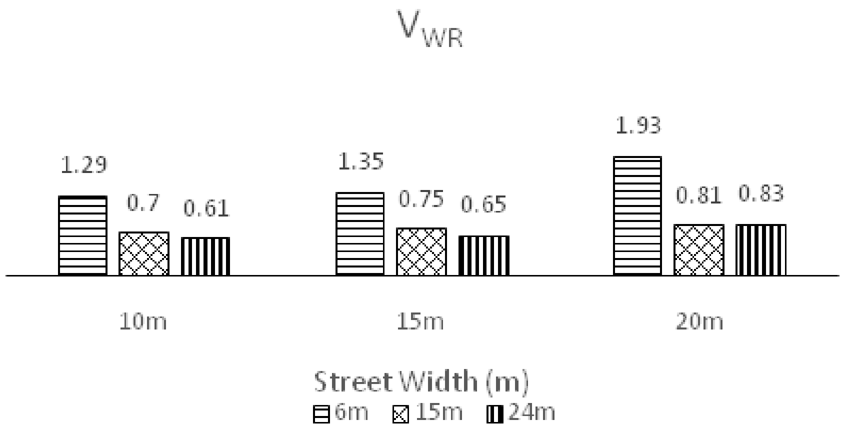
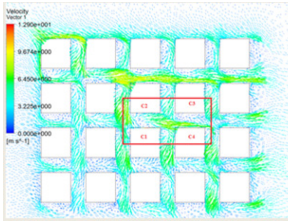
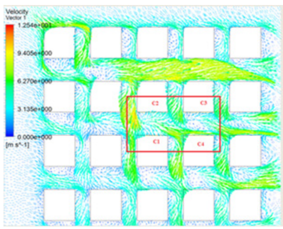
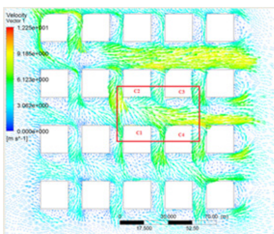


Figure 4. Wind velocity ratios calculated for different building heights and street widths.

Wind velocity ratios calculated as between 1.29-1.93 for 6 m building height, 0.7-0.81 for 15 m building height and 0.61-0.83 for 24 m building height (Fig. 4). Best result is determined with the largest street width (20 m) and shortest building height (6 m) as 1.93. On the other hand by increasing building height, ventilation performance of urban areas decreased. There is also a remarkable difference for wind velocity ratio of 15 m and 24 m height buildings for every street width due to 6 m height buildings. This means a remarkable effect of building height on ventilation performance of urban areas. AR values above AR:1 cause a negligible difference on ventilation performance. For example, 15 m and 24 m building heights present the V_{WR} values that are 0.7-0.61 for 10 m street width, 0.75-0.65 for 15 m street width and 0.81-0.83 for 20 m street width respectively.

Table 3. Flow field and V_{WR} for 6 m building height with different street widths.

Street Width (m)	Flow field	V_{WR}	Aspect Ratio (H/W)
W=10		1.29	0.6
W=15		1.35	0.4
W=20		1.93	0.3

When it is evaluated with the aspect ratios of urban configurations, it is observed that less the AR the better ventilation performance with a higher V_{WR} is possible (Table 3). On the other hand aspect ratio is doubling, when street width is decreasing from 20 m to 10 m while V_{WR} does not provide the same amount of variety.

Table 4 presents the flow field, V_{WR} and AR for 15 m building heights. When the building heights reach to 15 m in the configuration, V_{WR} values decreased and aspect ratio values increased. While street widths ranged from 10 m to 20 m, V_{WR} values decreased from 0.81 to 0.70. For 10 m and 20 m street widths, AR values are doubling while V_{WR} does not provide the same amount of variety.

Table 5 presents the analysis results for a building height of 24 m. While the lowest V_{WR} values were obtained for this part of the analysis, the highest AR values were also calculated among all the options.

When the flow field presented on Table 3-Table 5 analyzed stronger velocity vectors for 6 m building height could be noticed. As the building heights increase, it is seen that the wind speed decreases in the flow chart. Although the geometry of the urban configuration has an effect on this situation, the fact that increasing building heights create a barrier for the wind should not be neglected.

Table 4. Flow field and V_{WR} for 15 m building height with different street widths.

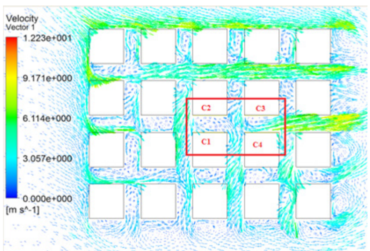
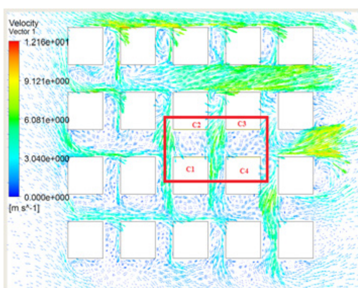
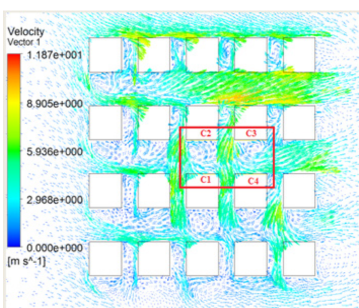
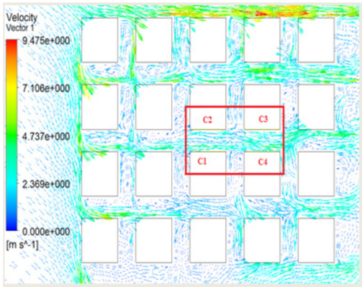
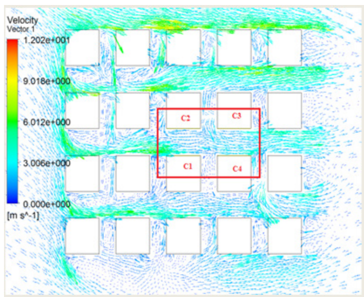
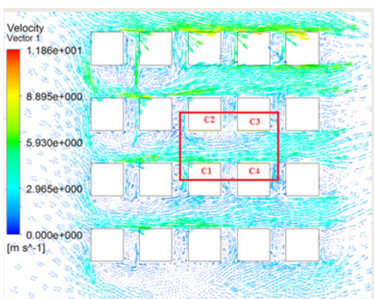
Street Width (m)	Flow field	V_{WR}	Aspect Ratio (H/W)
W=10		0.70	1.5
W=15		0.75	1
W=20		0.81	0.75

Table 5. Flow field and V_{WR} for 24 m building height with different street widths.

Street Width (m)	Flow field	V_{WR}	Aspect Ratio (H/W)
W=10		0.61	2.4
W=15		0.65	1.6
W=20		0.83	1.2

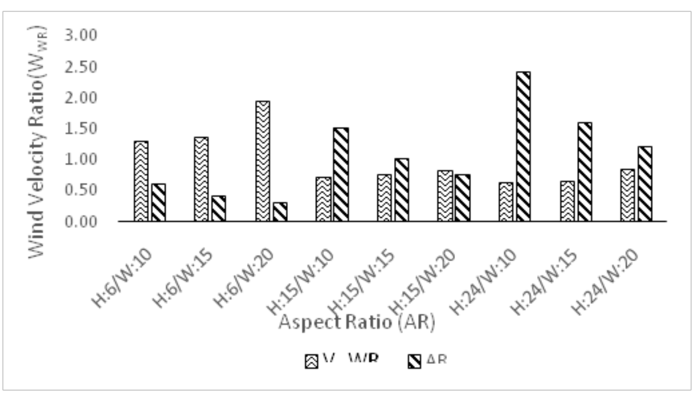


Figure 5. V_{WR} values obtained for varying AR values.

Fig 5. shows that there is an inverse relationship between AR and natural ventilation performance. However, this inverse ratio is mostly related to the building height variable. On the other hand, in cases where the building height is low and the street width is large, especially the AR value below 0.5 affects the ventilation performance positively.

4. Conclusion

In this work, the aim was to analyze the ventilation performance of a generic urban configuration existing in the old city center of Elazığ in relation with two parameters as wind velocity and aspect ratios. 10-15-20 m street widths to 6-15-24 m building heights were used to calculate aspect ratios. CFD-based simulations were completed considering, 3 m/s wind velocity and 45° (NW) wind direction.

The main findings of the study can be summarized as the following:

- AR has an inversely proportional relationship with V_{WR}.
- This inverse ratio is mostly related to the building height variable cause increasing building heights create a barrier for the wind in urban areas.
- AR values above AR:1 cause a negligible difference on ventilation performance.
- For some cases when AR values doubled, V_{WR} did not provide the same amount of variety.
- AR values below 0.5 affects the ventilation performance positively.

Geometric features of an urban configuration could be accepted as a main factor that affects the ventilation performance. Although AR is an effective parameter as mentioned in this study on V_{WR}, shape of the buildings in the urban area, its porosity due to wind effect, wind direction and speed are also important parameters that should be evaluated for this purpose. To support this attention, it is also planned to analyze the ventilation performance of different configurations with different geometric features, wind speed and directions based on aspect ratio.

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CHAPTER VI

A COMPARATIVE EXAMINATION OF EARLY REPUBLIC PERIOD PRIMARY SCHOOL BUILDINGS IN ANATOLIA WITH A COMPARISON ANALYSIS BY SPACE SYNTAX METHODOLOGY AND PRINCIPLE SUGGESTIONS FOR THEIR CONSERVATION

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1. Introduction

Architectural conservation is a field of study with a long history. However, professional approaches on this subject have started to be developed more recently. First of all, the process starts with basic questions about which building will be conserved and why; it has progressed by considering the conserved buildings over time from a wider perspective (Tanaç Zeren, 2010). In this sense, the scope of the buildings worth conserving has gradually expanded and has taken its present form.

Studies on conservation in Turkey have developed over monumental buildings, as in many other countries in the world. First of all, the conservation of qualified and symbolic buildings has gained importance. However, with the developments in this issue in the world, not only monumental buildings; it has been understood that many buildings with different functions and features should be taken under protection. In this context, architectural works with different functions such as health, industry and education have also become the working areas of the conservation discipline.

One of the important parameters of conservation is historical value (Ahunbay, 1999). Buildings with this value are primarily taken under protection. In Turkey, in the legal regulations made with the Law No. 2863 on the Conservation of Cultural and Natural Assets, it is stated that immovable properties built until the end of the 19th century can be considered within the scope of conservation (URL 1). For this reason, many qualified works belonging to the Republican Period remain outside the scope of conservation. Although works built after the date given, but considered worthy of preservation because of their importance and features, are also evaluated in the context of conservation, it can be noted that the works of Republic Period have not been sufficiently studied in terms of application (URL 1). Especially in Anatolia, many qualified buildings belonging to the period in question have been lost before even documentation can be made.

Educational buildings constitute an important part of the architectural works of the Republican Period in Anatolia. Many primary, secondary and high school buildings stand out for their qualities worth conserving. In this context, the aim of the study is to contribute to the conservation of the early Republican Period educational buildings in Anatolia by examining the qualities of the educational buildings with the space syntax method. Within the scope of the study, the primary school buildings of the period were examined in general and Malatya Gazi Primary School in the eastern region of Anatolia, Niğde İnönü Primary School in the middle region and Düzce/Akçakoca Orhangazi Primary School buildings in the western region were examined comparatively by the space syntax method. Based on the results obtained, the relevant literature was also examined, and suggestions were listed in the context of principle regarding the conservation of buildings. The study method consists of literature reviews and on-site investigations. As a result, with the analyzes and suggestions made, attention will be drawn to the conservation of the architectural heritage of the Republican Period; it is thought that it will contribute to the conservation of the examined buildings and other educational buildings that reflect the characteristics of the period.

2. General Features of Space Syntax Analysis

The natural environments and spaces that emerged as a result of the conditions and needs of the period are formed by being shaped according to the socio-cultural characters and identities of the region they belong to. The resulting space fictions are shaped according to the cultures and identities of the users, geography and period (Aydın and Çınar, 2009). Culture-space interaction reflects the dynamic relationship between people and their environment by including temporal traces in the formation of residential spaces. Cultural components that change during the process also affect behavioral and spatial characteristics in the acculturation process (Turgut, 2003). Over time, places have been in a transformation by developing with the effect of economic, cultural, social and technological factors. Due to these factors, there are also differentiations in the spaces and the buildings that make up these spaces and the environment. In this case, the effect and interaction of places, people and societies take place at the level of limitations (Hillier et al., 1993).

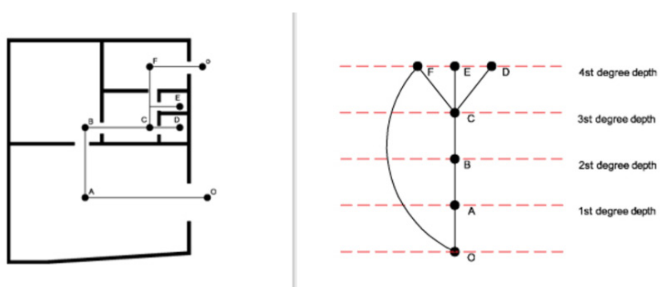
Morphological analysis method, which is one of the spatial analysis evaluations; it is a method that examines spatial and structural dimensions such as the reasons for the formation of space and mass, the principles of formation, the relations of space and architectural elements, and how users perceive spaces. In short, morphology is a science that examines forms and formations (Dursun, 1995). In the field of architecture, morphology is defined as the harmony of all spaces and elements that make up the building with each other and the formation of them in accordance with the function. In the architectural context, concepts such as unity, order, proportion, measure and composition come to the fore (Yıldırım, 2001; Yıldırım 2002).

Many studies are carried out to examine the space and the factors that make up the space. The space syntax analysis method, which is one of the morphological analysis methods, has been developed to understand the systemic building and fiction of spaces at the scale of building or settlement. Thus, the analysis method helps to understand the working style of the spatial system that makes up the environment and the building. Evaluations can be made by examining the positive and negative aspects of the spaces revealed with mathematical and visual graphics. Morphological analyzes in the plan were developed by Bloch (1979), Steadman (1983) and Hillier and Hanson (1984). Space syntax is a method developed for the morphological analysis of architectural designs, or in other words, for defining and analyzing the fiction of existing spaces in built environments (Yıldırım, 2001). In order to better explain the method used in this study, the concepts and expressions used in the analysis are briefly included. Of these, nodes are composed of n elements that are functionally related to each other; edge to the connection between the elements; the closed areas formed between connections are called regions. The name of the method in which all these are found is graph.

The graph method is used to analyze spaces and their relations with each other. To be able to comprehend the complex and intense functional relationships of spaces and space groups in architecture; at the same time, this method is used to reveal the data mathematically. A graph consists of a set of points connected by lines. While the dots represent a space or a set of objects; lines represent the connection between two objects or spaces. (Levin, 1964; Kahvecioğlu, 2001).

In the analysis method used in the study, each node is expressed with a point; relations between spaces are expressed by edges. Thus, the relationship between the two spaces is indicated by the terms of neighborhood and transition (Broadbend, 1973).

Figure 1 shows the neighborhood graph plan and the depth graph of a building. Each space of the building is indicated by a node and the connections between the spaces are indicated by lines. The concept of depth is an important factor for spatial configurations (Çakmak, 2011) On the other hand, the depth graph shows how many places you need to pass from one place to another. Briefly, there is information such as that you have to pass through at least 3 places to get to d or that the deepest places are d and e. Thus, a transition graph (neighborhood graph) is created to express the spatial organization of the building. Then, analyzes are made by creating a depth graph (arranged transition graph) in order to determine the depth of each space relative to the other space. In the transition graph obtained in the digital environment, the colors have certain meanings. While the red color expresses the most integrated and visual areas; the color dark navy blue represents the most differentiated and the last accessed space of the system (Özyılmaz, 2007).



(a) (b)

Figure 1: Examples of Transition Graph (Neighborhood Graph) (a) and Depth Graph (b) (Hillier and Hanson, 1984)

While using the graph method in this study, the following approaches were used as analysis tools:

- Connectivity value is the measurement of the space and the number of neighboring spaces. It gives basic information to comprehend a place. It includes information about the visual perception and permeability of a space (Ünlü and Edgü, 2007). In the digital environment, the red areas represent the parts where the visuality is high; dark blue areas represent areas where permeability and visual perception decrease.
- Visual integration value provides data on the visuality and permeability of the building and the spaces that make up the building. If the integration value of a building is high, it is shallow; in other words, it is understood that permeability and social interaction are high. In cases where the integration value is low, deep spaces; that is, areas where permeability and visuality are low (Ünlü et al., 2001).
- Visual mean depth value gives the most important data of space syntax method. Depth refers to the state of passing through spaces to reach a space. If the value revealed in this context is low, the building has shallow spaces; if it has a high value, it is understood that it has deep spaces. The average of these values represents the whole and provides the opportunity to compare with other systems (Hillier, 1984; Çakmak, 2011).
- Beta Index: Depending on the network's node and edge relationships; it gives numerically what kind of network it is. It is the ratio of the total number of edges to the total number of nodes. If this value is $\beta<1$, the building is tree; If $\beta=1$, loop; If $\beta>1$, it shows complex circuit property (Figure 2).
    - Beta Index (B=E/V= Beta Index: Graph Edge/Graph Node) (Broadbent, 1973)

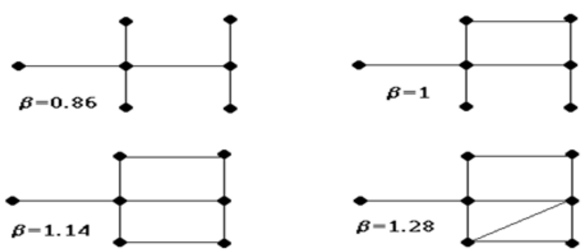


Figure 2. Beta Index (Broadbent, 1973)

- Gamma Index: Depending on the relationship density of the network elements; gives the "Connection" rate of the network numerically. It provides data on whether the building form is compact or segmented. A value of 1 indicates full connectivity, while a value of 0 indicates complete disconnection between network elements (Yıldırım, 2001) (Figure 3).
    - Gamma Index ($\mathbf{G = \frac{E}{(v2 - v)} / 2}$) (Broadbent, 1973)

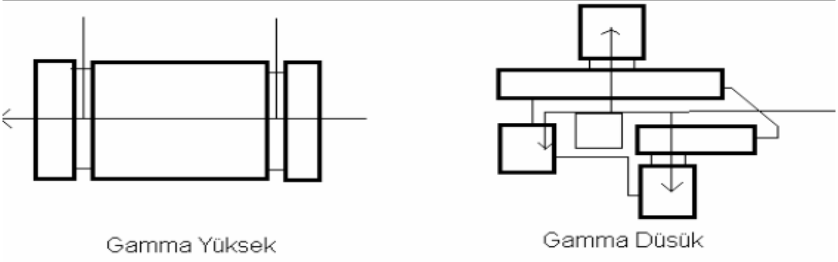


Figure 3. Gamma index building shape relationship, from left to right gamma high and gamma low (Yıldırım, 2002)

In this study, graph chart, depth chart, beta and gamma values of each building were compared in order to understand and compare the spatial configurations of the buildings. In addition, the Connectivity value, Visual integration value and Visual mean depth values and graphics of the buildings were included in the digital environment, and evaluations were made with the tables created.

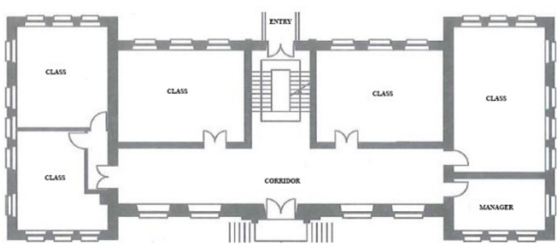
3. Characteristics of Early Republican Period Primary School Buildings in Anatolia

The Republican Period represents a dynamic process that brought many changes with it since the early 1920s in Anatolia. In this process, where radical transformations are experienced, studies in the field of education are at the forefront of the arrangements made. The Law of Unification of Education dated 1924 can be considered as the first of the changes made in this area (Ekmekçi, 2012). With the transition to coeducation in 1926, the changes made in the education system gradually increased and the steps taken in this regard accelerated (Alpagut, 2005).

With the proclamation of the Republic, many legal arrangements were made in the field of education. While making a great contribution to the education level in the urban area with these studies; the desired level could not be reached in rural areas. For this reason, it was tried to improve education in rural areas with the Night Classrooms application (Bozkurt and Bozkurt, 2009). Over time, many studies have been carried out to ensure educational equality in both urban and rural areas, and in this sense, primary schools have gained great importance.

Educational institutions, which were called 'Sıbyan Mektebi' in the Ottoman Period, were later named as 'İptidai' and 'Rüşti'. These institutions, which were considered as primary schools in the Republican Period, were named primary schools in the process (Parlak and Yaldız, 2017). Then, primary school education was made compulsory and free for all citizens (Alpagut, 2005; Parlak and Yaldız, 2017). In this way, many primary school buildings were built in different parts of Anatolia.

While the intellectual infrastructure of education was formed in the 1920s in the Republican Period; in the process dating back to the 1940s, it gradually matured and settled into a certain order (Kul, 2011). Especially in cities and large residential areas, many primary school buildings were built with taxes collected from the public (Parlak and Yaldız, 2017). In this context, by establishing a construction department within the Ministry of Education; type projects prepared here were implemented (Kul, 2011). These projects, which started to be implemented after 1926, differ according to the place where they were built. An important example of this is; it is the Ankara Gazi and Latife Schools project, which was implemented in many parts of Anatolia until the 1930s. The plans of this building were implemented in rural areas as a single storey (Kul, 2011) (Figure 4).



(a) (b)

Figure 4. Ankara Gazi and Latife Schools' general view (a) and floor plan (b) (URL 2; Erdoğan, 2009)

When we look at the Gazi and Latife Schools type project, which was implemented in the Republican Period, in the context of the plan; it is seen that the entrance axis of the settlement was designed to be close to the main transportation arteries.

The classrooms are rectangular in shape and the row order is formed with a blackboard on the short side. According to the needs, the spaces in this plan scheme have been increased and more administrative units and areas such as equipment room and conference hall have been added. In addition to the I plan scheme in Gazi and Latife Schools, there are also examples where rectangular and U plan schemes are applied. The rectangular plan scheme is symmetrical and features a courtyard. The U plan scheme is also symmetrical and there is a core at the ends of the corridors (Parlak and Yaldız, 2017) (Figure 5).

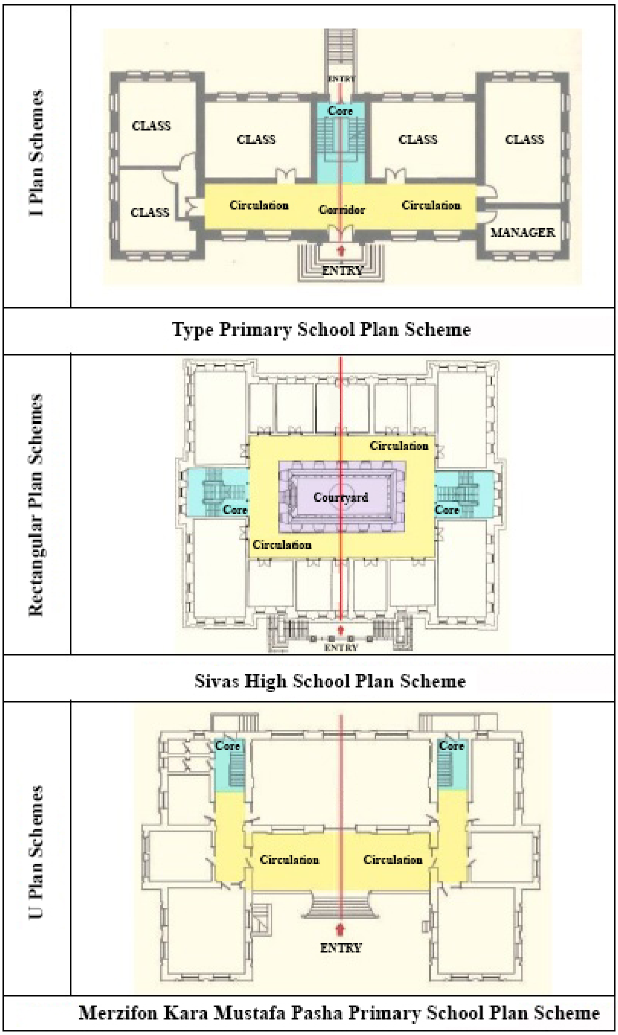


Figure 5. Plan schemes of educational buildings in the Early Republican Period (Parlak and Yaldız, 2017)

The plan schemes seen in educational buildings may differ according to time and needs. In this sense, factors such as the geography where the scheme is applied, being in the city or in the countryside, the availability of applied education, social activities are the main factors that affect the shaping of the schemes.

4. Application of Space Syntax Method in Early Republican Period Primary School Buildings in Anatolia: Gazi Primary School, İnönü Primary School and Orhan Gazi Primary School

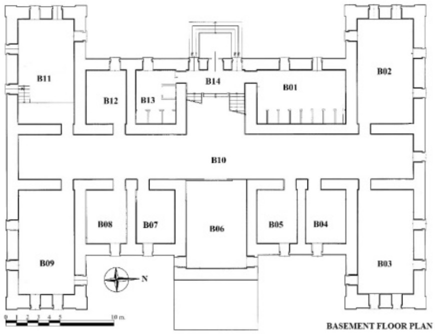
Anatolia has very rich qualities in the context of the works of the Republican Period. In the settlement areas that were not developed and deprived of many opportunities during the Ottoman period, progress was made with the investments made in the fields such as industry, health and education in the Republican period. While some of the buildings built with these developments can reach today as qualified architectural works; some have been lost. Among the buildings that have survived to the present day, those with educational functions are also found in many parts of Anatolia. In this context, the buildings of Malatya Gazi Primary School, Niğde İnönü Primary School and Düzce/Akçakoca Orhan Gazi Primary School were selected from the eastern, central and western regions of Anatolia and examined with the space syntax method.

Malatya Gazi Primary School is one of the first buildings built in the city during the Republican Period. The building, which is located in Saray Neighborhood of Battalgazi district, is located on block 92 and parcel 45 (Figure 6). The primary school building, which was registered with the decision of the High Council of Real Estate, Antiquities and Monuments, dated 14.04.1979 and numbered A-1622; it was determined as conservation group I with the decision of the High Council for the Conservation of Cultural and Natural Assets, dated 05.11.1990 and numbered 660. The property is owned by the Treasury of Finance and it continues to function as a school today (Çelemoğlu and Atıcı, 2021) (Figure 7).

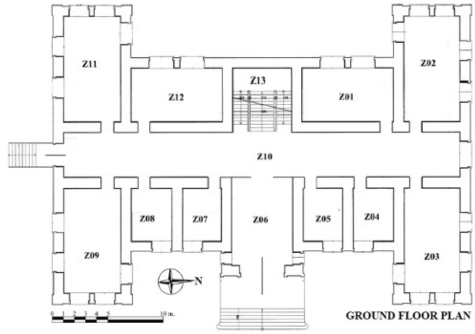
Figure 6. The location of Gazi Primary School in relation to İnönü Street, which is the main axis of the city (Google Earth, 2021)

Figure 7. General view of Gazi Primary School (2018)

Although there is no information about the construction date of the Gazi Primary School building, it is known that it was put into service in 1933 (URL 3). It consists of basement, ground and first floor. Its dimensions are 40x25 m and it has a symmetrical plan. It is possible to state that the plan scheme is similar to the I plan type in general (Figure 8). The corridor in the north-south direction has plans consisting of spaces in the east and west directions (Figure 9). The main entrance is on the east side. Access to the basement and first floor is provided by a three-armed staircase in the west (Figure 10). The top cover is a hipped roof.



