INNOVATIVE APPLICATIONS AND RESEARCH METHODS IN ARCHITECTURE

EDITOR

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CHAPTER 1

Restoration Processes in Historical Structures: The Case of Bursa

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1. Introduction

Historical buildings serve as tangible records reflecting the political, social, economic, cultural, and architectural characteristics of past eras. They are invaluable for conveying the identity, aesthetic sensibilities, and lifestyles of societies. Bursa, having hosted numerous civilizations and served as the first capital of the Ottoman Empire, has preserved significant cultural heritage, making it an exemplary case study for restoration research.

The concept of cultural heritage was first defined by UNESCO in 1976 and encompasses all tangible cultural assets. Cultural heritage establishes a link between past and future, safeguarding social identity and intergenerational belonging. Preserving historical structures is not merely an aesthetic concern but also a societal responsibility.

In this context, restoration aims to protect and sustain a structure's historical value by using original materials and techniques without compromising its authenticity. The development of restoration thought is often associated with the French architect Eugène Emmanuel Viollet-le-Duc (Aydın, 2017, p. 1). Today, this approach has merged with contemporary conservation principles, adopting the principle of minimal intervention.

Recently, there has been an increase in the use of modern materials, such as concrete and steel, in the restoration of historical buildings. However, the incompatibility of these materials with the original structural materials in terms of chemical, physical, and mechanical properties can negatively affect the durability of buildings (Kutlu & Bekar, 2021, p. 13). Therefore, selecting materials that are compatible with the structure's original character is paramount in restoration processes.

This study aims to examine the impact of proper material selection and application techniques on the preservation success of historical buildings. Using Bursa as a case study, both traditional and contemporary methods are evaluated, and the contributions of technology to restoration processes are analyzed. Supported by literature review and analytical examination, the research provides a comprehensive approach through local and international sources, reports, and visual documentation.

Chapter 1: Definitions and Concepts

1.1. The Concept and Importance of Restoration

Restoration is the process of renewing or repairing buildings or historical fabrics constructed in the past while preserving their original identity. In other words, it involves fixing a structure with minimal intervention, using original materials and techniques, without damaging its historical, cultural, and aesthetic value. Restoration is not only an architectural practice but also an approach to cultural heritage conservation. Therefore, restoration can be applied not only to buildings but also to objects and works of art (Aydın, 2017, p.1).

1.2. Restoration Process

Before initiating the restoration of a structure, a detailed preliminary investigation must be conducted. This investigation includes researching the building's history, examining historical documents, and analyzing period-specific characteristics. Such research is often referred to as restitution studies. Throughout the process, aesthetic values, technical requirements, and legal conditions must be considered.

Before commencing the restoration, all existing documentation related to the building is collected, and the extent of its damage is assessed. Based on this information, the necessary permits and approvals are obtained, and the implementation phase begins (Sert, 2017, p.17).

1.3. Historical Development of Restoration

The term "restoration" derives from the French word restaurer, meaning "repair" or "renewal." Although the roots of the concept date back to human history, its discussion as a scientific discipline began in the 19th century.

Following the French Revolution in 1789, anti-monarchy and anti-church sentiments led to the destruction of monumental structures representing these institutions. However, from the mid-19th century onwards, medieval buildings attracted renewed attention, prompting their repair.

Eugène Emmanuel Viollet-le-Duc (1814–1879), a French architect, was the first to bring a systematic perspective to restoration, which had previously been conducted according to the subjective approaches of different architects. According to Viollet-le-Duc, restoration does not mean preserving or rebuilding a structure, but instead bringing it to a state of completion as if it had never existed otherwise (Söylemez, 2009, p. 5). This approach laid the theoretical foundations of restoration.

By the end of the 19th century, the "Romantic View," advocated by John Ruskin, emerged. This perspective emphasized preserving monuments in their current state, minimizing intervention. This approach can be seen as more aligned with contemporary restoration practices.

Another critical approach, the "Historical Restoration Approach," developed by Luca Beltrami, argues that restoration should be carried out based on documented historical data (Söylemez, 2009, p. 6).

The contemporary restoration principles proposed by Camillo Boito synthesize these three perspectives and remain valid today. Boito advocated for balanced and scientifically based interventions in restoration. His principles can be summarized as follows (Ersoy Şahin, Günaydın & Öztürk, 2024, p.109):

- Structural reinforcement should be performed before intervention; if these measures are insufficient, restoration should proceed.
- Any addition or alteration to the structure should support its durability and integrity without compromising its originality.
- Repairs to incomplete or damaged sections should be made in a manner distinguishable upon careful observation.
- The aesthetic and original forms of artworks should be preserved, maintaining the artistic integrity of the building.
- Later additions can be preserved if they do not obstruct the structure; however, if they hinder the perception of the work, they should be carefully removed.
- Pre- and post-restoration processes should be documented with records, photographs, and project studies, and archived.
- Information obtained from restoration should be published to serve as a reference for future applications.

The principles established by Camillo Boito are accepted today as Contemporary Restoration Principles and form the foundation of the restoration discipline.

Chapter 2: Material Usage in the Restoration Process

2.1. The Importance of Material Usage in Restoration

Restoration is a process aimed at preserving the historical, cultural, and aesthetic values of a building and transferring them to future generations. Therefore, the compatibility of the materials used with the structure, their contribution to aesthetic integrity, their reflection of the period's cultural values, and their appropriateness to the historical fabric must be carefully assessed. Materials play a crucial role in documenting a building's historical identity, and they must be original and period-appropriate. Incorrect material selection can disrupt the aesthetic balance and integrity of the structure, leading to a loss of its original value (Mete, 2023, p.1).

One of the primary objectives of restoration is to ensure the longevity of the structure and its transferability to future generations. In this context, the selection of materials should take into account the local climate, landscape features, soil conditions, and environmental factors. Appropriate material selection enhances both the physical durability and the continuity of the building (Tellioğlu & Satıcı, 2023, p. 40). Additionally, in repurposed structures, the materials used must be suitable for the new intended function. Both the functional and aesthetic qualities of the material are essential in the restoration process (Çetin, 2021, p. 10).

2.2. Materials Used in Restoration

Historically, the primary building materials have been stone and wood, used since the earliest periods of human civilization. Depending on regional conditions, materials such as adobe, brick, and stone were often combined. Today, although contemporary construction techniques employ reinforced concrete and steel, traditional materials that harmonize with the original fabric remain dominant in restoration practices (Çavuş, 2011, pp.4–5).

The primary building materials used in restoration can be classified as follows:

Stone, Brick, Wood, Masonry, Mortar

The physical and chemical properties of these materials play a critical role, especially in load-bearing systems of masonry structures. Factors such as durability, thermal expansion coefficient, water absorption, and compressive and tensile strength directly influence the success of restorations (Çavuş, 2011, p. 6).

2.2.1. Natural Stone

Natural stone is one of the oldest building materials in human history and has been preferred for its high durability, longevity, and aesthetic appeal. The natural texture and color variety of stone impart a unique character to the structure. Consequently, stone is indispensable in architecture, both as a structural and an aesthetic element (Tellioğlu & Satıcı, 2023, p. 43).

Stone stands out for its homogeneous structure, resistance to atmospheric effects, and high compressive strength. These characteristics make it suitable for elements under compression, such as arches, vaults, and domes. The combination of stone and mortar is one of the most critical factors in determining a building's overall stability (Mete, 2023, p. 17).

Although processing stone is labor-intensive, its durability and cultural symbolic value make it indispensable for monumental structures. Historically, civilizations such as the Hittites, Assyrians, and Egyptians used stones such as granite, limestone, and sandstone, often covering them with marble for aesthetic enhancement (Özer, 2006, p. 43).

Photo 1. Examples of natural stone, Koza Han (left) and Orhan Cami (right), Bursa, Türkiye

Photo 2. Example of natural stone, Cumalıkızık, Bursa, Türkiye

2.2.2. Brick

Brick is a building material used since ancient times, primarily composed of clay. It is obtained by firing clay at high temperatures and offers advantages over stone due to its ease of handling, low cost, and lightweight properties (Mete, 2023, p.19). The strength of brick depends on production techniques, the firing process, the type of mortar, and masonry patterns (Çavuş, 2011, p. 10).

When combined with natural stone, brick adds aesthetic diversity and helps preserve the original material texture during restoration.

Photo 3. Government Mansion, Bursa, Türkiye

2.2.3. Masonry

Masonry structures are those built with load-bearing stone or brick walls, without columns. In such buildings, walls carry the entire load. The strength of masonry is directly related to the quality of stone and mortar used. While these systems are resistant to compression, they are weak under tension (Tellioğlu & Satıcı, 2023, pp.44–45).

During restoration, interventions to reinforce masonry should be carried out without damaging the structure. Additionally, elements such as foundations, floors, and roofs must be strengthened without compromising authenticity.

Photo 4. Bursa City Walls

2.2.4. Wood

Wood has been one of the most widely used building materials throughout history due to its ease of processing, light weight, and warm character. Its low thermal conductivity has made it particularly suitable for residential buildings (Mete, 2023, p.20). Compared to stone, wood has a shorter lifespan but offers superior tensile and flexural strength.

In traditional architecture, wood was used structurally in ceilings and floors, and decoratively in eaves and arched windows. In contemporary restoration, the preservation of original wooden elements remains essential (Tellioğlu & Satıcı, 2023, p.46).

Photo 4. Atatürk House, Bursa, Türkiye

To preserve wooden materials, water-based impregnations should be applied, and protective sprays against fungi and insects should be used. Wooden elements that have lost their strength should be replaced with the same type of original material (Tellioğlu & Satıcı, 2023, p.46).

Photo 5. Pınarbaşı Mevlevihanesi, Bursa, Türkiye

2.2.5 – Mortars

The general purpose of mortars is to serve as filling or binding materials. A mortar is a solidifiable and moldable construction material formed by mixing fine-grained aggregates, various additives, and water in specific proportions.

Depending on their chemical composition, mortars are categorized into types such as lime mortar, cement mortar, and horasan mortar. Based on their application areas, they can also be classified as plaster mortar, masonry mortar, screed, whitewash, or slurry.

In early constructions using brick and adobe as building materials, the first mortar was mud, known as the binder. It is believed that the Egyptians first used a mixture of sand, water, and lime. The Romans, on the other hand, employed lime mortar to join brick and stone walls and used a pozzolanic mortar—similar to concrete—when constructing vaults and domes. The base components of pozzolanic mortar are volcanic ash (pozzolana) and lime. By adding crushed or powdered brick fragments and charcoal in varying proportions, different types of mortar were developed to meet the needs of specific applications.

During the Seljuk and Ottoman periods, a distinctive mortar called horasan mortar was produced by adding egg white to the mixture of sand and lime (Özer, 2006, p. 45).

Photo 6. Hüdavendigar Mosque, Bursa, Türkiye

Chapter 3: Methods Used in the Restoration Process

3.1. The Importance of Methods Applied in Restoration

In the restoration process, the method of applying materials is as important as the selection of materials. This process requires meticulous craftsmanship; otherwise, permanent damage may occur and the structure's original character may be compromised. Therefore, the primary goal of restoration techniques is to preserve the building without causing harm (Tellioğlu & Satıcı, 2023, p.40).

For cultural heritage to be sustained, regular maintenance, repair, and restoration work are essential. Throughout history, societies have acted with the awareness of preserving their cultural heritage, and this consciousness has gradually developed under the influence of historical events. However, it is not only important that preservation work is carried out, but also that it is carried out correctly. Properly executed repairs contribute to the sustainable preservation of the building's fabric. Architectural design should reflect the spirit, cultural heritage, and emotional depth of the place; it must be compatible with the environment, climate, landscape, and collective memory, while avoiding imitation (Zakar, 2013, pp.3–5).

Before commencing restoration, research and documentation are conducted. These include examining the building's historical, aesthetic, and technical characteristics, preparing detailed surveys, and identifying damages. Such studies allow for a thorough understanding of the structure and provide a basis for selecting appropriate conservation techniques to eliminate or mitigate the causes of damage. Today, alongside traditional methods, contemporary technologies are actively used in this process.

