JOURNAL OF SCIENCE

PART B: ART, HUMANITIES, DESIGN AND PLANNING

Year | Yıl : 2025 **Volume** | Cilt : 13 **Issue** | Sayı : 3

Published Date: 30 / 09 / 2025

e-ISSN: 2147-9534

GAZİ UNIVERSITY FACULTY OF ARCHITECTURE
GAZİ ÜNİVERSİTESİ MİMARLIK FAKÜLTESİ

e-ISSN: 2147-9534

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

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PART B: ART, HUMANITIES, DESIGN AND PLANNING
e-ISSN: 2147-9534

Year I Yıl : 2025 **Volume** I Cilt : 13 **Issue** I Sayı : 3

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Research Article GU J Sci, Part B, 13(3): 317-333 (2025)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

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Ecotopia as an Experimental Field in Architecture: A Socio-Spatial Analysis on Space-Constructing Contextual Frameworks in Auroville

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Article Info

Received: 02/06/2025
Accepted: 01/07/2025

Keywords

Ecotopia,
Ecological spatial production,
Space-constructing contextual frameworks,
Auroville

Abstract

Ecotopia, approached through the lenses of environmental ethics, systems critique, and utopian fiction, has come to define an increasingly recognized field of inquiry within architectural and urban design. It represents a multilayered construct in which ecological transformation, social imagination, cultural restructuring, technological adaptation, and economic alternatives are collectively organize moving beyond a mere environmental ideal. In this context, the study aims to critically evaluate the vision of ecotopia in relation to ecological life practices through the lens of spatial production. It identifies the contextual frameworks that constitute ecotopia, analysing the interrelations among these frameworks and how they influence spatial configurations in practice. In this study, which examines the conception of ecotopia across historical, theoretical, and practical dimensions, the first part explores its historical development and intellectual foundations; the second part defines the space-constructing contextual frameworks that shape space; and the third part examines the Auroville case within these frameworks, assessing its spatial formation with attention to its experimental aspects. Through this approach, ecotopia is repositioned as a critical and operative tool to analyse and construct nature-integrated ways of living in spatial terms. Highlighting the experimental nature of ecotopia, this perspective provides a foundation for developing locally responsive, critical, and creative design approaches, and opens new theoretical and applied research avenues in architecture and urban design.

1. INTRODUCTION

Since the Industrial Revolution, spatial production practices driven by technological advancements—and often lacking a holistic consideration of environmental impacts—have weakened the balance between human biological, psychological, and environmental needs. This has contributed to a significant transformation in the relationship between the built and natural environments. The uncontrolled physical growth of cities has reduced the richness of human experience, especially by weakening meaningful engagement and social interaction (Neutra, 1954; Mumford, 1961). Viewing nature merely as a consumable resource has fostered spatial and social organization models that disregard the limits of biological and ecological integrity (McHarg, 1969). The degradation of natural ecosystems and the unsustainable exploitation of environmental resources have fractured the human-nature relationship, undermining the possibility of managing the interplay between built and natural environments in a sustainable manner. Consequently, urban spatial production has given rise not only to environmental but also to social and cultural crises (Bookchin, 1988). This complex and multi-layered crisis compels a re-evaluation of spatial production—not merely in terms of physical or functional aspects, but in ways that also encompass the multiple dimensions of human life, ecological responsibilities, and emergent forms of socio-spatial cohabitation. It calls for the development of experimental and transformative approaches that critically reimagine human-nature relationships through spatial production.

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In this context, deep ecology and social ecology emerge as two critical theoretical orientations for transforming the human-nature relationship. Deep ecology challenges anthropocentric thinking by asserting that all living beings possess intrinsic value, and it advocates for an ethically grounded relationship with nature (Naess, 1973). Social ecology, by contrast, contends that environmental problems are not merely ethical issues, but systemic ones deeply entangled with social inequalities and hierarchical structures. It argues that living in harmony with nature is only achievable through profound social transformation (Bookchin, 1988). Both approaches underscore the necessity of restructuring the human-nature relationship in a transformative and value-oriented manner, rather than a merely functional one. On the other hand, post-ecological thought, which foregrounds ontological and political pluralism, seeks to establish a more speculative, critical, and diverse foundation for rethinking the ecological crisis. This perspective expands the discourse beyond nature conservation to include resilience, collective futures, and ethical responsibility (Dryzek, 2005; Alberro, 2021). It emphasizes that the relationship with nature must be reconfigured not only ecologically, but also culturally, politically, and ontologically (Haraway, 2016). Moreover, deep ecology, social ecology, and post-ecological thought offer distinct yet complementary perspectives in the ongoing effort to redefine the human-nature relationship. Together, they reveal the complexity and multidimensionality of ecological challenges. Nevertheless, given the specific focus and limitations of each approach— deep ecology does not adequately address social structures, social ecology provides limited space for natural philosophy, and post-ecological thought remains unclear about practical transformation tools —there is a need for a more integrative framework to understand and guide ecological transformation processes. Within this framework, the concept of ecotopia holds the potential to provide a holistic and relational basis for rethinking human-nature relations in architectural and urban design—one that engages not only environmental but also social, cultural, technological, and economic dynamics.

In the context of the search for this holistic approach, utopia emerges as a compelling conceptual framework thanks to its capacity to integrate plural conditions, dynamics, and imaginaries into coherent yet speculative visions of alternative futures. Owing to its capacity for reproduction, the concept of utopia has evolved across a wide intellectual spectrum, from the early definitions of Thomas More (1516) to contemporary speculative theories. Within this historical continuum, Ruth Levitas's (1990; 2013) redefinition of utopia as a method and a field of intellectual inquiry, rather than as a fixed goal, has marked a significant turning point in current theoretical debates. In line with these approaches, the concept of "topia," together with terms such as utopia, dystopia, heterotopia, and ecotopia, offers a conceptual framework with the potential to question different socio-spatial life imaginaries and to generate an infinitely reproducible field of thinking. Positioned within the theoretical scope and intellectual richness offered by the concept of *topia*, this study focuses specifically on the notion of ecotopia, both within the integrity of these broader debates and as part of a comprehensive research series.[1] Ecotopia—traditionally discussed in the literature through the lenses of environmental ethics (Leopold, 1949; Naess, 1973), system critique (Bookchin, 1988a), or utopian fiction (Callenbach, 1975)—is increasingly finding resonance in the fields of architectural and urban design. Rather than simply presenting an environmental ideal, it is now seen as a multi-layered field

[1]atelierz, one of the vertical architectural design studios operating within the Faculty of Architecture at Gazi University, conceives the architectural design studio as a research laboratory structured around experimental content and carries out the design process through a series of thematic research explorations. The 'Topiagram' series, developed in line with this approach, is derived from the combination of the concepts of "*topia*" and "*gram*", and presents a series of design investigations that question the spatial fictions shaping the construction of space—fictions that can emerge infinitely from the contextual dynamics that constitute place—and examines these fictions in relation to the media through which they are designed, expressed, recorded, and transmitted. In the first phase of the series, spatial design experiments were conducted through various types of "topias" developed in different urban contexts in Turkey. In the second phase, the collective production of a farm topiary was explored at the Atatürk Forest Farm under the theme 'Living Spaces for All of Us'. In the next stage, titled 'Challenging Geographies, Extraordinary Cultures', context-specific topiary fictions were developed by problematizing diverse settlements across the world. This study, in turn, focuses on the concept of ecotopia as a theoretical investigation that supports the experimental design research conducted within atelierz, and aims to open up new theoretical and practical research possibilities in the fields of architecture and urban design.

of projection where ecological transformation, social imagination, cultural restructuring, technological adaptation, and economic alternatives are interwoven.

2. METHOD

This study adopts a qualitative research methodology, questioning the vision offered by the concept of ecotopia in the context of spatial production experiments. It investigates how ecotopia has been conceptualized in spatial thought, identifies the contextual frameworks that contribute to the formation of ecotopian space, and critically examines the practical possibilities and limitations encountered in practice.

In the first part of this three-part study, the historical development and intellectual foundations of the concept of ecotopia are examined through a method of conceptual analysis; the relationships between this concept and spatial production are explored through theoretical approaches that have emerged across different periods.

In the second part, a descriptive analysis of relevant literature and precedents informs a conceptual modelling through which the key contextual frameworks of ecotopian space-making are systematically defined and discussed.

In the third part, the concept of ecotopia is analysed through the case of Auroville, India, which is selected through purposive sampling for its capacity to comprehensively reflect and embody the proposed contextual frameworks. Auroville provides a rich empirical setting in which all identified frameworks can be critically examined in relation to spatial practices. The settlement's experimental nature, socio-spatial complexity, and the extensive availability of publicly accessible documentation, archival records, and academic studies further reinforce its relevance and accessibility as a case study. Accordingly, a critical analysis of its spatial structure is conducted, revealing its socio-spatial characteristics and experimental dimensions.

This multi-layered methodological structure is designed to facilitate a comprehensive understanding of ecotopia as both a conceptual and spatial phenomenon. The combination of conceptual analysis, descriptive analysis and modelling, and critical context-specific case study analysis enables the study to trace theoretical developments, construct an analytical framework, and test its applicability in a real-world setting. The qualitative orientation of the study aligns with the complex, interdisciplinary nature of ecotopia, allowing for an in-depth and interpretative exploration rather than quantification. By structuring the research in three interconnected parts, the study not only captures the evolution of ecotopian thought but also demonstrates how this concept materializes through spatial practices. This approach ensures that the findings are both theoretically grounded and empirically supported, offering a robust foundation for future investigations into alternative spatial imaginaries.

3. ECOTOPIA, THEORETICAL FOUNDATIONS AND CONTEMPORARY DEBATES

The concept of ecotopia is etymologically derived from a combination of two Greek-origin words: 'oikos' (home, environment) and 'topos' (place, space). This etymological fusion offers a rich semantic framework for rethinking life practices established in relation to nature within spatial organizations. Ecotopia was first introduced by Ernest Callenbach in his novel Ecotopia: The Notebooks and Reports of William Weston (1975). The fiction aimed to raise public awareness about the ecological consequences of technological developments, particularly considering the civil society movements that emerged in response to government policies during the late Cold War periods. At the same time, it sought to present a critical alternative to the consumer culture that became dominant after World War II. Callenbach constructed ecotopia as an idealized metaphor for a new form of social life—one that is integrated with nature, libertarian, and collective (Callenbach, 1975). His vision opened discussions on a wide range of issues, including ecological sustainability, gender roles, international relations, and cultural representations. Although ecotopia initially emerged in a fictional context, the concept has since been adopted across various intellectual traditions and reshaped around themes such as systemic critique, social transformation, ethical lifestyles, spatial organization, and post-ecological imaginaries. In this context, the conceptual groundwork laid by Callenbach has been further developed and enriched by a variety of theorists, including Aldo

Leopold, Arne Naess, Murray Bookchin, André Gorz, Félix Guattari, Donna Haraway, Bruno Latour, David Holmgren, Rob Hopkins, Timothy Morton, and Heather Alberro.