(a)



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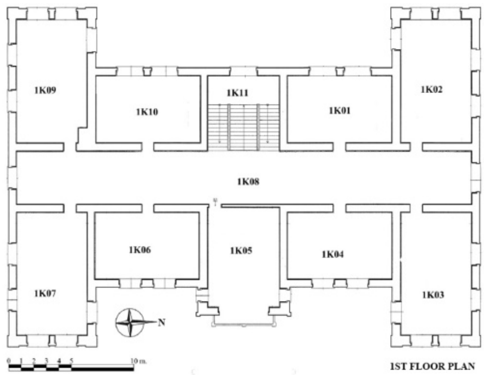
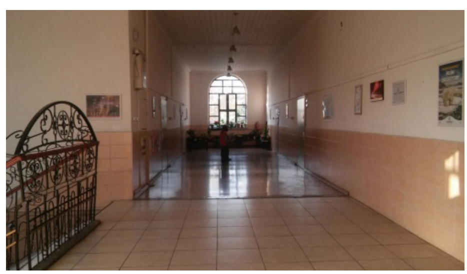


(c)

Figure 8. Gazi Primary School basement
(a), ground (b) and 1st floor plans (Çelemoğlu and Atıcı, 2021)

(a)



(b)

Figure 9. Gazi Primary School west facade
(a) and 1st floor corridor (b) (2018)

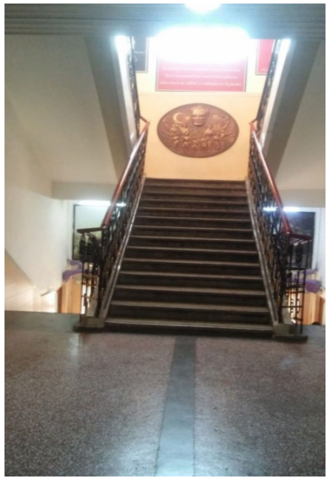


Figure 10. Gazi Primary School stairs (2018)

As a result of the evaluations, data about the spatial organization of the Malatya Gazi Primary School building were revealed. By creating syntactic diagrams and graph diagrams separately for each floor of the building, including the basement, ground and upper floors; tables consisting of numerical and visual data are included. Looking at the beta values of each floor in the tables; it has been understood that the ground floor has a cyclical form. When the upper and basement floors of the building are examined, it is revealed that the spatial organization has a linear form. Looking at the gamma indexes of the buildings; since the average values of each floor are the same and close to 0, it is understood that the building has a fragmented setup. Looking at the depth graph of the building; it has been understood that the basement and ground floors have the deepest spaces at the 3rd degree depth, while the upper floor consists of the spaces with the 1st degree depth. When we look at the connectivity visual analyzes in the tables in Figure 11, it is seen that red areas, visuality and permeability are high; on the other hand, it is seen that dark blue areas refer to deep spaces, that is, to areas where communication is reduced. In addition, when the integration value of the building is considered, the upper floor with the highest integration value has shallower spaces; in other words, it has been understood that it has a spatial setup where visuality and permeability are high. In the tables prepared, the data about the spatial values for each floor of the building are presented in detail. (Figure 11).

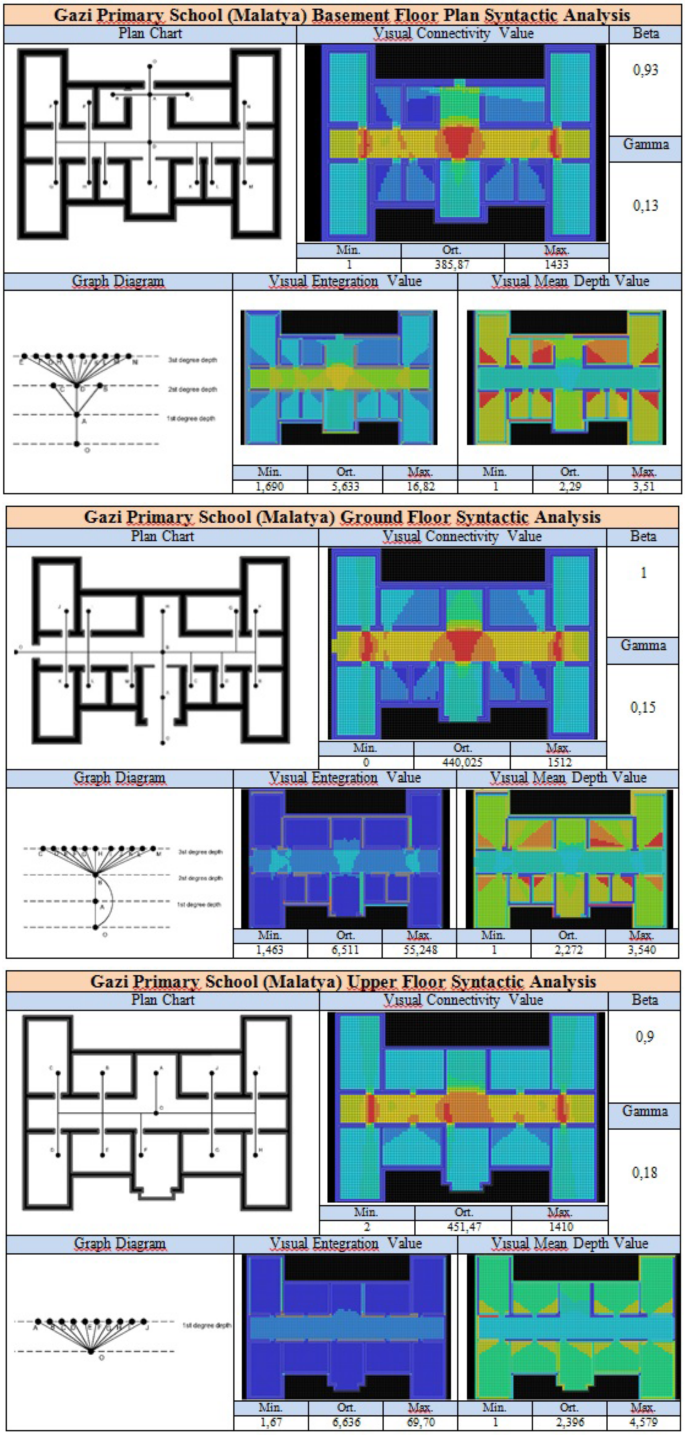


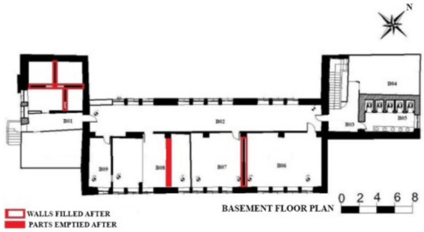
Figure 11. Gazi Primary School analysis

Niğde İnönü Primary School is located in Kayabaşı Neighborhood in the center of the city (Figure 12, Figure 13). The building, which was built in 1936, is one of the important stone masonry buildings in Niğde (Akçaözoğlu et al., 2019). The building continues to be used as a school today.

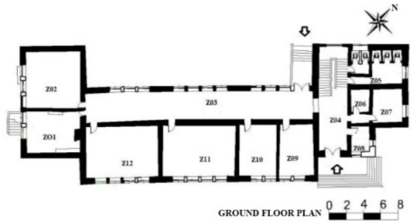
When the architectural qualities of the İnönü Primary School building are examined in general; it is seen that it is a three-storey building consisting of a basement, ground and first floors. The plan scheme of the building, which has a corridor in the northeast-southwest direction, conforms to the I plan type (Figure 14). The spaces on both sides of the corridor and in the southeast are the main elements of the plan scheme (Figure 15). The entrance door is located in the southeast direction. The basement and first floors are accessed via a two-armed staircase in the northeast direction. Top cover is hipped roof. (Akçaözoğlu et al., 2019).

Figure 12. The location of İnönü Primary School in relation to Municipality Building and city square (Google Earth, 2021)

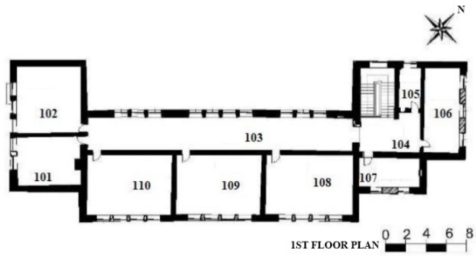
Figure 13. General view of İnönü Primary School (Akçaözoğlu et al., 2019)



(a)

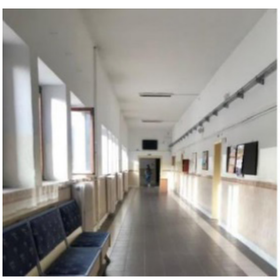


(b)

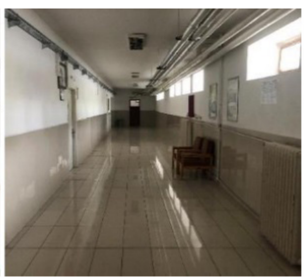


(c)

Figure 14. İnönü Primary School basement
(a), ground (b) and 1st floor plans (Akçaözoğlu et al., 2019)



(a)



(b)

(c)

Figure 15. Ground floor (a), 1st floor (b) and basement floor
(c) corridors of İnönü Primary School (Akçaözoğlu et al., 2019)

As a result of the evaluations, data about the spatial organization of the Niğde İnönü Primary School building were revealed. In this context, when we look at the beta index of the building; it has been determined that the ground floor has a cyclical form, while the basement and upper floors have a linear form. Looking at the gamma index of the building; it is understood that the floors have a fragmented function, and the top floor is the one with the most compact spatial organization among the floors. When the depth graph of the school building is examined; it has been determined that the basement floor has the deepest spaces with a depth of 4th degree, while the upper floor consists of shallow spaces with a depth of 2nd degree. When we look at the connectivity visual analyzes in the tables given in Figure 16, the red areas have high visual and permeability; it is understood that dark blue areas indicate deep spaces, that is, areas where communication is reduced. Considering the integration values of the building, it is understood that the ground floor, which has the highest integration value, has spaces with high visual and permeability.

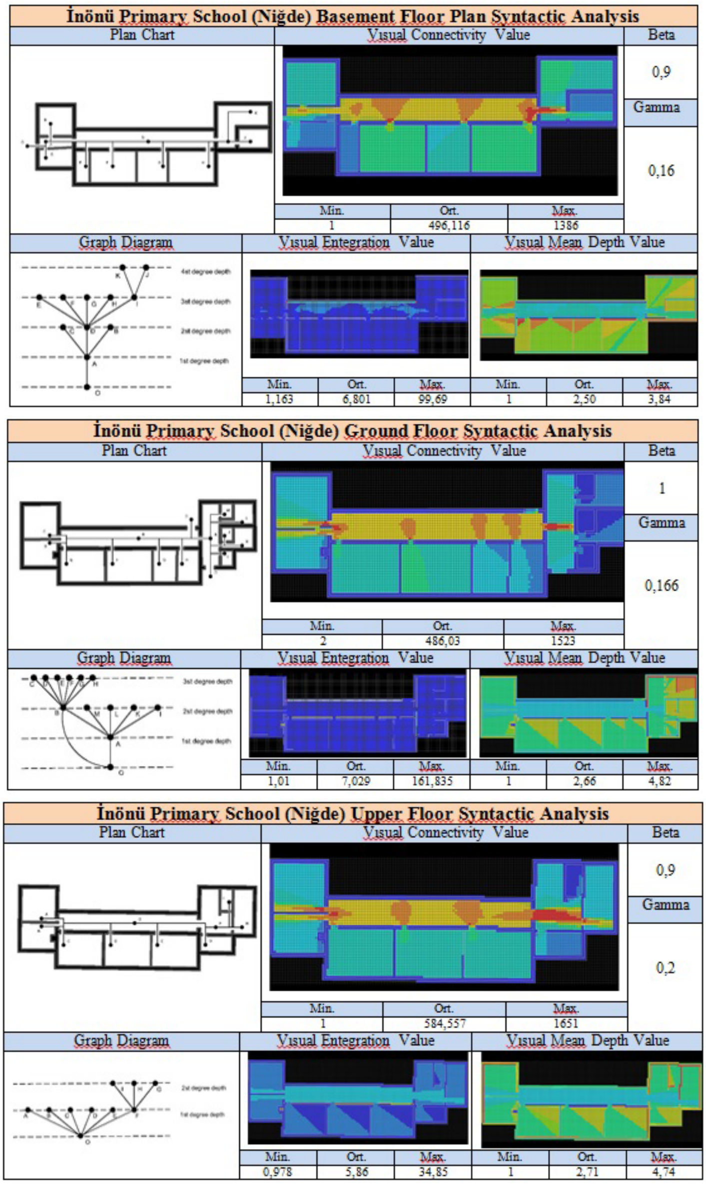


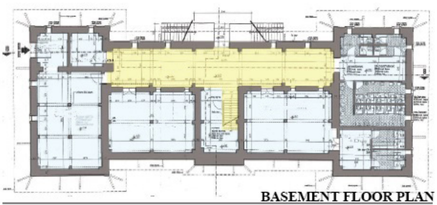
Figure 16. İnönü Primary School analysis

Düzce/Akçakoca Orhan Gazi Primary School is located in Kapkirli District, block 207, parcel 1 (Figure 17, Figure 18). Its construction started in 1926 and it was put into service in 1929. It has been registered with the decision of Ankara Cultural and Natural Heritage Conservation Regional Board dated 12.06.1995 and numbered 4023. The building is not used today due to the insufficient number of students. (Sahtiyancı and Benli Yıldız, 2020).

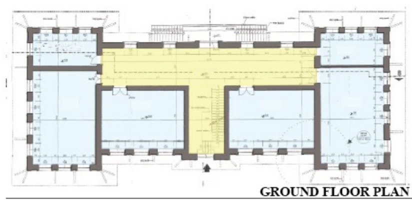
The Orhan Gazi Primary School building consists of a corridor located in the east-west direction and the basement, ground and first floors consisting of the spaces around it. The school building, which has a symmetrical plan, is similar to the I plan type (Figure 19, Figure 20). The main entrance gate is located in the south. Access to the basement and 1st floors is provided by a single arm staircase located close to the main entrance. However, apart from this staircase, there are other stairs in the building. The top cover is hipped roof. (Sahtiyancı and Benli Yıldız, 2020).

Figure 17. The location of Orhan Gazi Primary School in relation to Municipality Building (Google Earth, 2021)

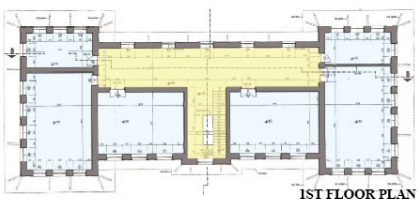
Figure 18. General view of Orhan Gazi Primary School (Sahtiyancı and Benli Yıldız, 2020)



(a)

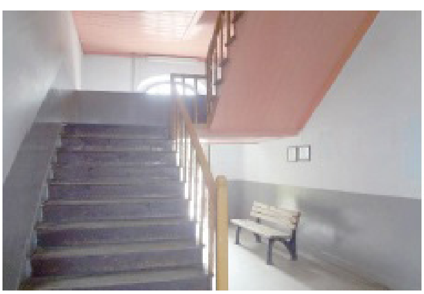


(b)

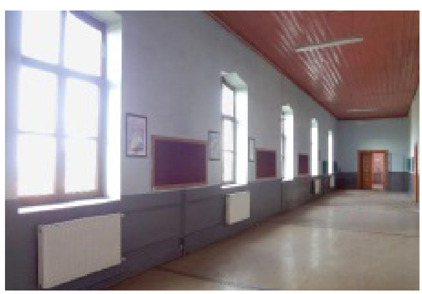


(c)

Figure 19. Orhan Gazi Primary School basement (a), ground (b) and 1st floor plans (Sahtiyancı and Benli Yıldız, 2020)



(a)

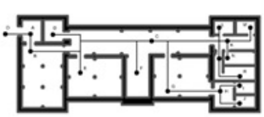
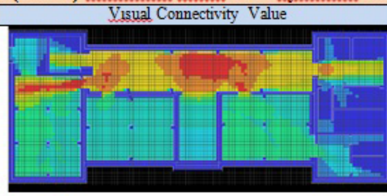


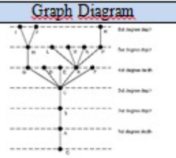
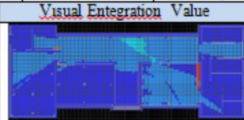
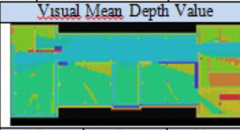
(b)

Figure 20. Entrance hall and main corridor of Orhan Gazi Primary School (Sahtiyancı and Benli Yıldız, 2020)

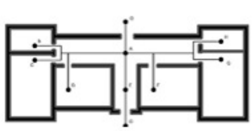
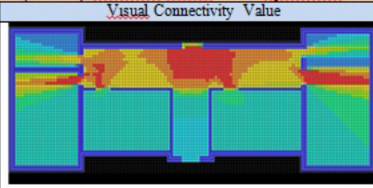
As a result of the evaluations, data about the spatial organization of the Orhan Gazi Primary School building were revealed. By creating separate syntactic and graph schemes for the basement, ground and upper floors of the building; tables (Figure 21) consisting of numerical and visual data are included. Considering the beta index values of the building, while the ground floor has a cyclical setup; it has been determined that the basement and upper floors have a linear spatial configuration. Looking at the gamma indexes of the buildings, it is understood that the basement floor has the most fragmented spatial organization. Looking at the depth graph of the school building; it is understood that the basement floor has the deepest spaces at the 6th degree depth. The ground and upper floors of the building also have 2nd degree depth. When we look at the connectivity visual analyzes in the tables, the red areas are high in visual and permeability; it is seen that dark blue areas express deep spaces, that is, areas where communication is reduced. Considering the integration values of the building, although it has similar integration values, it can be stated that the ground floor has a slightly greater integration, so its spatial organization is more permeable and its visuality is higher than the other floors.

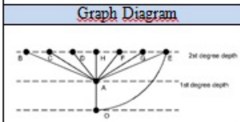
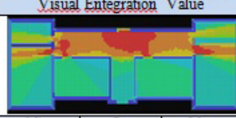
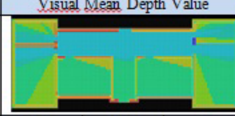
Orhan Gazi Primary School (Düzce) Basement Floor Plan Syntactic Analysis

Plan Chart	Visual Connectivity Value			Beta
				0,94
				Gamma
				0,11
	Min.	Ort.	Max.	
	0	577,16	1616	

Graph Diagram	Visual Entegration Value			Visual Mean Depth Value		
						
	Min.	Ort.	Max.	Min.	Ort.	Max.
	0,872	7,08	62,37	1	2,381	4,037

Orhan Gazi Primary School (Düzce) Ground Floor Plan Syntactic Analysis

Plan Chart	Visual Connectivity Value			Beta
				1
				Gamma
				0,25
	Min.	Ort.	Max.	
	3	757,23	1830	

Graph Diagram	Visual Entegration Value			Visual Mean Depth Value		
						
	Min.	Ort.	Max.	Min.	Ort.	Max.
	1,33	8,319	16,45	1	2,23	3,71

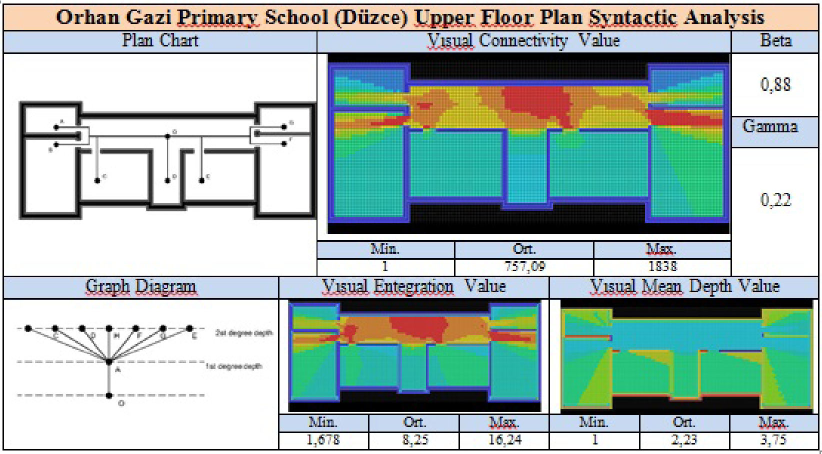


Figure 21. Orhan Gazi Primary School analysis

5. Evaluations and Conclusion

The Republican Period marked the beginning of radical changes and development in many areas for Anatolia. In this sense, various investments have been made in almost all of the Anatolian cities in every field; new buildings were built. One of the most important areas where this development has been observed is education.

The fact that the literacy rate was quite low in both urban and rural areas in the first years of the Republic brought along the necessity of building many educational buildings. This situation continued with the development of various types of projects in order to be fast. In this sense, various plan types that can be changed in accordance with geographical conditions and needs have been implemented for educational buildings at different levels. Some of these types are also seen in primary school buildings.

Primary school buildings with I, U and rectangular plan types are frequently encountered in the primary school buildings of the Republican Period. All three primary school buildings examined within the scope of the study are buildings with I plan type built in the early Republican Period. However, it can be stated that Malatya Gazi Primary School and Niğde İnönü Primary School buildings are larger and have more units because they are located in the city center and serve more population. However, while the use of these two buildings is still continuing with the educational function; Düzce/Akçakoca Orhan Gazi Primary School is not used.

Gazi, İnönü and Orhan Gazi Primary Schools, which are Republican Period buildings located in different regions, were evaluated with the space syntax analysis method within the scope of the study. In this context, each floor of the buildings was examined by graph, syntactic and visual analysis by creating separate tables in Figure 22. As a result of the evaluations, the following conclusions has been obtained:

Schools Building	**Syntactic Analysis Values**		**Functional Analysis Values**		
	Connectivity	**Entegration**	**Mean Depth**	**Beta**	**Gamma**
Gazi Primary School Basement Floor	**385.87**	**5.633**	**2.29**	**0.93**	**0.13**
Gazi Primary School Ground Floor	**440.025**	**6.511**	**2.272**	**1**	**0.15**
Gazi Primary School Upper Floor	**451.47**	**6.636**	**3.396**	**0.9**	**0.18**
İnönü Primary School Basement Floor	**496.116**	**6.801**	**2.50**	**0.9**	**0.16**
İnönü Primary School Ground Floor	**486.03**	**7.029**	**2.66**	**1**	**0.166**
İnönü Primary School Upper Floor	**584.557**	**5.86**	**2.71**	**0.9**	**0.2**
Orhan Gazi Primary School Basement Floor	**577.16**	**7.08**	**2.381**	**0.94**	**0.11**
Orhan Gazi Primary School Ground Floor	**757.23**	**8.319**	**2.23**	**1**	**0.25**
Orhan Gazi Primary School Upper Floor	**752.09**	**8.25**	**2.23**	**0.88**	**0.22**

Figure 22. Syntactic Analysis of Schools

- Considering the beta indexes of the buildings, it was determined that the ground floors of all 3 school buildings had a cyclical form; the basement and upper floors are wood; that is, it has been determined that it has a linear building. Thus, it has been determined that school buildings have similar beta indices despite being built in different regions.
- Looking at the gamma indexes of school buildings; although each floor of the buildings has similar values, it has been determined that the basement floor of Orhan Gazi Primary School, which is closest to 0, has the most fragmented spatial organization and the ground floor of this building reflects the most compact space organization.
- Looking at the depth graph of the buildings, it is seen that the basement of Orhan Gazi Primary School consists of places with 6th degree depth; it has been understood that the deepest spaces among other buildings are located on this floor.
- Considering the integration values of the buildings, this value is the highest; in other words, it has been determined that the ground floor of Orhan Gazi Primary School has the spatial setup with the highest visual and permeability. The lowest integration value was found in the basement of Gazi Primary School.

Although the analyzed buildings are units that belong to the same period and consist of similar plan types, they differ from each other in many aspects such as permeability and depth. In this sense, it is thought that examining the spaces in depth with space syntax analysis will contribute to evaluating the spaces from different perspectives and developing suggestions for their preservation. From this point of view, in order to conserve the buildings examined;

- First of all, similar qualities can be revealed, and the qualities that need to be conserved from the upper scale can be revealed with a holistic approach.
- Considering the environmental conditions of the buildings and the density of users; it can be prevented that they are out of use by the processes that can be done in the places.
- Each floor of the buildings can be handled individually and in this context, it can be applied by making separate decisions for each space according to values such as depth and integration.

- Since the buildings belong to the same period and reflect similar plan types, the decision to be made for each building can be improved by comparing it with other buildings.
- Analyzes can be increased by considering the exterior characteristics of the buildings and the open spaces they are located in, together with the space syntax analysis data applied to the interior, and more detailed conservation decisions can be made with the results obtained.
- Conservation decisions can be arranged as a model that can be applied to all educational buildings belonging to the Republican Period.

As a result, it is thought that the study will draw attention to the importance of the architectural heritage of the Republican Period, especially the educational buildings, and contribute to their conservation.

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CHAPTER VII

EVALUATION OF THERMAL COMFORT MODELS AND ENERGY-SAVING POTENTIAL IN AN OFFICE SPACE IN ISTANBUL

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1. Introduction

Research shows that the world's population is becoming increasingly dependent on energy-consuming indoor climates. (Chun et al., 2008; Walker et al., 2014). This energy dependence is meant to create a comfortable and healthy indoor environment for users (Wu et al., 2019). Almost half of the energy consumption in buildings is related to heating, ventilation and cooling (HVAC) systems, which are mostly used to achieve thermal comfort (Lombard et al., 2008).

Thermal comfort is defined as "that condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation" (ASHRAE, 2017). Therefore, it is important to provide indoor thermal comfort conditions without compromising user satisfaction and energy efficiency. Significant progress has been made in the creation of thermal comfort standards and guidelines, as well as technological tools for assessing the quality of thermal environments. (Ličina et al., 2018). Many standards such as ISO 7730 (ISO, 2005), ASHRAE Standard 55 (ASHRAE, 2017), EN 15251 Standard (EN 15251, 2007)and CIBSE Standard (CIBSE, 2006) have been established for indoor thermal comfort. Predicted mean votes (PMV) thermal comfort model and Adaptive comfort model (ACM) are included as comfort models in these standards. The PMV model was proposed by Fanger. Fanger created the PMV model, in which people's satisfaction levels were transferred to numerical data, based on indoor temperature, air velocity, average radiation temperature, relative humidity, activity level of people and clothing insulation values (Fanger, 1970). The PMV thermal comfort model is designed to be used in air-conditioned (AC) buildings without natural ventilation since it is a model created with a limited number of users in an air-conditioned laboratory environment. AC buildings are often centrally controlled and also their façade openings are closed. Users rarely have control over their thermal environment. For this reason, they can determine the thermal comfort level as colder or warmer than it actually is, in different climate types or in buildings with natural ventilation (Nicol, 2004; Yao et al., 2010; Wu et al., 2017; Rijal et al., 2017).

ACM is suggested by Dear and Brager. It was created by making 21000 measurements in 160 buildings, most of which are offices. Indoor temperatures or acceptable temperature ranges are associated with outdoor meteorological or climatic parameters. This method defines acceptable thermal environments only for user-controlled naturally ventilated spaces without any mechanical cooling and heating systems (de Dear and Brager, 1998).

Current International Standards cover AC and Naturally Vantilated (NV) buildings. However, PMV and ACM are implemented on three types of buildings; namely NV buildings, AC buildings and also MM buildings defined as "Mix Mode". MM buildings, also known as hybrid buildings, feature NV and AC to provide thermal comfort and save energy. The approach proposed by de Dear & Brager (2020) allows combining natural ventilation with some form of mechanical cooling. MM buildings designed by taking advantage of the strengths of both systems are more comfortable and consume less energy. The use of natural ventilation under recommended conditions throughout the year and the use of cooling system or mechanical ventilation when necessary to maximize comfort provide significant energy savings. Although there is no "standard" MM approach in practice today, it is necessary to evaluate each building with a unique approach (de Dear & Brager, 2020). There are studies that the adaptive comfort approach is valid for the occupants of all buildings, including AC buildings (Trebilcock, Soto-Muñoz & Piggot-Navarrete, 2020). It is an important opportunity in terms of energy consumption to switch the air conditioning application to an adaptive framework by programming synoptic and seasonal scale setpoints to building automation systems (Parkinson, de Dear & Brager, 2020).

In this context, by evaluating an office space in NV, AC and MM modes, which is assumed to be located in Istanbul, according to PMV and ACM;

- Comparison of comfort conditions of NV, AC and MM buildings according to PMV and ACMl
- Comparing comfort differences between PMV and ACM
- Calculating the energy saving potential of ACM is intended.

2. Methodology

The study covers the evaluation of an office space with NV, AC and MM building operation modes according to ASHRAE Standard 55-2017 PMV and ACM. It is assumed that the office space is located in an office building in Istanbul. Rhino 3D modeling tool, Grasshopper visual coding program, Honeybee, Ladybug plug-ins and EnergyPlus simulation engines were used for simulation studies.