The fundamental approach to protecting historical structures is to ensure continuous and sustainable maintenance. In many countries, historical buildings are systematically inspected annually or every 5 years, and necessary maintenance and repair work is carried out based on identified deterioration. This systematic approach allows the preservation of buildings without requiring costly interventions. However, unexpected events such as fires, earthquakes, or landslides may necessitate more comprehensive interventions (Halaç, Başer, Gülşen, & Fedakâr, 2022, pp.4–5).

3.2. Techniques Applied in the Restoration Process

Different techniques are used in the repair of historical buildings. The choice of technique depends on the material texture, type of damage, and general condition of the structure. Applications can be carried out individually or in combination. The main techniques used in restoration can be classified into six categories:

Strengthening, Integration, Renewal, Reconstruction, Cleaning, Relocation

The fundamental aim of scientific restoration is to preserve the building's historical and aesthetic value while adhering to the principle of minimum intervention. The scope of intervention ranges from strengthening to reconstruction. From a conservation perspective, the most appropriate approach is limited to reinforcement. However, as the extent of damage increases, more comprehensive interventions may be required (Barutçu, 2012, p.73).

3.3. Subcategories of Restoration Techniques

3.3.1. Strengthening

Strengthening involves reinforcing not only the load-bearing system but also the materials and ground characteristics of the structure. Techniques include section enlargement, support systems, tension and hoop systems, foundation reinforcement, stitching, and injection methods. Micro-injections, joint reinforcements, and ground improvement are also included. Strengthening is often preferred to prevent the collapse of old structures and to preserve their appearance during adaptive reuse (Tellioğlu & Satıcı, 2023, p. 41).

3.3.2. Integration

Integration refers to the repair or replacement of damaged or missing building elements while preserving their original design. Traditional or contemporary materials can be used. However, in archaeological structures, integrating non-functional sections is not recommended; in such cases, priority is given to strengthening. Reliable data on the building's original condition is necessary before the application. Integration based on assumptions carries a risk of error. To distinguish new sections from the original structure, different surface textures should be applied, and inscriptions indicating the date and architect should be included (Halaç et al., 2022, p.7).

3.3.3. Renewal

Renewal involves restoring parts of the structure that have lost their original characteristics using new materials and systems that are consistent with the original. This method is chosen when strengthening is not possible. During renewal, it is essential to implement new functions without compromising the building's appearance. This approach ensures both the preservation of historical values and adaptation to contemporary needs (Tellioğlu & Satıcı, 2023, p. 42; Zakar, 2013, p. 10).

3.3.4. Reconstruction

Reconstruction refers to rebuilding a damaged structure as an exact copy using the same materials, design, and techniques. It is usually applied to buildings destroyed by fire, earthquake, or war. For successful reconstruction, plans, photographs, and documents of the original structure are necessary. Reconstruction is important not only for its historical significance but also for the continuity of the construction tradition (Zakar, 2013, pp. 12–13).

3.3.5. Cleaning

Cleaning involves removing non-aesthetic additions and purifying existing surfaces using mechanical or chemical methods. Mechanical cleaning can be carried out with water or sand blasting, while chemical cleaning may involve solvents or absorbent clays. Documentation should be conducted before and after the procedure, and approval from the Cultural Heritage Preservation Board is required (Tellioğlu & Satıcı, 2023, p. 42).

3.3.6. Relocation

Relocation involves moving a structure from its original site to another location. This is often necessary due to dams, roads, or geological threats. The process should be supported by detailed measurement, numbering, and photographic documentation. Relocation can be done piece by piece or in its entirety, depending on the material. Successful execution requires technical expertise, appropriate transportation systems, and careful planning (Zakar, 2013, p. 13; Tellioğlu & Satıcı, 2023, p. 42).

Chapter Summary

This chapter discussed the primary methods and techniques used in the restoration process. Each applied method aims to preserve the building's originality and historical identity. The success of restoration depends on accurately determining the level of intervention, using documented data, and consciously applying contemporary techniques. These principles form the foundation of a sustainable conservation approach.

Chapter 4: Deterioration and Its Causes in the Restoration Process

Turkey's rich cultural heritage stems from its historical role as a host to numerous civilizations. However, these valuable structures have undergone deterioration over time due to various natural and human-induced factors. Such deterioration arises from multiple variables, including the building's function, construction technique, surrounding environmental conditions, and previous interventions.

Preserving historical structures is essential not only for physical integrity but also for cultural continuity. Therefore, the current condition of the building, the materials used, the construction system, and environmental factors should be thoroughly examined to identify the causes of deterioration (Mete, 2023, p.24). The leading causes of deterioration in historical structures are generally categorized into three groups: natural factors, design and construction errors, and human-induced interventions (Ekşi Akbulut, 2006, p.25).

4.1. Natural Factors in the Restoration Process

It is challenging for historical buildings to survive intact to the present day. In the absence of regular maintenance and conservation, natural effects lead to structural deterioration. These factors directly affect the physical and chemical properties of building materials, leading to wear, cracking, and discoloration (Mete, 2023, p. 25).

The primary natural factors include:

- Atmospheric effects
- Air pollution
- Water and moisture effects
- Temperature variations
- Wind effects
- Sunlight exposure
- Natural disasters

4.1.1. Atmospheric Effects

Atmospheric conditions created by seasonal changes, including humidity, temperature, wind, and sunlight, cause physical and chemical degradation of exterior surfaces (Mete, 2023, p. 25).

4.1.2. Air Pollution

Vehicle exhaust, industrial emissions, and acid rain trigger chemical reactions on stone and brick surfaces, leading to material loss. This process results in the erosion and darkening of the original textures of historical structures (Ekşi Akbulut, 2006, pp.35–36).

4.1.3. Water and Moisture Effects

Rain, snow, groundwater, and condensation cause water accumulation in materials. Water penetrates porous materials, leading to cracking and blistering during freeze-thaw cycles (Mete, 2023, p. 26).

4.1.4. Temperature Effects

Daily temperature fluctuations cause materials to expand and contract. Stress occurs mainly at joints between dissimilar materials, resulting in cracks (Ekşi Akbulut, 2006, p. 29).

4.1.5. Wind Effects

Wind creates erosion and rapid evaporation on surfaces, causing crystallization in materials. This leads to weakening and surface loss, particularly in porous stones (Mete, 2023, p.26).

4.1.6. Sunlight Effects

Prolonged exposure to sunlight causes fading and hardening of surfaces. Temperature differences between day and night further deepen surface cracks (Ekşi Akbulut, 2006, p.30).

4.1.7. Natural Disasters

Events such as earthquakes, landslides, storms, and floods can cause significant deformation of the load-bearing systems of historical buildings. Material fatigue and aging amplify these effects (Mete, 2023, p.27).

4.2. Design and Construction Errors

When site conditions, climate data, material properties, and user requirements are inadequately considered during the design phase, structural deterioration becomes inevitable. Poor artistry and a lack of supervision also lead to serious errors during restoration (Mete, 2023, p. 28).

4.2.1. Incorrect Material Selection

Using incompatible materials reduces the durability of historical structures. The replacement of traditional materials such as stone, wood, adobe, and brick with modern chemical-based materials leads to incompatibilities and rapid deterioration (Ekşi Akbulut, 2006, p.33).

4.3. Human-Induced Factors in the Restoration Process

Human-induced deterioration is among the most frequently encountered problems in historical structures. Misuse, unscientific restoration practices, fires, and traffic vibrations are key contributing factors (Mete, 2023, p.28).

4.3.1. Misuse

Actions such as scratching, painting, or hanging posters by users directly cause physical damage. Additionally, heavy tourism contributes to the wear and tear on building materials (Zakar, 2013, p. 23).

4.3.2. Incorrect Restoration Practices

Wrong material choices and faulty techniques can irreversibly damage the original fabric of historical buildings. Therefore, restoration should be conducted using scientific methods and based on documented evidence (Mete, 2023, p.29).

4.3.3. Fires

Fires can result in significant material loss, especially in wooden structures. Electrical systems, lighting elements, and careless interventions during restoration increase fire risks (Ekşi Akbulut, 2006, p.35).

4.3.4. Traffic and Vibrations

Vibrations from modern transportation can cause cracking and separations in historical structures. This poses significant risks, particularly for monumental buildings in city centers (Mete, 2023, p.29).

Chapter Summary

The causes of deterioration in historical buildings are multifaceted and usually arise from a combination of natural, structural, and human-induced factors. Each of these factors should be carefully analyzed during the restoration process, and interventions should be planned to be compatible with the building's original materials and historical identity. Without a conscious conservation approach, the sustainability of cultural heritage is at risk.

Chapter 5: Bursa Case Study: Restoration through Irgandı Bridge

The restoration process is a technical procedure carried out to repair the deterioration that many historical structures experience over time and to preserve their original identity. The primary aim of this process is to maintain the building's original characteristics while ensuring its transmission to future generations. Historical structures that possess cultural heritage value inevitably require such interventions due to the effects of time and environmental conditions (Zakar, 2013, p. 4).

Bursa, which hosts significant examples of early Ottoman architecture, is one of the most suitable cities for examining these processes. The transformation of the Ottoman State from a beylik to an empire is clearly traceable in Bursa. Today, Bursa preserves numerous historical structures and, as an authentic representative of Turkish urban tradition, holds a pioneering position both historically and architecturally. With its deep-rooted past, layered cultural structure, and historical continuity, Bursa justly earns the designation “the city where civilization sprouted” as a significant cultural center of Anatolia.

Archaeological research indicates that settlements in and around Bursa date back approximately 8,000 years. Known as “Prusa” in antiquity, the region was successively under the control of the Roman and Byzantine Empires. The arrival of the Turks began with the conquest of İznik in 1081. Bursa was incorporated into Ottoman territory by Orhan Bey in 1326 and became the empire's first capital (Aydın, 2017, p. 5).

5.1. Irgandı Bridge

Irgandı Bridge, one of Bursa’s unique historical structures, spans the Gökdere River in the Osmangazi district. The bridge functions not only as a historical structure but also as a commercial space. It holds a special place in architectural history as the only remaining “covered bazaar bridge” in Turkey. The bridge was constructed after the conquest of Bursa to connect the Kayhan and Yıldırım neighborhoods. It features a single-arch design spanning 16 meters and is 11 meters wide. Throughout history, it has been a frequent stop for travelers and tourists, maintaining its dual identity as a center of art and commerce (Önge, 1981, p. 425).

Numerous travelers and historians have documented the bridge's history. Evliya Çelebi provides one such account:

> ***"Evsaf-ı cisr-i Irgandı — Bursa has a market on the Irgandı Bridge over the Gökdere, with about two hundred small shops of yemin and yesar. The windows of the cells overlook the Gökdere flowing beneath... At both ends of the bridge, there are iron gates resembling fortress doors... One side of the bridge is empty, functioning as a hostel with horse stables."***

(Evliya Çelebi II:19, as cited in Bayram, 2024, p.69).

Sources indicate that Hoca Muslihuddin, a wealthy merchant of the era, commissioned the bridge. The origin of the name “Irgandı” is debated; some scholars suggest it derives from the verb meaning “to shake or sway,” while others claim it comes from the name of the bridge’s patron (Eyice, 1999, p.122).

5.2. Architecture of Irgandı Bridge

The bridge was constructed using stone. Sitting on the rocky slopes of the Gökdere Valley, it consists of pointed arches with spans of approximately 15–16 meters. The bridge accommodates 31 shops and a small mosque. The vaulted sections at both ends were historically used as storage areas or stables. Arched gates at both ends provide access.

The bridge’s original dimensions are approximately 62.50 × 11.40 meters. Stone brackets on the façade support the projecting shop fronts. Following damage in 1922, the shops were demolished, and during the 1949 repair, the façades were rebuilt and raised. The lower sections feature cut-stone masonry with polygonally carved stone extensions, which are still visible today. The roof system was initially made of wood and covered with lead, though from the 17th century tile roofing was preferred (Bayram, 2024, pp. 69–70).

Irgandı Bridge is unique in that its lower and upper structures were planned and constructed simultaneously. This feature makes it the only representative of the "covered bazaar bridge" type in Turkey (Sağıroğlu Arslan, 2014, p.141).