One of the first theoretical contributions that put the human relationship with nature on an ethical ground belongs to Aldo Leopold. Leopold positions human beings as part of the natural environment and argues that society should view nature not merely as a resource but toward which it holds ethical responsibility. In his approach known as 'earth ethics', he highlights the importance of establishing a sensory and emotional connection with nature (Leopold, 1949). Arne Naess, who developed the Deep Ecology approach, argues that human intervention in nature is both damaging and destructive, and emphasizes the need to cultivate an ecological consciousness that recognizes the intrinsic value of all living beings, rather than adhering to anthropocentric frameworks. According to Naess, we must explore ways of building systems that do not allow the exploitation of other species for human needs (Naess, 1973, pp. 95–100). André Gorz, a key figure in the ecosocialist tradition, critiques the unsustainability of the capitalist model of production and consumption. He asserts that addressing ecological crises is only possible through a socialist transformation (Gorz, 1980) Social theorist Murray Bookchin, a critic of deep ecology, opposes its tendency to overlook the creative and transformative potential of human beings in their interaction with nature. He contends that environmental problems are rooted in social hierarchies and structures of domination. Bookchin argues that the production-oriented systems that emerged during the Industrial Revolution disrupted natural cycles and triggered a global ecological crisis. He emphasizes that centralization in domains such as urbanization, industrial agriculture, and energy use has led humans to form a dissonant relationship with both nature and themselves, contributing to the degradation of ecological balance. Accordingly, Bookchin develops the concept of social ecology, maintaining that ecological problems arise not only from environmental factors but also from deeply embedded social and political structures. He considers the separation between nature and society to be artificial, and argues that the solution lies in constructing non-hierarchical, participatory, and ecological forms of social organization. He underscores that human capacity to intervene in nature can be exercised in ecological, rational, and sustainable ways (Bookchin, 1987). For Bookchin, the path to addressing the accelerating environmental degradation and ecological crisis involves building egalitarian social structures that are in harmony with nature and integrated with local ecosystems. In this direction, he proposes ecocommunes powered by renewable energy, using sustainable technologies, and supported by decentralized systems of local energy and agriculture (Bookchin, 1988b). In a complementary analysis, Félix Guattari argues that environmental, social, and mental ecologies are inseparably linked, and that ecological problems must be approached through a multidimensional framework. He stresses the necessity of addressing these issues not only through environmental regulation but also through transformations in social relations and individual consciousness (Guattari, 1989).

While all these intellectual approaches reveal that the ecological crisis has multilayered causes not only on environmental but also on social, political, and cultural levels, Donna Haraway extends this framework by incorporating interspecies relationships. In her ecofeminist philosophy, she argues that dichotomies such as nature/culture and human/animal must be overcome, and instead, complex relational networks in which these binaries are entangled should be acknowledged. She contends that ecological solutions are not merely technological or socio-political but require an ontological shift. According to Haraway, imagining a sustainable and just future depends on recognizing the interdependence between the human species and other living beings (Haraway, 1991). This call for ontological transformation becomes even more radical in Timothy Morton's concept of 'dark ecology'. Morton argues that focusing solely on the peaceful, harmonious, and aesthetic aspects of ecological relations is misleading. For him, our relationship with nature also entails uncertainty, contradiction, and discomfort; therefore, ecological awareness must include an engagement with the dark and unsettling dimensions of nature (Morton, 2016). This invitation to existential confrontation highlights that ecological awareness must be reshaped not only at the scientific or political level but also along ethical and affective dimensions. At this point, the disturbing consciousness presented by Timothy Morton's dark ecology enables the utopian imaginary to be considered not merely as an idealized vision of the future, but also as a mode of resistance against the prevailing order. Similarly, Bruno Latour questions the artificiality of the nature-culture divide through his notion of an 'actor network', in which human and non-human actors (actants) are deeply interconnected. According to Latour, responding to the ecological crisis is not only a technical or political matter, but also involves establishing a new regime of representation, responsibility, and partnership between humans and other beings (Latour,

2004). This approach resonates with the Gaia hypothesis developed by James Lovelock and Lynn Margulis, which conceptualizes Earth as a self-regulating living system and emphasizes that humans are merely one component of this larger whole (Lovelock, 1979; Margulis & Sagan, 1995). Thus, both Latour's actor-network theory and the Gaia perspective reveal that ecological awareness is not only a scientific or political concern, but also an existential, relational, and cosmopolitical one. These ontological and relational approaches open up space for rethinking ecological futures through critical and creative frameworks such as ecotopia. In this context, Heather Alberro considers the concept of ecotopia not only as a theoretical construct but also as a pragmatic tool for contemporary radical environmentalist movements in their pursuit of alternative lifeways and social structures that are ecologically integrated, sustainable, and intersectionally just. She emphasizes that utopian thinking provides a space for critical practice that resists dominant socio-political regimes and holds transformative potential for reconstructing ecological futures (Alberro, 2020, 2021).

In this framework, ecotopia refers not only to aspirations for social transformation, but also to a tangible design vision of how this transformation can take shape in space. It informs new design approaches grounded in the principles of sustainability, locality, circularity, and participation. The pursuit of symbiotic relationships with nature in urban spatial configurations; the creation of structures that are resilient to climate change; the development of participatory and inclusive planning strategies that uphold the principles of spatial justice; the integration of diverse cultural and belief systems into spatial experience; the use of technology as a tool for reconstructing ecological ways of living and the promotion of economic systems rooted in cooperation, regeneration, and local resilience—all demonstrate that the concept of ecotopia is gaining traction within contemporary spatial design and planning practices. The conceptual ground shaped by these tendencies engages with multi-layered themes, including environmental sustainability, social equity, cultural and belief diversity, technology-enabled ecological transformation, and solidarity-based economic models. In this context, studies such as Alan Marshall's utopian urban scenarios (2016), MVRDV's zero-carbon planning vision (2021), and Andrew Gingerich's research on sacred spatial experiences (2012) demonstrate that the idea of ecotopia is increasingly investigated through project-based architectural and urban practices engaging with alternative spatial imaginaries. While these efforts reflect a growing interest in ecological thinking within spatial design, they also underscore the need to move beyond fragmented visions toward more cohesive and context-sensitive frameworks. This indicates that a mature, open, relational, and pluralistic research framework in the field of architecture and urban design, which support the development of a more integrated understanding of ecotopia as a framework for experimental spatial practices, has not yet been fully established. Therefore, advancing context-based spatial approaches that define ecotopia not as a fixed or finalized design model but as a dynamic framework for spatial thinking and production is emerging as a critical research priority. This framework should evolve through interactions with ecological, social, cultural, technological, economic, and other relevant contextual parameters, and cultivate ecological spatial production practices.

4. SPACE-CONSTRUCTING CONTEXTUAL FRAMEWORKS IN ECOTOPIA

The understanding of ecotopia is discussed through multi-layered dynamics that include, but are not limited to, geographical structures, forms of social organization, belief systems, technological practices, and economic functioning (Leopold, 1949; Bookchin, 1988; Alberro, 2021; Callenbach, 2006; Taylor, 2009; Gingerich, 2012; Spash and Guisan, 2023). Accordingly, this study examines how these contextual dynamics influence the development and formation of ecological spatial constructs, conceptualizing them as space-constructing frameworks that vary depending on context. Through mutual interaction, these frameworks generate layered interdependencies that shape a flexible system offering a generative basis for understanding and reimagining ecotopian imaginaries in diverse contexts.

Geographical structure constitutes a contextual framework for understanding ecotopian spatial configurations evolution across different geographical contexts. Within the social ecology approach, the relationship between geographical structure and ecotopia is explained through the reciprocal interaction of nature and social life (Bookchin, 1988). Physical-morphological (topography, slope, geological composition), hydrological (surface and groundwater resources, drainage systems), climatic (temperature, duration of sunlight, wind direction, microclimate), biological-ecological (vegetation, biodiversity,

susceptibility to erosion), and geodynamic (earthquake, landslide, flood risk) factors that constitute geographical structure all play a significant role in shaping spatial constructs and functions. Rather than serving merely as physical data, geographical structure actively guides the physical, cultural, and functional organization of space through a sensitive interaction with local specificities and environmental conditions.

Social organisation constitutes a contextual framework for understanding the production, use, and distribution of space, based on how individuals associate and act collectively within ecotopian imaginaries. It shapes the norms and structures of collective life in space, including relations of production and consumption, access to resources, decision-making processes, and the pursuit of spatial justice and social equality (Bookchin, 1988; Alberro, 2021). Social organisation is shaped through its interaction with geographical settlement patterns, natural resource use, ritual practices, technological management, production-consumption operations, and property regimes. Shaping everyday life practices, it holds the potential not only to transform existing spatial systems but also to construct entirely new forms of life.

Belief systems constitute a contextual framework that shapes the relationship between nature and socio-ethical values in ecotopian imaginaries. Beyond traditional religious structures, this framework expands to include secular worldviews shaped by environmental sensitivity, offering a pluralistic foundation (Taylor, 2009). The sanctity and moral responsibility attributed to nature guide how communities engage with their environment and articulate spatial values (Leopold, 1949). Practices such as the sacralization of nature, participatory hierarchies, technological orientations, and solidarity economies develop in interaction with belief systems. This framework informs not only the symbolic meaning of space but also its material formation, use, and communal life through an ecological-spiritual sensibility.

Technology use practices constitute a contextual framework that shapes the cyclical systems and operational structures involved in spatial construction, production-consumption relations, and core functions like information flow, transportation, and energy management in ecotopian imaginaries. The transformation of technology's destructive impacts into tools for ecological sustainability remains central to these imaginaries (Callenbach, 2006). Within this framework, practices such as renewable energy systems, closed-loop waste and water management, and environmentally responsive construction shape the physical spatial infrastructure, while technologies and tools for communication, resource sharing, and participatory governance configure collective organization and social interaction in the spatial realm. Technology use thus informs not only the spatial layout but also the social dynamics of ecotopian communities.

Economic functioning constitutes a contextual framework for understanding how economic systems and processes form and evolve to shape the spatial organisation of ecotopian settlements. This framework enables ecotopias to be evaluated not only in terms of environmental and social aspects but also through the lens of economic sustainability. The structural limits and operational dynamics of ecosystems play a determining role in how economic processes unfold and influence spatial and social sustainability (Spash & Guisan, 2023). Accordingly, this framework encompasses land use patterns, ownership structures, production and consumption models, resource distribution mechanisms, and infrastructural choices, ultimately configuring the spatial logic, labour organisation, and everyday viability of ecotopian life.

5. SOCIO-SPATIAL PERSPECTIVES OF ECOTOPIA THROUGH THE CASE OF AUROVILLE

India offers a compelling context for exploring how the concept of ecotopia can inform approaches to urban spatial production. The convergence of ecological ideas and nature-based

Figure 1. *Layout and Spatial Configuration of the Auroville Settlement (https://auroville.org/page/vision-of-the-city)*

philosophies supports the creation of sustainable living practices[2]. As one of these practices, the Auroville Ecovillage offers a distinctive ecotopian experience through its community-based way of life shaped by its unique ecological, social, and spiritual understandings. Analysing the socio-spatial perspective introduced by the Auroville as an ecotopian practice—through its geographical structure, forms of social organisation, belief systems, technological practices and economic model—provides a critical basis for understanding how ecotopian spatial imaginaries are materialised in practice and for reassessing them within multiple contextual frameworks.