2.1. Location and climate

The present study was simulated using the weather data of Istanbul in Turkey located at a latitude of 41.01°N and a longitude of 28.58°E. Istanbul is located in the northwest of Turkey. There is the Black Sea in the north, the Marmara Sea in the south and the Bosphorus in the middle of the city. Due to this feature, Istanbul carries a bridge quality connecting the continents of Europe and Asia.

The province of Istanbul is located in a region where the transition from the Mediterranean climate with hot and dry summers and mild and rainy winters to the Black Sea climate with hot summers and mild winters yet rainy in all seasons takes place. While the southern parts of the province, where the settlement is more dense, have characteristics closer to the Mediterranean climate, the climate characteristics evolve towards the Black Sea climate as one goes to the north. In this case, the difference between the maximum temperature of the warmest month and the minimum temperature of the coldest month is around 25 °C. Monthly average temperatures and sunshine durations of Istanbul are given in Table 1.

Table 1. Monthly average temperatures and sunshine durations of Istanbul

	Average temperature (°C)	Average Maximum Temperature (°C)	Average Lowest Temperature (°C)	Average sunshine durations (hours)
January	6.6	9.3	4.2	2.2
February	6.6	9.7	4.0	3.1
March	8.4	12.1	5.5	4.3
April	12.7	17.0	9.3	6.0
May	17.4	22.1	13.5	8.1
June	22.1	26.9	18.0	9.5
July	24.5	29.4	20.4	10.3
August	24.2	29.2	20.5	9.3
September	20.8	25.5	17.4	7.6
October	16.4	20.2	13.6	5.1
November	11.9	15.2	9.3	3.3
December	8.5	11.2	6.2	2.2

2.3. Building Simulation

2.3.1. Building model description

The office space chosen within the scope of the study is 7.5 x 7.5 x 3 meters. The south façade of the space has 100% transparency. Assuming that the office space is located in a plan scheme, it is accepted that there is no heat exchange from the wall, floor and ceiling components (See Fig. 1). These surfaces are defined as adiabatic to the program.

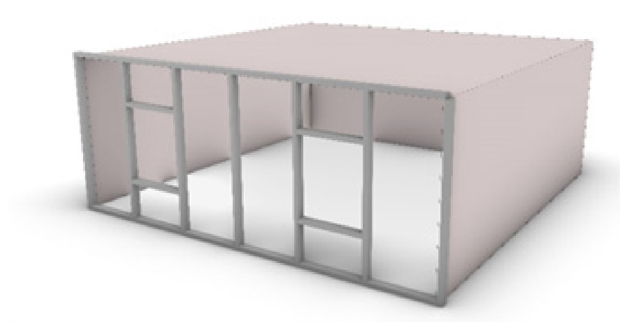


Figure 1. Model of office space

The thermophysical properties of the glass type selected within the scope of the study are given in Table 2. The joinery dimensions were determined as 50 mm x 150 mm and placed with 1.25 m axles. The U-value of the insulated aluminum joinery is 3.3 W/m²K.

Table 2. Thermophysical properties of the selected glass

	Solar Energy (EN410)		(U value) W/m²K
	g factor	SC	Air
6 +16+ 6	24	0.27	1.3
g factor : The total solar energy transmittance (solar factor) SC: The total shading coefficient U value: Thermal transmittance (W/m²K) *6 mm solar low-e glass + 16 mm air + 6mm clear float glass			

Climate data of the settlements to be simulated using the Ladybug add-on program. Climate data of Istanbul province has been uploaded to the program with "IWEC" extension.

2.3.2. Schedules, HVAC and internal gains

Office working hours are between 08:00-18:00. Total working hours per year is 2600 with Saturday & Sunday closed. The user density (number of people per area value) is 0.19 ppl/m². 22°C heating and 24°C cooling system will be activated. Below are the accepted values for the ACM and PMV in the simulation program:

- Adaptive Comfort Model (ACM)
  Metabolic rate: 1.0 - 1.3 met
  Occupants' clothing insulation: 0.5 clo-1.0 clo
  Air speed 0.2 m/s.
- Predicted mean votes (PMV)
  Metabolic rate: 1.0 met
  Occupants' clothing insulation: 1 clo
  Air speed 0.1m/s.
  Simulation results were used for indoor air temperature, average radiative temperature and relative humidity values.

HVAC contents were created for NV, AC and MM building operation modes within the scope of the study. Therefore;

- Naturally ventilated (NV)
  Heating only (No cooling + Air Contioned)
  HVAC: HeatCool HVAC (Residential heat pump with no cooling)
  Natural ventilation settings: Minimum outdoor temperature is 10°C, maximum outdoor temperature is 30°C. The minimum indoor temperature is 22°C and the maximum indoor temperature is 24°C.
- Air Conditioned (AC)
  Heating + Cooling + Air Contioned (No Naturally ventilated)
  HVAC: DOAS (Dedicated Outside Air System) (DOAS with fan coil chiller with central air source heat pump)
- Mixed Mode (MM)
  Heating + Cooling + Air Conditioned + Naturally ventilated
  HVAC: DOAS (Dedicated Outside Air System) (DOAS with fan coil chiller with central air source heat pump)
  Natural ventilation settings: Minimum outdoor temperature is 10°C, maximum outdoor temperature is 30°C. The minimum indoor temperature is 22°C and the maximum indoor temperature is 24°C.

3. Simulation results

PMV comfort model and ACM values for NV, AC and MM building operation modes and energy consumption rates were calculated in this section.

3.1. Thermal comfort condition depending on building operation

The simulation results for the NV, AC and MM building operation modes determined within the scope of the study are given in Table 3. Simulation analyzes were performed annually. Simulation outputs comfortable time statistics per year are given as %. The annual comfortable time percentage of the option with NA mode is quite low according to the results. Comfortable time statistics per year values are very close in AC and MM options.

According to the analysis results of AC and MM building operation modes, while adaptive comfort Comfortable time statistics per year value is 100%, this rate is 83% in the PMV model. The percentage of comfortable time was higher in the Adaptive comfort model according to the results. Comfort values increase when freer indoor environmental conditions are provided to the users. Figure 3, 4, 5 shows the annual data chart for ACM for NV, AC and MM modes.

Table 3. PMV and ACM comfortable time statistics per year (%)

		Comfortable time statistics per year (%)		
		Hot	Neutral	Cold
NA	PMV	84	14	2
	ACM	91	9	0
AC	PMV	5	83	12
	ACM	0	100	0
MM	PMV	5	80	15
	ACM	1	99	0

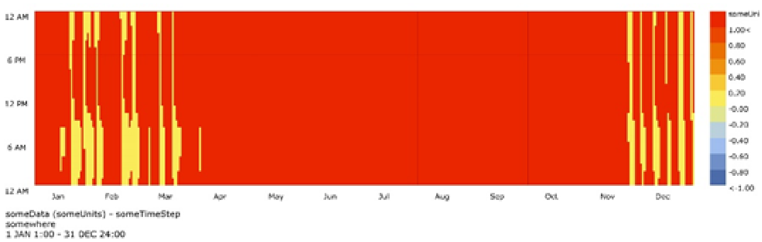


Figure 2. ACM- NV annual simulation data sheet

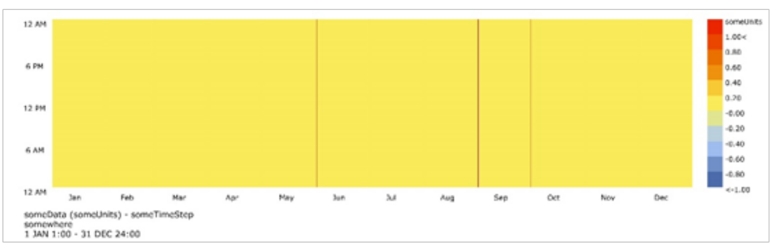


Figure 3. ACM- AC annual simulation data sheet

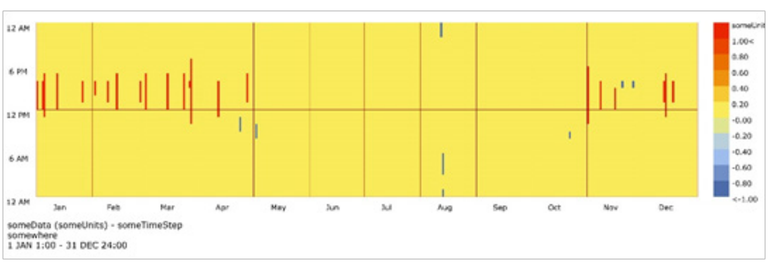
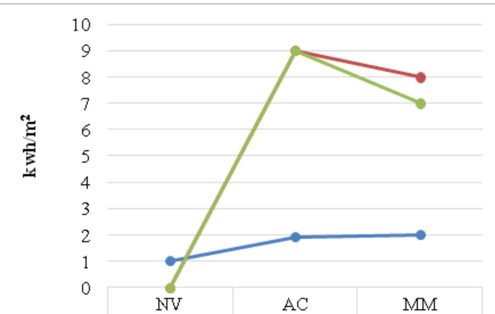


Figure 4. ACM- MM annual simulation data sheet

3.2. Energy consumption results of NV, AC and MM modes

In Figure 5, heating, cooling and HVAC fan energy consumption values are given for the NV, AC and MM modes determined within the scope of the study. According to the results, the energy consumption is very low in the NV option since the mechanical ventilation and cooling system does not work. In MM mode, cooling energy consumption is reduced by 11% and HVAC fan energy consumption by 22% compared to AC mode since natural ventilation is utilized. There is a potential for savings of approximately 16% in cooling and HVAC fan energy consumption if AC mode utilizes natural ventilation. This rate may vary in different places.



	NV	AC	MM
Heating energy comsumption kwh/m²	1	1.9	2
Cooling energy comsumption kwh/m²	0	9	8
HVAC fan energy comsumption kwh/m²	0	9	7

Figure 5. NV, AC and MM building mode energy consumptions

4. Conclusion

With the development of technology, high energy consumption is needed to provide comfort conditions today. Energy consumption can be reduced without compromising the comfort level with the right approaches to be taken at the design stage.

Within the scope of the study, an office space assumed to be located in an office building in Istanbul was analyzed according to the adaptive comfort and PMV comfort models, and the differences between ACM were observed. In addition, the energy saving potential of the adaptive comfort model was investigated by making energy consumption analyzes. According to the results, the PMV model has a lower comfortable time percentage than the adaptive comfort model. Since the NV mode space does not contain any mechanical cooling and ventilation system, the annual comfortable time percentage is quite low. Therefore, the energy consumption is also very low. The south facade of the office space has a 100% transparency rate, causing high level of unwanted heat gain in summer. In addition, the comfort value is very low due to the fact that the office space is ventilated from one side only and there is no cross ventilation possibility. In NV building modes, cross ventilation significantly increases the comfort value. Since the MM mode space benefits from natural ventilation, although the comfort values are close, the energy consumption is less than the AC mode space. The HVAC system, if designed in accordance with climatic characteristics and seasonal transitions, will create high thermal comfort spaces as well as providing a great deal of energy savings. In addition to this study, comfort analyzes can be made for different spaces and the simulation results can be compared with measurements using thermal comfort tools in the space.

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CHAPTER VIII

PARTHENON: A PHENOMENOLOGICAL EXAMINATION

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1. Introduction

Designed in 447 BC as a temple to house the statue of the Goddess Athena, the Parthenon became a Christian church when the Greeks converted to Christianity by 426 AC under the Roman Empire. In the fifteenth century, when the conquering Turks turned the Parthenon as a Muslim mosque the only alteration was the addition of the minaret, a traditional feature for a mosque. Parthenon was partially destroyed in 1687 during the war between the Turks and the Venetians.

Figure 1. Parthenon in Athens (URL-1)

This study is an examination of Parthenon in Athens (Fig.1) from a phenomenological perspective based on Edmund Husserl's formal and transcendental meaning. Husserl's theory of formal and transcendental meaning has been applied to architecture by Alberto Perez-Gomez. According to Perez-Gomez (1983), Husserl indicates the existence of two dimensions from which every system derives its meaning: formal and transcendental. The first dimension of meaning is the formal, or syntactic, dimension referring to the structure of the system, that is, to the relationship between the elements that constitute the system itself. The other dimension of meaning, according to Perez-Gomez, is the transcendental, or semantic, dimension that is the reference of each element of the system to the reality of the Lebenswelt, including its historic constitution. The German term Lebenswelt is translated as the world we live, the life-world, which includes the worldview of the period. Special attention is given to the formal properties of the building and primary and secondary written sources are examined to understand the architectural features, such as columns and the pediment.

2. Theoretical Framework

The theoretical framework chosen for this research is the German philosopher Edmund Husserl's theory of formal and transcendental logic as applied to architectural meaning by Perez-Gomez in *Architecture and the Crisis of Modern Sciences* (1983). Edmund Husserl (1859-1938) is the founder of phenomenology that is usually described as the philosophy of experience. Phenomenology examines the human experience and meaning in relation to the reality of the Lebenswelt, the world as lived, the life-world. Husserl's formal and transcendental dimensions of meaning provide a logical starting point to understand the roles that existing physical structure of a building and non-existing, intrinsic, qualities of the building play in architectural meaning.

The introduction of the theoretical framework is divided into two subsections. The first section will introduce Husserl's theory of formal and transcendental logic and its application to architectural meaning. The second section will discuss the nature of the relationship between a perceiver and a building using the terminology introduced in the first section and under the light of phenomenological hermeneutics.

2.1. The Formal and the Transcendental Dimensions of Meaning

According to Perez-Gomez (1983), Husserl indicates the existence of two dimensions from which every system derives its meaning. The word "system" in general might be considered as an object; such as a table, a tree, a text or a building. The first dimension of a system is the formal, or syntactic, dimension which refers to the structure of the system itself, that is, to the relations among its elements. The formal dimension of the meaning of a system signifies the autonomy of the system, i.e., the self-ruling, self-referential, self-determining character of every system. The word "self" here refers to the system itself and the formal dimension may be described as rules or standards according to which pieces are put together without regard to their specific signification or effect on people. Therefore, one might understand this dimension to be the objective dimension of meaning that is separated from the perceivers' life-world.

The other dimension of meaning, according to Perez-Gomez, is the transcendental or as Perez-Gomez suggests semantic dimension. This dimension is the reference of each element to the reality of the Lebenswelt, the life-world including its historic constitution. It is thought more appropriate to use the word transcendental instead of semantic because of its significance referring to human experience. *The Cambridge Dictionary of Philosophy* describes the word "transcendental" as "anything belonging to non-empirical thought that establishes and draws consequences from the possibility and limits of experience." This dimension might be considered as the subjective/semantic meaning of a system, which is derived from an interaction between the system and a perceiver.

To clarify the transcendental dimension, we might refer to the comparison of objectivism and transcendentalism. In contrast to objectivism, where the knowledge of the truth is supposed to be achieved through scientific empirical methods, transcendentalism assumes the ontic validity of truth for the individual experiencer. According to Husserl (1960), objectivism assumes the pre-given, taken for granted realities and search for objective truth that is valid for every human being: in other words the single reality as it is. On the other hand, transcendentalism is the achievement of experiencing the Lebenswelt, where the meaning and ontic validity of the reality as experienced are valid for individual experiencer.

At this point, to explain the notion of the Lebenswelt will be helpful to further clarify the transcendental dimension. Husserl (1960) uses this word, the Lebenswelt, as the life-world, "the world of lived/immediate experience." According to philosopher Herbert Spiegelberg (1960), "each life-world shows certain pervading structures or 'styles,' and these invite study by what Husserl calls ontology of the life-worlds." Spiegelberg (1960) further clarifies the notion of the life-world as the world as experienced by a living subject in his particular perspective, hence clearly a subjective and relative affair.

To reiterate the notion of the transcendental dimension, one might say that it is the reference of each element of a system to the life-world of individual human beings. It was stated that this dimension might be understood as the subjective meaning of a system; however, there is a significant difference between subjective meaning and the transcendental dimension of meaning, which should be emphasized. The subjective meaning indicates that the interpreting perceiver ultimately presides the meaning of the object, independent form the physical qualities of the object. On the other hand, the transcendental dimension of meaning indicates the relationship between an object and a subject as an event of understanding, in which the meaning is derived as an outcome. In this event of understanding, neither perceiver nor the object can be thought of as autonomous parts. The transcendental dimension of meaning not only requires the engagement of the life-world of the perceiver, but also provides a bridge to the life-world of the makers and users of the system, and possibly to human beings in general.

It is clear that, although described separately, the two dimensions are not totally independent from each other. While the formal dimension of meaning can, by definition, exist without the transcendental dimension, the reverse is not possible. The way the formal dimensions come together establishes possibilities as well as sets certain limits for the transcendental dimension of meaning that is derived as an outcome of the event of understanding. Furthermore, the transcendental dimension is made increasingly present as it takes hold of the human imagination.

To clarify the relation of formal and transcendental dimensions of meaning, one might examine the example of an arched openning. The construction of this arched openning may consists of heavy exposed bricks placed on top of a steel construction with a small cross section. In this case, although the openning may be structurally sound, it may give a feeling that it is going to collapse at any time. A person may not want to pass through the openning, feeling insecure. On emay further associate this experience with life being not always so secure, and thus one has to be careful. Another person might associate the construction of the openning with another experience: he/she might infer that things may llok weak and still be very strong to carry heavy things. Yet another person might suggest existence of an invisible force helping the arched openning to stand still almost magically, encouring his faith to move forward in one's life when faced weaknesses. What this example try to demonstrate is to degree to which the meaning is related to the formal dimension and yet requires the engagement of a perce,ver to bring the transcendental dimension into existence.

2.2. Phenomenological Hermeneutics

Hermeneutics was developed as biblical discipline concerned with how to interpret biblical texts. In the ninetieth century, hermeneutics became the theory of understanding dealing with texts only as one example of the event of understanding between persons (the *John Hopkins Guide to Literary Theory and Criticism*, 1994). The interaction between a building and a perceiver to derive meaning might be considered as one kind of event of understanding.

Within the hermeneutic theory there are two main opposing approaches to meaning, especially concerning the question of how the meaning of a text could be achieved. According to the so-called romantic hermeneutics pioneered by German philosophers Friedrich Schleiermacher (1778-1841) and Wilhelm Dilthey (1833-1911), the "true" meaning of a text is "fixed by the author's intention." Accordingly, this "true" meaning, the author's meaning, of the text is equal to "the use of words, the historical circumstances governing their use, and the author's intention" (the John Hopkins Guide to Literary Theory and Criticism, 1994: 376). To understand the author's meaning, according to Schleiermacher and Dilthey, one must perform the emphatic act of transporting oneself into the past and thereby become a part of that time. If one is to apply this to the case of architecture, one might say that in architecture, this "true" meaning could be achieved by studying architects' intentions, and by examining the architectural forms and the meaning of these forms.

There are some problems conceived by later philosophers in taking the original intended meaning, the author's meaning, as the only definitive, and therefore legitimate, meaning. To give an architectural example, any subsequent interpretation of a building will not be "true" if it differs from that originally intended. If one considers a building which has survived the natural forces as well as the successive generations of use while staying meaningful, we need to question the premise that the meaning of a building is fixed by the architect's intention. Moreover, the emphatic act of transporting oneself into the past can never be achieved without the influence of one's own presuppositions, and thus one can never get this fixed meaning as suggested by romantic hermeneutics.

As opposed to romantic hermeneutics, phenomenological hermeneutics argues that the principal subject of understanding is not the author's intentions. According to German philosopher Martin Heidegger (1889-1976), who is considered by most as "Husserl's legitimate heir," to understand a text is "not ferreting out some meaning placed there by the author, but rather unfolding the possibility of Being indicated by the text" (the John Hopkins Guide to Literary Theory and Criticism, 1994: 379).

Heidegger uses the notion of Being as presence, "what life itself, factual Dasein bears in it" (Zuckert, 1996). The German word "sein" of Dasein means "existence" or "being" and refers to the human existence, while the German word "da," meaning "there," emphasizes the spatio-temporal differences among individual human beings. To reiterate Heidegger, one might say that Being is the presence, the existence of the universe from the first day of its creation till today, and possibly till to the end, if there is an end, and *Dasein* might be understood as an individual human being who actually lives in a specific time and place.

When one understands in this manner, according to Heidegger, one "(*Dasein*) 'knows' how things stand with it: that is with its being-able-to-be" (Kockelman, 1977). One may interpret this as meaning, when one understands, one knows what one can and cannot do, the limits and possibilities for oneself, and how the other things in past, present, and future, are related to ones' own individual existence. Heidegger here not only defines the notion of understanding, but also emphasizes the significance of understanding in human life.

Paul Ricoeur, a contemporary French philosopher, further clarifies the nature of understanding from the phenomenological perspective and the nature of meaning as described by Heidegger. According to Ricoeur (1981), meaning is derived by the interpreter as an outcome of the interaction, a complementary act of a more existential character, between the text and the interpreter. Ricoeur describes the nature of this interaction between the text and the interpreter as the appropriation of meaning. Ricoeur explains that he translated the German word 'aneignung' as appropriation. The etymological root of appropriation is the Latin word appropriare, to make one's own. According to Ricoeur, to appropriate is to make one's own 'what was initially' alien. The interpreter's aim in the act of appropriation is to struggle against the cultural distance and the historical alienation of the interpreter so that interpretation brings together, equalizes, renders contemporary and similar (Ricoeur, 1981). It should be noted that, the legitimate meaning has changed from the author's meaning of the romantic hermeneutics to the phenomenological hermeneutics' the interpreters' meaning.

To clarify the notion of appropriation in the relationship between a building and a person, an example could be helpful. When one enters a building, for example, fort he first time, the building may be considered alien. One does not know the location of facilities, such as the toilets, the staircases and fire exits. The person tries to understand the structure of the building in relation to one's past experiences. In Ricouer's words one tries to appropriate the building, to make the building one's own. When the building is appropriated then the person knows where the features are located in relation to one another and in relation to the whole. One might say that when a person appropriates a building, the person has his/her mental image of the building, no matter how different it could be from anybody else's even the designer's. To clarify what 'made one's own' is, particularly in this example, Ricouer's explanation might be helpful. According to Ricouer what is appropriated, which is referred to as a mental image above, is the "projection of a World, the proposal of a mode of being-in-the-world, which the text discloses in front of itself by means of its non-ostensive references" (1981: 185). The non-ontensive, non-aparent references are combined with the perceiver's subjective background and at the end the object is appropriated.

To further clarify the role of formal and transcendental dimensions as well as subjectivity of the perceivers, we can consider the case of Hagia Sophia in Istanbul. The physical qualities of Hagia Sophia are not dependent on perceivers' point of view, although one might use different scales to measure and describe these physical qualities. In other words, the formal dimension of the meaning is the same for every perceiver in spite of the possible differences in description. However, the transcendental dimension of meaning, which cannot be separated from the physical qualities of the building, might include different associations depending on the perceiver's different personal backgrounds. The following is one description of Hagia Sophia, which reveals the formal dimensions but lacks the transcendental:

"The Church of Hagia Sophia stands in the South-east part of the city, not far from the sea. It is North-west of the Galerian complex and 120 meters South of Egnatia Street.. In its present form the church is a ponderous cube-shaped edifice the body of which is more or less square in plan with a tripartite sanctuary projecting eastwards from it. Its basic interior dimensions are 30.92m wide, 28.90m long without the apse, and 40.06m with the apse." (Theoharidou, 1988, 19)

The description at the formal level resembles the architectural historian Joseph Rykwert's definition of 'a plain reading' of a building. According to Rykwert, the plain reading of a building is "the univocal, anti-metaphoric account of it that presents itself as mute, as meaning no more than itself, the way it is built and used" (1996: 391), which does not include the perceiver's involvement at the transcendental level.

"So the church has become a spectacle of marvelous beauty, overwhelming to those who see it, but to those who know it by hearsay altogether incredible. For it soars to a height to match the sky, and like a ship riding at anchor, higher than the other building, it looks down upon the remainder of the city, adorning it, because it is a part of it, but glorying in its own beauty, because, though a part of the city and dominating it, at the same time towers above it to such a height that the whole city if viewed form there as form a watch-tower" (Kahler, 1967:16).

The above description reveals the transcendental dimension of Hagia Sophia as perceived by this particular observer. Somebody else living in the same period as this particular observer might not perceive the building in a similar way. Clearly, the transcendental dimension, although is not totally independent from the physical qualities, shoud involve the perceiver's lifeword.

3. The Parthenon

The Parthenon was first designed in 447 BC as a temple dedicated to the Goddess Athena and it housed the statue of the Goddess. It became a Christian church when the Greeks converted to Christianity by 426 AC under the Roman Empire. It was converted to a Muslim mosque during the fifteenth century when Turks conquered Athens. They added a minaret, a traditional feature for a mosque. Parthenon was partially destroyed in 1687 during the war between the Turks and the Venetians. This section examines the Parthenon in its totality starting from the worldview of the period when it was constructed, i.e. the Lebenswelt of the period. The building as well as its columns, pediment and sculptural details is also examined.

3.1. The Lebenswelt of the period

In order to examine the Parthenon we need to study the Ancient Greek worldview, the Lebenswelt, as it relates to the architecture of the period that dates from 585 until about 400 BC. This period is known as “the Pre-Socratic” phase of archaic Greece prior to the so-called Ancient Enlightenment of Plato and Aristotle. Strictly speaking, therefore, the Lebenswelt is of this limited time period.

The Pre-Socratic period is a time when the modern distinction between empirical science and speculative philosophy is not readily applied. This period was a time in which unified worldview existed between religion and metaphysics, between perception and legitimate knowledge. This unified worldview indicates that there was a high degree of integration between the subjective and the objective, i.e. subject and object, which might be reiterated as the integrity of the formal and the transcendental dimensions of meaning.

The Pre-Socratic theory, also considered to be the dawn of Western philosophy, began when Thales of Miletus, the first Greek philosopher, predicted an eclipse of the sun. The philosophy of Pre-Socratics can be seen in the works of Anaximendar. As architectural theorist Indra Kagis McEwen (1993) states Anaximendar is generally looked upon as the first real philosopher and his school as the place for transition from myth to philosophy. We might suggest that the formal and the transcendental dimensions were integrated in the Pre-Socratic worldview.

In order to understand legitimate knowledge, *episteme*, of the Pre-Socratic period and the Greek period afterwards we need to demonstrate the differences. McEwen (1993) suggests distinguishing the two kinds of *episteme*, “the skillful and the seeing kind.” The skillful kind, *sophia*, is related to the revelation of the *kosmos* through a *techne*, etymologically meaning “letting appear,” and the seeing kind, *philo-sophia*, etymologically meaning “love of wisdom,” is related to theory.

The first kind, the skillful kind, of *episteme* is related to the archaic Greek understanding of craft as a revelation of *kosmos*. To remind the reader, the English word “cosmos” etymologically comes from the Greek word *kosmos*. While the English cosmos refers to the universe as a material existence, the Greek word *kosmos* is related to *kosmoi*, an order, and suggests an unnamed standard by which things were well according to order. To cummarize, Attic Greek word *kosmos* refers to an orderly arrangement that “beautifies and is pleasant to contemplate, adornment, especially feminine (McEven, 1993). *Kosmos* also suggests political or moral order. According to McEwen (1993), the recognition of *kosmos* already assumes a standard of rightness external to itself. In this sense, the making of an artifact, *techne*, is itself a discovery of *kosmos*. McEwen poetically describes *techne*, letting *kosmos* manifest, as follows:

"The work of the carpenter revealed it [kosmos] through cutting and assembly, the textile embodied it through the rhythms of a shuttle moving over a loom, the dancing floor was its appearing in the dance, and the boat, which sped through the waves like a bird through the air, made it manifest through both its building and its navigation" (1993, 79).

The second kind of *episteme*, the seeing kind, was said to be related to theory or philosophy. Etymologically "theory" is derived from the Greek word *theoria*, a spectacle, and theoros, a spectator. According to McEwen, the word *theoros* derived from *thea*, meaning "seeing, spectacle" or "goddess" according to the placement of the accent on one of the last two syllables, and *horao*, "I see." To reiterate, one might say that the second kind of *episteme*, in which a subject observes an object through seeing, indicates a separation of subject and object. According to McEwen, although the sophia-as-skill was lost as the time passed from the Pre-Socratic to the Platonic era, what had been lost in human thinking was preserved in architecture and in its theory.