5.3. Restoration Process of Irgandı Bridge

The bridge has undergone various destructions and repairs throughout its history. It was heavily damaged during the Greek occupation in 1922 but reopened to pedestrians after repairs in 1942. A comprehensive restoration initiated by the Osmangazi Municipality in 2002 was completed on 17 March 2004. The restoration included 22 shops on the deck, a 3.60-meter-wide pedestrian path, and a 10-meter-wide bridge passage.

Today, Irgandı Bridge functions as an "Art Bridge," housing handicraft workshops and exhibition spaces. The vaulted areas below, historically used for storage, have been repurposed as a business called "Mahzen" (Atak, 2008, pp. 124–126).

Section Conclusion

Irgandı Bridge is an important indicator not only of Ottoman engineering but also of the sustainability of the historical urban fabric. The restoration process serves as a model for adapting a historical structure to contemporary use while preserving its historical identity. The bridge's adaptive reuse demonstrates a successful integration of cultural heritage into social life, highlighting that restoration is not merely a physical intervention but also a revival of historical memory.

Chapter 6: Evaluation and Conclusion

Within the scope of this study, the restoration processes carried out in Turkey over long periods to preserve historical textures have been examined. Throughout the study, the role of restoration practices in safeguarding the physical, aesthetic, and historical values of structures has been emphasized, and the fundamental principles to be considered in these processes have been addressed. Preserving historical buildings in line with sustainability principles is critical to the continuity of cultural heritage.

During the restoration process, the proper integration of materials and techniques used in historical structures is a decisive factor in maintaining their original identity. Incorrect material selection or the application of faulty techniques can cause irreversible damage to historical textures. Therefore, material selection must be considered not only for aesthetics but also for durability and longevity. Moreover, the protection of this heritage should be evaluated not merely as a technical requirement but also as a societal responsibility.

The restoration practices in Bursa, examined as case studies, play a significant role in preserving the city's historical fabric and upholding sustainability principles. Among the cases studied, both successful and unsuccessful applications were identified. This demonstrates that restoration processes must be conducted not only with technical competence but also with conscious, disciplined, and ethically grounded professional practices.

In conclusion, some of the errors encountered in restoration processes stem from a lack of professional experience and insufficient oversight mechanisms. Therefore, it is of utmost importance to enhance the professional qualifications of specialists involved in conservation and restoration, to ensure meticulous supervision of implementation processes, and to proceed according to scientific principles.

References

Aydın, F. (2017). Bursa: Re-examination of restitution and restoration based on new findings during restoration in four early Ottoman mosques. Maltepe University Institute of Science, Department of Architecture, Restoration Program.

Atak, E. (2008). Early Ottoman bridges—Çanakkale Onsekiz Mart University Institute of Social Sciences, Department of Art History.

Barutçu, B. (2012). Restoration project of Samatya Anarad Hığutyun Armenian Catholic Church. Istanbul Technical University Institute of Science, Department of Architecture, Restoration Program.

Bayram, M. (2024). Extraordinary examples of civil architecture: Covered bridges. Journal of Social and Cultural Studies, 10(20), 61–88.

Çavuş, M., & Arslan, M. (2023). Structural analysis of roofs completed with steel material in historical buildings. Düzce University Journal of Science and Technology, 11, 1563–1573.

Çetin, C. İ. (2021). Refunctioning historical buildings within a sustainability framework: The case of the Venice Flour Factory. Journal of Art and Design, 12, 10–17.

Ekşi Akbulut, D. (2006). A proposal for the selection of mortars to be used in the repair of historical buildings. Yıldız Technical University Institute of Science, Department of Architecture, Building Program.

Ersoy Şahin, S., Günaydın, H. M., & Ozturk, G. B. (2024). Time and cost management in public restoration projects. Istanbul Commerce University Journal of Technology and Applied Sciences, 7(1), 107–127. https://doi.org/10.56809/icujtas.1427031

Eyice, S. (1999). Irgandı Bridge. Islamic Encyclopedia, 19, 122–124. Türkiye Diyanet Vakfı.

Halaç, H. H., Başer, E., Gülşen, M., & Fedakâr, B. (2022). Method proposal for the assessment of integration interventions in historical buildings. Gaziantep University Journal of Social Sciences, 21(1), 1–21.

Kutlu, İ., & Bekar, İ. (2021). Use of glass in the refunctioning of historical buildings: The case of Trabzon Girls' Monastery. Karadeniz Research Institute Journal, 7(13).

Önge, Y. (1981). The original architecture of the Irgandı Bridge in Bursa. Vakiflar Journal, 13, 425–448.

Özer, S. S. (2006). Structural analysis of elements in traditional masonry buildings. Erciyes University Institute of Science, Department of Architecture.

Mete, H. (2023). Appropriateness of materials used in restoration: The case of Hoca Hasan Mosque and Şerefeddin Mosque. KTO Karatay University Graduate School, Department of Architecture.

Mikaeili, M. (2023). Urban imagery: Historical covered market bridges. Kesit Academy Journal, 9(34), 72–91.

Sağıroğlu Arslan, A. (2014). Latin influences in early Ottoman art. Zeitschrift für die Welt der Türken, 6(2), 131–155.

Sert, Ö. F. (2012). Mapping the restoration process in Turkey and identifying problems encountered in project tendering and implementation. Istanbul Technical University Institute of Science, Department of Civil Engineering, Construction Management Program.

Söylemez, M. (2009). Restoration techniques of the oud from plectrum instruments. Istanbul Technical University Institute of Social Sciences, Turkish Music Program.

Tellioğlu, S., & Satıcı, B. (2023). Determining materials to be used according to restoration techniques in historical buildings. Journal of Technology and Applied Sciences, 6(1), 37–49.

Zakar, L. (2013). Contemporary techniques used in restoration practices. Istanbul Technical University Institute of Science, Department of Architecture, Restoration Program.

CHAPTER 2

Urban Memory, Spatial Memory and Historical Buildings: A Conceptual Approach through the case of Koza Han

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1. Introduction

Cities are not merely assemblages of physical structures; they are complex systems in which cultural values, social relations, and spatial experiences accumulate over time. The most visible and identifiable aspect of these systems is urban identity. Urban identity is a multidimensional phenomenon that reflects the unique character of a settlement and distinguishes it from others. This identity emerges through the long-term interaction of various components, including natural environmental features, architectural fabric, social life patterns, and cultural values. Historical buildings, in particular, serve as tangible documents of the past and play a critical role in both the construction and continuity of urban identity.

In this regard, the concept of spatial memory is closely intertwined with urban identity. Spatial memory refers to the mental representations shaped by individuals' cognitive and emotional connections with the environments in which they live, integrating notions of place and time. At the collective scale, spatial memory acts as a vehicle for social belonging, collective consciousness, and continuity with the past. Preserving this memory amid urban transformation is essential for the sustainability of urban identity. In cities undergoing rapid change, the presence of historical structures becomes vital for safeguarding this memory through tangible, spatial elements.

The starting point of this study is to examine the influence of historical buildings on spatial memory and urban identity through a concrete case. In this context, Koza Han—one of the significant commercial structures of the Ottoman period—was selected as the subject of investigation. Commissioned by Sultan Bayezid II in 1492 to generate revenue for the mosque and madrasah complex in Istanbul, Koza Han has maintained its function for centuries while undergoing various physical and functional transformations. Located in the historical core of Bursa, between the Grand Mosque (Ulu Cami) and Orhan Mosque, the inn holds a symbolic place in the city's memory not only for its architectural qualities but also for its social and economic significance.

The primary aim of this research is to examine Koza Han's architectural transformation throughout its historical development, its position within the framework of spatial memory, and its contribution to Bursa's urban identity. Within this scope, the building's historical background and architectural characteristics were analyzed, and the physical transformations it has undergone were discussed in terms of their impact on the architectural fabric. Photographs and floor plans of Koza Han were reviewed to identify and interpret its spatial transformation processes. Furthermore, the structure's conservation and adaptive reuse practices were evaluated, and recommendations were proposed for ensuring the sustainable preservation of similar historical buildings within contemporary urban life.

This study first addresses the concepts of spatial memory and urban identity at a theoretical level. It then examines the historical development and architectural transformation of Koza Han to elucidate the functional role of historical buildings within urban memory. Finally, the study evaluates Koza Han's contribution to urban identity and its interaction with the public, and discusses principles of sustainable conservation in light of the findings.

Chapter 1: Theoretical Framework on Spatial Memory and Urban Identity

1. Spatıal Memory, Urban Identıty, And Hıstorıcal Buıldıngs

Spatial memory is a form of memory shaped through individuals' interactions with their environment and nourished by mental images associated with places. This memory functions not only at the individual scale but also collectively, playing a significant role in the construction of urban identity. Historical buildings, in particular, sustain urban memory through both their physical presence and the cultural and symbolic meanings they embody, thereby serving as bridges between the past and the present. This section explores the relationship between spatial memory and urban identity, as well as the role of historical structures within this dynamic.

1.1 The Concept of Spatial Memory

From birth onward, human beings are in constant interaction with the objects, tools, dwellings, transportation systems, and environments they use throughout their lives. The relationships formed with these physical elements transcend mere functional use; these elements become interwoven with the memories, emotions, and experiences accumulated over time, leaving permanent traces in the mind. Through this multilayered interaction with objects and places, individuals construct their personal memory and sustain their connection with the past (Taşçı, 2023).

Spatial memory refers to the specialized form of memory that enables individuals to recall the location of an object or structure or to remember how a past event occurred in a particular setting. This form of memory is shaped by an individual's interaction with their surroundings and develops through the accumulation of experiences, observations, and emotional impressions over time. In cities characterized by continuous transformation, spatial memory plays a crucial role in shaping urban identity. Urban identity emerges through the long-term relationship between natural environmental components and social, cultural, and economic dynamics. Thus, the formation of a unique and enduring identity depends not only on the presence of physical structures but also on their transformation over time and the continuity of the relationships individuals build with these evolving environments (Manley & Guise, 1998).

The collective memory of place incorporates the outcomes of production processes shaped by human activity and social dynamics, as well as shared consciousness, collective will, and critical societal evaluations (Özdemir & Cengizoğlu, 2023).

Spatial memory consists of mental representations formed through individuals' interactions with their surroundings. It is examined under two main categories based on its temporal dimension: short-term and long-term spatial memory. Short-term spatial memory stores temporary information, such as momentary orientation or the ability to remember an object's position, whereas long-term spatial memory retains more permanent spatial knowledge, experiences, and emotional connections related to one's environment. The functions and characteristics of both types are as follows:

- **Short-Term Spatial Memory:**

Short-term memory refers to the temporary storage of information after it has been processed and brought to consciousness. Its content is often equated with information an individual is consciously aware of. Information in short-term memory can be continually processed (e.g., through repetition or internal rehearsal). However, when attention is disrupted, information quickly fades (Roediger et al., 2008). The recognition of a place or structure previously seen is associated with this form of spatial memory.

- **Long-Term Spatial Memory:**

Information in long-term memory can be stored for several minutes to several decades (Karabekiroğlu et al., 2005). Long-term memory enables interaction with one's surroundings by enabling recall of past experiences (Engin et al., 2008).

Long-term spatial memory allows individuals to recall information learned in the past even after long intervals. The acquired knowledge is not limited to a single location or structure but becomes interconnected with other spatial elements. Through mental imagery and reconstruction, individuals use long-term spatial memory to establish and sustain relationships with places.

1.2 The Concept of Urban Identity

Urban identity is the holistic expression of a city's physical, social, cultural, and historical characteristics. The concept extends beyond the built environment, encompassing inhabitants' sense of belonging, collective memory, lifestyle, and interactions with urban space. Urban identity develops over time through the long-term interaction among natural environmental features, architectural heritage, social dynamics, and cultural accumulation.

Urban identity represents not only the physical reflection of a city but also the coherent whole formed by its characteristic features and social values shaped through historical, cultural, and social interactions. As a construct shaped by collective memory, lifestyle, traditions, and the meanings attributed to place, urban identity defines a city's uniqueness and distinguishes it from other settlements. Hence, urban identity is the result of a socially constructed process grounded in tangible realities and shaped by the integration of collective experiences with the physical environment (Bayramoğlu, 2010).