Auroville was founded on February 28, 1968, by Mira Alfassa in the Viluppuram District of Tamil Nadu, located in the southeastern region of the Indian subcontinent. Although the initial design was carried out by architect Roger Anger, the ongoing spatial development of the settlement is shaped through the contributions of a team of architects actively involved in design and planning processes. The settlement was symbolically established around a central banyan tree, where representatives from 124 nations gathered—marking the beginning of an experimental initiative based on international understanding, human unity, and the transformation of consciousness. Auroville, meaning "City of Dawn," was inspired by the teachings of Sri Aurobindo's[3] community. Although rooted in spiritual philosophy, it was envisioned as an experimental, universal township grounded in harmony, peace, and the temporality of human existence—articulated through a vision of "the city of the future." UNESCO has recognized Auroville as a project of international significance for the future of humanity. The settlement is based on the integrated and mutually beneficial development of urban and rural areas. It adopts a planning approach that encompasses both the city and its surrounding environments—not limited to the central urban core but inclusive of adjacent rural settlements. Contrary to the prevailing urbanization model, where expanding cities often marginalize rural areas into pockets of poverty with limited access to infrastructure and quality of life, Auroville aims to distribute urban resources—such as human capital and economic opportunities—equitably between the urban core and the surrounding

[2] In *Hind Swaraj* (1909), Mahatma Gandhi emphasizes local and self-sufficient communities and decentralised ways of living, thereby promoting a vision grounded in the principles of localism and self-reliance. In her work *Staying Alive: Women, Ecology, and Survival in India* (1988), Vandana Shiva highlights traditional agriculture, community-based ecological movements, and the role of women in ecological sustainability, aligning with community-driven and gender-sensitive approaches. In addition, Ramachandra Guha, in *Environmentalism: A Global History* (2000) and *How Much Should a Person Consume?* (2006), explores the interaction between local ecological movements in India and global environmental thought, offering a comprehensive discussion on the formation of ecotopian imaginaries within both local and global contexts. Furthermore, the Chipko Movement—established to protect forests and promote harmonious living with nature—stands as a concrete example of how communities in India engage with the environment and enact ecological resistance.

[3] Sri Aurobindo (1872–1950) was an Indian yogi, spiritual philosopher, and nationalist leader.

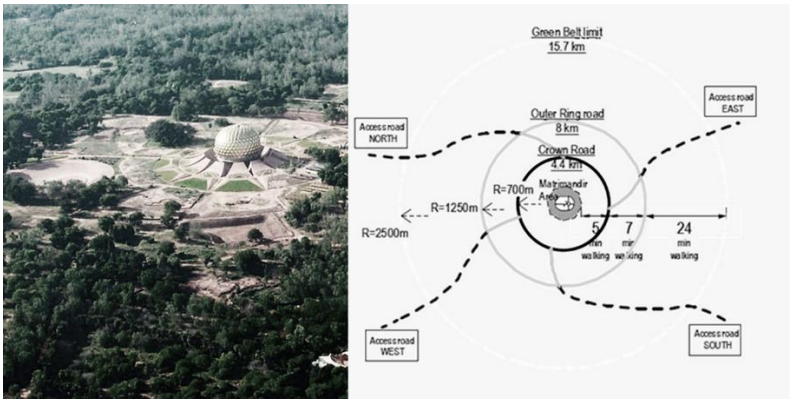

Figure 2. *Main Transportation Network of the Auroville Settlement (https://auroville.org/page/the-galaxy-a-pedestrian-based-city-1968-2003-5-2015-762, https://auroville.org/page/land-and--nature)*

villages. This approach represents a planning strategy oriented toward building a holistic, equitable, and sustainable social structure—challenging the typically imbalanced and exclusionary nature of contemporary cities. In this sense, Auroville not only seeks to establish an ecological and collective way of life within its own boundaries, but also to transform urban–rural relationships by enhancing the welfare and infrastructure of nearby rural settlements, offering a model of experimental urbanism (Auroville, 2025). Developed collectively on previously vacant land, Auroville has embraced a sustainable way of life grounded in the principle of zero ecological footprint, aiming to minimize its environmental impact. Its spatial planning emphasizes the coexistence of diverse lifestyles and the accommodation of cultural diversity. The spatial organization includes elements that reflect different national and cultural approaches to space-making (such as country pavilions), alongside experimental constructions and spatial layouts designed to foster collective life and enable interactive communal activities (Majumdar, 2017).

Planned to accommodate 50,000 residents from various nations, Auroville's urban design extends beyond the creation of a physical settlement layout to envision an integrated living environment encompassing social, environmental, and spiritual dimensions. At the heart of the city lies the Matrimandir—an oval, lake-encircled space designed for individual silent concentration—which symbolizes the "soul of the city." Surrounding this central area, the settlement is organized radially in accordance with a galaxy-based master plan, composed of four main zones: the Industrial Zone (north), which hosts production infrastructure; the Cultural Zone (northeast), dedicated to artistic and intellectual activities; the Residential Zone (south/southwest), which contains housing clusters; and the International Zone (west), where national pavilions represent various countries. These zones are connected by a secondary circular road encircling the center, referred to as the Crown. Extending outward from this circular road are twelve radial axes—referred to as Lines of Force—which form the city's structural skeleton. These axes not only organize the spatial structure but also facilitate connectivity between the central core and the peripheral areas through a series of prominent buildings. They are considered fundamental to the spatial coherence and urban integrity of Auroville. Despite this formal structural framework, Auroville is not conceived as a static or finalized urban model. Instead, its spatial configuration is envisioned as an open-ended, flexible, and participatory system—one that evolves through the everyday experiences, collective rhythms, and changing needs of its residents. In alignment with this philosophy, all spatial components beyond the Lines of Force are designed to be adaptable and transformable. This spatial flexibility is also reflected in Auroville's transportation policies. The city is largely free of motorized traffic and is equipped with pedestrian and bicycle pathways. Public transport is supported by electric vehicles and low-speed alternative systems, aiming to reduce environmental impact, enhance energy efficiency, and promote social interaction. At the city's periphery, a green belt has been planned, consisting of forests, agricultural lands, and ecological

Figure 3. *Auroville Yerleşkesinin Merkezinde Bulunan Banyan Ağacı (https://auroville.org/page/the-banyan-tree)*

conservation zones. This belt functions as a spatial manifestation of Auroville's symbiotic relationship with the natural environment and reinforces the ecological dimension of its sustainable living vision. In the general master plan of the settlement, the central point symbolizes unity and transcendence; the surrounding inner circle represents the generative idea of the city's creation. The leaf-shaped extensions radiating from this centre express the outward realization and lived manifestation of this conceptual foundation, embodying Auroville's holistic design philosophy (Auroville, 2025) (Figures 1–2).

The Role of Geographical Structure and Its Impact on Spatial Configuration and Practices

Auroville was established on an eroded, barren terrain devoid of vegetation. Storms and monsoon rains had carved deep gullies into the land, disrupting its ecological balance and rendering it initially unsuitable for settlement (Auroville, 2025). Selecting such a site reflects an experimental spatial strategy aimed at regenerating a degraded ecosystem, reversing environmental damage through human intervention, and redefining the human–nature relationship through a restorative lens. The community's spiritually rooted understanding of nature has framed its relationship with the environment within an ethical context, encouraging ecologically sensitive design decisions. A key symbol of this worldview is the Banyan tree, the only natural feature present on the site before the settlement was established. Considered sacred in Indian tradition, the tree represents the "soul" or spiritual heart of the future city. Its enduring presence, together with the Matrimandir constructed around it, has formed a powerful focal point in Auroville's spatial organization—expressing a deep integration of ecological, spiritual, and spatial values (Figure 3). Accordingly, Auroville's community—united by ecological awareness and a commitment to collective action—has developed environmentally attuned ways of living through shared resource management and participatory governance. Technology has also played a key role in unlocking the potential of the site. Water management systems have enabled rainwater harvesting and erosion control, improving soil quality and allowing the creation of green areas. Renewable energy systems—wind, biomass, and solar—have been integrated into the infrastructure, influencing spatial configurations in both functional and aesthetic terms. The spatial distribution of productive areas, shaped by the site's geographic conditions, has supported an ecologically grounded economy. Soil regeneration has enabled agriculture, while integrated land, water, and decentralized energy systems reduce external dependency and foster small-scale, community-based production. Together, these geographically informed systems establish a spatial-economic model oriented toward sustainability and resilience. (Auroville, 2025). In this context, Auroville presents a distinctive case that links environmental restoration with the activation of geographical and ecological potentials through a spatial strategy that is both integrative and adaptive. At the same time, it reveals how spatial configurations are shaped by site-specific constraints and socio-economic dynamics, prompting reflection on the tensions and adjustments that arise in translating such visions into practice.

Figure 4. *Community Gathering Area in Auroville (https://auroville.org/page/self-governance)*

The Role of Social Organisation and Its Impact on Spatial Configuration and Practice

All land and assets of Auroville were legally transferred to the Auroville Foundation under the 1988 Auroville Foundation Act, establishing an institutional framework for its community-based and autonomous governance. The Master Plan, approved by the Indian Town and Country Planning Organisation and published in the Government Gazette, provided legal authority for the settlement's spatial development. Within this structure, the Secretary of the Foundation oversees immovable properties, while day-to-day operations are managed by resident-elected working groups. Decision-making follows a participatory and non-hierarchical model based on collective harmony and inner development. This social organisation, grounded in inclusivity and shared responsibility, directly shapes spatial planning. Communal governance supports integrated development, where spatial decisions reflect collective priorities rather than individual ownership. The preference for shared spaces over private property is evident in architectural design: structures are planned to foster community interaction rather than serve individual needs (Figure 4). Public facilities, education, health, and transportation services are organized internally, reinforcing the self-sufficient ethos of the settlement. Nature and belief systems also play a formative role in shaping the community's organisation. Spiritually grounded understandings of the environment have cultivated a sense of ethical responsibility toward nature, influencing both communal values and ecologically sensitive spatial practices. The integration of sacred symbolism—such as the centrality of the Banyan tree and the Matrimandir—reinforces a collective identity tied to ecological consciousness and spiritual inclusivity. Furthermore, Auroville's economy relies on social enterprises that meet internal needs while promoting local development, enriching its communal organisation. Long-term, symbiotic relationships with neighbouring villages further strengthen this integrated socio-spatial model. Culturally, the belief in art as a tool for collective transformation manifests in the integration of music, theatre, and visual arts into daily life, shaping public spaces as platforms for shared expression. Therefore, Auroville's governance model shapes not only administrative functions but also the spatial logic of the community: communal decision-making, ecological ethics, economic interdependence, and cultural expression coalesce in a built environment that embodies egalitarian, sustainable, and participatory values. (Auroville, 2025). In this sense, the Auroville model envisions design as a medium for social transformation and sustainable, value-driven living. However, its emphasis on ethical integration and collective cohesion also reveals structural tensions such as internal conflicts, limited inclusivity and unequal relations with surrounding communities. These challenges expose a core paradox where idealistic spatial visions risk reinforcing exclusion and power imbalances when applied rigidly. Rather than serving as a replicable model, Auroville stands as a critical case that underscores the need for design practices to align ethical ambition with contextual adaptability and pluralism.