3.2. The Building

The Parthenon was intended to be a temple to house the statue of the goddess Athena Polias. It was a part of the Periclean building program that intended to reconstruct the Acropolis which was destroyed by the Persian attack in 480 BC. The aim of the leader of the Athenian democracy, Pericles, was not only to reconstruct the buildings but also to transform the Acropolis "into the monumental religious and artistic center of the city" (Rhodes, 1995). According to Scully (1962) Pericles overtly intended his buildings to create a fresh image of Athenian triumph.

The Parthenon was the first to be reconstructed and also the center figure of this building program. The building is located on the Acropolis (Fig.2), which is a limestone mass rising out of the Attic plain and surrounded by mountains and islands. The Acropolis was the focal point of the centralized structure of Athens. This location was sacred for the Athenians even before the construction of the first temple. The difference from the Mycenean cities, however, is the presence of sanctuaries, which had never existed in the Mycenean civilization. As McEwen suggests:

"... the archaic polis was an uncertain place that needed to be anchored at the strategic points of center, middle ground, and outer limit by the new sanctuaries. It was not a vessel with a fixed form, but like the appearing surface of a woven cloth had continually to be mended or made to reappear" (1993, 83).

Figure 2. Parthenon on the Acropolis of Athens. (URL-2)

Rhodes also supports McEwen's argument. According to Rhodes (1995), the sense of timeless permanence embodied in these spots is an elucidation for the essential universal human need for physical and spiritual orientation, the reason for the Greeks to associate these places with gods. According to Rhodes "in such spots there is a sense of adamantine permanence, a sense of the unchanging, never-ending, continuity of the power and the texture of nature" (1995, 26).

Athena, who was a guardian deity as well as the goddess of wisdom, is known as the patroness of all cities, but chiefly of course, of Athens. McEwen calls attention to the relation in the way the polis is established, which she describes as "appearing of a surface woven by the activity of its inhabitants," weaving being the craft specific to Athena: "it is Athena, bright-eyed patroness, also, of weavers, who taught people how to make these cities visible" (1993, 89). In other words, Athena is the goddess who taught people the techne to let the kosmos appear during the process of establishing the polis.

The Parthenon was one of the temples on the Acropolis built to praise and express Athena's characteristics. The Parthenon had two precedents previously constructed on the site of the Parthenon: the Hekatompedon and the so-called first Parthenon. The Hekatompedon was the first temple constructed on this site around 566 BC. The Hekatompedon was dedicated to Athena Polias and distinguished from the other temples on the Acropolis by its name: Hekatompedon, meaning "a hundred-footer," is an adjective referring to temples of this size. The name Hekatompedon survived as the name of the inner chamber of the Parthenon. The construction of the second building, the first Parthenon, was started in 490 BC after the victory of the Athenians at Marathon. The first Parthenon was intended to replace the older stone Hekatompedon with a new marble temple. When the Persians took Athens in 480 BC they destroyed the city, and every building on the Acropolis including the unfinished original Parthenon. The name Parthenon was the name given to the west chamber, and later extended to the whole temple.

Heidegger's description of Greek temples in general might help us to understand the relationship between a Greek temple and the life-world of the people who constructed these temples. Heidegger says:

"A building, a Greek temple, portrays nothing. It simply stands there in the middle of the rock-cleft valley. The building encloses the figure of the God and in this concealment lets it stand out into the holy precinct through the open portico. By means of the temple, the God is present in the temple. This presence of God is itself an extension and delimitation of the precinct as a holy precinct. The temple and its precinct, however, do not fade away into the indefinite. It is the temple work that first fits together and at the same time fathers around itself the unity of those paths and relations in which birth and death, disaster and blessing, victory and discgrace, endurance and decline acquire the shape of destiny for human being. The all governing expance of this open relational context is the World of this historical people" (1971: 41-42).

The ancient Greek temple including Parthenon, was the man-made element added to these sacred spots to personify and praise the characteristics and presence of the divinity in its specific landscape. In other words, the ancient Greek temples represent the sacred landscape and the God, which defined the life-world of the ancient Greek people. To represent means to make present or to bring into presence, i.e. *techne* that lets *kosmos* to manifest. What is made present, kosmos becomes a tangible reality, an immediate part of human experience. The artifact might be considered as an embodiment of this human experience that is parallel and sometimes even engaged with the human experience of the larger world in general.

The Parthenon in question was also intended to be a temple dedicated to the Goddess Athena Polias (Fig.3). Thus, the tradition of mainland temple architecture, which had existed for about five hundred years, continued in the design of the Parthenon. For Ancient Greeks the continuation of the ancestors' religious traditions was important to associate themselves with their forebearers (Rhodes, 1995). Moreover, the Parthenon was also intended to symbolize the Athenian military victory. In other words, one might argue that the architects interpreted the tradition of Greek architecture and at the same time fulfilled the specific need to symbolize the triumph of Athenian democracy.

Figure 3. Goddess Athena Polias reconstructed scuplture (URL-3)

3.3. The Columns

Among the three orders the Ancient Greeks recognized, namely Doric, Ionic, and Corinthian, Doric is the first one created. An order in architecture comprises a column and an entablature. The Doric column has a shaft, and a capital, but not a base, unlike the Ionic and the Corinthian columns. The entablature includes the architrave, the frieze, and cornice, which are supported by the columns.

The first timber Doric columns appeared as tapered tree trunks, in which the square abacus and circular echinus, comprising the capital, gathered and transmitted the load of the entablature to the column shaft (Vitrivius, 1960). The architrave acted as a lintel spanning from column to column and sustaining cross beams, the ends of which appeared as triglyphs in the frieze. The timber Doric columns were converted into stone at about 600 BC (Fletcher, 1975; Dinsmor, 1962). According to architectural historian Sir Banister Fletcher, this translation was quite direct, timber forms being imitated in stone with remarkable exactness. Accordingly, Greek architecture sometimes has been called “a carpentry in marble” (Fletcher, 1975).

Figure 4. The columns of the Parthenon (URL-4)

In other words, the Greek architects’ interpretation included an imitation of what they already knew, and through experience with unknown material, which was first timber and then marble, they produced the articulation of the Doric columns (Fig.4). The *techne* used for the columns evolved with time and with experience. As McEwen suggests, "the whole is an articulation of order in which the logic, far from being Aristotelian, is still very much rooted in "a logic of ambiguity" (McEven, 1993). One might suggest that the formal dimension of the Doric columns, timber and marble, evolved as an outcome of the experience of techne, which directs attention to the existence of the transcendental dimension. Therefore, one might say that the formal and the transcendental dimensions of the Doric columns were integrated.

The Roman architect Vitruvius locates the origin of the Doric column in an exemplary human being from whom the general properties were abstracted. According to Vitruvius, Dorus, son of Goddess Hellen and the nymph Phthia, built the first Doric temple in Argos and dedicated it to the Roman goddess Juno, the Ancient Greek Hera, the wife and sister of Zeus (Vitrivius, 1995). The Doric column was formed with reference to the proportions of a male body during the construction of the first Doric temple in Argos. As Vitruvius suggests, the Doric column began to furnish the proportion of a man's body, its strength and grace, and the Ionic column, the feminine slenderness. The similarity of these two origins is the way of producing, the techne that uses known experience and logic to produce the unknown.

Joseph Rykwert's explanation of techne, as a skill "required to form a commonplace artifact," might further clarify the nature of the relationship between the producer, the past experience, and the product. According to Rykwert, techne is "a skill that its inventor would have attained by decomposing the world order and recomposing it through the gestures of the craft by which the artifact was fabricated (1996, 124)." It is as a result of this skill that the integrity of the formal and the transcendental dimension is possible. It is noteworthy that Rykwert suggests that from this skill the artifact derives its dignity as well as its maker his/her social standing.

The interpretations of the Doric temples by contemporary historian Vincent Scully might indicate the significance of the integrity of the two dimensions for the subsequent perceivers. According to Scully, Doric temples present "an exterior, impenetrable presence, associated with the active force of the male standing out against the sky," while Ionic temples are like "a hollow, female shell, associated with enclosure by the goddess and by the earth" (Scully, 1962, 176). The Parthenon, being a Doric temple and having Ionic columns associated with female characteristics, in the inner chamber, is often described as an embodiment of the Goddess Athena, whose characteristics included both female gentles and male force, both earth goddess and intellectual will (Scully, 1962)

Another element that is a part of the Ancient Greek temple tradition and will be discussed in this section is the convex curvature of the stylobate. The important point for this research in the use of curvature is the way the Ancient Greek architects brought the power of the curvature into presence as an optical correction. According to Rhodes (1995), the convex curvature of the stylobate first appeared in Doric architecture, one hundred years earlier than the construction of the Parthenon, most possibly as a practical solution to the drainage problem. It might be considered as a simple solution as every piece of marble used in the stylobate was not exactly the same in size, so that a slight curvature in the temple platform, the stylobate, was produced.

The practical side of the curvature remained the same during the period of Ancient Greek architecture. However, the embodied power of the curvature was brought into presence by the Ancient Greek architects as an optical correction. The reason for this curvature is said to be to correct the optical distortion of the stylobate, architrave and cornice, which appear to sag or drop in the middle of their length if they are straight (Fletcher, 1975; Rhodes, 1995; Dinsmor, 1962; Scully, 1962). Although the curvature creates physical distortion, according to Rhodes, it also creates a visual effect in the beholder who unconsciously believes that the elements are vertical and horizontal and the like elements have the exact same sizes. The difference between the visual effect and the physical reality creates a tension in the eye of the beholder. As a result, according to Rhodes, in the eye of the beholder at a subconscious level, there is a constant battle to reconcile the gap.

The understanding of a functional element as an element to correct the optical distortions indicates that the relationship between the architects and their environment was at the transcendental level. This example is also significant because of, as Rykwert (1996) suggests, the lack of the origin related to a divine relation or hero-inventor unlike the invention of canonic proportions. This implies that the nature of *techne* contributes to the relationship between the architects and the built environment to be at the transcendental level. According to Rykwert, "*techne* of the architect is to play with the measurements and color of things to make them appear correct, that is above other *technai*, other arts, because it involved exact calculation and relied on scientific instruments" (1996: 222).

One might argue that the tradition of Ancient Greek architecture as a techne, in Rykwert's words (1996) as a "way of proceeding, accumulated experience, and know-how," was the mode of operation of ancient Greek architects, including Iktinos and Kallikrates. The Ancient Greek temples at first consisted only of the pronaos, the front portico, and the inner chamber, the naos, and sometimes an adytum, treasury chamber, behind. Later on, possibly to protect the mud-brick walls and to increase the impressiveness of the temple, the columns on the front and back facades were extended to the sides as well. The cella contained the statue of the god or goddess. The front and the back porticos, respectively known as the pronaos and the opistodomos, were the pedimented facades.

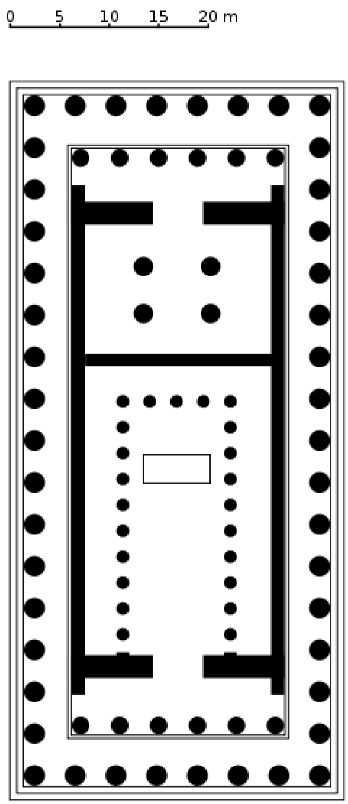

Figure 5. The plan of the Parthenon (URL-5)

The Parthenon, a Doric temple dedicated to goddess Athena, continued the tradition of Greek Architecture. However, the Parthenon has eight columns in front and back (Fig.5), while the older Parthenon had six, the Hekatompedon had two. The major result of this increase in the number of the columns was a larger interior cella. However, there are also other changes in the Parthenon that led contemporary architectural historians to consider other reasons for changes in the number of columns. According to Rhodes (1995), the use of eight columns reflects the traditional column count for the front of the colossal temples of Ionia; and therefore, in the Parthenon, the eight columns emphasized the Ionic, feminine, qualities of the Parthenon. Scully (1962), on the other hand, explains the purpose of the eight columns in relation to human perception. He states that most people cannot understand eight individual units when presented as a group, unlike six or seven units, which are quickly grouped into twos and threes and easily understood. Since they cannot immediately understand that there are eight separate units, people tend to group them all together, and perceive them as one unit. According to Scully (1962) this is a critical matter, since the temple is intended to be a Doric sculptural body which demands that it be perceived as one. He continues that the intention was to force the eye of the beholder to return again and again to the building, ever satisfying the observer. Both of the interpretations of Rhode and Scully seem plausible. One might simply conclude that the possibility of different and yet legitimate multiple interpretations is the outcome of the power embodied in these columns.

3.4. The Pediment

This section will examine the pediment of the Parthenon (Fig.6), an important and essential element of the Greek temples. The pediment is the triangular area between the inclined edges of the gabled roof and the horizontal covering of the porch, which is called actos and tympanum in Greek and Latin respectively.

The origin of the pediment is related to the development of the Ancient Greek temple form and ultimately their house form; from a rustic circular hut to a horseshoe plan, and then to a megaron type. According to Dinsmor (1962), as the plan gets elongated, the elongation of the ridged roof at the same time tended to form a gable in the front, leading to the pedimental facade. Accordingly, one might suggest that the pediment of the Parthenon has the genuine quality, an authenticity, as a consequence of putting a roof on top of post and beam construction. In other words, the pediment was the result of the construction process. As argued earlier, this construction process is the craft, the techne of the builder, which enables the integrity of the formal and the transcendental dimensions.

Figure 6: Reconstruction of the West Pediment of the Parthenon (URL-6)

The Enlightenment architectural theorist, Marc-Antoine Laugier also suggested the origin of the pediment as an outcome of the building process when he proposed the first hut. According to Laugier, “the pieces of wood set upright have given us the idea of the column, the pieces placed horizontally on top of them the idea of the entablature, and the inclining pieces forming the pointed roof the idea of the pediment (1977, 12)”. However, it should be noted that Laugier considered his hypothetical rustic hut as a truthful and economic expression of man’s need for shelter, to be replicated. In other words, he was primarily emphasizing the formal dimension of the first hut even when he was describing its authenticity.

Another type of study might reveal the authenticity of the pediment regarding the effects on the perceiver. One may argue, for example, that because the pediment is symmetrical it has a certain effect on people. The human body is symmetrical at front and back and the association of the front and the back of the temple with a pediment might be associated with the experience that human beings have with their own body regardless of differences in time or culture. One might further suggest that while being symmetrical and giving the impression of being in front or back, the pediment may even indicate that everything has a beginning and an end. This understanding of the pediment is not separate from the formal dimension; however, since the perceiver also engages his/her life-world, this understanding provides the transcendental dimension of the meaning of the pediment.

It might be this authenticity that enabled human beings to understand the pediment at the transcendental level. This may also be the reason architects of the Ancient Greek temple kept the pediment form when they turned the house form into a temple. Likewise, the architects of the Parthenon might also have kept the pediment for the same reason. The authentic origin of the pediment may explain why even after hundreds of years, people can still relate to this form and understand it at the transcendental level.

3.5. The Sculptural Decorations

This section examines the sculptural decorations of the Parthenon, in particular on the pediments and the Ionic frieze, with the aim to clarify how the mode of operation, *techne*, know-how, enabled the integrity of the formal and the transcendental dimensions of these decorations.

Historically, the first portion of the temple to be decoratively treated was the cornice, the ends of the rafters protruding under the eaves on the flanks. These were treated as decorative elements, and were adorned with wooden pegs or guttae. Architectural historian Dinsmoor (1962) argues that although these mutules could appear only at the sides of the temples, because of their decorative character, they were applied even to the horizontal cornice under a facade pediment. The evolution of the rafter ends as a decorative element of the Ancient Greek temples indicates that the relationship between the Ancient Greek architects and the physical qualities of these rafter ends was at the transcendental level.

The use of sculptural decorations on the Ancient Greek temples also reflects the interaction between the Ancient Greek architects and their built environment at the transcendental level. Ancient Greek temples, from the earliest times through the Parthenon and beyond, are very often ornamented with sculpture, usually on the pediment. The front pediment was always decorated and in some early temples the pediment facing away from the altar was left blank. The front side of the temples faced the main altar in the *temenos* where the Ancient Greeks came together to perform their rituals. These decorations represented the Ancient Greek understanding of the place of human beings within the universe and in relation to the forces of nature and the gods.

Figure 7. Front Pediment of the Temple of Artemis at Corfu (URL-7)

An example of the sculptural decorations might show the integrity of the formal and the transcendental dimensions of the meaning. The temple of Artemis at Corfu has one of the best known pedimental sculptures (Fig.7). Here, "Gorgons and immense flesh eating leopards, monsters from the darker side of creation, representatives of the inhuman side of the universe" (Rhodes, 1995: 46) were depicted. It incorporates the Olympian gods, which is included in the Ancient Greek religion. The physical qualities, the materials used, their sizes, the texture, the detailing, the coloring, and relationship to specific events, are some of the formal dimensions of these sculptures. The transcendental dimension of these sculptures offers the viewer a meaningful experience through non-apparent references. Since we are unable to observe the Ancient Greek people's experiences directly, we may instead consider a contemporary perceiver. The architectural historian Rhodes describes his interaction with the pedimental sculptures of the Temple of Artemis at Corfu as follows:

"Their strict frontal gaze forces us to interact with them. If there is any relationship between the intent of the creators of the Corfu sculptures and their actual effect, one purpose, if not the only one, was direct confrontational engagement with the viewer ... they invade our space and stir inarticulate, irrational, darkly emotional instincts about the universe and our place in them." (Rhodes, 1995: 47)

What Rhodes experienced is at the transcendental level. The fact that even a contemporary person may still have a relationship at the transcendental dimensions indicates that the non-apparent references that these depictions offer come into presence in this interaction at the transcendental level. These non-apparent references might be considered as the transcendental dimension of the meaning of these depictions.

Figure 8. East Pediment of Parthenon (URL-8)

One can observe the similar treatment of the pedimental decorations on the Parthenon as the embodiment of the powerful relationship between the architects of the Parthenon and the built environment. The changes in the treatment of the decorations on the pediments reflect the changes of the architects' perceptions of the divine and the human. However, the techne, the skill that the Ancient Greek architects used to let kosmos manifest during the production process of these decorations was the same for the three temples built on the location of the Parthenon. In the Hekatempedon, the first precedent of the Parthenon, pedimental decorations were representing the forces of nature depicted as a symmetrical pair of two lions shredding a bullock, flanked by a pair of wavy-bodied snakes on each side. In the Periclean Parthenon, on the east pediment (Fig.8), the theme is the birth of the Goddess Athena from the father of the Gods, Zeus. The depiction of the birth of Athena is an Olympian event set exclusively among the gods but referring more broadly to a general abstract sense of divinity. On the west pediment (Fig.6), the theme is the contest of Athena and Poseidon to rule Athens, a part of the early foundation myths of Athens, and a part of its ancient history. The context is divine but it takes place in Athens among the Athenian citizens, indicating the changing perception of the Ancient Greeks elevating the position of the human being in relation to the place of the gods.

The relationship between the architects of the Parthenon and the built environment was also embodied in the sculptural decoration in other parts of the Parthenon; for example, in the metopes and the Ionic frieze. In the west, south, and north metopes, the themes were representations of heroic battles from mythological or ancient history: first the Greeks versus the Amazons, then the Centaurs, and finally the Trojans. On the eastern metopes, the front of the temple, the Olympian gods are represented in a battle with the giants. In the Ionic frieze the theme is a procession, maybe a procession of Athenians. Although the themes of depictions changed over time, the mode of operation, the techne that enabled the integrity of the formal and the transcendental dimensions, was same.

To summarize, this section demonstrated that the sculptural decorations of the Parthenon embodied the powerful relationship between Iktinos and Kallikrates and their built environment. The expression of the sculpture, the way the pieces of sculpture come together including their relative sizes, placements in the pediment, and colors, which constitute the formal dimension of these sculptures, were integrated with the transcendental dimension, the non-apparent references that these depictions offer to perceivers.

4. Discussion and Conclusion

The Parthenon embodied a powerful relationship in the way that its physical qualities, i.e., the formal dimension, came together with the transcendental dimension in order to create the non-apparent references that the Parthenon discloses in front of itself. In other words, the Parthenon embodied the great power of its architects' relationship with the built environment as the integrated formal and transcendental dimensions of its meaning. It is this embodied power that the Parthenon endowed to subsequent perceivers.

The survival of the Parthenon as its first day until the eighteenth century reveals the power of its relationship with the people of later times. The Parthenon was first a temple for the Ancient Greeks, then a Christian church for Christian Greeks, and later a mosque for the Muslim Turks. Whatever the social and cultural background of these people, the Parthenon was appreciated by and used as a place for worship; their relationship with the Parthenon was at the transcendental level thus powerful. Contemporary architectural historian Robin Francis Rhodes describes his relationship with the Parthenon as such:

"The Parthenon... speaks to us in intentional, unambiguous terms of the value of humanity in this world, of its perceptions, of its infinite potential... Is this the power of classical architecture? Or is its power derived from a less historically specific source? Is there something in its appeal more basic, less intellectual?" (1995, 2)

The point Rhodes calls to our attention is the Parthenon's relationship to any human being regardless of cultural, social, or geographical background. According to Vincent Bruno (1974) our pleasure and satisfaction from the experience of Parthenon are indeed profound and real, and he further suggests that this experience is universal to mankind. This universal experience is the power that the Parthenon embodied as a whole as well as together with all of its parts.

This universal experience might be partly related to the unified worldview of the period. The understanding of architecture as a *techne*, letting *kosmos* manifest, which itself was the revelation of the divine in experience, enabled the integrity of both dimensions formal and transcendental, and thus this great power.

To illustrate the powerful relationship between architects from different periods and the Parthenon, the architectural critic Colin Rowe's (1976) study might be helpful. Rowe examined two different architectural pieces designed by two architects from different periods and somehow related to Ancient Greek period. These pieces are Villa Foscari, the Malcotanta designed by Andrea Palladio (1508-1580), and the Stein House at Garches designed by Le Courbusier (1887-1966), both of which have the Greek temple front.

As Rowe's examination demonstrates, the two architectural works are outcomes of two architects' different interpretations of the Ancient Greek architecture. Renaissance architect Andrea Palladio interpreted the archeological reconstruction drawings of the Ancient Greek and Roman architecture, the only sources available to him. Palladio's villa design, a central symmetrical block to which a portico consisting of six circular monumental columns and a pediment was added on four sides, in addition to his writings, reflect his understanding of Ancient Greek architecture.

Modern French architect Le Corbusier noted his interpretation of the Parthenon, that was at that time a ruin standing on the Acropolis in Towards a New Architecture: "here is something to arouse emotion ... There are no symbols attached to these forms: they provoke definite sensations; there is no need of a key in order to understand them" (Le Courbusier, 1946: 165). The physical qualities of the two designs, which reflect the architects' interpretation of the Parthenon, are quite different from each other. However, what is important is that these two architects had an interaction at the transcendental level with the Parthenon.

To conclude, the Ancient Greek temples represent the sacred landscape and the God, which defined the life-world of the Ancient Greek people, a time when the formal and transcendental dimensions of meaning were integrated. To represent means to make present or to bring into presence, i.e., *techne* that lets *kosmos* to manifest. What is made present, *kosmos* becomes a tangible reality, an immediate part of the human experience enabling the transcendental dimension to be an integral part of formal dimension. The artifact might be considered as an embodiment of this transcendental human experience that is parallel and sometimes even engaged with the human experience of the larger world in general.

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CHAPTER IX

AN INVESTIGATION OF THE USE OF VIRTUAL REALITY IN ARCHAEOLOGICAL HERITAGE AREAS IN THE CONTEXT OF CONSERVATION AND TOURISM

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1. Introduction

Archaeological and historical areas bearing the traces of previous civilizations should be considered as areas that transfer accumulation from the past to the future and even as common heritage areas of humanity. So much so that these common heritage areas are evaluated together with their environment. These evaluation criteria provide opportunities for these fields within the framework of education, culture and economic income opportunities. With this research, today, where digitalization finds intense use, virtual reality technology in archaeological and cultural areas on the benefits of using is focused. In the process of explaining the historical mystery of the past to future generations, interpreting it and integrating it into the present, the new physical structures of spaces, which started with the effect of time, virtual reality on learning by generations and acquiring in social memory make the most of the possibilities of technology are among the aims of this study.

These archaeological sites, which are considered important for tourism activities, are offered to their enthusiasts with the help of developing scientific research and technological opportunities. The use of these archaeological sites, which are very important to protect due to tourism opportunities, is increasing day by day. The destruction of these sensitive archaeological heritage sites is inevitable with the increase in use. Therefore, many previous studies and research shows that it is absolutely necessary to establish a balance between protection and utilization in order to let visitors view and use these areas, and at the same time to protect the existing values of the areas. In order to establish and maintain this balance, it is very important to determine all the existing potentials of the area, to identify the problems and opportunities throughout the area and to prepare emergency response plans.

It is a long and complex process and extremely important to protect the cultural and architectural heritage in archaeological areas, to bring it to future generations, to present it to local and foreign tourists, to take part in the urban economy and sustainable tourism activities. Culture Tourism; natural areas, monumental or civil architectural structures, art products, collections, encompassing cultural identities, traditions and languages, tangible and intangible cultural heritage an organization that aims to share and recognize its products defined as the type of trip (URL-1).

Social and technological developments that have emerged throughout the world in recent years have made tourism both easier to buy and more accessible. Thus, tourism has turned into a form of development in which people can have a pleasant time that is not available in their daily environment, an efficient alternative to recreational activities, and at the same time, discover their both physical and intellectual personalities. This transformation has turned from traditional nature, sea, sand and beach tourism to cultural attraction dimensions such as gastronomy, faith, education and folklore, and has become the fastest developing market of the world tourism industry within the scope of cultural heritage tourism. While the components of cultural heritage tourism constitute a wide spectrum, an important component is archaeological cultural assets. These assets constitute an accurate and impartial proof document for the cultural heritage of the past (Göğebakan, 2015, p: 50). The tangible finds of the cultural heritage of the past reflect the social mosaic, traditions, understanding of art, beliefs, taboos, joys and sorrows of that culture and therefore the diversity and character of that culture. Archaeological heritage tourism (archaeotourism), which is an important component of cultural heritage tourism, is a scientifically new sub-discipline that is studied both in the world and in Turkey. Anatolia is a very rich geography in terms of archaeological cultural assets. These assets are of high importance for Turkey to take a higher share of the world cultural heritage tourism industry. However, considering today's conditions, these cultural and architectural riches produce low value and cannot contribute enough to the country's economy (Göğebakan, 2015, p: 50).

As a result of researches from various literatures, the aim is to reach the point where archaeological tourism potentials are reached with the effect of archaeological cultural assets on tourism and new generation methods. It is thought that museums as places where archaeological cultural assets are preserved and exhibited, immovable cultural assets of countries, and even virtual reality and augmented reality, which are finding their place day by day, can play an important role in this change. In the research, it has been seen that the economic inputs that progress with the development of world archaeological tourism, mainly faith tourism, ethnic admiration and the longing for the remains of the past contribute to tourism. Quantitative and qualitative research methods, which have developed in parallel with the changes and transformations suitable for today's age, have become widespread rapidly. It is used especially in archaeological heritage sites and in the field of cultural tourism. Reality applications act as a bridge connecting the past to the present. In this context, knowledge and experience that takes visitors to the current atmosphere with realistically animated environments of historical places important in terms of gain.

Archaeological, cultural and architectural sites have been exhibition areas that attract people's attention with their mysterious history, topography, location and interesting stories. However, ancient cities have their own basic features, cultural, social and economic conditions of the communities living there, and important features such as the building blocks that define the city. With today's technology, it is possible to offer such places to the service of people as if they were living those moments and making them feel. Şanlıurfa Göbeklitepe (İlk and atc, 2018), Harput Castle, Gaziantep Castle and Museums, Istanbul Panorama Museum etc. are just a few of them.

2. Archaeological Remains-Archaeological Sites and Tourism

Archeology, can be defined as a branch of science that tries to understand and interpret the development process of civilization in order to contribute to future generations by looking at the material data of the past. According to this, what is expected from archeology is not to "recover something from the past", but to contribute to the cultural accumulation of people living today, to help them understand their place in this development process, and to convey this accumulation to future generations in order to understand the past. (Özdoğan, 2006:43). Since the understanding of history created without evidence is not possible, the "evaluation", "interpretation" or the attempt to explain the material cultural remains unearthed by archaeological excavations by archaeologists is a mandatory activity that should be carried out at the desk after field activities (Özbilen, 2020;43).