The identity of a city is a multilayered phenomenon shaped over time. It emerges through the interaction of social, cultural, economic, and spatial dynamics and evolves continuously. Particularly in cities with deep-rooted histories and slower transformation, the coexistence of layers from different periods contributes to the formation of a strong identity that reflects historical continuity. However, since social structures and interpersonal relations are constantly changing, urban identity also remains dynamic, continually reconstructed and redefined in line with contemporary social interactions (Tekeli, 1991).

Urban identity is not merely the sum of physical components; it is a multilayered phenomenon shaped by individuals' emotional, cultural, and cognitive relationships with their environment. Beyond the tangible elements that constitute urban form, Lynch (1984) emphasizes the "spirit of place" or "atmosphere" as a core component of individuals' sense of belonging and attachment to place. This concept pertains to the meanings individuals assign to their surroundings and their perceptual engagement with the environment. Meaningful places in cities take shape in the mind through the combination of past experiences, sensory impressions, and cognitive processes (Qazimi, 2014).

Unlike modern architectural environments, historical settings tend to foster stronger emotional connections. The sense of continuity with the past enhances individuals' attachment to place, demonstrating that the spirit of place is nourished not only by physical attributes but also by historical and cultural contexts. Therefore, historical buildings and environments function as powerful memory spaces in the construction of personal and collective identity (Lewicka, 2008).

The formation of urban identity depends on the preservation of material and immaterial values carried from the past to the present. Maintaining these values ensures that elements of the city's historical memory are transmitted to future generations. Structures and architectural ensembles from different historical periods hold a privileged place in daily urban life, contributing to cultural continuity and shaping the city's authentic identity. In this context, preserving buildings that reflect the architectural and socio-spatial characteristics of their period is crucial for sustaining cultural continuity, constructing an authentic identity, and transferring the existing identity to future generations (Birol, 2007).

1.2.1 Components of Urban Identity

Liggett and Perry (1995) classify the elements shaping urban identity into three main groups: the natural environment, the human environment, and the built environment. According to this framework, natural environmental components include a city's topography, climatic characteristics, vegetation, and geographic location—forming the first defining layer of its characteristic identity.

Human-environment components encompass the social, cultural, and historical values of individuals and communities. The lifestyle, traditions, cultural practices, belief systems, and collective memory of a society constitute significant elements of urban identity. Emotional and social bonds formed between individuals and the city strengthen abstract values such as belonging and place attachment.

The built-environment components include all human-made physical interventions and products of urban design. Squares, street patterns, parks, monuments, buildings, and other architectural elements shape the city's morphological structure, contributing to its visual memory and identity. These structures hold not only functional but also symbolic meanings, forming the spatial representation of urban memory (Yayınoğlu & Susar, 2008).

Solak (2014) expands these components into four main categories: natural environmental components, artificial environmental components, socio-cultural environmental components, and socio-economic environmental components. Natural components include geography, topography, climate, and landscape; artificial components consist of urban development patterns, architectural fabric, transportation infrastructure, and public spaces. The socio-cultural environment relates to the city's history, cultural heritage, demographic characteristics, traditions, and collective memory. The socio-economic environment encompasses economic structures, production relations, employment forms, and living standards.

Urban identity is thus the product of a multilayered system that extends from the physical environment to cultural memory and from social practices to economic structures. According to Table 1, this system is structured around four main components.

Table 1. Components of Urban Identity (Solak, 2014)

Component Type	Subcomponents / Characteristics
Natural Environmental Characteristics	• Geographical formations and topographical features • Climate and vegetation characteristics Jeolojik Yapı Özellikleri • Geological structure features
Built Environment Characteristics	• At the Settlement Scale: • Roads • Boundaries • Districts / Zones • Focal Points • Landmarks / Symbols • Open Spaces • Solid–Void Patterns • Buildings • At the Urban Amenity Scale: • Physical Amenities (parks, transportation, public spaces, etc.)
Socio-Cultural Environmental Characteristics	• Demographic Characteristics • Institutional Structure • Historical Characteristics • Cultural Characteristics • Functional Characteristics of the City
Socio-Economic Characteristics	• Income Level • Economic Conditions • Employment Structure

Human-shaped elements shape a city's visual memory. These components are examined on two scales. The settlement scale encompasses elements that determine the city's morphological structure, such as the road network, boundaries, districts, focal points, and symbols. As Kevin Lynch emphasizes in The Image of the City, the mental map that city dwellers construct is shaped by these elements. The amenity scale, on the other hand, includes more functional and user-oriented elements, such as parks, public spaces, seating areas, and transportation facilities. These features directly influence the city’s livability and social attractiveness.

One of the most abstract yet influential components of urban identity is the socio-cultural environment. Demographic structure, historical background, cultural values, and functional roles (e.g., industrial city, cultural city, port city) fall within this group. Everyday practices, traditions, and collective memory of the residents form part of this cultural framework. Cultural continuity plays a critical role in fostering a sense of belonging and preserving spatial memory.

Socio-economic characteristics encompass the city's economic dynamics and indicators of quality of life. Factors such as income level, employment structure, and overall economic conditions determine a city's capacity for transformation, sustainability, and social equity. These factors also influence processes such as migration, urbanization pressure, and spatial expansion.

The multidimensional and dynamic nature of urban identity is evident. While each component is significant in its own right, their interrelationships determine the city's holistic character. For example, a strong historical heritage, a built environment compatible with the natural landscape, and a balanced economic structure can form the foundation of a unique and sustainable urban identity.

Urban planning, architecture, landscape design, and cultural heritage management disciplines must consider the balance among these components to ensure that cities retain their identity while successfully transmitting it to future generations. Urban identity is not a static or fixed structure; rather, it is a dynamic process continuously shaped and reshaped through multifaceted interactions among humans, the environment, and time. This process emerges through the interplay of spatial, social, and cultural layers over time. Hall (1998) emphasizes this by asserting that identity is in a state of formation, shaped through the coexistence of elements that carry traces of the past and those that reflect contemporary life.

In *The Image of the City* (1960), Kevin Lynch explores how cities are represented in individuals' cognitive worlds and provides a theoretical framework for the concept of the "city image." According to Lynch, the city image is the product of cognitive representations developed through interactions with the environment and should be evaluated along three dimensions: identity, structure, and meaning. He analyzes how perceptions of urban space contribute to navigation, the development of a sense of belonging, and the formation of urban identity.

To explain how urban images are organized in individuals' minds, Lynch proposed a model consisting of five key elements: paths, edges, districts, nodes, and landmarks.

- Paths are the primary channels along which individuals move and experience the city, including streets, avenues, and pedestrian routes.
- Edges are boundaries that separate urban areas; they may be natural (rivers, coastlines) or artificial (walls, railways) and play a significant role in the perception of spatial organization.

- Districts are urban areas perceived as a whole due to shared physical or functional characteristics, such as a historic bazaar or residential neighborhood.
- Nodes are critical locations where urban movement converges, and decisions or directional changes occur, including squares, intersections, and transport hubs.
- Landmarks are prominent, easily recognizable features that assist in orientation, such as monuments, towers, or distinctive buildings.

Lynch's classification provides a key reference for understanding how individuals structure urban space cognitively. Concepts such as legibility, ease of navigation, and spatial attachment can be interpreted through these components. In this regard, Lynch's theory remains relevant not only for urban planning and design but also for approaches focused on spatial memory, urban identity, and user experience.

Chapter 2: Historical Background And Architectural Characteristics of Koza Han

2.1 Historical Background

Bursa, as one of the first capitals of the Ottoman Empire, has historically served as a hub for trade, culture, and architecture. Among its most notable structures, Koza Han stands out as a significant cultural heritage site, representing both economic and cultural history from the 15th century to the present. Commissioned by Sultan Bayezid II in 1491, Koza Han functioned as a central hub for the silk trade, attracting both local and foreign merchants for centuries (Tiryaki, 2021). Designed by the architect Abdül Ula Bin Pulat Şah, Koza Han was primarily used by silk traders to sell and store their products and simultaneously served as lodging for visiting merchants.

Situated within the Hanlar (Caravanserai) District, Koza Han occupies a central location between Ulu Cami and Orhan Camii, an area historically dense with Ottoman-era caravanserais that have survived to the present day. The han forms a physical and functional continuity with its surroundings and is located at the core of a historical trade axis (Figure 1). The Hanlar District has played a pivotal role in shaping Bursa's historical and cultural texture, serving as a spatial organization center where trade, production, and social life intersected for centuries. While some han structures have not survived for various reasons, those that remain have often undergone functional transformations, adapting to contemporary uses. This reflects both the physical continuity of the buildings and the area's dynamic historical evolution.

Figure 1. Hanlar District and Koza Han (Satellite image processed from Google Earth/2025)

From the 19th century onward, as the Ottoman Empire weakened and new transportation routes developed, the silk trade gradually lost its former significance. This shift affected the functional continuity of commercial structures like Koza Han, distancing them from their original economic context. Today, Koza Han has become one of Bursa's most visited tourist and cultural sites, retaining its historical texture. The ground floor hosts shops selling silk fabrics, souvenirs, and traditional products, while the upper floor primarily accommodates commercial areas for handicrafts and silk-based items (Eklemezler & Adiloğlu, 2022). At the center of the han's courtyard lies a historic mosque (mescit), a symbolic element of original Ottoman architecture that adds meaning to the structure; the courtyard itself has been transformed into a social space currently functioning as a tea garden.

2.2 Architectural Characteristics of Koza Han

Koza Han is a two-story inn that reflects the characteristic features of Ottoman commercial architecture, notable for its distinctive design. Built in 1491 under the commission of Sultan Bayezid II, the structure was carefully designed in line with the architectural understanding of the period, combining aesthetic appeal with functional efficiency.

The han features a nearly rectangular courtyard plan, surrounded by arcades (revak) that extend across both floors. Constructed using masonry techniques with stone and brick, the ground floor primarily consists of vaulted units used as shops. In contrast, the upper floor contains rooms designed for lodging and commercial activities. The building comprises a total of 95 rooms—45 on the ground floor and 50 on the upper floor (Atalan & Arel, 2016; Şimşek & Perker, 2019; Gürhan, 2013). Access to the upper-floor units is provided via symmetrical stone staircases located at the north and south sides of the courtyard.

The spatial organization of Koza Han is designed for versatile circulation and connectivity, consistent with the functional logic of commercial inns of its period. The upper floor has a south-facing exit, while the ground floor offers entrances to the north toward the Bursa Covered Bazaar and to the west toward Orhan Camii and its surroundings (URL-1). These multiple entrances not only facilitate internal circulation but also establish the han’s physical and functional relationship with surrounding commercial and religious structures. This multi-directional entry system reinforces the central position of the han within the urban fabric and supports commercial vitality.

The northern façade features the main gate (taç kapı), adorned with turquoise tiles and braided stone motifs. These decorative elements, influenced by Seljuk art, enhance the entrance's aesthetic value while giving it a monumental character. The embossed ornamentation serves not only a decorative function but also symbolically reflects the artistic sensibilities of the period (Figure 2).

Figure 2. The Main Gate (Taç Kapı) of Koza Han (URL-1)

To better understand the architectural composition of Koza Han, the ground- and first-floor plans (Figure 3) were analyzed for spatial organization, functional distribution, and structural characteristics.

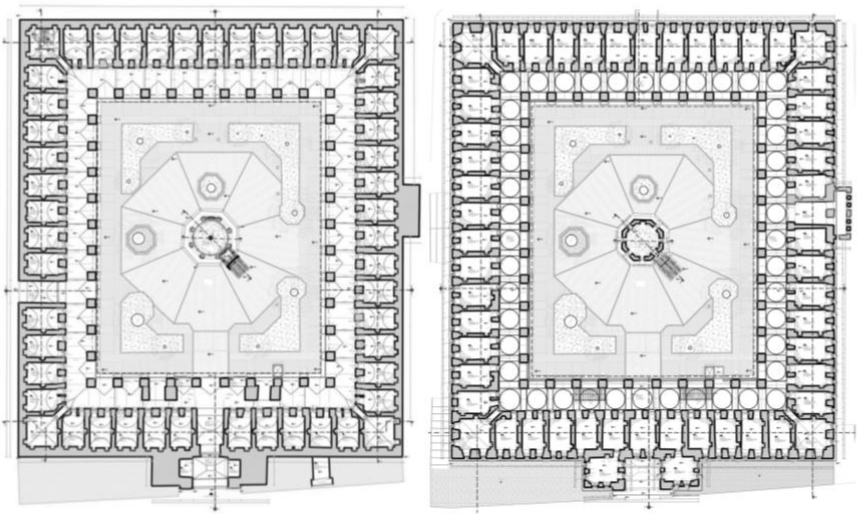

Figure 3. Ground Floor Plan (left) and First Floor Plan (right) of Koza Han (Bursa Metropolitan Municipality, 2024).