The Role of Belief Systems and Their Impact on Spatial Configuration and Practice

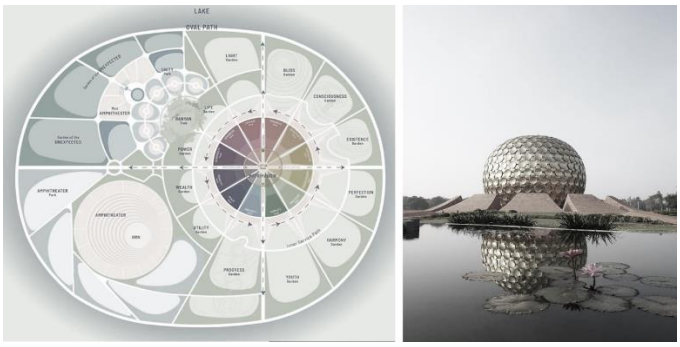

Figure 5. *Matrimandir: The Spiritual Center of Auroville (https://auroville.org/page/matrimandir-and-peace-area)*

The belief system of Auroville is grounded not in any formal religion, nor does it adopt the exclusivist stance often associated with institutionalized faiths. Instead, it is shaped by an inclusive and affirmative spiritual understanding based on principles of inner exploration, individual and collective transformation, wholeness, and the expansion of consciousness. This conceptual orientation influences not only personal spirituality but also directly informs the spatial programming of the settlement, shaping design principles and patterns of use across the site. The spatial expression of this approach is epitomized by the *Matrimandir*—a spiritual structure located at the heart of Auroville. Deriving its name from the notion of the "Temple of the Mother," Matrimandir is conceived as a symbolic embodiment of a universal maternal figure and is understood as the evolutionary, conscious, and intelligent force behind life itself. It aims to support humanity's progression beyond its current limitations toward a supramental state of awareness. As such, it functions not only as a space for personal inner transformation but also as a guiding symbol of the ethical and spiritual values that inform Auroville's social and spatial organisation (Figure 5). The Matrimandir and its surrounding Peace Area are designed as spaces of silence and concentration, open to individual introspection. Adjacent to the Banyan tree—Auroville's central ecological and symbolic axis—the Matrimandir is encircled by twelve meditation rooms, each associated with a corresponding "garden of virtue." These twelve virtues are inspired by Eastern philosophies and represent essential qualities to be cultivated by individuals: *Ren* (compassion, love), *Yi* (righteousness, justice), *Li* (propriety, appropriateness), *Zhi* (wisdom), *Xin* (trust, honesty), *Xiao* (filial piety), *Chung* (loyalty, devotion), *Yong* (courage), *Jie* (self-discipline, temperance), *Cheng* (forgiveness, tolerance), *Qian* (humility), and *Gong* (diligence). Meditation practices are held in each room in alignment with its corresponding virtue and its spiritual responsibility (Auroville, 2025). This symbolic framework demonstrates that belief systems in Auroville influence spatial organisation not only aesthetically but also conceptually and functionally. While the spiritual character of space fosters a holistic environment that deepens inner experience, it also challenges designers to uphold pluralism and inclusivity in a diverse community. In this light, belief systems act as both a shaping force and a critical lens for understanding ecotopian space. Yet, to what extent can spiritually rooted values inform spatial design without limiting openness, adaptability, or the diversity of lived experiences comes to the fore.

The Role of Technology Use Practices and Their Impact on Spatial Configuration and Applications

In Auroville, architectural and building technologies are shaped by principles of sustainability, reinforcing a symbiotic relationship with nature. Water harvesting systems, renewable energy infrastructures and waste treatment networks are embedded into the spatial logic of the site, influencing the distribution of zones, the relationship between buildings and landscape and the design of circulation and communal activity areas. The use of compressed earth blocks, climate-responsive design and passive cooling strategies has directly informed the spatial configurations. These material and environmental choices affect not only the appearance but also the

Figure 6. *Use of Natural Materials and Experimental Applications in Auroville (https://auroville.org/page/earth-institute)*

orientation, performance and placement of buildings, establishing a spatial rhythm attuned to ecological cycles. Technological solutions have also enabled programmatic innovation. Shared kitchens, open-air gathering spaces and solar-powered public infrastructure reflect a design ethic grounded in collective use and environmental responsibility. The research and education initiatives led by the Auroville Centre for Scientific Research and the Auroville Institute of Applied Technology generate knowledge in sustainable architecture, renewable energy and ecological infrastructure, disseminate it through training programmes and contribute to local development (Auroville, 2025). In Auroville, technology is embedded not only in infrastructure but in the very logic of spatial and social organisation. Its use of climate-responsive design, renewable energy and natural materials illustrates how technological choices shape spatial experience and reinforce ecological ethics. Yet the reliance on site-specific innovations raises critical questions about scalability, cultural fit and long-term maintenance. Auroville thus reframes the role of technology in settlement-making as a socio-technical construct shaped by ethical, environmental and communal priorities, inviting design practices to reconsider how tools, values and spatial forms evolve together.

The Role of Economic Functioning and Its Impact on Spatial Configuration and Applications

Auroville's economic model was developed with the intention of allowing individuals to engage in work aligned with their nature, while also having free time for inner growth. In this context, work is not merely seen as a means of livelihood, but as a process of self-realization, contribution to the community and personal development. Rather than being driven by material gain or social status, this model proposes a way of life in which an individual's value is defined by their contribution and growth. Accordingly, Auroville's economy was designed to minimise the use of money and enable the collective management of resources. Residents receive monthly support in exchange for contributing to the community, while community-run enterprises allocate a portion of their profits to a central fund. Additionally, social enterprises that provide employment opportunities beyond Auroville have established small-scale, non-polluting industries to meet basic community needs. This economic model has also shaped spatial practices by prioritising collective infrastructures over private investment, supporting shared facilities and modest housing types that reflect principles of equality and access. However, the implementation of this model has faced several challenges. External dependency, issues related to property and access and administrative limitations have negatively affected both spatial organisation and daily life in the settlement. Auroville's economic sustainability remains highly dependent on external funding sources, including the Indian government, international donors and visitors. Moreover, although private property is prohibited, new members are required to make substantial financial contributions to settle in the community. This has exacerbated economic inequalities and limited inclusivity. While principles of centralised planning and collective ownership have guided the design of residential areas, financial constraints and governance issues have hindered the full realisation of planning goals. Limited economic resources have slowed infrastructure development and contributed to

Figure 7. *Social Enterprises in Auroville (https://auroville.org/page/social-enterprises-of-auroville)*

deficiencies in certain services. Economic inequalities and barriers to access have led to social tensions within the community, ultimately weakening the inclusive character that Auroville seeks to maintain (Auroville, 2025). The case of Auroville reveals that economic systems not only determine how resources are distributed, but also who produces space, how it is produced, and to what extent it is accessible. This invites critical reflection on the influence of economic functioning on spatial planning, equitable access, community participation, and spatial sustainability. It also raises a broader issue relevant to ecotopian imaginaries, concerning the ways in which economic structures shape, limit, or enable the production of space.

The case of Auroville offers a meaningful lens through which to examine the tension between the idealistic ambitions of spatial utopias and the socio-economic and cultural challenges encountered in practice. It also provides fertile ground for critically assessing how ecotopia seeks to organise nature-aligned ways of living, along with the possibilities and limitations inherent in that process. Despite its idealistic approach to spatial organisation, Auroville has been subject to criticism due to various practical difficulties (Parker, 2018; Bhatia, 2014). Internal conflicts, inefficiencies in governance, and cultural integration problems have hindered the settlement's development. Furthermore, although the community has made efforts to maintain economic sustainability, the increasing prioritisation of economic growth over spiritual and community-based values illustrates how utopian ideals, when put into practice, encounter multi-layered dynamics that reshape them over time (Bhatia, 2014; Kundoo, 2007). This situation is often explained within the broader context of the difficulties faced by ecovillages operating within capitalist and growth-oriented systems. Additionally, Auroville's practices of community participation, sustainability initiatives, educational offerings, and economic opportunities have drawn criticism at the regional level for their unintended negative impacts. Critics argue that such settlements must be evaluated not only in terms of their internal functioning but also in relation to their effects on surrounding communities (Venkitaraman&Joshi, 2022). Despite its idealistic rejection of private property, Auroville has faced critiques regarding spatial and social sustainability due to power imbalances with local populations, limited participation, and low population density. These critiques have even led to associations with neo-colonial tendencies (Parker, 2018; Jazeel, 2023). Although the settlement was founded on a vision of collective life, critics argue that individual influence has increasingly shaped its development. Rather than transforming the founding vision through internal community dynamics, the project has been seen as confined to implementing a predetermined ideological design (Bhatia, 2014). Therefore, the Auroville experience should not merely be approached as a replicable model, but as a critical terrain for rethinking ecotopian approaches within plural and situated contexts. All these overlapping contextual layers play a foundational role in shaping spatial constructs and in the development of experimental configurations and practices (Figure 8).

Figure 8. *Diversified Spatial Configurations and Practices in Auroville (https://auroville.org/page/architecture)*

6. CONCLUSION

The body of knowledge and experience built around the concept of "topia" does not frame utopia as a fixed ideal but rather establishes a framework for an experimental design practice that can evolve, multiply, and adapt to changing environmental, social, cultural, technological, and economic conditions. Within this framework, "ecotopia," as a derivative of "topia," should be redefined not only as a utopian imagination but also as a critical and operative conceptual tool for constructing and implementing ecological and socio-spatial configurations, guided by locally responsive, critical, and creative approaches. Explaining its contextual, pluralistic, and evolving nature makes it possible to conceptualize and open up ecotopia as a field of thought and action through which spatial design practices at different scales and contents can emerge. Accordingly, this study addresses ecotopia not merely as a theoretical concept but also as a viable socio-spatial practice. Through a discussion of space-constructing contextual frameworks, it examines ecotopia as both an idea and an implementable model, critically analysing its manifestations through the case of Auroville.

Grounded in the philosophical approaches of deep ecology, social ecology, and post-ecological thought, this study does not treat ecotopia as an idealized vision of the future, but rather as a critical and practice-oriented research field that evolves through interactions with ecological, social, cultural, technological, economical and other contextual dimensions. Spatial configurations developed within the scope of ecotopia are examined through five contextual frameworks: geographical structure, social organisation, belief systems, technological practices, and economic functioning. The critical examination of Auroville reveals that ecotopia-based practices go beyond the production of physical space to present a layered spatial imagination interwoven with speculative visions, critical reflections, and socio-spatial ecological experimentation.