Archaeological sites can have very different structures. Since each field is a discipline that is separated from each other structurally and physically, they are examined in different manners. Sites can be examined under many sub-titles in terms of regional or area characteristics. Site concept used apart from the archaeological sites are areas to be protected. They are created naturally or by human labor. They are divided into parts according to their characteristics. Namely; natural site, urban site, archaeological site, historical site, rural site, complex site.

Many studies in archaeological sites also investigate structures, architecture and art from the past. After these works are interpreted and evaluated with an interdisciplinary study, they are taken under protection and construction is not allowed.

They are generally kept under protection. Studies aiming to reach the socio-economic and cultural characteristics of people living in the past are carried out. Archaeological sites are divided into three. These groups can be defined as follows:

1st Degree Archaeological Sites; are areas to be protected except for scientific researches aimed at conservation.

2nd Degree Archaeological Sites; are the areas that need to be protected. Conditions of use and how to protect them are determined during scientific studies. No construction is allowed in these areas.

3rd Degree Archaeological Sites; are areas that are open to use within a certain framework according to protection and usage conditions (URL-2).

Tourists attracted to historical places in archaeological sites, cultural realizing the aims of tourism paves the way. The increase in the number of tourists to archaeological sites, as well as archaeological tourism, from its earnings to its contribution to the country's economy affects so many issues. Appropriate technology and visual promotion in archaeological areas will both keep the historical place in memory and increase the interest in it.

Archaeological tourism, is a type of tourism that increases the interest of the people in the historical remains and places in the archaeological areas through trips to the ruins and museums, satisfies the cultural curiosity of the people by teaching the cultural level of the civilizations that lived in the past, and provides national and local gains to the city economy.

The old city settlements of Anatolian cities, which have been modernized with archeology tourism, attract more attention and are one of the most visited areas by the society. Cities, as places where nations will learn about their history and past experiences, therefore represent the “beginning”. Nations will protect their future as well as their past by protecting cities (Negiz, 2017, p: 163).

2.1. Basic Conservation Principles for Archaeological Sites

Archaeological assets bearing the traces of the past are sources of information that can help define the human behavior and social processes of the period they belong to, with their cultural layers and strong spatial and temporal relationships between the past and the present. The protection of these information resources, which are the products of the collective consciousness of the society, is important for the development of the traditional cultural values of the societies and accordingly the sense of self and identity. In this context, the issue of determining sustainable protection-development strategies in archaeological sites for the archaeological heritage left by societies to present comes into question (Tuna, 2019, p:725).

Conservation architects and technicians gathered in Venice in 1964. In the Venice Statute, which was developed by the experts, the 1956 UNESCO recommendation on “International Principles to be Applied in Archaeological Excavations” was adopted; basic principles for protection “The ruins should be protected, necessary measures should be taken for the permanent preservation of architectural elements and finds should be taken. All rebuilding must be abandoned in advance.” According to Article 15 of the Statute of Archaeological reconstruction in areas is not appropriate, only anastylosis can be done (Ahunbay, p.109).

The main problems encountered in the protection of archaeological sites in Turkey are not very variable. Illegal excavations in areas that are not under control and supervision have been the most important factor causing natural destruction since past times. In addition, property problems due to disagreements problems, zoning activities developing in areas whose archaeological potential has not been determined or whose importance has not been realized, inappropriate service units that are open to visitors exceeding the land carrying capacity, and problem-aggravating transportation solutions and so-called tourism activities that cause the destruction of the property can be listed as problems.

In the protection of historical sites and cultural heritage in Turkey, in addition to the problems related to property, some problems experienced in the process of integrating the historical texture into the present in Anatolian cities that have been modernized in line with scientific studies cause a change in the perception of conservation. In conservation practices, it is said that urban areas can be evaluated with detailed studies based on scientific criteria“ and it is possible to apply land use policies developed specifically for local scale instead of the classical zoning approach for “reorganization of urban/rural areas” (Mataracı et al., 2017).

Disciplining the protection and transfer of cultural heritage with various laws and regulations, undoubtedly play an important role in the success of these actions. However, these actions only with prohibitions before the public, who is one of its most important stakeholders, or the individual, who is its most basic actor. İt is not possible to sustain the conservation action (ICOMOS Turkey, 2013).

International principles regarding conservation practices in archaeological sites have been developed and discussed at an international level in the last 60 years. The following; “European Cultural Convention” signed in Paris on 19 December 1954, UNESCO’s 1956 “Recommendation on International Principles to be Applied in Archaeological Excavations”, “Venice Statute” (1964), “European Convention for the Protection of the Archaeological Heritage” first signed by the Council of Europe in London in 1969, . The protection of archaeological sites, which have universal value and are included in the World Heritage List, is carried out according to the rules of UNESCO’s 1972,”World-Heritage-Convention”(Ahunbay,2010,p:109).

“Recommendations on the Protection of Historic Sites and Their Contemporary Roles” adopted by UNESCO in Nairobi in 1976, “Management of the Archaeological Heritage” of ICOMOS (1990, Lausanne) and “Conservation and Management of Underwater Cultural Heritage” (1996, Sofia) legislations exist in this field.

The first legal regulation allowing the protection of archaeological sites in Turkey was the Law No. 1710 enacted in 1973, and in its 1st article, a site was defined as "topographic regions that are the work of nature or people's collaboration with nature, and that need to be protected and evaluated in terms of their homogeneity and characteristics". According to the decision of the High Council for the Protection of Cultural and Natural Heritage, dated 5.11.1999 and numbered 658, "the ruins are social, economic and cultural characteristics of the periods in which the ancient civilizations lived from the existence of humanity to the present, underground, surface and underwater products" (Ahunbay, 2010,p.110).

UNESCO's Recommendation on International Principles to be Applied in Archaeological Excavations dated 5 December 1956, expressed that the preservation of the archaeological heritage, which provides information about the history of all humanity, should be carried out according to tried methods. Responsibility for the continuous maintenance, conservation and restoration of the site is placed on the excavation manager. According to our laws, our cultural assets, which have national and universal value, are protected by our Law No. 2863 on the Protection of Cultural and Natural Assets.

Although there is a legal and theoretical basis in the field of protection of cultural assets, there are various gaps in the system. Despite the fact that excavation and repair works have been carried out for more than a century and the existence of museums spread all over the country, it is an important shortcoming that the desired level of success has not yet been achieved in the field of inventory, conservation and exhibition.

2.2. The Use of Archaeological Sites in Various Points of Tourism in Turkey and Related Examples

Turkey is a country with many ancient civilizations, and has been the center of various civilizations that come from prehistory of Anatolia to the present day and form a whole. Historical and cultural values are the most important factor in Turkish tourism. Turkey attracts the attention of foreign tourists with its historical and cultural values, they come to Turkey not only for the sea, sand and sun, but generally to see these values (Türk, 2000, p: 43).

The richness of the Anatolian heritage, which has survived to the present day, has inevitably made people responsible of this wealth. Creating new and beautiful works without denying tradition requires knowledge, experience and expertise.

As Altınoluk said, it is important to restore, keep alive and transfer them to future generations by giving new functions in accordance with today's conditions to buildings that have been abandoned for years and have been empty and dilapidated. Just like buildings that have been restored and converted into a music palace (White Mansion), a tea-cake room (Malta, Tent, San, Pink) and many new functions. Hotels, hostels, museums, conference and ceremonial palaces, etc. It has been the first groundbreaking original usage examples in Turkey, creating valuable and various cultural and tourism uses (Altınoluk, 1981, p:16).

One of the structures brought back to life by re-functioning is the Istanbul Archeology Museum. The foundation of the Istanbul Archaeological Museums is based on the collection of archaeological artifacts in the Hagia Irene Church in 1869 under the name of 'Hümayun Museum'. The building, which was built by Sir Osman Hamdi as 'Sanayi-i Nefise Mektebi' (Fine Arts Academy) in 1883, is used as the Museum of Ancient Oriental Works today. Thus, three museums under the name of Istanbul Archeology Museums were formed around the same garden (URL-3).

Our country, which has a rich architectural and cultural heritage, has a rapidly increasing tourism potential in recent years. Many valuable artifacts and places are unearthed in many researches and excavations carried out underground as well as above ground. However, our buildings, which cannot be saved from demolition and/or integrated into the modernized Anatolian cities with a new function, cause a great loss in terms of both the urban economy and sustainable tourism.

Virtually navigating the space one of the examples is the Ministry of Culture and Tourism and the Governorship of Elazig. It creates examples that have been brought to life through projects carried out in many parts of our country, with applications in which Elazığ-Harput Castle and its Architecture are animated in 3D (URL-4). In this project, visitors are provided with the opportunity to virtual tour in archaeological and historical areas and feel the past through programs that can also be downloaded to Android and IOS compatible vehicles with the reality application.

Tourism is a large industry with many different business lines. Especially the economic benefits of developing countries from the tourism industry are the main focus of attention of many researchers. However, tourism activities are of vital importance in terms of transferring the cultural data of countries and regions to future generations, beyond being just an economic line of business. Archeology museums are places where historical artifacts unearthed through archaeological excavations are preserved and exhibited. Archeology museums are considered as a touristic product on their own, by exhibiting the physical documents of the history and culture of the relevant region when evaluated from a touristic point of view. On the other hand, the incomes obtained from the visits of tourists traveling for cultural purposes every year also contribute to the sector in economic terms.

3. Digital Interactions in a Changing and Developing World

According to the Turkish Language Association, the concept of virtual, which means non-existent, conjecture, hypothetical and predictive, comes from the Latin virtualis root. (TDK, 2014).

Thanks to virtual reality technology, places in archaeological heritage areas will be able to be informed about historical places and current conditions without going to the area, and it will be possible to perceive them with promotional brochures to be prepared, by means of programs to be installed on mobile devices and computers, as well as their historical dimensions.

As Ak stated "Designs that respond to the user's movements, work simultaneously with the user, offer personalized experiences, created with virtual reality, augmented reality", mixed reality methods or that can be experienced in the real world are called interactive designs.(Ak, 2006)

The user is allowed to experience the virtual world with maximum immersion with the blending of mixed reality, virtual reality and augmented reality technologies, without disconnecting from the real world. The connection with the real world is also preserved during the experiences in the virtual world, in this respect mixed reality completely differs from virtual reality and it also differs from augmented reality with its stronger connection with the virtual world.

Virtual reality is 3D spaces modeled by computer technology experienced by the user through some interactive interfaces. Users can experience the space under their own control in the virtual world designed in 3D and can change the space in line with their instant decisions. The word "virtual reality" was first used by Jaron Lanier in the 1970s, and the first example of virtual reality is a flight simulation. In an experiment conducted in the 1970s, Krueger attached receptors to the human body and placed tubes containing phosphorus and water particles at the four corners of the room. The users perceived the artificial environment they are in as a natural environment (Ak, 2006, p.30). Malatya Arslantepe Mound, which is included in the Unesco World Heritage list, and Elazığ-Harput Castle and Architecture, Gaziantep Castle and museums, which are on the temporary heritage list, and many museums owned by private sectors are just a few of the beautiful examples that offer their visitors the longing of the past with digital opportunities.

Augmented reality production was first made in the 1960s by MIT Professor Ivan Sutherland. Sutherland produced the first augmented reality prototype glasses (HMD). The most obvious difference of these glasses from the glasses used today is that they are much heavier and therefore produces difficulties in use. In 1990, a researcher at Boeing first used the concept of augmented reality when describing head-mounted prototypes (HMD). In this way, the concept of augmented reality entered the literature (Ak, 2006, p: 33).

4. Examples of Interactive Design in Museum and Exhibition Areas

Interactive designs used in museums can be listed as QR code systems, audio guides, touch screens, VR glasses experiences, designs experienced with applications integrated with interactive tablets or smartphones, etc. in general. The methods used in museums will be examined and information will be given about interactive design methods in indoor areas.

" In historical and touristic places, we can provide augmented reality to enter that place and to visit that place". Thanks to virtual and augmented reality digital applications, local and foreign visitors will listen and feel the Harput architecture of Elazig, which is on the UNESCO temporary list, the civilizations that lived in the past and the people of that time, in their own words (Figure 1a-b, Figure 2).

William Farquhar creates an interactive design with augmented reality by focusing and animating 69 paintings from his Natural History Drawings collection. Visitors photograph the animal or plant they want to get information about in animation and save it in their archive with an application they can download to their phones or tablets while they are experiencing the forest of the Malay Peninsula in the 19th century. Application offers features such as feeding, hunting, lifestyle of the archived being to the user. Thus, visitors get information about rare species (URL-5).

(a) (b)

Figure 1: Harput, Urartu Period Photo (a), Harput Bizans Period (b) (İ.Aytaç Archive)

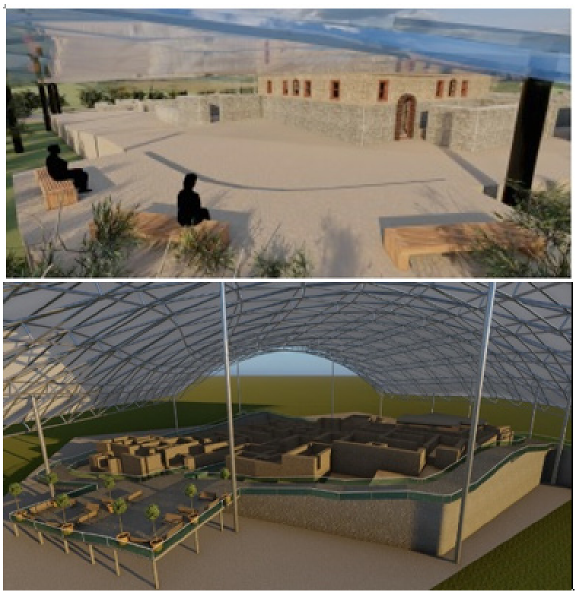


Figure 2: Harput Castle , Middle Neighboorhood, Past Period of Animation

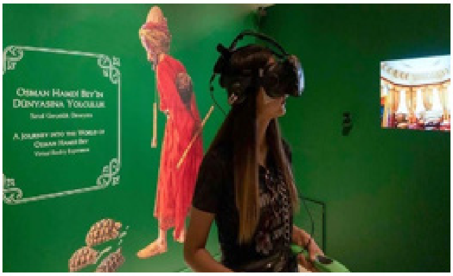
The purpose of the SheepTag, which was exhibited at the museum in 2011, is to get people to accurately complete the skeleton of the sheep. When the bone pieces are touched to the red dot on the table, which bone of the sheep it is and which bone it corresponds to in the human body is shown on the screen. Thus, the animal skeletal system, which will not stay in user's memory for a long time when they look at a picture, is learned through experiencing by the user (URL-5).

(a)

(b)

Figure 3: SheepTag (a) (URL-5) , Anadolu Med.Müzesi.AG application (b)

The project carried out by the Muse VR team in 2019 and exhibited at the Pera Museum is the production of Sir Osman Hamdi's Tortoise Trainer painting in a 3D virtual reality environment (Figure 4). Users can move in the virtual environment with VR glasses and bluetooth control in accordance with their wishes, and interact in a virtual reality where they can feed the turtles in the virtual environment. The design is an example for the concept of virtual reality, which adapts the user to the virtual environment with the immersion method (URL-5).



(a)

(b)

Figure 4: Pera Museum,(a), (URL-5), Pure Museum (b)(Carressimo ve at.2010)

The Museum of Pure Form, which is a joint work of many countries in Europe, as in our country, and supported by the European Union, provides with an interactive experience was developed for to visitors.

Archaeological sites are places that are not easy to perceive for visitors. Therefore, a person visiting the archaeological site may not be able to make sense of the information box next to the ruins efficiently. In order to eliminate this ambiguity and the complexity of the characteristics of the ancient city, new ways have begun to be sought with the development of technology. The ruins in ancient cities are modeled with virtual reality and completed, enabling the user to experience the space with augmented reality and mixed reality methods. In the study, three examples designed in archaeological and historical areas will be examined.

Ancient ruins such as Hera temple (in Figure 5) etc. are modeled as they existed in the past and experienced by users thanks to augmented reality tablets (Sürücü, atc.,(2016). Visitors start the tour by choosing one of the digital tour guides available when they come to the ancient city area. Visitors are provided with the necessary tools for augmented reality experience such as augmented reality glasses, camera, headset before starting the tour. When the visitor comes to the ruins of the Temple of Hera, the augmented reality model is completed and articulated on the real-time image perceived by the camera, with a kind of virtual rebuild (reconstruction). The visitor has the opportunity to experience the temple as it was used in ancient times. Information about the temple structure is simultaneously given via the headset while watching the ruins completed with augmented reality (Farid, 2018, p:7).

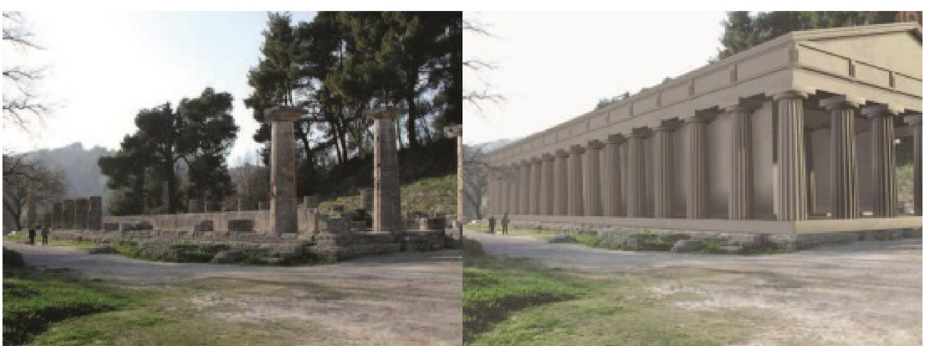


Figure 5: Hera Temple Ruins -Hera Temple
Augmented Reality Model (URL-6)

The project is to model the frescoes in the Ancient City of Pompeii using virtual reality and augmented reality methods and present them to the user simultaneously with the real world. The frescoes contain a lot of information about the period they are from, therefore by transforming the information they contain into 3D virtual reality, the visitor can experience the stories told in the frescoes inside the space. It can be shown as an example of mixed reality application (Papagiannakis et al., 2005, p: 12).

5. Conclusion

Conserving, preserving and transferring cultural heritage to future generations has taken its place among the basic responsibilities of contemporary societies with national and international laws, regulations and conventions. The importance given to conservation and survival and the success in this field have become an indicator of inter-communal modernization (Tekeli, 2009).

Archaeological cultural tourism is an important type of sustainable tourism and important measures should be taken to ensure that cultural heritage is not damaged. It is considered that non-seasonal archaeological tourism is a type of sustainable tourism that brings more income than other types of tourism due to its high economic contribution to the region. In the reintroduction of cultural heritage sites to the city where they are located, raising the awareness of the people living there has an important place, as well as the perspectives of protection put forward by the notables of the region. Archaeological sites, each of which has its own internal dynamics and should be evaluated in its own way, become more attractive in terms of tourism after the conservation-repair and exhibition works. This situation contributes to the increase in economic gain, especially in the vicinity of archaeological sites. Therefore, every scientific and contemporary intervention to the archaeological site increases the potential use of the area. If these areas, which become popular with tourism activities, are used over their current carrying capacity, destruction becomes inevitable. At this point, it is important to determine the capacities of archaeological sites in terms of protection-use balance and to prevent destruction by making interventions when necessary (Tandoğan, 2011, p:101).

In this context, determining the boundaries of the historical places in the archaeological areas, determining the places that can be visited and creating a certain travel route will both eliminate the physical uncertainty of the concept of space in the ancient settlements and provide a better service to the visitors with the places transferred to digital technology with virtual reality application and kept alive submission will be possible.

The discipline of architecture, which is intertwined with technology, has transitioned from physical space designs to virtual space designs. With the ambiguity of the concept of space, people's interactions with space have also begun to transform. The user, who can intervene in the physical environment up to a point, has begun to affect the space more freely in the virtual environment. Interactive space designs, which are a result of new media technologies, such as games, fashion design, museums, exhibition areas, archaeological sites, architectural presentation techniques, etc. started to be used actively in the fields. Within the scope of the study, interactive design examples seen in museums, exhibition areas and archaeological sites were examined, and as a result of the examinations.

Considering that the perception of unconsciousness, vandalism, and protection is not sufficiently established in the society, we will ensure that the awareness of conservation is settled in the society with virtual reality applications, and we will both increase the interest in archaeological sites and our cultural heritage and save this kind of historical and cultural heritage from extinction. Virtual the importance of protecting, keeping alive and transferring the cultural heritage, It has been found to be an effective method used by.

Experiencing the historical ruins with new media methods by the visitors of the archaeological site will greatly change the spatial setup in the ancient city, which is open to visitors. Virtual reality experience, which does not require a large physical area, is a method developed to provide maximum space experience with minimum additions, by avoiding the design of an additional system that would damage the historical area.

When we look at the many restoration applications made today, unfortunately, the number of historical structures that the competent and expert people can touch is very few. The buildings lose their originality either due to the wrong restoration application or by giving wrong function. Thanks to digital technologies (virtual reality, AG, etc.), it is possible to see the old state of a deteriorated space or a destroyed artifact in archaeological sites without deteriorating its structure. Today's site conservation strategies have adopted the tendency to leave some of the ruined and destroyed parts of the ruins in the restoration process in order to preserve and exhibit the historicity of the sites.

Thanks to the studies that have become widespread in our country as well as in Europe, the perspective of life of many civilizations that lived in the past has been brought to the fore in history. From the beginning to the present, we will have the opportunity to better examine and promote, and we will make a great contribution to the urban economies. The preservation of immovable cultural assets in our country, a better understanding of conservation awareness in the eyes of the society, historical our wealth is better in the world we can ensure that the world's important tourism potential reaches large masses with the help of technology.

Sustainability in conservation can be achieved with the participation of the individual (Aygün, 2011). It is extremely important for each individual to be conscious and raise awareness in the transfer and protection of cultural heritage to future generations. The formation of this awareness and awareness depends on the awareness and perception of the cultural heritage of the society, its education on this subject, and the frequent use of current and widespread technologies in the field of conservation

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CHAPTER X

THE THEORITICAL FRAMEWORK OF URBAN MORPHOLOGY

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1. Introduction

Studies on morphological structures of cities began to be research in the 19th century. The components that emerge the physical pattern of the city are defined as urban morphology. The formation and transformation of these components and the examination of the factors affecting this process constitute the basic research questions of the urban morphology. In this context, theoretical approaches to urban morphology have developed since the 19th century. In this process, different approaches have been developed by researchers from different disciplines. The development of different approaches has led to the increase and diversification of studies on urban morphology. Thus, the components that emerge the urban morphology can be handled at different scales and the urban units that emerge the whole urban texture can be analyzed. In other words, by examining each physical component that shape the urban morphology, findings related to the physical texture of the city can be obtained both at the macro and micro scales.

The developing process of urban morphology started in the 19th century, developed primarily on the basis of geography. With geography-based approaches, methods and theories have been developed for the urban form and the transformation of cities in the historical process. Then, urban morphology studies were also handled by architectural disciplines. In this way, new theoretical approaches have been developed and different sub-fields of morphological studies have done. Though the architectural based, typological approaches and typo-morphological analyzes developed. Apart from typo-morphology researches, studies on urban design have started. A process has begun in which the relationship between urban morphology and urban design is examined and studies on urban design are discussed within the urban morphology.

Urban morphology theories which have been developing for nearly a century, have developed around three basic schools. The University of Birmingham in England, the School of Urban Morphology in Italy and the Versailles School of Architecture in France are the institutions of the three main schools of urban morphology. The studies of these institutions which developed different theories and methods from each other were gathered under a single roof at the International Seminar of Urban Form (ISUF) in 1994. Thus, they were accepted as three important schools in the field of urban morphology.

In this study, the theoretical framework of urban morphology is discussed. The theoretical development of urban morphology from the 19th century to the present has been examined. In this context, different researchers from the disciplines of geography and architecture and the approaches they developed were mentioned. Three important schools accepted in urban morphology which gather these approaches under a certain roof are handled, and the chronological development of this entire development process is discussed.

1.1. Definition of urban morphology

Etymologically, *'morph'* means form in Latin, and *'logy'* means branch of science or field of study. It has emerged as a term that expresses the structure of form of something. Morphology is a term used in linguistics, biology, architecture and planning. Commonly the term is used in disciplines such as medicine, biology and veterinary, mostly related to the anatomical, cellular and physiological properties of human, animal and plants. The form and structural features of cells, tissues and various physiological features are defined as the morphology of living species. In the American Heritage Dictionary, *'morphology'* is defined as the study of the form and structure of an organism or a part of it.

Urban morphology, similar to other disciplines expresses the form and structural features. It expresses the forms and sequences of the components emerge the physical environment of the city. It has emerged as a field that examines the forms and sequences of the physical components that generate the city and conducts research related to the physical environment.

Moudon (1997) defined the urban morphology as the study field that focus on the formation of human settlements and the process of their formation and transformation.

Urban morphology consists of settlement plans, urban form, parcel arrangement, parcel dimensions, building forms and structuring order, building typology, floor heights, arrangement of open space systems, green areas, open area typologies, city silhouette, urban landscape elements. The combination of these components reveals the morphological character of the city. In addition to these components, the natural and geographical features of the city are among the factors that shape the morphological character of the city.

2. Research field of urban morphology

Urban morphology is a field of study that researches the form, formation and transformation processes of settlements. Also their spatial characteristics since their historical development processes and analyzes the components that emerge the settlements and aims to produce typological classifications when necessary.

In other words, urban morphology can be defined as the examination of the conditions of coming together of the components that define the physical pattern of cities. It examines the processes and stakeholders that cause formation, change and metamorphosis in the urban pattern.

Urban morphology which is a field of study aimed to analyze the city in terms of physical environment. It examines the interactions and coming together of urban components of different scales from past periods to the present, and puts the physical transformation of the city at its center. In this context, it basically aims to research the formation and transformation process of settlements.

Bilge (2010) emphasizes that urban morphology is related to the temporal conditions, therefore, changes in urban forms are related to historical/periodical changes. For this reason, urban morphology researches give importance to retrospective studies to understand the current situation. The physical structure of the city can be analyzed and the urban evolution can be explained in this way with the researches from the past to the present.

Akyıldız and Akbaş (2020) defines the urban morphology as a research field that examines physical components of the city and relation between them though the morphological transformation in historical process.

Kostof (1991) states that urban morphology is the product of a multi-component structure and there are approaches and researchers from different disciplines. Urban morphology which is a common field of study of disciplines related with the city such as; geographers, landscape architects, city planners, and architects. Hence, it is a field of study handled by different disciplines.

Scientists who contribute to urban morphology generally gather around an idea. They examine the transformation process of the city, starting from its formation years, along with subsequent changes and transformations by identifying its various components and dividing them into different parts (Topçu, 2003). In this context, studies on urban morphology are mostly carried out in the form of examining certain components according to the relevant discipline. Whitehand and Larkham (2000) divided researches on urban morphology into three main groups;

1) Researchers in first group describe the spatial changes that cities have undergone from past to present, the evolution of urban space through maps, city plans, photographs and written sources. These studies are mostly carried out in cities and settlements with a strong historical background, in order to shed light on the current situation by revealing the urban evolution.
2) The researches in the second group are evaluated through the physical change in cities and the actions of the stakeholders involved in this change process.
3) The researches in the third group define the decision-making mechanisms and processes related to the transformation of urban space and the relations between the tools and stakeholders that direct these processes.

Urban morphology intersects with many other research fields. In addition, it is related to urban archeology in examining the physical transformation of cities in the historical process. It is associated with disciplines such as archeology in the analysis of spatial evolution in the historical process.

In terms of space production, the social, cultural, economic and politic factors are also handled as parameters which play a role in the formation of urban forms. In other words, the factors affecting the morphological formation in the city are examined though the urban morphology.

The conditions and forms of the coming together of different physical elements in the city constitute the morphology of the city. This coming together also reveals the urban landscape. Therefore, urban morphology studies are related to the concept of urban landscape and include studies on the analysis, transformation and maintenance of urban landscape.

The legibility of places and spatial perception are also shaped within the framework of the character of urban morphology. Individuals' perception of space, orientation and the legibility level of spaces are shaped depending on the character of urban morphology. The forms and sequences of the physical components that emerge the urban morphology define and change the spatial perception.