The ground-floor plan reveals a central courtyard surrounded by a two-story arcade, consistent with the Ottoman inn typology. The rectangular plan exemplifies both structural balance and symmetry, characteristic of traditional Ottoman hans. At the center lies an octagonal mescit (mosque), fulfilling religious functions while providing a symbolic and spatial focal point (Figure 4). The surrounding arcade shelters the vaulted commercial units (rooms/shops), each opening onto the courtyard, facilitating accessibility for commercial activities (Figure 5).

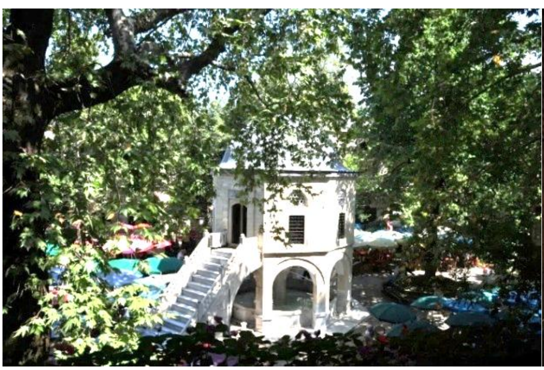 

Figure 4. The Mesjid Located at the Center of Koza Han (Left) and Figure 5. Commercial Units (Rooms/Shops) at Koza Han (Right) (URL-2).

The first-floor plan follows a similar geometric arrangement to the ground floor but is primarily designed for lodging, storage, and production purposes. The floor plan features modular, evenly sized rooms arranged symmetrically around the courtyard. Each room opens onto the arcade, which provides continuous circulation along the courtyard. Rooms are independently accessible, ensuring privacy and secure use for occupants while maintaining the classical characteristics of Ottoman inn architecture.

Chapter 3: The Role of Koza Han in Shaping Urban Identity

3. Koza Han’s Contrıbutıon To Urban Identıty

During the Ottoman period, commercial inns (hans), baths, mosques, and shops dedicated to production and sales emerged as key elements shaping the physical structure and planning principles of cities. Koza Han is situated in the historic center, where trade was concentrated, between Ulu Cami and Orhan Camii, in an area with numerous Ottoman-era hans. Its physical and functional relationship with surrounding structures enhances its significance within the urban context.

Today, Koza Han serves not only as a historical building but also as a vibrant public space that contributes to urban life economically, culturally, and socially. The upper floor hosts shops selling silk fabrics and scarves, supporting the sustainability of traditional handicrafts and local production, while the ground floor houses cafés and souvenir shops that provide both social spaces for locals and attractions for tourists (Albayrak, 2015). In this way, Koza Han not only supports the city’s economy but also strengthens Bursa’s urban identity as a rare example where cultural heritage is integrated into daily life. Its contribution to the city’s identity is valuable not only through its physical presence but also through its multidimensional relationships with cultural continuity, historical memory, economic vitality, and public life. Koza Han is a cultural heritage site that makes traditional production methods and local crafts visible, serving as a dynamic structure that represents Bursa’s past in the present.

The economic significance of Koza Han is rooted in its historical role as a commercial center. As a focal point of the silk cocoon trade during the Ottoman period, the han continues to function as a shopping area for silk products and traditional handicrafts today. This continuity contributes to the preservation of Bursa’s cultural and commercial identity, establishing a link between past and present. Moreover, Koza Han plays an important social role, serving as an interactive space for locals and tourists and becoming a living focal point that nourishes the city’s social fabric (URL-3).

The spatial arrangement of the Hanlar District establishes an integrated relationship with other historical and symbolic structures, such as Ulu Cami and Orhan Camii. This urban configuration not only strengthens the physical context but also nurtures collective memory. Urban design interventions around Koza Han enhance accessibility and visibility, allowing both residents and visitors to engage more actively with the historic fabric.

Buildings in the Historic Bazaar and Hanlar District, reflecting Bursa’s economic vitality, were primarily constructed between the 14th and 16th centuries and represent early examples of the Ottoman urbanization model (URL-4). The district's spatial layout, in conjunction with symbolic structures such as Ulu Cami and Orhan Camii, establishes a cohesive urban setting that sustains social memory. Urban interventions around Koza Han increase the area's accessibility and visibility, enabling stronger interaction between both residents and visitors with this historic fabric.

Kevin Lynch's (1960) theory of the urban image provides a robust conceptual framework for understanding how individuals perceive cities, navigate them, and develop a sense of belonging. His five key components—paths, edges, districts, nodes, and landmarks—are instrumental in analyzing how an urban space is mentally organized and gains identity. Applying this framework to Koza Han highlights its significance as an essential element of Bursa's urban identity:

Paths: Koza Han is located along a key circulation and transition axis within the Hanlar District, surrounded by the historic bazaar fabric. Its physical connections integrate the han into transportation routes, actively shaping individuals' wayfinding experiences within the city. The surrounding streets and courtyard entrances represent paths for horizontal movement that facilitate orientation.

Edges: Non-historic structures and the transportation network around the han create separating edges between the historic area and the modern urban fabric. These edges, as defined by Lynch, act as boundaries that delineate spatial organization and constrain the perception of Koza Han's traditional texture, gradually diminishing its organic cohesion with the surroundings.

Districts: Koza Han's presence in the Hanlar District, its association with the silk trade, traditional architecture, and socio-cultural functions, endows the area with characteristic features that distinguish it from other districts.

Nodes: Koza Han functions as an urban focal point within historical bazaar axes. Its courtyard, with new uses such as cafés, shops, and social interaction spaces, serves as a node where visitors spend time and experience the space. The Han's location at the intersection of surrounding streets further establishes it as a center of concentrated movement.

Landmarks: Koza Han can be easily recognized for its architectural identity, historical significance, and distinctive details. The turquoise-tiled main gate on the northern façade, the octagonal mescit, and the symmetrical arcade arrangement around the courtyard contribute to its status as a symbolic urban landmark.

When evaluated through Kevin Lynch's (1960) urban image theory, Koza Han emerges as a key spatial element that forms and sustains Bursa's urban identity. With its historical continuity, functional diversity, and perceptual recognizability, Koza Han occupies a lasting place in urban memory, directly supporting wayfinding, sense of belonging, and integration with the city, thus continuing to serve as both a spatial and cultural carrier of urban identity.

Chapter 4: Evaluation and Conclusion

Koza Han is not only a reflection of Ottoman commercial architectural understanding but also a key determinant in shaping Bursa's historical, cultural, and economic identity. Constructed in the 15th century as a center for the silk trade, the building continues to serve as a hub for production and commercial activities that sustain this tradition. Examination of the ground and first-floor plans reveals how Koza Han addressed the spatial and functional needs of its era, demonstrating a comprehensive representation of classical Ottoman inn architecture through its symmetrical layout, arcaded courtyard, and centrally located mescit.

Moreover, Koza Han's position within the urban fabric is of considerable importance for historical continuity. By establishing physical and cultural connections with structures such as Ulu Cami and Orhan Camii, the han functions not merely as a commercial node but also as a vibrant center for social interaction and urban memory.

When evaluated through Kevin Lynch's (1960) urban image theory, considering fundamental components such as paths, edges, districts, nodes, and landmarks, it becomes evident that Koza Han occupies a strong position in the urban memory, directly contributing to processes such as wayfinding, developing a sense of belonging, and preserving historical continuity. Accordingly, Koza Han should be considered not only as a historical structure requiring physical preservation but also as a dynamic urban element that carries urban identity and sustains the continuity of spatial memory.

With its architectural identity and historical background, Koza Han can be regarded as a strong carrier of long-term spatial memory. Having been the center of the silk trade for centuries, the han is not only a physical structure but also a symbol embedded in Bursa's social memory, maintained and transmitted across generations. Its distinctive architecture and characteristic features leave lasting impressions on visitors' mental representations, fostering emotional connections with the space.

However, the dominance of commercial use today complicates visitors' ability to experience the han's historical context deeply. The building is increasingly perceived as a consumption-oriented space, detached from its past social and economic functions. Adverse transformations, such as development pressures, silhouette loss, and disruptions to visual relations with the urban fabric, threaten the continuity of spatial memory. This situation highlights a complex transformation concerning cultural heritage preservation and public awareness. Therefore, structures like Koza Han must be preserved not only physically but also in their cognitive and emotional dimensions, which is crucial for the sustainability of urban identity.

Currently, Koza Han serves as a dynamic public space used by both locals and tourists. This multifunctional use not only preserves its physical presence but also integrates it into Bursa’s urban identity. Nevertheless, careful consideration must be given to balancing cultural heritage preservation with contemporary urban needs. The increasing dominance of commercial activities challenges visitors’ ability to engage with the han’s historical context fully, positioning the space primarily as a site of consumption rather than a locus of its original social and economic functions.

Koza Han provides important insights into how historical structures can be integrated into contemporary urban life and how cultural continuity can be sustained through architecture.

References

Albayrak, M. (2015). The importance of complexes and inns in the development of cities: Ottoman-era Bursa. Uludağ University Faculty of Arts and Sciences, Department of History, Research Projects in History (Application).

Bayramoğlu, N. (2010). Urban identity in the context of user perception: Barbaros Boulevard–Büyükdere urban axis.

Eklemezler, S., & Adiloğlu, S. (2022). Evaluation of contemporary usage practices of Bursa inns and visitor opinions in the context of sustaining cultural heritage. Dumlupınar University Journal of Social Sciences, (71), 128–143.

Engin, A. O., Calapoğlu, M., & Gürbüzoğlu, S. (2008). Long-term memory and learning. Kafkas University Journal of Social Sciences Institute, 1(2), 251–262.

Gürhan, P. (2013). An investigation of inns located in Bursa's Inn District. In 2nd Turkey Graduate Studies Congress – Proceedings Book (Vol. 5, pp. 6–8).

Hall, S. (1998). Cultural identity and diaspora. In J. Rutherford (Ed.), Identity: Community, Culture, Difference (Trans. İ. Sağlamer).

Karabekiroğlu, K., Gimzal, A., & Berkem, M. (2005). Memory problems in psychiatric disorders. Anadolu Psychiatry Journal, 6, 188–196.

Lewicka, M. (2008). Place attachment, place identity, and place memory: Restoring the forgotten city past. Journal of Environmental Psychology, 28, 209–231. https://doi.org/10.1016/j.jenvp.2008.02.001

Liggett, H., & Perry, D. C. (Eds.). (1995). Spatial practices. London: Sage.

Madanipour, A. (1996). Design of urban space: An inquiry into a socio-spatial process. Chichester: John Wiley.

Lynch, K. (1960). The image of the city (Çev. İ. Başaran, 2010). Istanbul: İş Bankası Publications; original work published 1960, Cambridge, MA: MIT Press.

Özdemir, E. E., & Cengizoğlu, F. P. (2023). Construction and transformation of collective memory in the relationship between space and memory: Mersin Lunapark case. Eskiz: Journal of Urban and Regional Planning, 5(1), 77–95. https://doi.org/10.5281/zenodo.8204555

Qazimi, S. (2014). Sense of place and place identity. European Journal of Social Sciences Education and Research, 1(1), 306–311.

Roediger, H. L., Zaromb, F. M., & Goode, M. K. (2008). A typology of memory terms. In Learning and memory: A comprehensive reference (pp. 7–19).

Şimşek, S., & Perker, Z. S. (2019). A study on natural stone material issues in historical inns in the Bursa Inn District. Journal of International Social Research, 12(62).