Auroville exemplifies not only the restoration of a degraded ecosystem and the proposal of a nature-aligned spatial production model, but also the construction of a design environment that integrates geographical potentials, ecological ethics, collective values, the transformation of basic techniques through contemporary knowledge, and the search for economic models realizing a spatial experimentation grounded in contextual responsiveness. This holistic structure privileges flexible and evolving systems based on experience over fixed design templates. Strategies that transform and integrate geographic potentials; a horizontal and participatory model of social organisation grounded in spatial justice and collective living; belief systems developed around principles of pluralism, secularism, and inclusivity; technological practices aimed at achieving spatial and social sustainability through symbiosis with nature; and a solidarity-based economy responsive to local needs—together configure space not merely as a physical construct, but as a multilayered domain produced through values, relations, and ways of life. In this way, Auroville opens a field of thought and action for reconsidering ecotopia-inspired design as a vehicle for social transformation and sustainable living.

However, the degree to which the Auroville model can be reinterpreted in different contexts remains open to question. Issues such as how geographical conditions shape settlement patterns, how forms of social organisation influence spatial use and collective life, how belief systems inform design decisions, how technology affects spatial organisation and daily practices, and how economic structures shape community dynamics and spatial programmes together construct a multi-dimensional research agenda for developing plural and open-ended ecotopian design models. Thus, while Auroville presents a powerful reference with its holistic planning and spatial organization strategies, its limitations in practice must be acknowledged. Idealizing this model risks overlooking the contextual variability and critical potentials necessary for ecotopian practices. It is essential to approach Auroville as an experimental field, critically engaging with its spatial design, challenges, mismatches, and processes of transformation. These practical issues foreground the question of how such visions can integrate with local conditions and community dynamics, positioning Auroville as a site for reflecting on the boundaries and potentials of utopian design.

As such, the experiences derived from Auroville offer a foundation for critical thinking on ecotopian design, contributing to the development of multi-dimensional approaches for designing and assessing sustainable ways of living. The Auroville experience presents ecotopia not solely as an environmental utopia but as a site for ontological reconstruction, where values, social relations, and individual transformations are deeply intertwined. In this respect, the study highlights the replicability of ecotopian constructs in plural, relational, and context-sensitive forms. It emphasises the experimental nature of ecotopia and provides a theoretical and practical foundation for developing speculative, critical, and locally responsive spatial design practices. This contribution positions itself within a broad theoretical and applied research field that interrogates the relationship between ecological thought and spatial production, engages with post-ecological theories, and reconceptualizes design research across multiple scales. Investigating how ecotopian constructs can take shape in diverse geographic, social, cultural, technological and economical contexts—and exploring the interplay between experimental spatial practices and processes of social transformation—offers fertile ground for advancing design theory and sustainability-oriented spatial practices.

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Research Article GU J Sci, Part B, 13(3): 335-351 (2025)

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The Politics of Architectural Discourse: A Comparative Study of Renaissance Treatises and Mimar Sinan's Risales

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Article Info

Received: 28/01/2025
Accepted: 16/07/2025

Keywords

Architectural Treatises, Giorgio Vasari, Andrea Palladio, Mimar Sinan, Cultural Context in Architecture

Abstract

The 16th century witnessed some of the most transformative moments in history, marked by the intersection of diverse theories and practices across different geographies. These changes in political life are also reflected in the historiography of architecture. This article compares two treatises from the Italian Renaissance —those of Giorgio Vasari and Andrea Palladio— with Mimar Sinan's risales within the context of political discourse and architectural expression. Similarities and differences characterizing architectural writing are examined through cultural contexts. The comparison focuses on the style and structure of the texts, followed by an analysis of prefaces, chapter organization, and narrative strategies employed in recounting personal and professional trajectories. The article investigates the purpose and scope of these writings, along with their approach to describing buildings and processes. The identity of the architect is explored in relation to governance and their contemporary professional networks, while considering the cities they encountered and their relationship with religion.

1. INTRODUCTION

The discourse of architecture has witnessed the development of in-depth academic research across different cultural landscapes and eras, each contributing to the evolution of design principles and aesthetic ideologies. This comparative study examines two treatises from the Italian Renaissance alongside Mimar Sinan's treatises through the lens of political discourse and architectural expression. The study aims to identify similarities and differences that characterize the writing of architectural works in different geographies. The 16th century was a period of development characterized by significant political and social changes in both geographies.

Architects didn't just aim to create buildings that would stand the test of time; they also sought to ensure their work and ideas would be remembered through the written word. While Renaissance thinkers like Andrea Palladio and Giorgio Vasari meticulously documented their era and its history, the lack of similar systematic studies in the Ottoman tradition has left gaps in our understanding of their architectural theories and practices. To address these lacunae and engage with the textual traditions that shaped architectural memory, this article takes a closer look at some key texts: Palladio's *Four Books on Architecture*, Vasari's *Lives of the Artists*, and Sinan and Sai Çelebi's works, including *Untitled Treatise*, *Risâletü'l-Mi'mâriyye*, *Tuhfetü'l-Mi'mârîn*, *Tezkiretü'l-Ebniye*, and *Tezkiretü'l-Bünyân*. These particular treatises were selected because they represent self-authored or institutionally mediated reflections on architecture, written by figures who simultaneously occupied design and historiographical roles in their respective contexts. While this study does not aim to provide an exhaustive survey of architectural treatises in either tradition, it focuses on representative figures whose dual engagement with practice and textual production enables meaningful comparison.

To support this comparative reading, and in addressing the narrative and ideological dimensions of architectural treatises, this study draws on a range of scholarly works that have examined the intersection of authorship, institutional power, and cultural production. Patricia Rubin's analyses and situate Vasari's

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historiographical strategies within Renaissance humanism and explore how biography became a vehicle for constructing artistic identity and legitimizing cultural narratives at *Giorgio Vasari: Art and History* (1995). James S. Ackerman's *Palladio* (1991) investigate Palladio's engagement with classical models, his methodical use of visual representation, and his positioning of architecture as a discipline rooted in theory and proportion. On the Ottoman side, Gülru Necipoğlu's *The Age of Sinan: Architectural Culture in the Ottoman Empire* (2005) provides a foundational interpretation of Sinan's self-representation and authorship, embedded within the hierarchical and religious structures of the Ottoman court.

Together, these studies frame the comparative scope of this article and support its central claim that architectural authorship is a culturally contingent construct, shaped by differing relationships between the individual, the state, and the intellectual systems in which they operated. While these studies provide deep analyses of each figure individually, this article builds a comparative dialogue among them, focusing on how different modes of authorship and historiographical strategies reflect contrasting socio-political realities. To maintain analytical depth within a wide-ranging comparative framework, the article focuses specifically on three architect-writers whose treatises are central to their respective cultural traditions.

2. METHOD

This study delves into the architectural writings of Giorgio Vasari, Andrea Palladio and Mimar Sinan using comparative textual analysis to explore how each approached architectural discourse. The research illuminates the unique ways in which these figures were conceptualized and communicated their ideas about architecture. Primary sources include Vasari's *The Lives of the Artists*, Palladio's *Four Books on Architecture* and Sinan's *Untitled Treatise, Risâletü'l-Mi'mâriyye, Tuhfetü'l-Mi'mârîn, Tezkiretü'l-Ebniye and Tezkiretü'l- Bünyân.* These texts were chosen because they represent reflective, authorial engagements with architecture, written by figures who were both practitioners and documentarians of their respective traditions. These sources are critically analysed to reveal how each author situated architecture within their specific cultural and historical contexts.

To enrich this analysis, the study also draws on secondary sources that examine the intellectual, political and artistic environments in which these works were created. Using a qualitative approach focused on content analysis, the research identifies key thematic and structural differences between the texts. It pays close attention to elements such as prefaces, chapter divisions, and language that reveal the authors' intentions, audiences, and conceptualizations of architecture. Beyond the texts, the study situates these works within broader traditions of architecture and historiography, considering the influences on their narratives, such as patronage, state ideology, and professional practice.

While previous scholarship has explored architectural authorship in single cultural contexts—such as Ackerman's work on Palladio or Necipoğlu's monograph on Sinan—comparative analyses across Ottoman and Renaissance treatises remain rare. This article aims to address this gap by placing these texts in dialogue with one another, without imposing a false equivalence.

By blending historical analysis with literary study, this research offers valuable insights into how architectural theory and biography have been constructed across cultural landscapes. It not only highlights the distinct voices of, Vasari, Palladio and Sinan, but also the interconnectedness of architecture, culture, and history in shaping their enduring legacies.

To support this cross-cultural comparison, particular attention has been paid to source selection and interpretive strategy, especially when engaging with the Ottoman treatises. While the study draws on English and Turkish translations of the Ottoman texts, limitations related to genre, translation, and the asymmetrical nature of the sources are acknowledged. The aim is not to assert a one-to-one correspondence between the works, but to explore how differing historical and institutional frameworks shape the way architecture is narrated and remembered. These methodological considerations are further complicated by the structural disparities among the primary texts themselves.

3. TEXTUALIZING ARCHITECTURE: RENAISSANCE AND OTTOMAN TRADITIONS

The Renaissance was a period of deep connections between art, science, philosophy, politics, and architecture. Architects of this period often worked under the patronage of powerful political figures and designed buildings that were not only symbols of wealth and power, but also of cultural and ideological dominance.

A number of important treatises were published during this period, which greatly influenced the intellectual and artistic community. These works allowed architects to share their methods, showcase their designs, and influence architectural practice. Some of the most important examples include Sebastiano Serlio's *I Libri di Architettura*, Giorgio Vasari's *Le Vite de' Più Eccellenti Pittori, Scultori, e Architettori*, and Andrea Palladio's *I Quattro Libri Dell'architettura*. These texts had deep roots in the foundational works of Vitruvius' De Architectura and Leon Battista Alberti's De Re Aedificatoria, both of which laid the groundwork for theoretical and practical advances in architecture.

In the 16th century, the Ottoman Empire began to develop its own tradition of architectural writing. The famous architect Mimar Sinan pioneered this by documenting his works and aiming to leave a mark on the historical record. His close friend Sai Mustafa Çelebi also played a key role, contributing two important treatises, *Tezkiretü'l-Bünyân* and *Tezkiretü'l-Ebniye*. Although these texts deal with many of the same issues, each emphasizes different structures, suggesting that they offer complementary perspectives on the architectural achievements of the period.

The tradition of writing about architecture in the Ottoman Empire continued to grow beyond Sinan and Çelebi. Other influential figures, such as the architect and historian Ali Kuşçu, contributed to these works with his Risâletü'l-Muhammediyye, which focuses on the geometric and mathematical foundations of Ottoman design. The Kitab al-Mimar, attributed to an anonymous Ottoman architect, also contributed by providing architectural plans and drawings of important buildings, offering valuable insights into the craft for future architects.

All of these treatises, which aim to document the architectural achievements of the empire, reveal different approaches and priorities. Some, like Sinan's, are more personal and reflect his individual experiences, methods, and challenges as an architect. Others, like Çelebi's, offer a broader perspective, emphasizing the teamwork involved in Ottoman construction and the roles of various craftsmen, engineers, and laborers. Together, these writings form a complex and layered record of Ottoman architectural practice and provide rich resources for historians and architects alike.