Urban morphology is a field that is studied at different scales as well as being a field handled by different disciplines. It is discussed both in urban planning as macro scale and also urban design and architectural scale as micro scales. In macro scales such as city plans, transportation solutions in cities, roads, parcels, geographical features are all factors in determining the morphology of the city. In sub-scales, urban design decisions, architectural typology, urban landscape are the issues that generate the urban morphology.

Gebauer and Samuel (1983) define the urban morphology as study of the physical and spatial characteristics of entire urban structure. In addition, Gebauer and Samuel (1983) evaluate urban morphology as an analysis method used to determine urban design principles and theories. In this way, it is accepted as a part of urban design. Alper (2009) also states that urban morphology is a tool for urban designers to understand a space and is the main field of study required for spatial analysis. Especially in urban design, urban morphology is viewed as a research method to analyze and understand the visible and invisible rules related to sequences and forms of buildings and open spaces (Yaygın, 2016).

3. Development of theoretical approaches in urban morphology

Urban morphology is a collaborative field by researchers from different disciplines. The first approaches in this field did not arise from a single discipline. The approaches that emerged from different disciplines formed the basic theories of urban morphology. These theories are emerged under the disciplines of geography and architecture. Urban morphology has a history of nearly a century as a branch of science. According to Whitehand (1986), urban morphology and urban geography complement to each other.

In the last quarter of the 19th century, studies on urban morphology began to take place among research topics in England. The researches and theoretical framework of urban morphology based on geographical approaches. Theoretical approaches started to develop with urban geographers. Whitehand (2007) emphasized that urban morphology keeping with its origins in geography, inherently about distinguishing, characterizing and explaining urban landscapes.

In this context, Martiny (1928) in Germany studied examining the formation of plans for urban and rural German settlements. This study which is one of the first examples of morphological studies was criticized and found incomplete by Geisler (1924). The main reason for this criticism is that the scientists who carried out the studies kept the scale of their studies large and they only benefited from topographic data without considering the origins of the plans and urban spaces they defined. For this reason, this first study was criticized because the historical development process of the city was not handled and the urban evolution could not be defined.

According to Kuban and Dökmeci (1994), the reason for the emergence of such a situation is that the researchers working on urban morphology of that period were geographically based and therefore did not take into account the spatial data related to the urban space.

Until World War II studies on urban morphology developed on the basis of urban geography both in Europe, England and America. After the war years, it started to develop within the framework of architecture and planning disciplines. While urban morphology in Europe ceased to be based on geography, it developed within the framework of architecture and planning. However, it remained a sub-branch of urban geography for a long time in U.S.A. (Vance, 1977).

After the World War II, geographers studying in this field began to consider the studies of urban historians, architects and planners. Urban geographers Meier and Roring (Meier and Roring, 1990) and urban historians Klaiber (Klaiber, 1912) and Siedler (Siedler, 1914) began to recognize architectural and planning-oriented studies. Also the factors that formed the morphological structure of cities began to be examined. Whiteland (1981) emphasizes that, urban morphology developed and changed in these periods. The studies of Bobek and Christaller were also influential in the development of morphological research from the basis of geography to the basis of architecture and planning. Hence, the cadastral maps and urban layouts began to be used in addition to topographic data in studies for analyzing the urban morphology.

3.1. Geographic based approaches

Morphological research of geographic based was started on the work of Schlüter in Germany in 1899. Schlüter's work in Germany is a monographic study of German settlements. Schlüter's one of the study was on the settlement plans of cities, and the other was on the scale of settlement geography. Then, Schlüter produced two different methodological studies on the impact of human geography in the geographical sciences and on the aims of human geography. Schlüter (1899) developed different methodologies on the importance of geography and human geography. Hence, he laid the foundations of the philosophy of geography. Geographical studies initiated by Schlüter on the morphological structures of settlements.

Even though these studies were early examples of the tracing of the historical development of urban form, during the time it become the central feature of urban morphology. These studies were continued with Hassinger, Geisler, Bobek and Conzen. In Table 1, the development process of geography-based approaches of urban morphology is shown chronologically.

Table 1. Development of Geography-based
Approaches of Urban Morphology as Chronologically

Researcher	**Research year**	**Approach / Subject of Study**
Schluter	1899	➢ Cultural landscape and landscape morphology ➢ Relationship between physical pattern and function
Hassinger	1912	Density analyzes focused on urban conservation
Geisler and Martiny	1914	Defining the morphological character of settlements with topographic and geographical data
Bobek	1927	Defining of spatial and urban features by examining form and functional changes in the historical process
Scharlau	1941	The use of cadastral plans in the analyzing of the formation and transformation processes of cities
Conzen	1949	➢ Researching of the factors that occur the physical form ➢ Analyzing of the current situation of urban pattern by examining the historical development of cities in the physical features
Whitehand	1967	➢ Analyzing of the transformations of physical urban pattern ➢ Continuing Conzen’s approach

Schlüter who laid the foundation of research on urban morphology with a geographical approach, studied on *'cultural landscape morphology'* through geography and culture.

Within the scope of urban geography, he drew attention to the appearance and physical form of the city and the urban landscape which is the main subject of morphological research (Whitehand, 1987). The urban landscape is the focus of Schlüter's morphological studies and he interprets the urban landscape formed by physical formation as the most important element of urban morphology.

After Schlüter, Hassinger (1916) conducted studies on settlement densities, land uses and types. Hassinger has focused on the conservation of the urban landscape and the physical pattern of cities from history to the present. It focused on land and building uses and building density. He mapped out the distribution and architectural styles of monumental buildings for historical cities in Austria for architectural conservation. In addition, Hassinger mapped the urban landscape and the historical development process of the city. In this way, he mapped urban evolution in terms of morphologically in different periods.

After the First World War, Geisler (1924) and Martiny (1928) analyzed city plans and building types based on monographic classification and discussed the physical formation of the city in more detail than previous studies. In their researches, generally using topographic and geographical data. They produced morphographic classifications of city plans and building types (Whitehand, 1987). In the same period, Meier and Roring (1990) studied the historical background of cities. Similarly, Klaiber (1912) and Siedler (1914) studied the evolution of urban morphology within the history of urban planning.

In this period, other factors that shape the urban morphology of the city were also focused on. Apart from the historical process of the physical development and transformation of cities, the effect of socio-cultural characteristics on physical formation and functional factors in the formation of physical pattern have been analyzed.

On the other hand, Bobek (1966) focused on the relationship between functional changes and morphological structure. In this context, Bobek dealt with cities according to functional change over time. He studied the reflections of functional uses and changes on the physical environment. Therefore, Bobek researched the relationship between them with thought that function is a factor in determining the morphological character.

In 1941, the German geographer Scharlau began to examine the morphological change and urban evolution in cities by using cadastral plans. He examined the physical formations and spatial sequences of cities by using cadastral plans that including streets, building blocks and building plans.

According to Dennis and Prince (1988), until the 1960s, the studies of urban geographers on urban morphology were defined within the framework of components such as city plans, different historical components of the city, building types and spatial uses. After this period, M.R.G. Conzen proposed his own methodology in studies on urban morphology and developed his own approach which is accepted as the basis of urban morphology.

3.2. Conzen's approach in urban morphology

Conzen dealt with the studies on urban morphology since the 1960s and produced a methodology in this field. Conzen's approach analyzes the development and transformation of the physical components of cities though the historical process. In this context, he proposed a systematic analysis of the formation and transformation of the physical components that occur the morphological character of the city. In Conzen's analyses morphogenetic method was seen. Cartographic representation and terminological precision was preferred. Conzen divided the factors that shape the urban morphology into five groups. These are;

- Urban landscape
- Function
- Place
- Socio-economic characteristics
- Urban development

According to Conzen, the urban landscape is the most important indicator of morphological analysis among these factors that reveal the morphological character. Therefore, urban morphology should be focused on the urban landscape according to Conzen. For this reason, Conzen divided the urban landscape into three sub-titles. These sub titles of urban landscape are;

- The city plan (town plan)
- Land use
- Building fabric (Conzen, 1960).

In Conzen's classification, the city/town plan refers comprising the site, streets, plots and block plans of the buildings. Land use refers land and building utilization, thirdly with building fabric Conzen indicates three dimensional form of the physical components. Whitehand (2007) states that Conzen who defined the basic approach of urban morphology considers these components as the basic components of morphology. He indicates that these components are strongly related to each other and Conzen's approach developed on the focus of these three components. Whitehand emphasizes also, he made the morphological analyzes of the city on the focus of these three components. Among these three components, the city plan is divided into three parts as;

- Road/path pattern
- Plot pattern
- Building pattern

Kropf (2009) indicates that there are different combinations of plan units and sub-units are formed by these components in Conzen's approach. In other words, it is indicated that the morphological character of the city is emerged with the configuration of these sub-components.

On the other hand, *'place'* which Conzen states, refers to the distribution and spatial relationships of natural physical features such as topography, geology, hydrology and vegetation (Kropf, 2009). Although social and economic characteristics which are another factor that shape the physical pattern are considered as a factor in the shaping of the urban morphology, they were not kept in the foreground in Conzen's studies. The Conzen's analyzes of the urban morphology were made on the focus of physical elements and functional characteristics.

According to Kuban and Dökmeci (1994), these studies of Conzen not only provide an example of building typologies and building/land uses, but also give results showing how the physical structure of the city should be handled for the conservation of the urban landscape. The findings in this context are evaluated as the findings that will be used in the conservation or redesign of the existing morphological character and urban landscape.

Conzen studied the forms of both urban and rural settlements in England in 1949. However, Conzen's most important work on urban morphology *is 'Alnwick, Northumberland: A study in town-plan analysis'* in 1960. In this study, he developed principles for urban morphology. In addition, the analyses of the existing physical pattern, the evaluation of the building blocks as an analysis unit, detailed map analyzes and urban development have been concluded. In Conzen's method, maps are the main material of researches. From different periods and several types of maps are used to reveal urban evolution and morphological development.

Slater (1983) indicates that in order to create a rational analysis method in Conzen's analysis of urban morphology, the development process of the city/ space though the history should be handled. In this process, it became necessary to examine historical records and plans apart from current maps. Therefore, sources that present the non-existing urban pattern and researches for previous urban pattern form the basis of Conzen's morphological analyzes. Apart from current maps and maps of previous periods, written sources and other visual materials are also materials that help explain the morphological change. In this way, it is aimed to reveal the transformation of urban morphology and urban evolution.

Hence, the most important goal of Conzen's analyzes is to reach the origin of urban existence from reliable maps and to understand the transformation of the urban environment by analyzing this urban development process (Koster, 2001). In addition to the current situation in Conzen's works, it is aimed to define the physical characteristics of the city or the urban space in question belonging to different periods. In this context, it aims to draw conclusions about protecting and maintaining the *'urban landscape'* today.

3.3. Architectural based approaches

Researches of urban morphology that began though the geographical-based approaches since19th century continued to develop though architecture and planning disciplines. Architectural based approaches started with typological classifications of buildings on the basis of architectural disciplines and then researches spread to urban scale. Urban morphology studies which developed on the basis of architecture, first started with typological studies focusing on building types in Europe.

The French architectural theorist J.F. Blondel classified buildings according to different types in his work titled *"Cours De Architectura",* which he prepared in the 19th century. However, Blondel's classification was accepted as a function-based type of classification, was not morphologically based classification.

In the development process of typological researches from functional based classification to morphological approach, Blondel's students Ledoux and Boullee, different from Blondel focused on the change of urban pattern during the historical process (Vidler, 1977). Similar to Blondel, the French educator and architect Louis Durand also classified buildings in the 18^{th} century. Since he made a morphological classification unlike Blondel, therefore, the first morphological classification in the architectural field was made by Durand (Forty, 2000).

The significant development of typological studies based on urban morphology on the framework architectural based started in the late 19^{th} and 20^{th} centuries. These studies continued to develop first in Italy and France, and then in the U.S.A.

The typological approach in Italy developed in the 1950s with Saverio Muratori. Muratori and the Roman School pioneered the development of typo-morphological studies in Europe. Muratori has made studies both on typo-morphology and on an urban scale. In this context, he focused on morphological analyzes at different scales and focused on environmental concepts. Muratori studied the components that emerge the urban morphology. In addition, he handled form-function relations and urban scale researches (Caniggia and Maffei, 2001).

According to Muratori, typological changes in the historical process and the development process of urban design show that there is a dialectical relationship between time and morphological pattern (Petruccioli, 1998). After Muratori, Caniggia focused on changes in typology over time. He examined the typological and urban evolution and the variables in the components that change the physical pattern.

Levy (1997) also indicates that, Caniggia's basic approach is on the historical formation and transformation of the urban pattern. Canggia's approach was called the *'typological process',* and though this approach, he acted with the idea that building typologies are the basic element of urban form. For this reason, he focused on functional and physical forms and cultural impacts that are effective in morphological formation and transformation.

At the same time, Canggia touched upon the continuation of the existing typological and urban character for the next generations. In other words, he touched on morphological changes deal with urban memory and identity. Argan (1963) also produced theories on formal typology and morphological memory.

Caniggia's *'process of typological approach'* aims to analyze the historical formation of the urban environment and to develop architectural and urban proposals regarding the current situation with these analyses. Caniggia primarily used spatial correlation and temporal correlation as methods in his morphological studies. Spatial and temporal parameters are focus on both in his method and in his approach (Caniggia & Maffei, 2001). Caniggia divided his studies about urban morphology into four groups as buildings, building pattern, settlements and cities. In this context, the main purpose of Caniggia's studies on urban morphology is to classify how architecturally rural buildings acquire an urban character, evolve into an urban character and when examined on a settlement basis, how small-scale settlements and urban models turn into more complex cities.

Hence, the *'spatial correlation'* analysis used by Caniggia is based on the components that emerge the space. Caniggia defined the subcomponents of spatial correlation as; components, component structure, system of structures, and system organization. At the urban scale, the component structure is the building ensembles that form the urban pattern. On the other hand, the city-scale system of structures refers to the combination of patterns that emerge neighborhood units or neighborhoods (Caniggia and Maffei, 2001). In this combination, not only the buildings, but also the combinations of open spaces and other physical elements that generate an urban area are expressed. Although Caniggia's studies on urban morphology though an architectural basis, the approaches of Caniggia and other theorists are actually based on Conzen.

On the other hand, urban morphology studies in France started to develop as a research field in architecture schools since the 1960s. Urban morphology studies in France developed under the leadership of the Versailles School of Architecture. After the 1970s, studies on urban morphology developed on a postmodern basis with the *'l'architecture urbaine'* (urban architecture) approach in other architectural schools in France (Bilsel, 2018).

In this development, research on urban morphology has gained a dimension in which the understanding of urban design is developed along with historical processes. Bernard Huet, the founder of Paris-Belleville School of Architecture, defined this approach as *'urban composition'*.

Urban morphology studies on historical cities were carried out at the Paris-Belleville School of Architecture. These studies have been developed with an urban design focus and a post-modern urban architectural approach has been developed in these applications. On the other hand, Philippe Panerai, Jean Castex and Jean-Charles Dépaule developed a methodical framework for urban space analysis at the French School of Urban Morphology (Bilsel, 2018).

They developed concepts and methods on the principles and elements of urban analysis. Under the titles of '*Eléments d'Analyse Urbaine'* (Elements of Urban Analysis) and *'Principes d'Analyse Urbaine'* (Principles of Urban Analysis) various studies have been conducted on urban morphology, urban structure, transportation systems, urban pattern, plot forms, typo-morphology and urban landscape approaches in the focus of architecture (Phillippe et al., 1999).

In these studies, special attention was paid to the analysis of the urban landscape when considering the urban space in terms of visual perception, and the concept of urban landscape was discussed within the analysis of urban form. Therefore, the concept of urban landscape indicates an important change in approach in urban planning and urban design practices in France.

It is seen that the *'urban architecture'* approach was emerged as a result of the concepts, principles and methods of urban morphology and urban analysis studies and typo-morphology studies at the Schools of Architecture in France. With this approach, a radical transformation has started in urban planning, urban conservation and urban design practices in France. This approach has been used in urban design practiced in the city center since the 1980s (Bilsel, 2018).

Aldo Rossi and Rob Krier are other important names in the field of urban morphology. Rossi's approach contributed to the field of urban morphology in Italy and Krier's in the U.S.A. The common point of both Rossi's and Krier's theories on urban morphology; how historical processes and temporal changes affect the urban pattern. While Rossi (1982) shows typological analysis as a tool for understanding urban phenomena, Krier and Rowe (1979) identified and examined the morphological components of the concept of urban space. On the other hand, Aldo Rossi handled the factors that were effective in the formation of the morphological structures of the cities depending on socio-cultural reasons.

Whitehand (1988) states that the studies of historical development of American cities by urban historians and sociologists since the 1980s, has also improved the studies on urban morphology. While urban morphology developed related to architectural approaches in Europe, in U.S.A. it developed under urban geography.

The development of urban morphology in U.S.A. continued with Moudon, apart from Krier, and morphological studies were made for American cities. Moudon (1997) based his morphological research on three basic components that he identified as form, time and decomposition. Moudon also focused on the cultural, social and economic data that influence the form. Kostof (1991) also emphasized that socio-cultural, economic and functional reasons should also be handled in order to analyze the urban form straightly and to understand the reasons for the physical formation and transformation of the city.

Although all theoretical studies are based on Conzen and Caniggia, research methods on urban morphology have changed in the last quarter of the 20th century in parallel with technological developments. The theory of *'space syntax'* was developed by Hillier who started a method combining technology and spatial/urban analysis. Hillier expressed the space syntax theory as a research program in the morphological variables of the urban environment. According to Hillier, the purpose of this method is to combine formal definitions of spatial features with an experimental observation that makes connections with statistics (Hillier, 1998).

Space syntax method is used for defining the functioning of the physical structure of the space in urban design projects. It tests whether the physical pattern in question fits the needs of the users or how it can be made more suitable. It helps to understand the suitability of the form in question by testing the relationship between the user and the physical pattern. In this context, it is used not only for past evaluations of analyze the urban evolution, but also for the projects to be made and for the determination of problems in current situations.

With space syntax, the physical structure of the city is defined. Also it is possible to evaluate the physical structure of a space in terms of many subjects such as; understanding the relationship between users and physical pattern, identifying and solving problems, measuring the legibility of a space, analyzing and planning for movement / circulation organization in urban areas. It presents quantitative findings for spatial use and urban environment. Therefore, by the virtue of quantitative findings morphological changes during the history and future projections can be evaluated. It also gives results regarding the effects of future designs on the space and users.

In Table 2, architectural-based urban morphology approaches are indicated chronologically. It is based on the approach of Conzen and Caniggia on the basis of all the studies and theoretical approaches developed on the architectural basis and interpreted as derivatives of these approaches.

Table 2. Development of Architecture-based Approaches of Urban Morphology as Chronologically

Researcher	**Research year**	**Approach / Subject of Study**
Durand	18th century	typo-morphological classification
Blondel	19th century	typological classification
Muratori	1910	➢ Morphological studies at urban scale ➢ Analyzing the components that generate the urban morphology ➢ Typo-morphological classification
Caniggia	1930	➢ Morphological analyzes in the historical process ➢ Morphological changes/urban change ➢ Relationship between morphological character and urban memory ➢ The 'typological process' approach
Argan	1960	Studies on morphological memory
Huet/ Panerai/ Castex	1960	➢ Analysis of changings in the historical process ➢ Evaluation of urban morphology within the scope of urban design concept. ➢ Urban space analysis
Rossi ve Krier	1970	How different typological processes affect the urban fabric
Mouden	1980	Research the social, cultural and economic aspects as a factor of morphological changes
Hillier	1980	Use quantitative data and develop a method for space analysis by computer aided program

3.4. Urban morphology schools

Different approaches from different disciplines have been developed since the 19th century on the field of urban morphology. The most important institutions research on urban morphology are the University of Birmingham in England, the

School of Urban Morphology in Italy and the Versailles School of Architecture in France.

The studies of these institutions which have developed different approaches from each other were gathered under a single roof at the International Seminar of Urban Form (ISUF) in 1994. Thus, they have been adopted as three important schools in the field of urban morphology (Bilgi, 2010).

The English school of morphology was founded in 1974 under the name of *'The Urban Morphology Research Group'* (UMRG) under the University of Birmingham. UMRG is the largest urban research center in the country. UMRG's studies are basically based on the Conzen's approach. UMRG research group carries out its studies on urban morphology on the basis of morphological changes of urban areas during the history, formation and transformation processes of urban environment. At the same time, the British research group ISUF plays an active role in urban morphology researches.

The Italian school was started with Saverio Muratori. Unlike the English school, Italian urban morphology studies are typologically and design-oriented. It focuses on the examination of typological changes in cities since the historical process and the sustainability of the urban pattern. Italian school follows more typological and design detailed way different from British and Conzen's approaches. Apart from Muratori, Rossi is another name in this school who studied on urban typology. Cataldi et al. (2002) stated that the Italian school focused on typological changes by making more detailed studies with typo-morphology studies compared to the English school. They also aim to develop theories on urban design through urban form studies.

The French school, represented by Jean Castex, Philippe Panerai and Depaule, founded in the 1960s. Although the French school is similar to the Italian school, it founded as a reaction to modern cities (Moudon, 1997). Although there are typo-morphological studies similar to the Italian school, the French school has a much more theoretical. The most important approach of the French school is to understand the spatial formations and transformations as a result of the first spatial transformations (Moudon, 2000). Koster (2001) also indicates that this school examines spatial trends as a natural consequence of previous transformations.

Like the other two schools, in the French school, urban analyzes for physical pattern are made by using written and visual sources. Then the changes over time are handled for urban scale. In this context, French urban morphology studies focus on developing theories for urban design and how cities should be.

In French morphology studies, the social aspect of space was also discussed with the urban sociologist Henri Lefebvre. Hence, French researchers argued that the urban environment in modern times prevents people from using their instincts in their living spaces and weakens their relations with their environment. For this reason, Moudon (1997) emphasized that the French school is in the cross section of the English and Italian schools. Kahraman (2014) also indicates that the French school defines private space, collective space and public space, and each space they define is evaluated in the context of social life practices.

4. Conclusion

Urban morphology studies have continued to increase in the 21th century from the beginning. New approaches and studies from architectural disciplines have been added to the urban morphology researches that started on the basis of geography. When the theoretical development of urban morphology is examined, it is seen that it is handled around the disciplines of geography and architecture, and that all theoretical approaches and analysis methods are shaped around these disciplines. Different researchers from these disciplines have dealt with the subject at different scales and within different components. This situation allows the analysis of the elements that emerge the urban morphology both holistically and by separating them into parts. In this context, different classifications and methods have done in theoretical development. However, although different classifications and methods have been developed, it is seen that all approaches to urban morphology are based on Conzen and Caniggia. A process in which the framework drawn by Conzen and Caniggia is diversified and developed is seen.

It is obvious that, the analysis methods and materials which constitute an important part of the morphological studies have basically been used unchanged since the 19th century. Visual sources such as historical maps, photographs and cartographic sources are still used today as the most important materials of studies in urban morphology, especially in the analysis of historical change of cities.

On the other hand, in the examination of physical components of the city, new theories and methods that include today's technology have improved apart from these traditional materials. Supporting the analyzes of urban morphology with computer-aided programs ensure a new dimension to the studies on this subject. This new process which started with Hillier's space syntax theory provides the evaluation of the physical form with perceptual and functional aspects, together with the morphological analysis. Thus, urban morphology studies started to examine other factors that cause the formation and transformation of the physical urban pattern.

As a research area, urban morphology produces findings about past, present and future characters of cities. While the understanding of urban evolution is provided by examining the first formation of cities and their transformation processes over time, urban problems can be revealed with studies on today's urban fabric. With the use of computer aided analysis programs in urban morphology studies, evaluations can be made both for the current texture and for future conditions.

Especially in the field of urban design, urban morphology has been frequently discussed in recent decades and has developed as a subject that has been studied in relation to urban design. In this context, urban morphology is an important field of study in determining urban design theories and practices. In addition to urban design, urban morphology continues to develop in the 21st century as one of the most important fields of study on issues such as urban form, urban growth, and urban fringes at the planning scale.

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CHAPTER XI

LANDSCAPE PLANNING CRITERIA IN HISTORICAL ENVIRONMENTS

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1. Introduction

Humankind has so far requested to integrate the environment that it has always lived in simple living spaces, imposing temples or palaces with nature. In this desire, the form and the identity that he had built carried over to the nature. In the plants, on the rocks, he practiced the feelings he saw on the ground, around the space he used the serious symbols. The change of art in history reflected in the gardens and green spaces as well (Sözen, 1988).

The 'Historical Environment' in the whole of the environment we believe to be in the best possible way to protect and preserve is not really a special kind of environment but an area that contains some characteristics specific to the region that surrounds the formation that will occur in the historical perspective (Yazgan ve Erdoğan, 1992).

In the 2nd International Congress of Historical Monuments Architects and Technicians convened in Venice in 1964, the decisions taken under the name of the "Venice Charter" were formed. In the charter; it has been accepted as a principle to ensure the continuity of protection and to use and evaluate the monuments for social purposes in contemporary life. The European Architectural Heritage Year in 1975 became a milestone in Europe as it began to recognize conservation issues in its old neighborhoods, and as middle-class citizens began to recognize the historical centers as places to live (Orbaşlı, 2000). Conservation and rehabilitation of historic city centers today is a common practice in Europe. Sustainability of history is based, unquestionably, on the criteria that values impose; it is useful to assume that cultural heritage is inherently good (Stubbs, 2004). So, with sustainability and architectural conservation, our building heritage is closely related not only as a cultural resource, but also when it is accepted as material (Rodwell, 2003).

Strange (1997), defines the "historic city" as one in which the economy depends heavily on tourism, attracts attention with historical character, and promotes the economic exploitation of heritage values through presentation, interpretation techniques (Strange, 1997). In contrast, it is easier to hide in the roof of the historical environment, historic sites, cultural heritage and tourist sites. The cultural heritage market is so lucrative that history towns in all shapes and sizes are looking for historical identities to increase cultural tourism potential (Stubbs, 2004).

Tourism and visitor economics constitute an important component of the economic lending to many historic towns and cities as a valuable financial resource to protect historical textures and provide protection at the urban scale. Because of the tourism heritage, too many urban heritages may have been preserved or may be destroyed in significant amounts as a different result (Orbaşlı, 2000).

In this article, the principles to be considered in planning activities for the protection of cultural and natural assets in Turkey and the methods to be followed will be discussed. Historical environmental protection, planning and implementation problems will be examined and the planning studies carried out in various scales and qualities in our country and in the world will be mentioned. The village of Safranbolu Yörük, which constitutes the study topic, has a different value in terms of historical texture, environmental parameters, courtyard-street-garden relations. For this reason, Yörük village urban conservation area has been chosen as sampling and study area.

2. Historical Heritages and Conservation

Heritage is a special piece of the past and can only be partially interpreted today (Stubbs, 2004). UNESCO's legacy defines it as "the heritage we have inherited from our past, the heritage we live in today and for generations to come" (URL-1). Heritage is broader than cultural fields and / or processes; "an economic asset and a social commodity" and a "product and dynamic process that undergoes constant change" (Guzman, Roders & Colenbrander, 2017). 'Conservation', on the other hand, can be defined as the whole process of looking at a place that maintains its cultural significance, and cultural significance is the union of material and non-material issues (Rodwell, 2003).

The transition from the conservation of art-worthy structures to the idea of urban conservation has come after the understanding of the formal and historical values of the people who make up the doctrine of settlement. At the end of the nineteenth century in Europe, it began with the preservation of the urban fabric, which was the source of funds for important monuments. Historical environmental conservation practices have been expressed in the context of increasing the aesthetic value of historical monuments in the Athens Conference organized by the international 'The Organization of Museums' in 1931 for the first time in international level. It was mentioned "While the constructions are being made, the surrounding monuments should be respected around the historical monuments, especially those who want special care about the personality of the buildings and the surroundings, and even some building clusters should be preserved in beautiful scenic landscapes" in the related article (Ahunbay, 1999).