Taşçı, H. (n.d.). Evaluation of urban transformation from the perspective of spatial memory. Dicle University Journal of Social Sciences Institute, 32, 573–591.

Tekeli, İ. (1991). Thoughts on urban identity. In Urban Planning Talks (pp. 79–88). Ankara: Chamber of Architects of Turkey.

Tiryaki, F. (2021). The impact of historical bazaars and inns on shopping tourism: Bursa case. Unpublished master's thesis, Istanbul Commerce University, Istanbul.

Ulu Government Portal – Koza Han. (n.d.). Retrieved from http://www.bursa.gov.tr/kozahan

Culture Portal – Koza Han. (n.d.). Retrieved from https://www.kulturportali.gov.tr/turkiye/bursa/gezilecekyer/koza-han

Arkitera. (n.d.). Bursa Hanlar District Urban Design Project. Retrieved from https://www.arkitera.com/proje/bursa-hanlar-bolgesi-kentsel-tasarim-projesi/

Bursa Metropolitan Municipality. (n.d.). Hanlar District – Orhan Gazi Complex and surroundings. Retrieved from https://alanbaskanligi.bursa.bel.tr/hanlar-bolgesi-orhan-gazi-kullliyesi-ve-cevresi/

Yayınoğlu, P. E., & Susar, F. (2008). City, visual identity, and communication (1st ed.). Kocaeli: Umuttepe Publications, No. 3.

CHAPTER 3

The Present and Future of Facade Conservation in Cultural Heritage Elements

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Introduction

Cultural heritage is one of the most significant elements that reflect a society's history, identity, and values. Historical buildings hold great importance as tangible carriers of this heritage. The integrity embodied in these structures is also evident in their facades. As one of the main components that define a building's architectural character and strengthen its connection with the surrounding environment, facades are not only the visible faces of structures but also cultural documents that reflect the social, economic, and cultural atmosphere of the period in which they were built, enduring through time.

Under today's pressures of urbanization and modernization, many historical buildings are being damaged, destroyed, or losing their authentic identity, which highlights the increasing importance of conservation efforts. The preservation of facades in historical buildings is essential for maintaining the continuity of urban cultural identity and the sustainability of the original fabric. This study highlights the importance of facade conservation in historical structures and examines various methods applied in this field. The methods are discussed within a broad spectrum, ranging from traditional restoration techniques to the use of modern materials and technologies. They are evaluated meticulously to preserve both the aesthetics and structural integrity of facades.

Turkey boasts a rich cultural heritage, marked by significant historical structures, including castles, fortifications, mosques, bridges, and churches, which bear the traces of numerous civilizations throughout history. However, environmental factors such as the country's location in an earthquake zone, soil problems, floods, fires, as well as physical and chemical deteriorations, adversely affect the structural integrity and appearance of these buildings. Over time, historical monuments and structures wear down or suffer severe damage due to natural disasters.

In the process of conserving historical buildings, the effectiveness of interventions depends on an accurate and detailed determination of the building's history, the extent of existing deformations, the load-bearing system, and the damage that has occurred in its structural elements. Various factors, including material characteristics and strength values, load distributions, foundation and soil properties, and bonding elements of construction techniques, must be thoroughly analyzed.

This study emphasizes the significance of facade conservation in historical buildings, which constitute our cultural heritage. Many factors contribute to the deterioration of historical structures, including deficiencies in facade protection, poor artistry, damage resulting from the building's location, faulty structural design, and inappropriate material use. In this context, the study particularly concentrates on the conservation issues of stone facades and aims to examine the methods that contribute to their long-term and sustainable preservation.

TYPES AND CAUSES OF DAMAGES OBSERVED ON HISTORICAL BUILDING FACADES

Historical buildings are exposed to various environmental, physical, and human-induced factors over time, resulting in different types of damage. These deteriorations not only reduce the aesthetic value of structures but also negatively affect their structural durability. The causes of damage observed in historical buildings can be examined under two main categories.

Errors in the initial design, poor artistry and material quality, or the use of improper construction techniques are defined as internal causes. At the same time, external factors such as natural disasters and human-induced effects are classified as external causes (Ahunbay, 1996). Different types of deterioration and damage are observed, particularly on facades constructed with natural stone.

Cracks and Deformations

As a result of natural disasters, compressive and tensile stresses to which the structure is exposed, and material fatigue, the integrity of the construction materials begins to deteriorate, leading to the formation of cracks. These cracks may appear individually within materials or evolve into structural cracks affecting the entire building over time. This not only disrupts the aesthetic integrity of the structure but also poses challenges in its conservation.

Cracks in buildings generally occur due to settlement, earthquakes, or vibrations from the surrounding environment. Foundation settlement occurs when soil compression causes structural movements and the formation of cracks, as voids within the structure become apparent. It is often observed that the size of cracks decreases in the upper floors of the building.

Figure 1. Example of cracks observed on a building facade (Original, 2025)

Abrasion and Erosion

Structures built with natural stone are not only durable and long-lasting but also provide thermal comfort and sustainability due to their thick walls. From the perspectives of energy efficiency and environmental impact, such buildings can be considered environmentally friendly and energy-saving (Dal & Yardımlı, 2021).

The stones used in these structures were generally sourced from nearby quarries, resulting in buildings with varying levels of durability depending on their environmental and usage conditions (Dal, 2021). The causes of damage in these structures can be classified into external factors and internal factors originating from the stone's characteristics (El-Gohary, 2017). External factors include the building's location and geometry, as well as climatic elements such as rain and wind (Dal & Yardımlı, 2021). Internal factors are related to the chemical and mineral composition, as well as the microstructure, of the stone. The alteration and transformation of minerals within the material through chemical reactions can increase porosity, ultimately leading to significant structural damage (Öcal & Dal, 2012).

The natural stones used in historical buildings exhibit varying degrees of resistance to external factors depending on their type. Climatic conditions, including precipitation, wind, and temperature fluctuations in the region, cause abrasion and erosion on facades, which can weaken the structural material over time (Kurt, 2020).

Figure 2 Erosion observed on Çandarlızade Atik İbrahim Pasha Mosque (Original, 2025)

Moisture and Water Damage

Moisture and water—whether rising from the ground or penetrating from rainfall—can cause significant deterioration on facades. Capillary water rising from the soil may result in discoloration, flaking, or blistering on the facade surface.

The dissolution of minerals contained in both the infiltrating water and the building material can cause chemical degradation, as well as the formation of voids, which in turn leads to material loss and severe structural damage.

Figure 3 Moisture and water damage observed on Çandarlızade Atik İbrahim Pasha Mosque (Original, 2025)

Chemical Deterioration

Chemical deterioration refers to damage caused by chemical changes occurring within building materials. Acid rain, resulting from air pollution, and exposure to various chemicals can lead to corrosion and similar degradation processes. For instance, chemical reactions occurring within limestone can compromise the material's surface integrity.

Figure 4 Chemical deterioration and corrosion observed on Zincirli Han (Original, 2025)

Formation of Black Patina on Facades

Black patinas observed on historical buildings and archaeological remains are primarily formed due to air pollution or microbial activity. The darkened appearance commonly seen on facades of historical structures located in large urban areas is typically the result of severe air pollution.

Unplanned urbanization and excessive fossil fuel use release harmful gases, which mix with soot particles that adhere to building surfaces, forming a black crust. For instance, soot, carbon, and sulfur dioxide accumulating on calcareous stones react with gypsum components to create this black layer. Since gypsum crystals have a larger volume than calcite, the black crust eventually detaches from the stone surface over time (Parlak & Böke, 2010).

Figure 5 Alyanak Han (Original, 2025)

Black patinas on facades are removed using various cleaning methods. However, improper material selection or incorrect cleaning techniques may result in material loss on the facade (Kurt, 2020). Moreover, insufficient control of air pollution—the main cause of black patina formation—often leads to its recurrence after cleaning interventions (Parlak & Böke, 2010).

BIOLOGICAL EFFECTS

Over time, seeds carried by various environmental factors may germinate on the facades of historical buildings, leading to the growth of lichens, mosses, and fungi. These biological formations not only deteriorate the visual appearance of the building but also cause serious material and structural damage.

Another biological factor affecting the structure is exposure to high temperatures, typically caused by fires. Such damage can lead to irreversible losses in the entire building or in specific sections, as the excessive heat and smoke reduce the durability of building materials and weaken the structural integrity.

Incorrect interventions carried out during different phases of the building's use, as well as the inappropriate use of materials and techniques in restoration applications, may also negatively affect the integrity of both the building and its materials. Such forms of damage are classified as human-induced damage, with vandalism being one of the most significant examples (Polat, 2008).

Figure 6 Çandarlızade Atik İbrahim Pasha Mosque (Original, 2025)

CONSERVATION METHODS

One of the most significant elements determining both the aesthetic and functional character of historical and modern structures is the facade, which reflects the identity of the building while serving as a barrier against external environmental conditions. However, building materials naturally deteriorate over time due to physical, chemical, and biological factors. This deterioration threatens not only the visual integrity but also the structural stability of the building.

Therefore, preserving material and structural integrity on facades is crucial for sustainable building practices and the continuity of cultural heritage. The concept of conservation is defined as encompassing all methods used for understanding, ensuring the preservation of the material of cultural heritage, and facilitating its promotion, restoration, and development when necessary (Kasap, 2024). In this context, preserving the material and structural integrity on facades is crucial for sustainable building practices and the continuity of cultural heritage. Before determining conservation strategies, the properties of the materials and the surrounding environmental conditions must be carefully analyzed. Natural materials, such as stone, wood, and brick, exhibit varying levels of resistance to environmental impacts. External factors, such as air pollution, acid rain, wind erosion, solar radiation, and biological growth, contribute to both physical and chemical deterioration of facades.

The first step in maintaining material and structural integrity is to identify the types and causes of deterioration accurately. Cracks, material losses, discoloration, and biological effects should be thoroughly examined to determine suitable conservation methods. During cleaning processes, instead of using high-pressure water or harsh chemical agents, environmentally friendly and material-sensitive techniques should be applied. Protective coatings and waterproofing treatments are also effective methods for increasing the resistance of facades against external factors.

In facade conservation practices, restoration and repair processes play a significant role. The materials used during restoration must be compatible with the original materials and support the structural integrity of the building. The selection of inappropriate materials may cause irreversible damage to the facade. Moreover, interventions on the facades of historical buildings must be carried out meticulously to preserve the cultural and historical value of the structure.

For facades to remain durable and sustainable over time, regular maintenance and preventive measures are essential. Periodic inspections help detect and address early-stage deterioration. Today, modern technologies provide significant advantages in scanning facade surfaces and digitally analyzing deterioration conditions (Tellioğlu & Satıcı, 2023).

Ahunbay (1996) classified conservation and restoration techniques into six categories: consolidation, reintegration, renewal, reconstruction, cleaning, and relocation.

The stone facades of historical buildings often require the application of consolidant chemicals, which can be sprayed, brushed, or vacuum-applied to strengthen the material (Ahunbay, 1996).

Among the most common conservation and restoration techniques for facades is cleaning. Cleaning applications can be performed through various methods such as mechanical, chemical, water washing, absorbent paper pulp, or absorbent gel techniques (Ahunbay, 1996).

Mechanical cleaning is carried out by spraying abrasive materials onto the facade surface. In contrast, chemical cleaning involves applying a cleaning agent impregnated into paper pulp onto the facade, leaving it for a specific period, and then rinsing it with water.

Water washing is preferred when the surface dirt is water-soluble; however, excessive water use should be avoided, as it may penetrate the material through capillarity and cause deterioration (Ahunbay, 1996).

The use of absorbent clay or paper pulp is effective for removing soluble salts, oils, and similar substances from within the material. The prepared pulp is applied to the facade, left to dry, and then removed (Ahunbay, 1996).

In absorbent gel applications, a basic gel is brushed onto the surface and covered to prevent evaporation. After a specified duration, the covering is removed, and the surface is rinsed with water. This method is suitable for facades that are not highly porous (Ahunbay, 1996).

THE FUTURE OF FACADE CONSERVATION

Facade conservation plays a critical role in preserving historical and cultural heritage. With technological advancements, new materials, methods, and techniques for facade protection are continually emerging. The future evolution of facade conservation technologies will consider multiple factors, including sustainability, durability, preservation of aesthetic values, and energy efficiency.