4. KEY FIGURES: GIORGIO VASARI, ANDREA PALLADIO, AND MIMAR SINAN

4.1. Giorgio Vasari and *The Lives of the Artists*

Giorgio Vasari, who is considered the first art historian, was an Italian architect, painter and writer. Born in 1511 in Arezzo, Tuscany, Vasari was the son and grandson of craftsmen. Vasari, who showed interest in art from an early age, carried out his work under the patronage of the Medici in Florence from 1530 onwards, and was left without a patron when Alessandro de Medici was killed in 1537. After this event, he traveled to Rome and Venice. Although he made paintings in which the influences of Michelangelo and Andrea del Sarto were seen, the book "Le Vite De' Più Eccellenti Pittori, Scultori, e Architettori", the first edition of which was published in 1550, brought him to the forefront as a writer. Vasari not only documented the lives of artists in his book but also provided important information about the cultural and artistic environment of the Renaissance while covering the broad period from the 13th to the 16th centuries. As Patricia Rubin has demonstrated, Vasari's Lives should not be read merely as a collection of biographies but as a carefully constructed historical narrative that elevates the artist as a central figure of cultural renewal, grounded in Florentine civic ideology [1]. When viewed from a contemporary perspective, it can be said that although the events recounted in the book are not entirely true, it is still used as an important source for understanding the personalities, lives, successes and failures of many Renaissance artists.

Vasari also advanced his career in architecture, playing a role in the construction and renovation of various buildings, including the Palazzo Vecchio in Florence and the design of the current Uffizi Gallery. He also served as the court architect of Duke Cosimo I de' Medici. Giorgio Vasari passed away in Florence on June 27, 1574, leaving behind a lasting legacy as both an artist and a pioneering figure in the field of art history

His approach, blending anecdotal storytelling with critical analysis and historical context, laid the groundwork for the field of art history [2]. Despite its occasional factual inaccuracies and the bias toward Florentine artists, Vasari's *Lives of the Artists* remains a foundational text in the study of Renaissance art and offers invaluable insights into the artistic and cultural developments of the period [3].

4.2. Andrea Palladio and *The Four Books on Architecture*

He was born Andrea di Pietro della Gondola in Padua in 1508 and later took the surname *Palladio.* Andrea Palladio stands out as one of the most important architects of the Renaissance. Palladio, who worked as an apprentice to stonemasons from a young age, was taken to Rome by Gian Giorgio Trissino in 1541. In Rome, he began to study classical architecture and ancient buildings. During these travels, the architect, who admired ancient structures, adopted classical proportions, orders and symmetry in his designs. These principles are clearly seen in his designs for his legacy villas and country houses.

I Quattro Libri dell'Architettura (*The Four Books on Architecture*) was first published by Palladio in 1570. Much of Palladio's theoretical foundation draws from Leon Battista Alberti's *De Re Aedificatoria*—the first major architectural treatise of the Renaissance, published in 1485—as well as from the ancient Roman architect Vitruvius [4]. As James S. Ackerman argues, *The Four Books on Architecture* should be understood not simply as a manual of rules and proportions, but as a deliberate intellectual project that elevates architecture to the level of a liberal art rooted in classical knowledge and humanist values [5]. According to Ackerman, Palladio's systematic approach—through both text and drawing—reflects a broader Renaissance ambition to rationalize and legitimize architecture as an autonomous discipline. This effort to align architectural practice with the legacy of Vitruvius and Alberti also served to position the architect as a learned professional, capable of both building and theorizing. Seen in this light, Palladio's work is not only a reflection of Renaissance ideals but also a political and cultural statement about the architect's role in society.

A completeEnglish translation of I Quattro Libri was published in 1715 by Giacomo Leoni, an enterprising Venetian architect who had settled in London. In the following years, Palladianism became the dominant style in England [6].

4.3. Mimar Sinan and Risales

Born in 1489/90 in Ağırnas near Kayseri, Mimar Sinan—also known as Sinaneddin Yusuf or Abdulmennan's son Sinan—emerged as a defining figure in Ottoman architectural history. While the exact date of his birth and his ethnic background have been topics of debate, his architectural legacy is undisputed, spanning the reigns of four sultans, with notable contributions during the rule of Süleyman the Magnificent, Selim II, and Murad III. Mimar Sinan's groundbreaking approach to architecture established him as the foremost figure of 16th-century Classical Ottoman Architecture. In a context where artists and architects were less visible compared to their European counterparts, Sinan's decision to document his works—a rarity in Ottoman culture—reflects a conscious effort to secure his legacy. In the 1580s, nearing the end of his life, Sinan began authoring his own biographies.

Sinan composed three texts: Untitled Treatise (Adsız Risale), Risâletü'l-Mi'mâriyye, and Tuhfetü'l-Mi'mârîn. The first of these, the copy known as Untitled Treatise probably serves as an index for the biography that Mimar Sinan planned to write. Risaletü'l Mimariyye can be considered an improved version of Untitled Treatise. Tuhfetü'l-Mi'mârîn, on the other hand, is distinguished from the others by its index of works, although it shows similarities to both. After writing these works, Mimar Sinan may have thought that it would be more appropriate to leave literary writing to the experts. The reason for this may

be that literary culture in the Ottoman Empire was not based on prose as in Europe, but on poetry, and Sinan did not consider himself sufficient in conveying. The most extensive biographical account of Sinan's life and career is found in the treatises authored by his close friend and contemporary, Sai Mustafa Çelebi—*Tezkiretü'l-Bünyân* and *Tezkiretü'l-Ebniye*—which combine personal reflection with courtly narrative and architectural documentation.

5. A CROSS-CULTURAL ANALYSIS OF ARCHITECTURAL TREATISES

The treatises are analyzed based on their writing styles, sections, and how they portray the identities of architects and artists. Distinct cultural differences emerge in their approaches to architectural writing. For instance, Vasari's work is poetic and detailed, Palladio's treatise is didactic, and Sinan's writings serve as both a personal account and a record of achievements.

When comparing the Italian treatises with those of Sinan, significant differences become evident in aspects such as writing style, structural composition, and overall coherence. Although a comparison based on page numbers may not be entirely precise due to the varying editions of the texts, it nonetheless provides a useful basis for forming a general understanding.

In this study, the English translation of Vasari's *The Lives of the Artists*, published by Oxford University Press in 1998, has been used. The work spans 512 pages and includes visual representations of several artists' paintings and sculptures. However, following the descriptions of artworks and the narrative progression within the text can occasionally present challenges. Vasari's language can be characterized as possessing an ornate, almost poetic quality. Given his background as a painter, it is likely that Vasari intended to translate visual expressiveness into written form. For this research, the 1965 Dover Publications edition of Palladio's *The Four Books of Architecture* has been referenced, which spans 581 pages. In this work, Palladio includes detailed drawings of both his own works and some of the structures he encountered in Rome. The treatise is written in prose and is relatively easier to read compared to the other two works to be examined.

Untitled Treatise, Risaletü'l-Mi'mariyye and *Tuhfetü'l-Mi'marin* are found in *Sinan's Autobiographies: Five Sixteenth-Century Texts,* published by Brill in 2006. The English translation of *Untitled Treatise* is about two pages, that of Risaletü'l-Mi'mariyye is also two pages, while *Tuhfetü'l-Mi'marin* spans approximately twelve pages.

Sinan's *Tezkiretü'l-Bünyân* and *Tezkiretü'l-Ebniye*, published in 2003 by Koç Kültür ve Sanat in the book *Yapılar Kitabı: Tezkiretü'l-Bünyân ve Tezkiretü'l-Ebniye (Mimar Sinan'ın Anıları),* contain 80 pages, featuring a modern translation of Mustafa Sai's writings.

Thus, the five treatises of Mimar Sinan total 96 pages. In terms of length, Sinan's writings are much shorter than the Renaissance counterparts. This difference can be attributed to the contrasting approaches to prose and verse in the two regions' literary traditions.

Sinan's texts, like Vasari's, sometimes follow a non-linear narrative structure, making them harder to follow. One striking difference is that Sinan's writings do not include any drawings, highlighting the distinct ways in which architecture is conveyed in the two regions.

Another point of comparison in these writings is the perspective from which they are written. Palladio writes in the first person, while Vasari generally uses the first person but refers to himself as "Vasari" in the section about Michelangelo. Sinan, too, uses the first person in his treatises, but in *Tezkiretü'l-Ebniye* and *Tezkiretü'l-Bünyân*, there are sentences written in the voice of Sai. For example, in *Tezkiretü'l-Ebniye*, the phrase: "Raise your hand for prayer, O Sai, move your tongue in gratitude to God." [7] serves as an example of this shift. The few instances where both Vasari and Sinan's writings shift in voice might be due to different reasons. Vasari may have used his name to present himself as an independent figure in the narrative, while Sai may have aimed for his own name to be recorded in the work as the author.

Despite the significant differences among the treatises examined, contemporary historians suggest that the writers might have been aware of each other's works. As Necipoğlu points out, Vasari's depiction of the architect with divine/sacred titles like "saint" might suggest that Sai Mustafa Çelebi was familiar with Vasari's work [8].

Another connection exists between Mimar Sinan and Palladio. Norton suggests that Sinan may have obtained a copy of Palladio's text through the Venetian ambassador Marcantonio Barbaro and Grand Vizier Sokullu Mehmet Paşa [9].

5.1. Central Themes and Methodological Approaches in Architectural Treatises

Vasari's treatise is organized into three sections, the first section examines the artists of the 13th and 14th centuries, the second addresses those of the 14th and 15th centuries, and the third focuses on the 15th and 16th centuries. Rather than following a strict chronological order, Vasari structures his work based on artistic schools and stylistic movements, reflecting a thematic and pedagogical approach to the history of art.

Palladio's *Four Books on Architecture* is structured around four main themes: Fundamentals of Architecture, Residential Architecture, Urban Architecture, and Temple Architecture. This thematic organization not only reflects his engagement with Vitruvian principles but also emphasizes his intent to offer practical guidance for architectural practice. In contrast, Sinan's treatises are mainly concerned with the architect's own works and thus result in autobiographical sketches of the career of the architect and his achievements. The form of these texts allegorizes the increase and decrease in the work of Sinan, respectively, and provides clues on Sinan's academic conception and the cultural background in which he operated. Rather than presenting a comprehensive architectural theory, Sinan's treatises are rooted in personal narrative and the documentation of his monumental contributions to Ottoman architecture. As Gülru Necipoğlu notes, Sinan's treatises should not be interpreted as efforts to assert an individualist artistic identity, but rather as institutional texts shaped by the bureaucratic and ceremonial structures of the Ottoman court. In these writings, Sinan's voice emerges not as that of an autonomous artist, but as a loyal servant of the state, articulating architectural accomplishment through the lens of dynastic service and collective imperial representation. Necipoğlu emphasizes that this form of authorship reflects a distinctive Ottoman mode of professional self-fashioning, one that prioritizes duty and continuity over stylistic innovation or theoretical speculation [10].