Historical environmental protection problems arise from the inadequacy of transferring holistic approaches put forward in international documents to conservation practices in recent years. The historic character and scale provide a picturesque and authentic environment for pleasant cafes and shopping opportunities. Despite the convenience and comforts that technology brings, at a time when half of the world's population cannot be adequately fed and the energy resources of the world are limited and the preservation of nature is considered as a living condition, it is an important issue that protection of human created physical environment more economical and more conscious (Kuban, 2000). Social gains of cultural heritage; to create a pleasant environment, to mitigate over-urbanization, and to improve the quality of life of urban residents in order to adapt to climate change. Evans (2005), has shown the positive impact of reforms in historic and urban areas, which encouraged many local governments to develop their culture leadership qualities, urban strategies (Evans, 2005). Bandarin and Van Oers (2012), point out that especially cultural heritage and values play an important role in historical areas and contemporary urban transformation, especially benefiting from social and economic dynamics. For this reason, it can be stated that the cultural heritage must be economic, social and harmonious with the environment in order to be accepted as sustainable (Guzman, Roders & Colenbrander, 2017).

The first stage of historic environmental conservation work is the precise identification of cultural and natural heritages to be preserved. It is impossible to talk about conservation without doing an inventory work. Buildings such as houses, fountains, hammams in relation to daily life in a historical settlement; building components contributing to the formation of environmental images such as religious buildings, bazaars, street textures are included in the inventory. Every element that contributes to the formation of a whole in a site area is worth protecting (Altınoluk, 1998). The preservation of the elements that affect the aesthetic and visual impression of the historical environment is also related to the identity of the place. For this reason, it is very important to preserve the silhouette and landscape characteristics of the historical environment and to ensure visual integrity between the historical environment and the new construction in the restoration of cultural heritage (English Heritage, 2005a)

The main purpose of the planning of the historical area is to protect, evaluate and develop the cultural heritage and transmit it to future generations. The rehabilitation of the old urban fabric should be carried out in accordance with the conservation plans. According to the characteristics of the area, archaeologists and art historians, architects and urban planners, sociologists, landscape architects should be concluded with the preliminary investigations defined by the contributions of experts such as urbanism analysis and evaluation. (Figure 1)

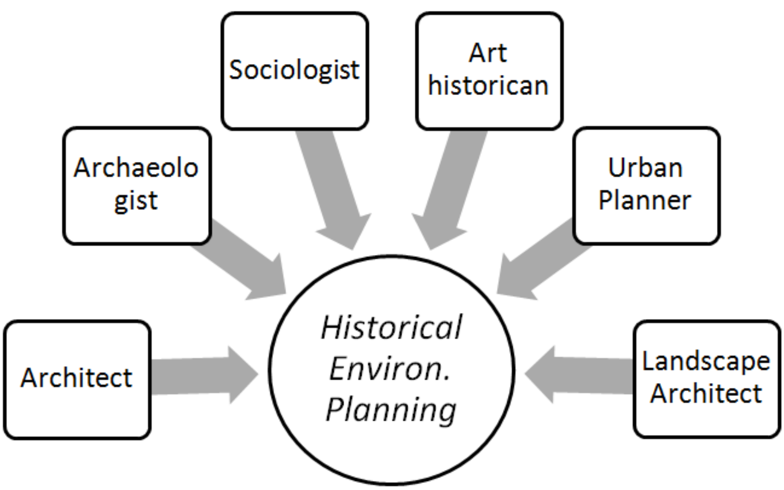

Figure 1. Professional occupation groups that should be included in the plan

3. Basic Issues of Historical Environment

Historical city centers are areas where monuments are concentrated. Despite the diversity of appearance, the historic environment in itself often shows a homogeneous structure. Usually the historic center spontaneously grows, but there is no complexity in settlement. On the contrary, this tissue has a masterful harmony (Gürdal, 1997). The type of historical landscape varies greatly depending on the nature of the constituents of it and the old town centers are the areas where monuments are intensely located. Despite the diversity of images, the historical environment often shows a homogeneous structure within itself. The architectural style is rich and varied in detail, with the proportions and dimensions of the historical landscape being in line with the whole. Generally, the historical center grows with spontaneous development, but there is no disorder on the entire settlement.

The settlement texture is shaped by natural needs as well as vital necessities, building tradition and economic possibilities. It is closely related to the fact that the settlement structures of the settlement are located on narrow plots adjacent to each other or adjacent to each other (Kuban, 2000).

In this context, a number of criteria are covered in the scope of conservation and the criteria are defined.

3.1. Historical document criterion

The structures and places that reflect the special structure of society or lifestyle and the traces of technical development, must be protected by these characteristics. For example, production techniques and building types of printing presses, mints, olive oil producing oil wells, flour mills, windmills, tanneries, winery and silk factories with an abandoned technology are documented today (Ahunbay, 1999).

Historic cities are places where people sometimes create societies based on a few centuries ago. The functions of the buildings depend on the cultural heritage and the human traditions in one place without economic life. In the past it leads to the protection of the dominant physical character of a place in design development and to take place in future improvements (Rodwell, 2003). Since local managers focus on the demands made by the visitor economy, heritage planning and urban conservation are often determined, influenced and directed by tourism. In any town and especially at the historical center scale, streets and squares are used by local people to move from one point to another. On the other hand, for the visitor, the historic city center is the point of destination at the end of a longer journey (Orbaşlı, 2000).

It is a historical document that villages, towns, neighborhoods which reflect the life style and settlement order of different sections of societies. These settlements, which have emerged at the end of the requirements of an unfinished life order, are shaped by the possibilities and limitations of local material traditions and climatic conditions. In addition to the residences in these areas, the texture, mass, and space characteristics of the bazaar areas where commercial activity and handicrafts intensify should also be protected with historical document standards (Kuban, 2000).

3.2. Time criterion

Heritage is an economic and social product and a dynamic process that is wider than cultural fields and / or processes. Many scientists have defined heritage as the intersection of three dimensions of urban sustainability (Guzman, Roders & Colenbrander, 2017). The opinions of how long after the construction of a building can be regarded as an ancient monument change from country to country. In order to be included in the conservation of the 20th century structures, it is necessary to carry special qualities such as the work of an important architect, the representative of an architectural movement, the part of a building sequence. Instead of putting definite time boundaries, it is a more correct approach to define a different concept of art, lifestyle, technical level and the protection of structures and environments, which are the product of a famous artist or a movement (Erder, 1975).

1.3. Aesthetic value criterion

Being beautiful is an important influence that strengthens the willingness to protect buildings and environments. However, the fact that the “good” judge is not objective, changing from person to person, from society and depending on time, causes debate. For example, in Turkey, people generally do not value protecting an old house. The privilege of seeing the beauty of the first design of a ruined building and evaluating it in its own era belongs to those who have scientific accumulation in this regard (Ahunbay, 1999).

The determination of immovable cultural and natural assets (monuments and sites) and determination of national cultural assets is called “registration”. With this process, the cultural assets that need to be protected are under legal guarantee, their boundaries are defined, and the extent to which their original qualities are to be maintained (Altınoluk, 1998). Within these processes, the building heritage is an important part of the cultural heritage perspective of towns and cities. However, the present definition of built heritage is very narrow and architecture is based on conventional concepts in terms of historical value (Tweed ve Sutherland, 2007).

The building tradition is closely tied to the material possibilities and climate conditions. Roof shapes, mass size and shape, materials and colors used on exterior surfaces depend on the common construction tradition, and when all these features come together, a homogeneous appearance characteristic of the city arises. A city skyline with a descriptive character for the city is formed by the general appearance is that around one or more of the dominant monuments a combination of repeating elements such as locality-specific roof forms, chimneys, dome and pavilions, minarets (Bekişoğlu, 2002).

Whatever the purpose of protectionist approaches, the main problem is; change in the light of evolution and how conservation is integrated. Historical building has no meaning alone, but it makes sense when it is evaluated together with the surrounding environment. This study also introduces a new perspective on the planning of conservation and sustainable historical environment design from the context of landscape architecture.

4. Case Study Area

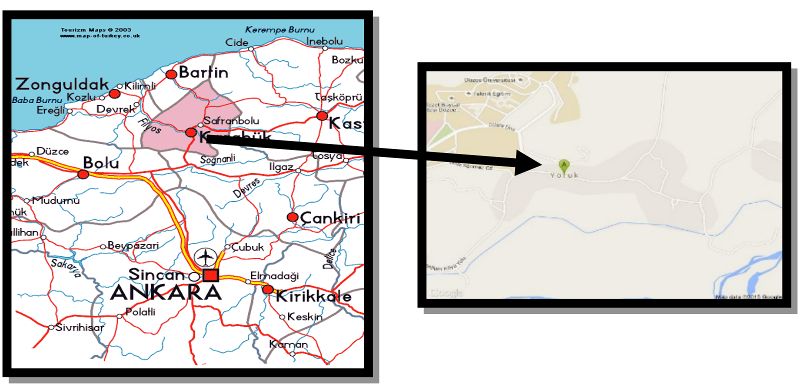

Figure 2. The location map of the Yörük Village

The Yörük Village is located in the western Black Sea and is connected to the Safranbolu district of Karabük (Figure 2). It is located to the east of Safranbolu, at the 13th km on the road to Kastamonu. In the east Akören and Yacı, in the west Konarı and in the north Sırçalı villages are located and also in the south Araç Stream is located (Bekişoğlu, 2002).

4.1. Natural Landscape Features of the Village

The village, which is settled about 600 meters above sea level, is surrounded by mountains from the north and south. The mountain ranges in the north of the region provide a characteristic of the Black Sea climate and Central Anatolia climate. The annual temperature was recorded at maximum 40 degrees in the summer and -10 degrees in the coldest months. In the region, the wind usually blows in the southwest, southeast and north-west. The strongest breeze comes from the west and southwest winds. Generally, the type of vegetation in the surrounding is forestry. Natural landscaping is remarkable due to the forests covered with different species from the leafy and coniferous plants around the village (Bekişoğlu, 2002).

4.2. Cultural Landscape Features of the Village

The first establishment date of Yörük Village is not known precisely. Nevertheless, it is estimated that the first arrivals of the novices settled in the region as a nomad tents in the early 15th century. Today, only 62 of the 140 villages in the village are permanently occupied and the population is around 240 people. The other 43 houses in the province have 180 people living, but they come for a couple of times of a year at festivals and holidays, for up to 2 months (Çan, 2011).

Yörük Village is a settlement consisting of two districts built on a slightly sloping land. Today, there are about 144 houses, 2 mosques, 1 laundry, 1 village coffee house and reeve building in Yörük Village. 119 of them are examples of traditional civil architecture and were registered in 1997 by the Ministry of Culture of Turkey. The most notable element in the Yörük Village is the cluster of houses. They are closely aligned along the roads as if they were adjacent (Figure 3). The oldest of these houses is the 450-year-old Odabaşıgil House (Demirarslan, 2011). The houses in this region are designed as urban structures consisting of different places specialized to serve different life activities. This situation carries the rural character of the village to urban character. The fact that every house surely owns a garden has increased the importance of the courtyard walls, which are the fronts to the streets. The texture of the trees extending from the rugged stone-walled courtyard walls of the houses to the paved organic streets enriches the traditional texture of the village. Another important point is that the contrasting surfaces between the plastered walls in white and cream colors and the dark brown wooden framing system that make up the structures make the building facades even more interesting (Figure 4) (Türkoğlu, 2014). The village is a typical Ottoman settlement consisting of two quarters on a main axis. Unlike the Ottoman cities, the houses of the Yörük Village, which were planned close to each other as adjacent to each other, were built in such a way that they could live their daily lives comfortably in accordance with the traditions and customs of the Yörüks. Again, this settlement differs from a typical Ottoman village settlement due to the fact that the houses are larger than a village house and have the characteristics of a mansion (Özkul, 2007). In the village, the positioning of the houses within the parcel is varied according to the building and road relations. The settlement pattern was created by considering the privacy and neighbor rights with neighboring parcels (Demirarslan, 2011).

Today, income source of the many families living in the village are agriculture and animal husbandry. In addition, a large part of the population work in various business sectors in Karabük and Safranbolu. According to the villagers, the only source for the solution and development of current economic problems is tourism. Today, Yörük Village is the place frequented by many tourists who come to Safranbolu. Functionally, it is a village settlement unit, and it is a developing settlement of tourism and its functions depending on the registered buildings and Urban Sit texture. It is inevitable that tourism and its related commercial activities should be developed because of visitors from every city of Yörük Village. The study area is a place that has the potential of tourism with its layout and residential structures which are different from the traditional village structure. Moreover, over time, it has been able to protect its structure without being touched or repaired (Bekişoğlu, 2002).

Figure 3. Facade views from houses (Bekişoğlu, 2002).

Figure 4. Facade views from houses (Bekişoğlu, 2002).

5. Integration Between Historical Conservation and Landscape Planning

The perception and comprehension of the identity of the cities in a continuity from the past to the future is an important point. Historical environments, with their organic integrity and correctly resolved functional distributions, give aesthetic satisfaction to their living people and their users. The conservation of historical sites, which are a bridge between the past and the future, is also important in this respect.

Landscape designers are interested in many different areas of different issues and scales related to outdoor space, and they are working on protecting, developing and maintaining these areas. One of these works is the designing of the landscape with historical textures.

A single sculpture or religious structure that is a preserved or immovable antiquity, or a residential area that reflects the architectural and cultural values of the past is considered together with the green space around it in the countries with conscious awareness of the conservation of the historical environments. The conservation of the accumulated day-to-day heritage from the past for the protection of the historic landscape needs to be watched closely the future. The architectural heritage includes not only valuable buildings and their surroundings, but all areas of villages and cities with historical and cultural ties (Yazgan ve Erdoğan, 1992).

Particularly, there is a need for physical protection schemes prepared with a new conservation mentality because the historical touch is intense and this touch is deteriorating due to factors such as rapid urbanization, growing economic needs, rising land value, increasing population.

The historical environment, that is wider than cultural fields and / or processes is an economic, social and a dynamic process. Many researchers have identified cultural heritage as the intersection of three dimensions of sustainability (environmental, social, economic). Green space and natural and cultural heritage values for sustainable development are remarkable sources. Therefore, an interdisciplinary understanding of the management of these resources is needed and a landscape-based approach should be developed (Guzman, Roders & Colenbrander, 2017).

The originality of the structures can be maintained when the historical environment serves only for the purpose of the visit. Only a section of structures or fronts, an authentic show for tourists, or just a special historical heritage can be remembered.

From this point of view, tourism, in terms of historical towns and villages;

- Improve the external appearance of buildings in the conservation process and emphasizes attitudes towards new buildings and developments in historic neighborhoods,

- A historical approach to the view of the street landscapes and the urban area (Figure 5),
- Provides the creation of museum-like model towns within wider, urbanely isolated boundaries (Rodwell, 2003).

Figure 5. Street texture from Yörük Village (Bekişoğlu, 2002).

As a result, planning for the protection of the historic environment to be carried out in the organization and transportation, recreational, aesthetic, cultural and economic values should be resolved. The buildings are important in the sense of historical environment.

6. Conclusions and Discussion

The link between historical environment and landscape design based on policy and conservation plans is a new subject for Turkey. The purpose of the essay, together with a review of a specific townscape area, is to discuss the design and planning of landscape elements in historical environments in terms of sustainability. Historical landscapes are a field in which researchers from different disciplines must participate. A methodology is developed by analyzing developmental and restoration-related difficulties of the historical cities.

It is a fact that the planning legislation in Turkey is inadequate, in that the planning case is not usually carried out in the plan dimension to the application dimension. Cultural heritage values can be preserved and maintained as they are used. Because a historical structure left in its own form will be eroded with natural and social effects over time and will lose its quality. The goal of conservation in planning is not to build a museum city but to provide it for a city that is constantly and currently living and used. In this direction, for the criteria and the evaluations to be considered, a process index was set up for the goals of planning the historical environment from the perspective of landscape architecture (Table 1). In the studies related to historical landscapes, it is necessary to study the existing literature, data collection, field surveys and analytical studies. For planning and sustainable management; map overlays, visual analysis and process assessments and plan decisions can be produced (Table 2). The problems that can be encountered in historical landscape planning of study area are listed below.

- Inadequate understanding of the environmental relationship,
- Local governments do not attach enough importance to conservation-related tourism within the scope of sustainability,
- Rejection of planning objectives due to lack of participation of local people and stakeholders in the planning process,
- Predictions of future change are usually speculative.

Table 1: Landscape Planning Process Index

Targets	Indicators	Analysis of Current Situation
Conservation	Condition of listed buildings Arts and culture Infrastructure Occupancy-space ratio Aesthetic	• Incompatible facades • Empty parcels • Architectural quality • Paving pattern • Electricity, water, heating infrastructure • Parcel typology • Restoration plans • Landscape resources
Urban Vitality	Be located on major bus routes Visitor mode of travel Degree of crowd in the streets Parking changes Land usage Demographic structure Urban functioning	• Transportation network • Connection to touristic tour network • Habits of local people • Carrying capacity • Parking areas • Abandoned Lands • Real estate market • Population and educational status • Type and range of buildings (shopping, hotel, restaurant)

Targets	Indicators	Analysis of Current Situation
Historical Sustainability	Heritage towns creation Social participation and belonging	• Appraisal of physical change • Change in quantity of green areas in the town • Change in historic buildings • Recycling • Pedestrian safety and comfort • Street texture and urban furniture • Promotion of unemployment • Wider benefits of visitors/tourists to local and regional economy, to include impacts on investment/ regeneration • Public/visitor understanding and awareness of the heritage sector and links to sustainability

Table 2. Planning-sustainable management interactions

Planning	Sustainable Management
Development and functioning of spatial alternatives	New vision and the landscape process in it.
Compatibility of building functions and uses	Traditional green spaces or landscaping units in land use

With the examination of a specific area of work, the aim of the article is to discuss the planning of landscape factors in historical environments, in the context of sustainability. The environmental difficulties that the historical towns encountered along with the restoration were also revealed. It is necessary to increase the quality of the environment and to emphasize and strengthen the identity of the historical environment in order to prevent degradation in the physical environment. Nowadays, it is desirable to find a healthy harmony and aesthetic beauty between the human-built environment and the natural environment for only one structure or in city scale applications. The active use of the spatial elements and environments of the traditional settlement texture will enable the cultural values to be used without deterioration and will enable the local people to benefit from tourism and revitalize the economy of the region.

In summary, the adoption of conservation and sustainability goals in historic cities is necessary to consider the historical landscape planning approach to survival. On the management level, work should be included as an integral part of the whole.

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CHAPTER XII

DETERMINING THE EFFECT OF FACADE DESİGN IN BUILDINGS ON SUNLIGHT RECEPTION AND LIGHTING ENERGY PERFORMANCE ON THE BEP-TR REGULATION AND BEP-BUY PROGRAM

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1. Introduction

In today's space design, it is important to systematize the space in accordance with the function based on the psychological and physiological comfort needs. In this sense, the effective use of daylight and artificial lighting elements in the space is an important element that should be considered in buildings to provide visual comfort conditions. The decisions taken from orientation on visual comfort to shaping the façade openings need to be evaluated in detail (Kim, 2015).

Starting from the early design phase, considering the daylight factor in facade design is important in providing user comfort and visual comfort and increasing the building's energy performance. Accordingly, one of the most important effects of daylight performance, which is examined in terms of volume, on building energy performance is on energy consumption for lighting (Kılıç, 2018).

Libraries selected as sample building groups have served the cultural, social, and economic development of many civilizations throughout history. In today's information age, where societies' development is measured according to their knowledge, libraries' value is increasing day by day in parallel with the advances in science and technology. Lighting design is one of the most important factors affecting the performance of the employees in the library structures, where the physiological and psychological needs of the users are important. With the appropriate lighting design, light quality, visual comfort, and aesthetic features can be added to space. In today's libraries, the combination of printed and digital resources shapes these lighting designs. Natural and artificial lighting is used in an integrated way to illuminate the spaces. However, researches emphasize the importance of natural lighting in library designs.

Within the article's scope, a sample library scheme is examined, different facade alternatives are created to provide visual comfort conditions and minimize energy consumption for lighting, and the changes in daylight performance and accordingly in lighting energy performance are analyzed. Various scenarios have been created for the parameters of glass color, glass thickness, glass type, window transparency rates, which are among the variables that affect the daylight performance in the interior regarding the facade openings. Also, within the study's scope, the effect of solar control elements, which is an important component of facade design, on indoor daylight performance is examined. According to the scenarios created, the lighting values obtained depending on the daylight performance occurring in the library were determined by BEP-BUY software. The data obtained as a result of the study are expected to be a guide for various standard and design guides prepared for libraries.

Additionally, although this study sets an example for buildings with similar spatial properties, it should not be overlooked that the facade alternative that provides optimum daylight performance and energy consumption in the interior, which is one of the scenario alternatives created, may vary depending on the climate zone, obstacle status and interior characteristics of the building under consideration.

In the studies, it has been revealed that ideal daylight in the space provides visual comfort conditions and invisible effects that positively affect the users' psychological and physiological conditions. In this direction, it is seen that people prefer to increase the daylight activity instead of using artificial lighting to meet the lighting needs of the space during the hours when daylight is active (Kılıç, 2018). User's preferences to increase natural lighting performance, in a sense, reduce the amount of energy consumed and contribute to environmental sustainability.

It is possible to achieve optimum daylight performance indoors with the correct intake of daylight into space. The building envelope, which creates an interface between the interior and the external environment by separating the natural and artificial environment from each other, takes the sunlight reaching the facade surface into the interior space through gaps. The building envelope creates the building's emergence as a product and creates the spaces where the building users are provided with thermal, visual, and acoustic comfort conditions by creating a surface. Thus, building shells are evaluated as a system that protects against external environmental conditions by surrounding the indoor environment, creating a layer between the indoor and outdoor environment (Rivard et all, 1995) (Aksamija, 2013) (Gowri, 1990).

Two basic components make up the building envelope of a building. These are facades and roof components that significantly affect the daylight performance occurring indoors. Facades are defined as the view that looks perpendicular to the surface of a building from infinity and includes walls, floors, etc., it consists of opaque surfaces and openings such as windows and doors that provide light, access, and ventilation (Rivard et all, 1995) (Hasol, 2012). Facades have a great potential to control the natural environment's effects and provide comfort conditions in buildings by creating a barrier between the indoor and outdoor environment. In this sense, the correct provision of daylight efficiency in the interior for the building function and minimization of energy consumption for artificial lighting depends on the facade's openings' architectural compositions. Therefore, during the design phase, the building form's formation directly affects the daylight intake of the building and is an important parameter in energy consumption.

2. Natural Lighting Design and Lighting Standards in Library Buildings

At the point where today's technology has come, it is very important to determine whether the spaces are illuminated adequately and at appropriate values for their function. For this purpose, analyzes are made to determine the daylight performance even when the building is still in the design phase. There are many daylight assessment methods in these analyses, and these methods vary according to the analysis. One of these methods discussed in the study is the daylight factor. The daylight factor is the percentage expression of the ratio of the illuminance level of a point located on the working plane indoors to the outdoor light level that occurs horizontally under clear and overcast sky conditions. Another method of daylight assessment is the average illumination level. The average illumination level is an indicator of daylight efficiency required for visual performance, and its unit is lux (Kılıç, 2018).

In this context, standards regarding lighting have been established by many different domestic and foreign institutions to ensure the optimum level of daylight performance in space according to the building's function. The main ones of these standards can be listed as;

- English Standards (CIBSE) (Chartered Institution of Building Service Engineers)
- German Standards (DIN) (Deutsches Institut für Normung)
- US Standards (IES) (Illuminating Engineering Society)
- International Commission on Illumination Standards(CIE) (International Commission on Illumination)
- Standards published by the Turkish Standards Institute (TSE) on lighting.

Table 1, contains an overview and comparison of the values specified by different standards for the appropriate illuminance levels required in library designs.

Table 1. Comparison of Lighting Level Values in Working Environments Recommended by CISBE, DIN, IES, CEN, CIE

CIBSE	**DIN**	**IES**	**CEN**	**CIE**
In the normal operating condition, the average illumination level that should be provided in the working plane is between 300 and 730 lux.	In the normal operating condition. the average illumination level to be provided in tire working plane is between 300 and 1000 lux.	For working environments D and E categories (between 200 and 1000 lux] are recommended as illuminance levels that should be provided on the job	For working environments the illuminance values that should be provided on the job range between 200 and 750 lux.	Average illumination levels in the working plane are given according to the volume and the type of work, and there are 3 values for each category. Low-Medium- High

Since the daylight factor corresponding to the 300 lux illuminance level, which is identified by EN17037 for Turkey, is 1.6%, the optimum daylight factor accepted within the study's scope is 1.6% (Tab. 2) (URL - 1).

Table 2. EN 17037 Daylight Factors Corresponding to the Determined Light Level for Turkey (URL -1)

Nation	**Capital**[a]	**Geographical latitude <P[°)**	**Median External Diffuse Illuminance**	**D to exceed 100 lx**	**D to exceed 300 lx**	**D to exceed 500 lx**	**D to exceed 750 lx**
Cyprus	Nicosia	34.88	18 100	0.6%	1.7%	2.8%	4.1 %
Malta	Valletta	35.54	16 500	0.6%	1.8%	3.0%	4.5%
Greece	Athens	37.90	19 400	0.5%	1.5%	2.6 %	3.9%
Portugal	Lisbon	38.73	18 220	0.5%	1.6%	2.7%	4.1%
Turkey	Ankara	40.12	19 000	0.5%	1.6%	2.6%	3.9 %
Spain	Madrid	40.45	16 900	0.6%	1.8%	3.0%	4.4 %
Italy	Rome	41.80	19 200	0.5%	1.6%	2.6%	3.9%
Former Yugoslav Republic of Macedonia	Skopje	42.00	15 400	0.6%	1.9%	3.2%	4.9 %

3. Field of Study and Natural Lighting Analysis

The city of Kayseri was selected as the study field, and two plan schemes consisting of a ground floor and 1st floor were taken as an example. (Figure2-3) Located in the Central Anatolia region between 340 56 'and 360 59' east longitudes and 370 45 'and 380 18' north latitudes, Kayseri city center's altitude is 1054 meters from sea level. The prevailing climate in the province of Kayseri is the continental Central Anatolian climate. Therefore, winters are cold and snowy, and summers are hot and dry. The dominant vegetation throughout the province is the steppe vegetation. In Kayseri, where the number of overcast days is quite low, the average number of overcast days is 68, while the average number of clear and sunny days is 110 days. The average relative humidity is

65%, and the average rainfall is 375 kg per square meter (Kayseri Provincial Directorate of Culture and Tourism, 2020). Coordinated universal time (UTC) throughout the country, which is applied throughout the country, is also valid for Kayseri. According to the time between sunrise and sunset, the day's length is approximately 15 hours on June 21 and approximately nine and a half hours on December 21 in Kayseri (URL- 2)

Fig 1. Pilot-Scheme Schema-1 (Ground Floor)

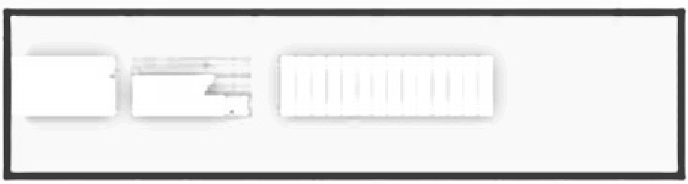


Fig. 2. Pilot-Scheme Schema -2 (1st floor)

Depending on the glass and facade variables, the dates of June 21 and December 21 are determined as the reference day for the selected plan scheme to determine the natural lighting performance, and the reference hours are 09:00, 12:00, 14:00, and 17:00. Each surface area of the space is 44.5 m X 10.75 m, and the height of the floor is h: 3.60 m. The reference height for the volumes has been accepted as h: 0.85, and the external obstacle status is considered to be absent. In the calculations, parameters such as glass color, glass thickness, glass type, window transparency rates, and solar control elements vary, and other factors affecting daylight intake are considered constant. Thus, it was aimed to determine the effect of glass and facade variables on daylight intake and natural lighting performance.

3.1. Scenarios Created for Facade Design

Choosing the right glass type is one of the main issues regarding facade design and creating an effective natural lighting system. The penetration of daylight through any opening depends on many external factors (climate, external obstacles, the direction of the window, shading element, etc.). Also, since daylight reaches the glass surface, the glass's light transmission properties determine the daylight's amount taken into the interior. The glass type selection approach is generally based on the window profile and the material of the glass forming the external appearance of the window system. It is also important to consider the components' performance criteria to provide visual and thermal comfort in the selection of glass types. In this sense, indoors can be listed as important performance parameters regarding the selection of effective daylight (increasing daylight permeability), thermal comfort and ventilation, controlling glare, preventing condensation, providing sound control, durability, air and water impermeability glass type (Carmody, 2000). In this direction, within the study's scope, how different glass types affect the amount of daylight in the library environment and how the lighting energy performance changes depending on the amount of daylight is examined. While creating the scenarios, glass types that can be analyzed jointly by VELUX Daylight Visualizer simulation and BEP-TR programs were discussed.