Use of Digital Technologies (3D Scanning and BIM)

The conservation of heritage facades requires detailed analysis, precise measurement, and long-term planning. Alongside traditional methods, digital technologies have become essential tools in making these processes more effective and efficient. In particular, 3D scanning and Building Information Modeling (BIM) offer high precision and sustainability in cultural heritage projects (Öğütcü, 2023).

3D Scanning Technology:

3D scanning is used to create three-dimensional digital models of cultural heritage structures. This method enables the documentation of historical facades with millimeter-level accuracy. 3D laser scanners record the current condition of a structure, allowing comparisons before and after restoration. Additionally, deterioration and damage can be quickly and accurately identified, especially on facades with complex details, minimizing potential restoration errors (Öğütcü, 2023).

Building Information Modeling (BIM):

BIM is increasingly being used in the conservation of cultural heritage. It creates a digital representation of the structure that combines material information, structural data, and previous restoration history. This system provides an effective platform for collaboration among restoration teams, architects, and engineers. Through BIM, restoration planning can integrate data about past interventions and the building's original state (Korumaz et al., 2011).

Smart Facade Systems and Technologies:

Bright facades integrate advanced sensor and automation technologies into building design, enabling facades to adapt to environmental factors dynamically. These systems optimize indoor climate conditions and enhance facade durability by responding to external variables such as temperature, humidity, sunlight, and wind. They not only improve energy efficiency but also contribute to the long-term conservation of facades (Çalışkan, 2019).

Sensor Technologies:

Sensors integrated into facades monitor environmental parameters (temperature, humidity, UV radiation, wind speed), helping to preserve facade materials and structural integrity. These systems detect potential damage early, enabling timely maintenance, and can also track the facade's life cycle, alerting users to necessary interventions (Köroğlu, 2021).

Innovative Materials and Nanotechnology:

Innovative materials represent one of the most significant advancements in facade conservation. Nanotechnology and advanced coatings provide solutions that enhance durability and reduce maintenance requirements (Köroğlu, 2021).

Nanotechnological Coatings:

Nanotechnology-based coatings enhance resistance to water, humidity, and dirt, while also providing UV protection, thereby extending the material's lifespan. Such coatings can also optimize building energy performance and improve indoor climate conditions (Çalışkan, 2019).

Smart Materials:

Emerging innovative materials can respond to environmental stimuli. For instance, thermosensitive materials expand or contract in response to extreme heat or cold, thereby preventing damage to the facade. These materials enhance facade durability while allowing greater flexibility in facade design.

High-Performance Insulation Materials:

In facade conservation, high-performance insulation materials are becoming increasingly important for energy efficiency. These materials provide advanced thermal insulation, reducing energy consumption and extending the lifespan of facades. Moreover, they help facades become more resilient to the impacts of climate change (Çalışkan, 2019).

Digital Twins and Simulations:

Digital twin technology enables real-time monitoring and simulation of a building's digital model. In facade conservation, digital twins can track facade performance, environmental interactions, and structural changes in real time, allowing for more proactive and data-driven conservation strategies (Köroğlu, 2021).

REFERENCES

Ahunbay, Z. (1996). Tarihi çevre koruma ve restorasyon.

Çalışkan, G. (2019). Kent dokusunda cephe korumanın rolü. Mimari Koruma Dergisi, 16(4), 92–104.

Dal, M., & Yardımlı, S. (2021). Taş duvarlarda yüzey bozunmaları. Kent Akademisi, 14(2), 428–451.

El-Gohary, M. A. (2017). Environmental Impacts: Weathering Factors, Mechanisms, and Forms Affecting Stone Decay in Petra. Journal of African Earth Sciences, 135, 204–212.

Güleç Korumaz, A., Dülgerler, O. N., & Yakar, M. (2011). Kültürel mirasın belgelenmesinde dijital yaklaşımlar. Journal of the Faculty of Engineering and Architecture of Selçuk University, 26(3).

Kasap, S. (2024). Examination of architectural heritage centered around Bilecik Province. International Journal of Social and Humanities Sciences Research, 11(110), 1456–1469.

Köroğlu, İ. (2021). Restorasyon ve koruma sürecinde cephe tasarımının önemi. Tarihi Yapılar ve Koruma Dergisi, 28(1).

Kurt, M. (2020). Mimari restorasyonda cepheler ve koruma stratejileri. Tarihi Yapı Koruma Dergisi, 11(3).

Öcal, A. D., & Dal, M. (2012). Doğal taşlardaki bozunmalar. İstanbul: İstanbul Mimarlık Vakfı İktisadi İşletmesi.

Öğütcü, R. (2023). Bütünleşik bina tasarımı yaklaşımı çerçevesinde BIM tabanlı araçların sürdürülebilir bina tasarımına etkisi: Bir toplu konut projesinde gün ışığı analizi (Unpublished doctoral dissertation). Bülent Ecevit Üniversitesi, Fen Bilimleri Enstitüsü, Yapı Bilgisi Anabilim Dalı.

Parlak, B., & Böke, H. (2010). Tarihi yapı cephelerinde siyah patina oluşumu. Mimarlıkta Malzeme Dergisi, 17, 83–85.

Polat, E. E. (2008). Türkiye'nin modern mimarlık mirasının korunması: Kuram ve yöntem bağlamında bir değerlendirme (Unpublished master's thesis). Yıldız Teknik Üniversitesi, Fen Bilimleri Enstitüsü.

Tellioğlu, S., & Satıcı, B. (2023). Tarihi yapılarda restorasyon tekniklerine göre uygulanacak malzemelerin belirlenmesi. İTÜ Teknoloji ve Uygulamalı Bilimler Dergisi, 6(1).

CHAPTER 4

The Role of Artificial Intelligence Applications in the Protection of Cultural Heritage Elements

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INTRODUCTION

The combination of advancing technology and humanity's instinct to discover the unknown led to the invention of machines in historical processes, and subsequently, the aim was to make these invented machines more intelligent. The first machines were designed as tools intended to provide a gain in muscle power for humanity. As time progressed, these machines were developed to calculate in addition to physical strength, bringing them to a level that facilitates human life. The rapid advancement of science and technology today, through the mediation of experts, aims for machines to possess intelligence (AI), enabling the production of programs and applications that allow the machine itself to execute and control the necessary software and processes.

In light of these developments, cultural heritage elements are tangible or intangible resources that allow us to gather information about the lifestyles, habits, and histories of a specific region, society, or individual. These elements exist physically as writings, inscriptions, structures, and artifacts, as well as intangibly as songs, folk songs, sayings, and customs. The protection, preservation, and transmission of these elements to future generations, which illuminate the history of societies, nations, and even humanity and serve as documentary evidence, are crucial for the preservation of history and culture.

Considered one of the great revolutions of our age and expected to shape future periods, artificial intelligence programs and applications have also begun to be used for the protection of cultural heritage elements. With the developed methods and techniques, studies are being carried out using AI programs and applications specific to the operations required for the protection of cultural heritage elements. The number of AI programs produced and the studies conducted with them for the preservation and transmission of tangible and intangible cultural heritage elements to future generations are increasing day by day.

This study examines the AI-supported applications and efforts carried out for the preservation of tangible and intangible cultural heritage elements and investigates the methods and techniques that can be followed in the protection of architectural heritage elements, which are a part of cultural heritage and shed light on individuals' lifestyles.

Artificial Intelligence Concept

When examining the definitions of the Artificial Intelligence (AI) concept, it can be generally described as machines that think and act like humans. AI is defined as a collection of systems that, by taking in information, mimic human intelligence instead of natural intelligence, process, and improve the acquired data (Kasap et al., 2025). The appearance of studies in this field in the literature took place in the 1950s. The article titled “Computing Machinery and

Intelligence" written by Alan Turing is considered the foundation of these studies. This work, which questions the thinking ability of machines, also introduced the concept of the Turing Test to the literature (Powell, 2019).

The Darthmouth Conference, organized in 1956 by John McCarthy, known as the father of artificial intelligence, led to the scientific definition of the artificial intelligence concept (Nilsson, 2009; Kasap et al., 2025). Since its initial use in 1955, AI has branched into several sub-disciplines depending on the nature of the problem, including Artificial Neural Networks (ANN), Fuzzy Logic, Expert Systems, Computer Vision, and Genetic Algorithms (Kasap et al., 2025).

As an umbrella concept containing different methods and specialized techniques for various functions, artificial intelligence has several sub-branches and areas of expertise. Ünal and Kılınç (2020) classified artificial intelligence as narrow AI, general AI, strong AI, and weak AI.

Artificial intelligence encompasses multiple methods and working principles. These methods and principles, which can be defined as sub-components, are customized for different processes to achieve the best result in the conducted studies. It includes sub-branches such as "Machine Learning" and "Deep Learning."

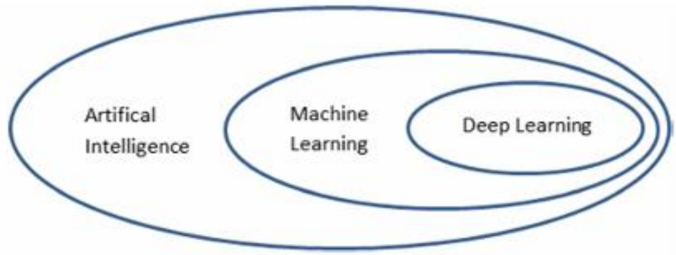

Figure 7 The relationship between artificial intelligence, machine learning, and deep learning. (Cantemir ve Kandemir, 2024)

Machine Learning (ML)

Machine learning is fundamentally defined as giving computers the ability to learn (Samuel, 1959). This working principle is based on data, and the computer works on the given inputs to generate predictions for future data (Russell and Norvig, 2016).

Machine learning has more than one method. These methods differ depending on whether the machine learns by itself or if there is a supervisor (Cantemir and Kandemir, 2024). In supervised learning, the machine is trained with data consisting of labeled inputs and outputs by a supervisor. Zhou (2021) also defined reinforcement learning and semi-supervised learning models alongside supervised and unsupervised learning.

Deep Learning (DL)

Deep learning can be described as a more detailed version of machine learning. In this system, learning results from the sequential operation of multiple layers. The working principle in these layers is arranged so that the output of one layer becomes the input of the next (Deng and Yu, 2014). It has different sub-branches such as CNN, RNN, and GAN.

Convolutional Neural Network (CNN)

CNN, a type of multilayer perceptron, gives good results in studies involving visual data and was developed inspired by the visual cortex of animals (Şeker et al. 2017). These algorithms learn from data and classify visuals, therefore they do not require human intervention (Albawi et al., 2017). The working principle of CNN is based on processing the given image by turning it into smaller images (Şeker et al., 2017).

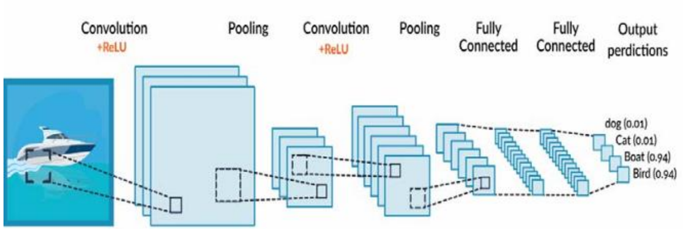

Figure 8 Operating principle of Convolutional Neural Networks (Lee et al., 2021)

Generative Adversarial Networks (GAN)

In this system, unlike CNN, there are generator and discriminator algorithms (Balcı et al., 2020). The two algorithms work in relation to each other, producing outputs similar to the given input while also questioning the reality of these outputs, thereby improving itself (Balcı et al., 2020).

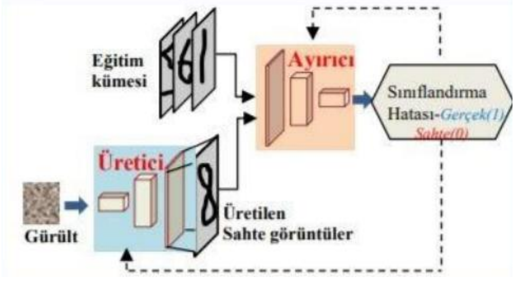

Figure 9 Operating principle of Generative Adversarial Networks (Çelik and Talu, 2019)

Definition and Conservation Values of Architectural Heritage

A significant portion of cultural heritage elements consists of structures and spaces built throughout history. These structures and areas can be damaged over time due to natural or human-made reasons, resulting in the loss of cultural heritage elements. Conservation and restoration applications are of great importance in transmitting these structures to future generations.