5.1.1. Analyzing the Prefaces of the Treatises

The prefaces of the treatises provide insights into how political and religious structures shaped architectural narratives in 16th-century Italy and the Ottoman Empire.Prefaces are an important source for understanding Vasari. The author began the preface of the treatise by explaining historical processes. While mentioning that sculpture and painting were attributed to the Egyptians, he first mentioned that God used them in creating nature and expressed his gratitude [11]. There are contradictory expressions in the work. He mentions that important artists went to Constantinople when the Eastern Roman Empire was established, and that art in Europe declined even further [12]. This framing situates Vasari's historical account within a teleological narrative of cultural loss and renewal.

Palladio's preface, by contrast, contains few political references.it includes the architects he was inspired by. He first referred to the books of Vitruvius, Alberti, and Vasari, and then he used important figures such as Giacomo Sansovino [13]. Palladio concludes by expressing his gratitude to God.

In each of Sinan's treatises on the other hand a long space is first devoted to praising God. *Risaletü'l-Mi'mariyye* starts with the phrase: "All praise, gratitude, and unparalleled glory be to that magnificent Creator, Allah, the Almighty" [14]. Similar sentences are also present in the other four treatises. Later, the creation of man is discussed. In *Tuhfetü'l-Mi'marin*, where man is described as: "He created humanity by kneading water and mud and made it more distinguished and superior than other creatures through "the veil of perfection" [15]. The reason why the creation of man is discussed in each treatise may be that it

was used as an intermediary phase after God to praise the Prophet. In the treatises, Hz. Muhammad is described with words such as the beloved of Allah," "the reason for all creation," "the master of all creation," and "the essence of creation." This is followed by praise for the reigning Sultan of the time.
When the three works are examined, it is seen that the figures given in the preface that give the first impression about the work are different from each other. While Palladio expresses his gratitude to God after mentioning the figures he was inspired by, Sinan's treatises include God, the Prophet and then the sultans. Vasari, however, begins by referencing Alberti, whom he describes as "our artist," indicating that he considers him the progenitor of the development of art, before speaking of God, though his references to God focus more on his relationship with mankind rather than expressions of gratitude [16].

Vasari's treatise diverges from the others by discussing the origins of painting, sculpture, and architecture, as well as the decline of these arts following the fall of the Western Roman Empire. He refers to the groups responsible for this decline as "barbarians" [17], a term also used by Palladio in reference to those who disrupted the classical legacy of Ancient Greece and Rome. In both cases, the term functions within a classical historiographic framework, referring to non-Roman or non-classical groups rather than to any specific later religious or ethnic identities. In contrast, Sinan does not articulate a narrative of artistic decline rooted in a lost golden age. Rather than looking backward to a distant classical past, his writings reflect a vision centered on his own time. While engaging with earlier structures—including Ottoman monuments and Hagia Sophia—Sinan positions his own works as surpassing them, presenting the classical phase of Ottoman architecture as both a culmination and a pinnacle of architectural achievement within a continuous imperial tradition.

5.1.2. Exploring the Chapters of the Treatises

Vasari divided his into three parts while Palladio structured his treatise into four books. In the case of Mimar Sinan's treatises, this division does not occur, as each treatise consists of a single section. In terms of internal organization, Vasari provides information closer to his own time in his work. He characterizes the three periods he defines: the first as more immature, the second as having more pattern and a better style, and the third as the period of maximum progress. In the first section of his book, Vasari focuses on the lives of two artists. The work includes numerous events, but certain notable points stand out in the overall structure. Alongside the artists' works, the places of birth, their students, and occasionally the names of family members are provided.

The relationships between the patrons and the artists also play a significant role in the book. In the first section of Palladio's work, there are descriptions of materials, their uses, the quality of soil, foundations, wall types, methods used by the ancients in stone wall construction, column types, their bases, capitals, the forms of the architrave, the places the architect visited, proportions, and other building elements. The book also includes detailed information about the dimensions of each building element, materials that can be used, and warnings about incorrect uses. Palladio's work appears to have a didactic aim. He states:

"Although Vitruvius, Leon Battista Alberti, and other excellent writers have established very useful rules regarding the selection of materials, I will still make sure to mention the most fundamental ones so that this work will not seem lacking" [18].
Illustrations accompany each chapter to reinforce the textual explanations. Occasionally, Palladio interjects his own aesthetic opinions, such as:
"However, in many ancient buildings, I have seen Attic bases placed under the columns of this order, and I like this way more, so I have drawn this base on top of the pedestal" [19].
However, he argues that these aesthetic tastes should also adhere to certain rules, and it is by following these that the ancients produced beautiful works:

"Although variety and novelty can please everyone, these should not violate the principles of art and the dictates of reason. Therefore, one can see that although the ancients show variety, they never deviated from the universal and necessary rules of art, as will be evident in my books on ancient works" [20].

In contrast, Mimar Sinan's treatises, after the praises that serve as a preface, the architect begins to narrate his life. In each treatise, a similar sentence is included, where Sinan initially provides the name of his birthplace but does not mention his childhood or family. He then discusses his various assignments and his promotions as a soldier. Although he mentions these events in his treatises, he does not elaborate on the experiences within them. In the treatises written by Sai, however, the difficulties and significant figures in the processes are discussed. At the end, a list of the architect's buildings is provided. In *Tuḥfetu'l-Mimārīn*, the section immediately following the list of buildings can be seen as an attempt by the architect to present a systematic explanation. It emphasizes the importance of considering architectural principles, foundation types, and the stability of the land where a structure is built.

Tuḥfetu'l-Mimārīn differs from the other treatises in that it includes an epilogue section. It is also noteworthy that neither Palladio nor Vasari has such a section. In this part, Sinan explains how he was inspired by Hagia Sophia when designing the Süleymaniye Mosque.
In this context, when comparing Palladio, Vasari, and Mimar Sinan, it can be said that their treatises differ in terms of writing styles. Palladio's work is somewhat didactic, while Vasari's is biographical. Sinan occupies a middle ground between the two. While Sinan's treatises sometimes include historical information, materials, forms, and dimensions of his works like Palladio, his anecdotes about his life bring his work closer to Vasari's.

6. READING THE PERSPECTIVES OF ARCHITECTS THROUGH TREATISES

6.1. The Motivations and Intentions Behind the Writings

Vasari explains the reasons for writing his book in different sentences at various points in his work. . In the preface to the first book, he describes the purpose of writing as recording the current situation in case art faces a collapse again and ensuring that it can be overcome [21]. Additionally, one of the book's objectives is to describe the challenges faced by successful individuals and the methods they used. However, in this context, Vasari also mentions in the preface of the second part that he would focus more on the characteristics of the era than on the artists themselves [22].

Palladio mentions that he wrote his book to transform the remains of ancient buildings into a form that would be enjoyable for observers and beneficial for architecture enthusiasts [23]. Looking at the scope of the book, it is clear that Palladio focuses more on ancient works than on his own structures, indicating his intention to write a book that would extensively describe ancient Greek and particularly Roman architecture.

Sinan explains the reason for writing *Tuḥfetu'l-Mimārīn* as ensuring that the monumental buildings completed under his supervision remain as examples and memories in the pages of time [24].

When comparing the purposes of writing, it can be said that all three works were generally written with the goal of "recording history." However, there are differences in the details. Vasari wrote about the lives of significant artists other than himself in order to provide a light for future generations in case art collapses again. Palladio, on the other hand, describes the architecture of a different era, sometimes including his own work, to provide benefit to others. In this sense, both treatises aim to serve the public. However, it can be said that the goal of benefiting society is secondary in Sinan's treatises. During a period when there were no established examples of architectural historiography in the Ottoman context, Sinan's treatises aimed primarily to document his own era through the lens of his architectural works. His focus was on ensuring that his contributions would be remembered as defining achievements of his time. Unlike Vasari and Palladio, who construct broader historical narratives that frame individual artists and buildings within the evolution of their disciplines, Sinan positions himself and his oeuvre at the center, presenting his work as both a reflection and culmination of the Ottoman architectural tradition.

6.2. The Authors' Approaches to Describing Structures and Processes

In the second book, Palladio extensively discusses how residential architecture should be shaped according to the user. He refers to the beauty of the human body and emphasizes placing beauty where the eye can see, along with details such as the functions to be assigned to room sizes and which rooms should be used according to the season.

At this point, when discussing how decorations should be applied, the sentence "however, an architect is generally more obliged to comply with the wishes of those who are spending money, rather than with the criteria that should be taken into account" [25] is particularly noteworthy.

In the third chapter of the second book, Palladio introduces the villas he built for the city gentlemen. He describes his clients as gentlemen who possess noble, generous characters and excellent judgement, and thanks God for their listening to him [26].

From the fourth to the eleventh chapter, Palladio thoroughly examines the residential architecture of ancient Greece, Rome, and Egypt. In the twelfth chapter, he transitions to where villas should be located. Chapters fourteen and fifteen are dedicated to his own designs. In these chapters, he mentions the names of his clients and the regions they lived in, expressing his gratitude towards them. In the sixteenth chapter, he returns to discussing ancient villas. Chapter seventeen is dedicated to describing the innovations he implemented, how he used them, and where he positioned them. In this sense, it is evident that the order of the chapters is not chronological.

There is no mention in Sinan's treatises about how the desires of the clients influence the design language, which is found in Palladio's work. Since Sinan’s treatises do not include residential architecture, except for palaces, a comparison on this specific topic cannot be made. However, Palladio’s inclusion of clients' names and his gratitude towards them, in addition to describing them as having excellent judgment, bears significant similarities to Sinan’s treatises.

Palladio dedicates the third book to cities. This section includes roads, the positioning of roads, roads outside the city, their names, materials used, applications in antiquity, and bridges. He mentions the bridge built during the time of Caesar, as well as ancient bridges. In chapters thirteen and fourteen, he discusses the two bridges he built himself.

Similar to Palladio’s third book, Sinan’s treatises also include mention of aqueduct arches and bridges. The construction of the aqueducts of Kırkçeşme, commissioned by Sultan Süleyman to supply water, and the construction of Uzun Kemer, Kovuk Kemer, Güzelce Kemer, Mağlova Kemeri, Müderrisköy Kemeri, and Büyük Havuz, are detailed in the section "the construction of water arches resembling the sky" in *Tezkiretü'l-Bünyân*. The heights of these structures are also mentioned in the treatise. Sinan provides a few pages of information about how the aqueducts were built, with a particular emphasis on the Büyükçekmece Bridge. Details regarding the decision-making process, the location research, the technical specifications, and the costs of the bridge are provided.

However, there is no similar level of detail provided for the arches. Both architects discuss the techniques they used, but Palladio's use of drawings and greater emphasis on technical information make his explanations more robust. According to the numbers in *Tezkiretü'l-Bünyân*, Sinan built seven bridges and fifteen aqueduct arches. If Palladio’s book does not mention any other bridges he built beyond the two he describes, this reveals a significant difference in the number of bridges and arches between the two architects.