Glass Color Variable

Glass colors were taken as the basis as the first variable in the analysis studies. Colored glasses are formed by coloring normal glass surfaces or frits. These glass types cause less light transmission to the interior and prevent some or all of the ultraviolet rays from being taken into the interior, preventing more heat gain from occurring. Tinted glasses, which absorb light and heat at certain rates and change colors according to the absorption rate, reduce the glare originating from the external environment and minimize the solar radiation passing from the glass to the interior. In the study, five different colored glass variables in Table 3, namely neutral, green, blue, smoked, and bronze, were analyzed by assuming the glass thicknesses as constant.

Table 3. Scenarios for Glass Color

Scenario No	Glass Type	Variable
1	6 min Tinted Float Glass +■ İS mm AB + (#3) S mm Low-E Glass / Neutral +■ Low-E Glass **j** 0.78 After 2007-low E Combination Insulating Glass (d-16mm Air+6) (U: 1.3-G: 1.3)	Neutral
2	6 min Tinted Float Glass +■ İĞ min AB + (rt3) 6 mm Low-E Glass / Green +■ Low-E Glass *!* 0.63 After 2007 -Low E Combination Insulating Glass -Green [Ğ+ldmmAir+ö] [U:1.3- G:l.3] ‘	Green
3	6 min Tinted Float Glass +■ 16 min AB + (#3) 6 mm Low-E Glass / Blue + Low-E Glass / 0.49 After 2007-low E Combination Insulating Glass-Blue (6+1 ânım Air-6] (U: 1.3- G:l.3]	Blue
4	6 min Tinted Float Glass + Id mm AB + («3) d mm Low-E Glass / Smoke + Low-E Glass **j** 0.39 After 2007-Low E Combination Insulating Glass -Smoke [6+16mmAir+â) (TJ: 1.3- G:l.3]	Smoke
5	d min Tinted Float Glass + 16 mm AB + **[TF**3] 6 mm Low-E Glass / Bronze + Low-E Glass / 0.44 After 2007-Low E Combination Insulating Glass -Bronze [6+16nunAir+6] [U:l,3- G:l.3]	Bronze

Glass Color and Reflective Surface (1/2 Surface Coated) Variable

The second scenario’s content was created by combining tinted glasses and reflective glasses, i.e., reflective glasses (Table 4). The frit of reflective glasses is thinner than colored glasses, and therefore the light transmittance is higher. These glass types are preferred in situations where concerns about heat gain from the sun are at the forefront and provide an aesthetic appearance to the buildings (İlgürel, 2002). By increasing the reflective properties of the glasses, a decrease in the heat permeability value is achieved (Baker et all, 1993). Therefore, it is expected that there will be differences in the energy consumption performance of the building, depending on the reflectivity of the glass type. The glass unit’s coated surface can be used with the inside (2nd surface) or outside (1st surface). If the coating is in the interior, the color is in the foreground and the outside’s reflection (Url -3). Within the scenario’s scope, neutral, green, blue, smoked, bronze, and silver glass types are considered as 1 surface coated and 2 surfaces coated.

Table 4. Scenarios Created for Glass Color and Reflective Surface (1/2 Surface Coated) Variable

Scenario No	Glass Type	Variable	**Coated Surface**
1 (Available)	6 ram Tinted Float Glass + 16 min AB + (#3) 6 mm Low-E Glass / Neutral + Low-E Glass / 0.78 After 2007-Low E Combination Insulating Glass (6+16minAir+6) fU: 1.3G: 1.34	Neutral	-
2	6 mm Tentesol (#2) + 16 mm AB + (#3) 6 mm Low-E Glass / Green + Low-E Cam / 0.28 After 2007-Low E Combination Insulating Glass - Green Reflective (1 surface coated) (6+16mmAir+6)(U:1.3-G:1.3)	Green	1 Surface
3	6 mm Tentesol (#2) + 16 mm AB + (#3) 6 mm Low-E Glass / Green + Low-E Glass / 0.28 After 2007-Low E Combination Insulating Glass - Green Reflective (2 surface coated) (6+16mmAir+6)fU:1.3-G:1.3)		2 Surface
4	6 ram Tentesol (#2) + 16 mm AB + (#3) 6 mm Low-E Glass / Blue + Low-E Glass / 0.21 After 2007-Low E Combination Insulating Glass - Blue Reflective (1 surface coated) (6+16mmAir+6)(U:1.3-G:1.3)	Blue	1 Surface
5	6 ram Tentesol (#2) + 16 mm AB + (#3) 6 mm Low-E Glass / Blue + Low-E Glass / 0.21 After 2007-Low E Combination Insulating Glass - Blue Reflective (2 surface coated) (6+16mmAir+6)(U:1.3-G:1.3)		2 Surface

Scenario No	Glass Type	Variable	**Coated Surface**
6	6 ram Tentesol (#2) + 16 mm AB + (#3) 6 mm Low-E Glass/ Smoke + Low-E Glass/0.17 Insulating Glass - Smoke Reflective (1 surface coated) (6+16mmAir+6) (U:2.7-G:2.7)	Smoke	1 Surface
7	6 mm Tentesol (#2) + 16 mm AB + (#3) 6 mm Low-E Glass / Smoke + Low- fi Glass/0.17 Insulating Glass - Smoke Reflective (2 surface coated) (6+16mmAir+6) (U:2.7-G:2.7)		2 Surface
8	6 mm Tentesol (#2) + 16 mm AB + (#3) 6 mm Low-E Cam / Bronze + Low- fi Cam / 0.20 Yalıtım Camı- Bronze Reflective (1 surface coated) (6+16mmAir+6) (11:2.7- G:2.7)	Bronze	1 Surface
9	6 mm Tentesol (#2) + 16 mm AB + (#3) 6 mm Low-E Glass / Bronze + Low- fi Glass / 0.20 Insulating Glass - Bronze Reflective (2 surface coated) (6+16mmAir+6) (U:2.8-G:2.8)		2 Surface
10	6 mm Tentesol (#2) + 16 mm AB + (#3) 6 mm Low-E Glass / Silver + Low-E Glass / 0.33 After 2007-Low Combination Insulating Glass - Silver Reflective (1 surface coated) (6+16mmAir+6) fU: 1.3-G: 1.3)	Silver	1 Surface
11	6 mm Tentesol (#2) + 16 mm AB + (#3) 6 mm Low-E Glass / Silver + Low-E Glass / 0.33 After 2007-Low E Combination Insulating Glass - Silver Reflective (2 surface coated) (6+16mmAir+6) (U:1.3-G:1.3)		2 Surface

Glass Thickness Variable

The change in the wall thickness of the glass used in the library was examined in two alternatives by keeping the glass color constant (Table 5). When the effects of these alternatives on lighting energy consumption are evaluated, it is hoped that they will guide designers in glass selection.

Table 5. Scenarios for Glass Thickness

Scenario No	Glass Type	Variable
1 (Available)	6 min Tinted Float Glass +16 min AB + (#3) 6 mm Low-E Glass / Neutral + Low-E Glass l 0.78 After 2007-Low E Combination Insulating Glass (6-16mmHava+6) (U:13-G:1.3)	6-16 mniAir+6
2	4 min Low-E Glass f42) - 16 linn AB + 4 mm Clean Float Glass / Neutral / 0.72 After 2007-Low E Combination Insulation Glass f4-16inniAir+41 fU: 1.3-G: 1.31	4-16 mniAir+4

Glass Type Variable

The behavior of the glass forming the window against sunlight causes different energy consumption in different climatic conditions. How much of the solar heat and light the glazed surface transfers to the indoor environment is very important in lighting energy consumption and natural lighting in the interior. Glass alternatives are shown in Table 6. In line with the defined glass types, the effect of daylight permeability on indoor lighting is examined.

Table 6. Scenarios for Glass Thickness

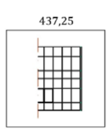
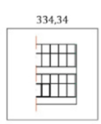
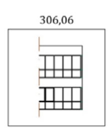
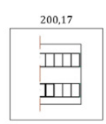
Scenario No	**Glass Type**	**Daylight Transmittance%**
1 (Available)	6 mm Tinted Float Glass + 16 mm AB + (#3) 6 mm Low-E Glass / Neutral + Low-E Glass / 0.78 After 2007-Low Combination Insulating Glass (6+16mmAir+6) [U:1.3-G:1.3]	78

Scenario No	Glass Type	Daylight Transmittance%
2	6 mm Temperable Low-E Glass (#2) + 16 mm AB + 6 mm Clean Float Glass / Neutral (71/53) / 0.72 Temperable Low E (with heat control coating) 6-16-6 air filled double glazing (U:1.4-G:1.4)	72
3	6 mm Temperable Solar Low-E Glass (#2) + 16 mm AB + 6 mm Clean Float Glass / Neutral (70/37) / 0.69 Temperable Solar Low E neutral 60/40 segment (with heat and solar control coating) 6-16-6 Air (U:1.4-G:1.4)	69

Transparency Rate

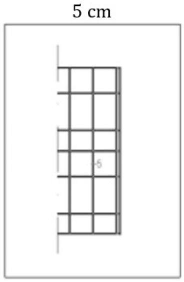
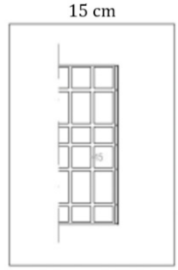
Another parameter to be considered when analyzing natural lighting is the rate of transparency. Within the scope of the study, the transparency rate was determined using two different methods. The first of these methods is the determination of the transparency rate obtained due to the surface area's ratio to the window area. In this direction, four different scenarios were created in which the surface area was kept constant, but the window area was changed. These scenarios where the transparency rates are determined as 91%, 69%, 63%, and 41% are included in Table 7.

Table 7. Scenarios Created for Transparency Ratio-1

Scenario No	1 (Available)	2	3	4
Dimension (m) Surface (m-') Window Space (m^2)	44.5 X 10.75 478.37 	44.5 X 10.75 478.37 	44.5 X 10.75 478.37 	44.5 X 10.75 478.37 
Transparency Rate (m^2)	91%	69%	63%	41%

Another method in which the transparency rate is determined in the study is changing the window profile thicknesses. Accordingly, natural lighting analysis was performed for the AGU library over three different scenarios in which the profile thickness was used as it (5 cm), and alternatively, the profile thickness was doubled (10 cm) and triple (15 cm) (Table 8).

Table 8. Scenarios Created for Transparency Ratio-2

Scenario No	1 (Available)	2	3
Profile Thickness (cm)	5 cm 	10 cm 	15 cm 

3.2. Introduction of BEP-BUY Lighting Calculation Method

The software program used to issue the energy performance certificate (EKB), which basically can be defined as a document containing information about the energy need and energy consumption classification of the building, insulation properties, and the efficiency of the heating and/or cooling systems, is called BEP-TR. (Environment and Urban Ministry).

The lighting section of the calculation method, the standard EN 15193, is prepared based on an improved method to set forth Turkey's conditions. This calculation method introduces the calculation steps for evaluating the amount of energy consumed for interior lighting in buildings and a numerical indicator that can be used for certification for lighting energy requirements. This method can be used for evaluation purposes for existing buildings during the design of new or to-be renovated buildings. Besides, it has the feature of guiding in determining the targets for the amount of energy allocated to lighting and provides a method for calculating the lighting energy to determine the total energy performance of the building (prEN 15193, 2006). According to the method, first of all, the utilization rate of the volume from daylight affects the calculations as a factor that reduces lighting energy needs. The size of the volume, geographical conditions, dimensions and positions of the windows, the type of glass used in the windows, and the external obstacles are the factors that affect a volume benefit from daylight. These obstacles are classified in the method of calculation as:

- Other buildings and natural obstacles such as trees and mountains
- The building itself in buildings with courtyards and atrium
- Horizontal or vertical shading elements on the facade
- Double skin facades with glass (Url-4) (Sevin, 2019) (Esen, 2015).

With the renewed calculation method in 2014, the renewal process of the BEP-TR software started, and the second version of the software was developed. BEP-TR 2nd version software consists of two parts, and it is the Bakanlık Uç Yazılımı (BEP-BUY) that runs online and offline on the desktop and the operating system (BEP-IS) server program that works on a web-based basis. Building geometry and building information can be defined through the drawing module included in the BEP-BUY software, and Energy Performance and greenhouse gas (CO2) emission calculation can be made according to the National Calculation Method without the need for any user name and password. However, to obtain a valid EKB, the project must be sent to the web- based BEP-IS server software by an active EKB expert working under a company (Environment and Urban Ministry).

For each of the scenarios determined for the library building selected within the article's scope, calculations were made in the BEP-BUY program to examine the indoor daylight performance and the effect of this factor on lighting energy consumption and determine the energy class. Within the program's scope, a distinction has been made on different building typologies such as housing, hospital, education, and shopping mall. Since the library space analysis will be made in the study, the education structure option has been chosen. The lighting energy need calculation depends on the daylight factor, the artificial lighting power in the volume, and the hours of use. As the variables related to daylight were examined within the study's scope, other parameters were accepted as constant. The lighting energy performances of the scenarios designed according to the data obtained from the program were analyzed.

4. Analysis Results and Evaluation

At this stage of the study, the daylight performance related to the study field has been analyzed with the help of the BEP-BUY program in line with the scenarios which are mentioned in Chapter 4 and created for facade design. The annual lighting energy consumption values obtained from the analysis, lighting-class, building class, and CO2 class data are explained according to the scenarios created.

Glass Color Variable

In this part of the analysis studies, 5 scenarios have been created to determine how the colored glasses affect the amount of lighting energy in the library structure, and the data and results of the scenarios are given in Table 9. These glass types' energy consumption values differ as to the daylight transmittance of the glasses, which are neutral, green, blue, bronze, and smoked, respectively, decreases. The daylight transmittance of bronze glass is 44%, and that of blue glass is 49%. With the increase of daylight permeability, it is predicted that more natural lighting will be used indoors, and energy performance is expected to increase. However, blue glass's annual energy consumption is 29.22 kWh / year more than bronze glass when the consumption values are compared. This difference may not be large enough to change the lighting class. Moreover, the inverse ratio between daylight transmittance and energy consumption values between blue and bronze glass colors is an important factor. When the values between green and blue glass are examined, it is seen that the lighting energy performance decreases with the decrease of daylight transmittance. Therefore, according to the results, it is obvious that the relationship between daylight and lighting energy consumption would not be correct for all life colors.

Table 9. Glass Color Variable Analysis Results

No	Glass Type	Glass Thickness	Color	Daylight Permeability (%)	Zone	Annual Lighting Energy Consumptions		Class		
						FINAL CONSUMPTION (Kwh/Year)	CONSUMPTION PER M2 (Kwh/M2,Year)	LIGHTING CLASS	TOTAL BUILDING CLASS	C02 CLASS
1	Solar Control Glass (Body Tinted)	6+16 mmAir+6	Neutral	78	G. Floor 1st Floor	4208.84	9.85	A 31	C 95	C 93
2			Green	63	G. Floor 1st Floor	4399.70	10.30	A 33	C 96	C 93
3			Blue	49	G. Floor 1st Floor	4447.31	10.41	A 32	C 96	C 93
4			Smoke	39	G. Floor 1st Floor	4429.36	10.37	A 33	C 96	C 93
5			Bronze	44	G. Floor 1st Floor	4418.09	10.34	A 33	C 96	C 93

Glass Color and Reflective Surface (1/2 Surface Coated) Variable

Another group of criteria evaluated on glazed surfaces is reflective glasses. Within the scenario's scope, 11 glass types alternatives were created as neutral, green, blue, smoked, bronze, and silver with 1-surface-coated and 2-surfaces-coated. Energy consumption amounts of neutral, bronze, silver, smoked, green, and blue glasses, respectively, increase in 1-surface- coated glass types. The differences between energy consumption values vary as 336.2 kWh / year, 88.53 kWh / year, 22.98 kWh / year, 729.97 kWh / year, 132.41 kWh / year, respectively. An annual energy saving of 1310.09 kWh / year is achieved in the library structure when the neutral glass is preferred instead of blue glass among 1-surface-coated glasses.

Lighting energy consumption amounts of neutral, bronze, silver / smoked, green and blue glasses increase respectively in 2- surface coated glass types. The differences between energy consumption values differ as 327.01 kWh / year, 43.01 kWh / year, 722.86 kWh / year, and 127.81 kWh / year, respectively. As a result of the analysis, it is seen that while the annual illumination energy consumption values of 1-surface coated silver and smoked glasses are different, the energy consumption amounts of these 2-surface coated glasses are the same. The energy consumption of blue glasses is 1177,68 kWh / year higher than neutral glasses with two surfaces. In this context, when designing the buildings' envelope, the window colors' choices are not only an architectural view. Besides, it has been determined as a result of the analysis that it is one of the main parameters affecting energy consumption.

Also, it is seen that the energy performance of glasses with 2 surfaces is higher when 1 and 2 surfaces coated types of glasses with the same color are compared. (Table 10)

Table 10. Glass Thickness Variable Analysis Results

NO	Glass Type	Glass Thickness	Color	Coated Surface	Daylight Permeability %	Zone	ANNUAL LIGHTING ENERGY CONSUMPTIONS		CLASS		
							FINAL CONSUMPTION (kWh/m2.year)	CONSUMPTION PER M2 (kWh/m2.year)	LIGHTING CLASS	TOTAL BUILDING CLASS	C02 CLASS
1	Solar Control Glass	6+16mm Air+6	Neutral		78	G. Floor 1st Floor	4208.84	9.85	A 31	C 95	C 93
2			Silver	1 Surface	63	G. Floor 1st Floor	4633.57	10.85	A 32	C 96	C 93
3				2 Surface	49	G. Floor 1st Floor	4578.86	10.72	A 32	C 96	C 93
4			Green	1 Surface	39	G. Floor 1st Floor	5386.52	12.61	A 34	C 95	C 92
5				2 Surface	44	G. Floor 1st Floor	5258.71	12.31	A 31	C 95	C 93
6	Solar Control Glass (Refle)	6+16mm Air+6	Blue	1 Surface		G. Floor 1st Floor	5518.93	12.92	A 33	C 95	C 92
7				2 Surface		G. Floor 1st Floor	5386.52	12.61	A 34	C 95	C 92
8			Smoke	1 Surface		G. Floor 1st Floor	4646.55	10.90	A 32	C 97	C 94
9				2 Surface		G. Floor 1st Floor	4578.86	10.72	A 32	C 97	C 94
10			Bronze	1 Surface		G. Floor 1st Floor	4545.04	10.64	A 32	C 97	C 94
11				2 Surface		G. Floor 1st Floor	4535.85	10.62	A 32	C 97	C 94

Glass Type Variable

For three glass alternatives in line with the glass types defined in Table 18, the effect of daylight permeability on lighting loads was examined. While the percentage difference of daylight transmittance between the alternatives between scenarios 1 and scenario 2 is higher than the difference between scenarios 2 and 3, the difference between the energy consumption values indicates the opposite situation, being 13.79 and 125.3, respectively. Although alternative 1, which transfers the natural lighting amount to the building with the highest capacity, provides energy savings compared to other alternatives, thanks to this effect, the numerical data in the lighting class has decreased compared to Scenario 2. While daylight transmittance and energy consumption value progress in direct proportion among the alternatives, it is seen that this is not the case for the lighting class.

In Scenario 3, the fact that the glass has the feature of heat and sun-controlled glass significantly restricts the amount of daylight entering inside. Therefore, this situation increases the amount of lighting energy consumption compared to alternatives 1 and 2 and has the lowest value in the lighting class among the scenarios. Besides, depending on the glass types' properties, it was observed that the lighting performance was affected, while no change in co2 emission occurred. (Table 11)

Table 11. Glass Type Variable Analysis Results

No	Glass Type	Glass Thickness	Color	Daylight Permeability (%)	Zone	ANNUAL LIGHTING ENERGY CONSUMPTIONS		CLASS		
						FINAL CONSUMPTION [kWh/year)	CONSUMPTION PER M2 [kWh/m2.yea)	LIGHTING CLASS	TOTAL BUILDING CLASS	CO2 CLASS
1	Solar Control Glass	6+16mm Air+6	Neutral	78	G. Floor 1st Floor	4208.84	9.85	A 31	C95	C 93
2	Temperable Heat Control Glass			72	G. Floor 1st Floor	4222.63	9.84	A 30	C96	C 93
2	Temperable Heat and Solar Control Glass			69	G. Floor 1st Floor	4347.93	10.18	A 33	C96	C 93

Transparency Rate

The first method in the study of transparency rate is the determination of the transparency rate obtained due to the surface area's ratio to the window area. In this method, 4 alternatives were examined by changing the library's glass sizes and including their current ratios. The library's dimensions, the window areas for each designed alternative, the transparency rates obtained from these data, and the energy consumption values corresponding to the transparency rates are included in Table 12. According to the data in the table, it shows that the increase in the glass surface causes a significant increase in the lighting energy performance (Figure 3). Also, it should not be ignored that the need for artificial lighting decreases as the rate of daylight use increases indoors. Other important details should be taken into consideration, as well as increasing the transparency rate saves energy. With the increase in this ratio, the amount of natural lighting entering the library environment also increases, and it is a fact that it will affect the performance of working individuals positively.

The differences between the 1,2,3,4 transparency rates of the analyzed alternatives are 22%, 3%, 22%, respectively, and the differences between the lighting energy consumption values are 170.4 kWh / year, 20.46 kWh / year, and 510.32 kWh, respectively. / year. It is seen that the differences between the percentages and the energy consumption values are not equivalent. Another remarkable result is that while the energy consumption between alternative 1 and 2 is 170.4, the lighting classes are A 31 and A 33, respectively; while the energy consumption between alternative 3 and 4 is 510.32, the lighting classes are A 33 and A 33, respectively. Although the consumption amount between Alternative 3 and 4 is higher, numerical data in the lighting class has not changed.

Besides, 701.18 kWh / year of energy is saved compared to alternatives 1 and 4 per year. Accordingly, window sizes, which have an important role in energy consumption, are a matter to consider in the design.

Table 12. Transparency Ratio-1 Analysis Results

No	Dimension (m)	Surface (m^2)	Window Space (m^2)	Transparency Ratio (m^2)	Zone	ANNUAL LIGHTING ENERGY CONSUMPTIONS		CLASS		
						FINAL CONSUMPTION (kWh/year)	CONSUMPTION PER M2 (kWh/m2.year)	LIGHTING CLASS	TOTAL BUILDING CLASS	C02 CLASS
1	44.5 X 10.75	478.37	437.25	91%	G. Floor 1st Floor	4208.84	9.85	A 31	C 95	C 93
2			334.34	69%	G. Floor 1st Floor	4379.24	10.25	A 33	C 96	C 93
3			306.06	63%	G. Floor 1st Floor	4399.70	10.30	A 33	C 96	C 93
4			200.17	41%	G. Floor 1st Floor	4910.02	11.449	A 33	C 95	C 92

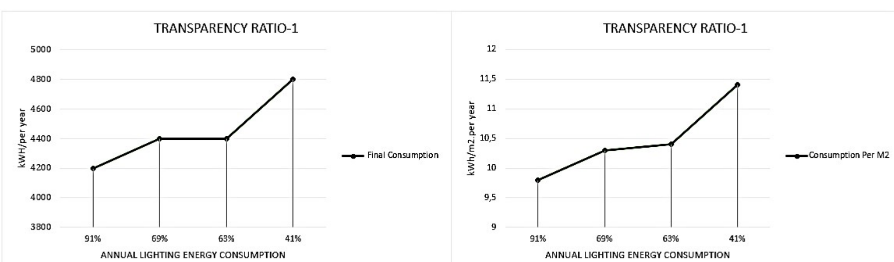


Fig. 3. Comparison of Transparency Ratio-1 Analysis Results

In the second method in the transparency ratio analysis, an evaluation was made for window profile thicknesses. When profile thicknesses are increased to current (5 cm), doubled (10 cm), and tripled (15 cm), the differences between energy consumption values are respectively 68.51 kWh / per year and 350.92 kWh / per year, with alternative 1 (5 cm). Compared to 3 (15 cm), the difference is 419.43 kWh / per year (Figure 4). Therefore, it is possible to say that the thickness of the window profile also affects the annual energy consumption, and it affects the energy consumption at a lower rate compared to the transparency rates evaluated in the first method.

It is noteworthy that the change in lighting class is not in the same direction, although the amount of energy consumption increases gradually between alternative 1 (5 cm), 2 (10 cm), and 3 (15 cm). It is seen in Table 13 that the differences.

Table 13. Transparency Ratio-2 Analysis Results

No	Dimension (m)	Surface (m^2)	Window Space (m^2)	Transparency Ratio (m^2)	Zone	ANNUAL LIGHTING ENERGY CONSUMPTIONS		CLASS		
						FINAL CONSUMPTION (kWh/year)	CONSUMPTION PER M2 (kWh/m2.year)	LIGHTING CLASS	TOTAL BUILDING CLASS	C02 CLASS
1	44.5 X 10.75	478.37	437.25	91%	G. Floor 1st Floor	4208.84	9.85	A 31	C 95	C 93
2			334.34	69%	G. Floor 1st Floor	4379.24	10.25	A 33	C 96	C 93
3			306.06	63%	G. Floor 1st Floor	4399.70	10.30	A 33	C 96	C 93
4			200.17	41%	G. Floor 1st Floor	4910.02	11.449	A 33	C 95	C 92

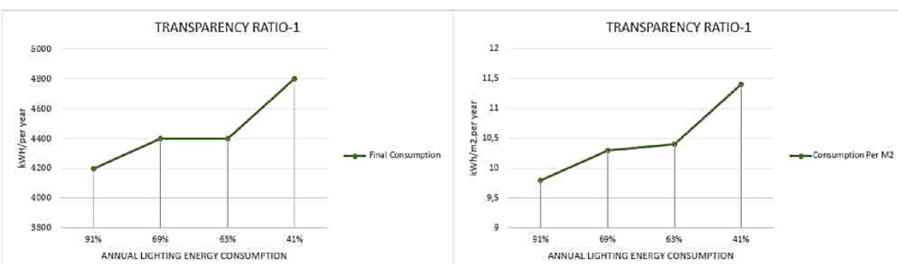


Fig. 4. Comparison of Transparency Ratio-2 Analysis Results

5. Conclusion

It is possible to create spaces with high energy performance and good visual comfort by making maximum use of daylight. For this reason, in the designs made, it is necessary to use daylight and artificial lighting elements effectively in the space. Considering that daylight has many positive features such as improving visual perception, increasing productivity in building users, and reducing energy consumption by balancing the building's heating-cooling loads, a delicate balance should be established between natural lighting and artificial lighting. In this study, the effect of facade variables on natural lighting and the role they play in lighting energy consumption is emphasized with numerical data.

Within the study's scope, various facade scenarios were created to determine the level of daylight and energy performance in the selected space. The visual comfort conditions needed while using the library were analyzed with measurements made in line with these scenarios. Measurements were made through BEP-BUY software, and the data obtained were evaluated according to national and international standards. The data obtained revealed that different glass colors, glass thickness, glass type, window transparency rates, and the use of solar control elements have an important role in determining the energy consumption of lighting.

The building typology discussed is the library structure, a type of building where it is extremely important to provide visual comfort conditions at an optimum level and where lighting will affect the building users psychologically and physiologically. As a result of the scenarios affecting the lighting energy, the lighting energy performance of the volume has been determined as "Class A," and the lighting energy consumption amounts differ according to each scenario. Accordingly, the savings and losses obtained in return for glass alternatives depend on the designer's glass type and facade design choice. Therefore, while determining the features of the facade, the designer should make choices considering the climatic conditions, visuality, psychological factors, and daylight and lighting factor.

Also, in some selected scenarios, it is seen that the energy class remains the same, although the lighting energy consumption varies considerably. Used to assess the energy performance of buildings in Turkey, the "BEP-TR" and "BEP-BUY" software developed depending on the EN 15193 standard and currently continues to be developed should be updated parallel with the country developments and conditions in the lighting field.

As a result, lighting design, which is performed correctly and effectively, is very important in terms of determining the experience people will experience in the space. This study, which was carried out in a chosen place in Kayseri province, once again demonstrated the importance of lighting design. With the data obtained from the scenarios, it was possible to determine the appropriate visual comfort and energy efficiency values required. In this context, the study is expected to create a resource for lighting professionals and improve the lighting standards prepared for libraries in our country.

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