Definition of Immovable Cultural Heritage

Cultural heritage first entered a scientific field with the UNESCO "Convention Concerning the Protection of the World Cultural and Natural Heritage" in 1972 (Kasap, 2022). Immovable cultural heritage or cultural property is defined by the International Council on Monuments and Sites (ICOMOS) in the statute created in 2008 as: "An area, natural appearance, architectural complex-space legally protected due to its historical and cultural importance" (Kasap, 2022). This definition shows that cultural assets are discussed in three different dimensions: time, space, and quality. The idea of conservation should include the past, present, and future; the goal of conservation is not to freeze the past but, on the contrary, to keep it alive (Güleç, 2019 cited in Kasap, 2022).

Values Attributed to Heritage

In determining the main idea involving the conservation of architectural heritage, it is essential to define, conserve, and ensure the sustainability of the original values of the cultural property (ICOMOS Turkey, 2013, Article 4.1.3). Understanding these values, which are the subject of the conservation process, is critical for the success of Artificial Intelligence applications aimed at protecting architectural heritage. The 2013 "Architectural Heritage Conservation Declaration" of the ICOMOS Turkey National Committee states that cultural heritage includes historical, artistic, documentary, aesthetic, social, and spiritual values. Some of the core elements of these values, important for conservation science, are (Kasap, 2022):

- Authenticity: Refers to the preservation of design, workmanship, material, and environmental characteristics.

- Integrity and Continuity Value: The wholeness of the features originating from the structure's type, form, material, spirit, and location.

- Historical Value: Associated with the heritage's relationship with its important historical past or its age.

- Technical and Technological Value: Shows the level of technology and techniques used during the construction period of the structure.

- Multi-Layeredness Value: Arises from the relationship that cultural assets, hosting multiple periods and cultures, establish with other periods, adopting a holistic conservation approach.

Artificial Intelligence Applications in the Protection of Cultural Heritage

With technological developments, the determination of the current condition of structures, the performance of analyses, and the implementation of appropriate interventions have become easier. In architecture and design disciplines, technology, initially limited to two-dimensional drawing software, later advanced design processes with Three-Dimensional Modeling (3D) and Building Information Modeling (BIM) applications (Kasap et al., 2025). Following these processes, Artificial Intelligence technologies also began to be integrated into architectural design processes. AI systems automate repetitive and time-consuming tasks, allowing designers to save time and resources (Gaber et al., 2023; Kasap et al., 2025). It stands out not only for facilitating mathematical operations such as visualization and cost calculations but also for its abilities to solve complex problems, quickly generate design alternatives, and improve existing options (Kasap et al., 2025).

The artificial intelligence techniques used in the protection of cultural heritage elements are applied in many different areas, from reconstruction to restoration. Visual scanning systems, professional equipment, and artificial intelligence tools are currently used in the conservation field. AI techniques used in conservation applications are utilized in many different areas, from the restoration of paintings and frescoes to the period analysis of structures. Gaber et al. (2023) point out that manual techniques in visual restoration applications are subjective, high-cost, and time-consuming, while artificial intelligence is more useful in data analysis, processing, and digitization processes.

Some examples from field studies include:

- Dunhuang Caves (China): In a study by Yu et al. (2022), artificial intelligence was used for the restoration of caves dating back to the 4th century. AI analyses were performed to detect artifacts from different periods within the cave.

- Hera Temple (Italy): Pepe et al. (2022) performed a 3D re-dimensioning of the temple using unmanned aerial vehicles and machine learning algorithms (Random Forest). The obtained point cloud data (973,125 points) was classified by AI into structure, environment, and vegetative elements, which was used for current status detection.

- Architectural Style Determination: Cantemir and Kandemir (2024) aimed to determine the periods (Gothic, Modern, Deconstructivist) of built structures using Convolutional Neural Networks (CNN). An accuracy rate of 84.66% was achieved with a dataset consisting of 1043 images.

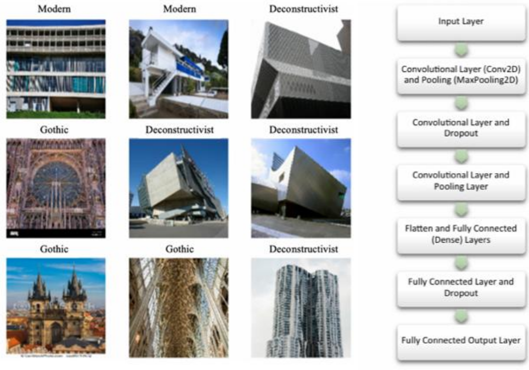

Figure 10 Sample images belonging to the dataset and the operating principle of artificial intelligence (Cantemir and Kandemir, 2024)

- Pagoda Image Search: Lee et al. (2021) trained an AI algorithm using images of Pagoda structures to prevent subjective approaches of experts in restoration applications. After 20,000 cycles with the revised 1000-data set, the accuracy rate was determined to be 98%.

Figure 11 A result image showing the correct and incorrect outputs produced by artificial intelligence (Lee et al., 2021)

CONCLUSION

Artificial intelligence technologies are present in every area of life today, and their effects are increasing day by day. AI applications are also used in the protection and transmission of cultural heritage elements—which act as a bridge between the past and the present, appearing in tangible and intangible forms—to future generations, and their usage areas are increasing with ongoing studies.

In the field of conservation and restoration, one of the specialization areas of architecture, the number of applications performed with artificial intelligence is increasing daily. AI provides time, manpower, and resource savings, while also preventing authorities from developing personal approaches and preventing the work from becoming subjective. AI is positioned not as a threat to the architectural discipline but as a powerful opportunity that transforms production methods, broadens the designer's vision, and augments their capabilities (Bernstein cited in Kasap et al., 2025).

In applications carried out with machine learning and deep learning systems, which are sub-branches of artificial intelligence, increasing the accuracy rate and selecting the appropriate method for the study ensure that AI usage yields more accurate and objective results. The size, definitions, and repetition counts of the data set during the training process affect the accuracy rate of the outputs.

These methods, effective in the digital archiving, exhibition, and conservation applications of cultural heritage elements, enable the determination of architectural style, the prediction of the structure's state before deterioration, and the recognition of the period or structural features of the buildings when trained with a data set belonging to specific typologies. Especially in the process of protecting the values of immovable cultural heritage such as authenticity, integrity, historical, and multi-layeredness, AI programs can ensure the creation of survey (rölöve), restitution, and restoration data required in the conservation and restoration process, contributing to the faster and more accurate completion of studies.

REFERENCES

Akkem, Y., Biswas, S. K., & Varanasi, A. (2023). Smart Farming Using Artificial Intelligence: A Review. Engineering Applications of Artificial Intelligence, 120, 105899. https://doi.org/10.1016/j.engappai.2023.105899

Albawi, S., Mohammed, T. A., & Al-Zawi, S. (2017). Understanding Of A Convolutional Neural Network. In Proceedings Of The 2017 International Conference on Engineering and Technology (ICET) (pp. 1–6). Antalya, Turkey. IEEE. https://doi.org/10.1109/ICEngTechnol.2017.8308186

Balcı, O., Terzi, Ş. B., & Balaban, Ö. (2020). Çekişmeli Üretici Ağlar (GAN) ile Harita Üretimi ve Manipülasyonu. Journal of Computational Design, 1(3), 95–114.

Cantemir, E., & Kandemir, O. (2024). Use Of Artificial Neural Networks in Architecture: Determining The Architectural Style Of A Building With Convolutional Neural Networks. Neural Computing and Applications, 36(1), 6195–6207. https://doi.org/10.1007/s00521-023-09395-y

Çelik, G., & Talu, M. F. (2019). Çekişmeli Üretken Ağ Modellerinin Görüntü Üretme Performanslarının İncelenmesi. BAUN Fen Bilimleri Enstitüsü Dergisi, 22(1), 181–192. https://doi.org/10.25092/baunfbed.679608

Deng, L., & Yu, D. (2014). Deep learning: Methods and applications. Foundations and Trends® in Signal Processing, 7(3–4), 197–387. https://doi.org/10.1561/2000000039

Gaber, J. A., Youssef, S. M., & Fathalla, K. M. (2023). The role of artificial intelligence and machine learning in preserving cultural heritage and art works via virtual restoration. ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 10, 185–190.

Kasap, S. (2022). Koruma sürecinde çok katmanlı Tokat tarihi yerleşiminin mimari mirasının değerlendirilmesinde bir yöntem önerisi (Unpublished doctoral dissertation). Fatih Sultan Mehmet Vakıf Üniversitesi, Lisansüstü Eğitim Enstitüsü, Mimarlık Anabilim Dalı, Mimarlık Programı.

Kasap, S., Doğan, İ. B., Seri Yeşil, G., & Güneş, P. (2025). The impact of artificial intelligence on architecture. International Journal of Research and Innovation in Social Science, 9(9), 625. https://doi.org/10.47772/IJRISS.2025.90900056

LeCun, Y. (1989). Generalization and network design strategies. In R. Pfeifer, Z. Schreter, F. Fogelman, & L. Steels (Eds.), Connectionism in perspective (pp. 143–155). Elsevier.

Lee, B., Kim, S. K., & Kim, S. (2021). A Study On Pagoda Image Search Using Artificial Intelligence (AI) Technology For Restoration Of Cultural

Properties. KSII Transactions on Internet and Information Systems (TIIS), 15(6), 2086–2097. https://doi.org/10.3837/tiis.2021.06.016

Mohammad, A. S. (2019). Hybrid Elevations Using GAN Networks (Master's thesis, The University of North Carolina at Charlotte). The University of North Carolina at Charlotte Institutional Repository.

Nilsson, N. J. (2009). The quest for artificial intelligence. Cambridge University Press.

Pennachin, C., & Goertzel, B. (2007). Contemporary approaches to artificial general intelligence. In Artificial general intelligence (pp. 1–30). Springer Berlin Heidelberg.

Pepe, M., Alfio, V. S., Costantino, D., & Scaringi, D. (2022). Data for 3D reconstruction and point cloud classification using machine learning in cultural heritage environment. Data in Brief, 42, 108250. https://doi.org/10.1016/j.dib.2022.108250

Powell, J. (2019). Trust me, I'm a chatbot: How artificial intelligence in health care fails the Turing test. Journal of Medical Internet Research, 21(10), e16222. https://doi.org/10.2196/16222

Russell, S., & Norvig, P. (2010). Artificial intelligence: A modern approach (3rd ed.). Pearson Education, Inc.

Russell, S. J., & Norvig, P. (2016). Artificial intelligence: A modern approach. Pearson.

Samuel, A. L. (1959). Some studies in machine learning using the game of checkers. IBM Journal of Research and Development, 3(3).

Şeker, A., Diri, B., & Balık, H. H. (2017). A review about deep learning methods and applications. Global Journal of Engineering Science, 3(3).

Yıldız, H. K. (2025). Mimari Tasarımda Yapay Zekâ Etkisi (Master's thesis, Eskişehir Teknik Üniversitesi, Eskişehir). Eskişehir Teknik Üniversitesi Lisansüstü Eğitim Enstitüsü.

Yu, T., Lin, C., Zhang, S., Wang, C., Ding, X., An, H., Liu, X., Qu, T., Wan, L., You, S., Wu, J., & Zhang, J. (2022). Artificial İntelligence For Dunhuang Cultural Heritage Protection: The Project And The Dataset. International Journal of Computer Vision, 130(10), 2646–2673. https://doi.org/10.1007/s11263-022-01665-x

Ünal, A., & Kılınç, İ. (2020). Yapay zekâ işletme yönetimi ilişkisi üzerine bir değerlendirme. Yönetim Bilişim Sistemleri Dergisi, 6(1), 51–78.

Zhou, Z. H. (2021). Machine learning. Springer Nature.