Sinan’s treatises provide more detailed information than Palladio’s work about the processes of building bridges and waterworks. He not only discusses technical accomplishments but also documents the practical difficulties he encountered. In *Tezkiretü’l-Bünyân*, he recounts a moment when Sultan Süleyman insisted that such issues be handled by the chief architect, remarking that “every task must be entrusted to its master.” [27]. Sinan then explains to the sultan that although a waterwheel could technically be

installed where the sultan had suggested, the location would not allow water to reach all areas. This anecdote underscores both Sinan's authority as an expert and the value placed on applied knowledge over theoretical speculation within the Ottoman imperial system.

Palladio dedicates the fourth book to temple architecture. Palladio reconstructs ancient temples according to Vitruvius' principles and includes his drawings in the book. The architect states that he did not add anything of his own to these drawings [28]. After providing information about where the temples should be located and their characteristics, he opens chapters on important temples in Rome. These chapters include the names, locations, construction dates, materials, and measurements of the temples, along with drawings. After covering the temples in Rome, Palladio also discusses those outside Rome (in Pola and Nîmes).

What is different about this section is that Palladio does not include any chapters about the churches he designed. Although he mentions designing the San Giorgio Maggiore Church in Venice in the second book, where he says, "Also, the churches in the shape of a cross are quite commendable... And in this form, I designed the San Giorgio Maggiore Church in Venice" [29], it is surprising that he does not dedicate a chapter to this church.

In Sinan's treatises, the chapters dedicated to mosques, which he considers a great source of pride, hold an important place. While it is written that he built 80 mosques and more than 400 smaller prayer spaces, the number of smaller mosques varies significantly between treatises. In particular, the number of smaller mosques is reported as being between 50-70 in other treatises, which is intriguing.

The first mosque discussed in the treatises is the Şehzadebaşı Mosque. Though much is said about Sinan's hard work during its construction, no technical details about the structure are given. Instead, the mosque is described with symbolic expressions, such as "its two minarets stood tall in front of an elderly man with a generous heart, ready to serve like graceful young men" [30]. For the Süleymaniye Mosque, similar symbolic descriptions are used. For example, the marble columns' origin, the four columns representing the four caliphs, the dome resembling the sky, and the stained-glass windows resembling the wings of Gabriel [31]. One of the most striking sentences in the Süleymaniye description is, "I showed all the care and effort in it, and created a work in which all arts were completed" [32]. This can be related to the Renaissance men who mastered multiple arts. Selimiye Mosque is described in *Tezkiretü'l-Bünyân* as "beyond the limits of possibility." While the mosque is described as being six ziras higher and four ziras wider than Hagia Sophia [33], these proportions appear to be symbolic rather than based on exact measurements. Similar to the other two mosques, symbolic descriptions are used for Selimiye. The dome is compared to a suspended ball, the crescent represents the prophet, and the arches to a rainbow [34]. Minarets are described as being taller than the nine layers of the sky.

When comparing Palladio's treatise with Mimar Sinan's treatises in terms of building descriptions, it becomes evident that Palladio adopts a more quantitative approach, while Sinan favors a qualitative one. Palladio places significant emphasis on ancient structures, meticulously documenting their proportions and technical details, whereas Sinan focuses on describing his own works, highlighting their symbolic and aesthetic aspects.

In comparing Vasari and Sinan regarding biographical narratives, both prioritize the storytelling of events over detailed architectural descriptions. Vasari's work, encompassing all forms of art, does not dedicate specific sections exclusively to architecture. However, he allocates chapters to prominent Renaissance architects such as Brunelleschi and Alberti. The section on Brunelleschi stands out as one of the more extensive parts of the book. Interestingly, in this section, Vasari shifts from his usual detailed descriptions of artworks to focus heavily on the events surrounding Brunelleschi's buildings, offering limited insight into their technical characteristics.

The processes Vasari describes are valuable for comparing the architectural processes of the Renaissance to those of the Ottoman period. A notable event in the life stories Vasari describes is the architects' participation in competitions to bring their projects to life. The dome of Santa Maria del Fiore was

brought to life in this manner, and the process was recorded in all its intricacies by Vasari. During this time, the assembly asked Lorenzo to cooperate, but Brunelleschi refused. The fact that the architect had the right to make such a decision is an important piece of information regarding the artist's authority. When the architect went to Rome, the overseers pleaded for his return to Florence. A true Renaissance man, Brunelleschi chose architecture because it was more useful, aiming to reintroduce good architecture [35].

The section on Alberti, much shorter than that on Brunelleschi, mainly provides information about the architect's works, but Vasari's criticisms are also noticeable. According to Vasari, there were better architects than Alberti, but due to his treatises, he was believed to be very skilled [36]. However, it is mentioned that due to his insufficient application of theoretical knowledge, he made design mistakes [37]. In Sinan's treatises, there is a narrative that cannot be considered either autobiographical or biographical. Detailed information about family and sometimes childhood, which is found in Vasari's *The Lives of the Artists*, is not present in Sinan's treatises. Regarding the period when Sinan was devshirme, Sinan mentions it in *Risaletü'l-Mi'mariyye* with the following sentence: "Now, I recall the time when this little-known servant, truly the son of Abdullah, and in accordance with the Ottoman dynasty laws and the glorious imperial customs, known as Sinan, son of Abdulmennan, came to the Gate of the State along with other devshirme children from the Karaman province and Greek lands" [38].

After working in various roles, he mentions his promotions as a soldier. Although he refers to these events in his own written treatises, he does not mention what he experienced during these processes. In contrast, in treatises written by others, such as those by Sai, there are mentions of the difficulties he faced and important figures during the processes. For example, he was appointed as an architect to build a ship, and after being promoted to ship captain by the pasha's order, he was asked to build a bridge over the Prut River. During this time, Ayaz Pasha suggested adding a tower to the bridge, but Sinan rejected this idea. Lütfü Pasha, upset by this, mentioned that Sinan's fear was to become a janissary in the castle, but after it became clear that Sinan's decision was appropriate and his successes were recognized, he was offered the position of chief architect [39]. After accepting this offer, he worked as an architect during the reigns of Sultan Süleyman, Sultan Selim, and Sultan Murad.

Sinan, in his treatises, rarely mentions his personal life or the individuals he collaborated with. However, he provides significant details about the construction processes of key works such as the Şehzade Mosque, the Kırkçeşme water supply system, the Süleymaniye Mosque, the Büyükçekmece Bridge, and the Selimiye Mosque. While historical events are occasionally referenced in his writings, these mentions lack the depth and narrative detail found in Vasari's works.

Unlike Vasari's account of Brunelleschi or the deliberate career trajectories seen in the cases of Vasari and Palladio, Sinan's entry into architecture does not appear to have been the result of a conscious artistic decision. Rather, his career was shaped by the needs of state officials and his demonstrated architectural talent. Distinct from Renaissance artists, who often engaged in multiple artistic disciplines, Sinan devoted himself exclusively to architecture, creating monumental works that addressed the functional and symbolic demands of his era.

Furthermore, the competitive environment that characterized architectural practice during the Renaissance was absent in the Ottoman context. Architectural projects in the Ottoman Empire were managed by the Imperial Architects' Corps, an institutional body directly under the authority of the sultan. This system eliminated the need for competitions, as architects worked collectively within an institutional framework rather than as independent practitioners.

The differing objectives of architects in these distinct cultural and political contexts significantly shaped the evolution of architectural practice. While Sinan is credited with introducing numerous technical and aesthetic innovations to Ottoman architecture, his treatises reveal no explicit effort to distinguish himself from or critique his predecessors. In contrast, Palladio and Vasari both exhibit a tendency to elevate the architecture of a specific period while disregarding or criticizing other traditions. This suggests that the institutionalized nature of Ottoman architecture under the sultan's patronage fostered a sense of historical

continuity. Despite his contributions to the advancement of Ottoman architecture, Sinan's writings do not indicate an intention to redefine or revolutionize the discipline but rather to enhance its existing traditions. This contrast reveals not only differences in personal authorship but also diverging political and cultural mechanisms by which architectural authority was legitimized.

6.3. Architectural Practices, Collaborative Networks, and Cultural Contexts in Architectural Treatises

While Andrea Palladio provides extensive guidance on architectural principles and classical forms in *The Four Books on Architecture*, he offers little reflection on the social or professional identity of the architect himself. In Vasari's work, there are many stories about the relationships of architects and other artists with their patrons, the administration, and the papacy. These narratives generally reflect relationships of mutual admiration and trust between artists and their patrons. For instance, Cosimo de' Medici's trust in Donatello was so profound that he entrusted his son's education to him before his death [40]. Despite such expressions of trust and respect, artists often found themselves undervalued both materially and morally. Consequently, they were compelled to accept work that did not align with their desires.

These narratives also highlight the mobility of artists within Renaissance Italy, often accompanying their patrons to new cities, where they encountered diverse influences. For instance, after Pope Leo X, who was particularly interested in natural philosophy and alchemy, ascended to power, Leonardo da Vinci traveled to Rome with Giuliano de' Medici [41]. This movement between cities not only enriched the artists' perspectives but also provided opportunities to engage with new patrons and artistic circles.

In contrast, the patron-artist dynamic described in Vasari's treatise differs markedly from that of the Ottoman Empire. When detailing the construction of the Süleymaniye Mosque, Sai Mustafa Çelebi records how Sultan Süleyman's reaction to delays in the mosque's completion affected Mimar Sinan. While Sinan expresses a certain fear in this account, there is no indication of anger or direct confrontation. Although Sinan's treatises do not include discussions of his fees, it can be inferred that his position within the Ottoman court restricted him from openly criticizing governance. This constraint suggests that Sinan's writings lacked the degree of freedom seen in the works of Renaissance artists.
From patron-artist relations, the discussion naturally transitions to the collaborative and competitive dynamics among artists, another key theme in these treatises. Vasari provides a rich tapestry of anecdotes about how artists inspired one another, drew ideas from their peers, and even critiqued each other's work. These relationships, as well as their introductions to influential figures in cities they visited, reveal the social and hierarchical positions of artists and the respect they commanded. For example, Vasari mentions that Dante facilitated Giotto's introduction to Ravenna [42]. Moreover, Vasari notes that artists and architects frequently began projects they would later entrust to their assistants.

In stark contrast, Palladio's treatise is largely devoid of commentary on collaboration between architects, whether from antiquity or his contemporaries. Similarly, Sinan's treatises rarely mention the individuals who assisted him in his designs and construction activities. The sole exception is Kâtip Hasan, referenced in *Tezkiretü'l-Bünyân*. This omission may stem from the collective identity fostered by the Ottoman Architects' Guild, as well as Sinan's tendency to portray his projects as exclusively his own. This approach is also evident in the inflated number of buildings listed at the end of his treatises.

The theme of collaboration and mobility naturally extends to the broader context of travel, which played a pivotal role in shaping the architectural perspectives of Vasari, Palladio and Sinan. Vasari provides no evidence of having traveled outside Italy, while Palladio extensively toured Italy but only ventured beyond its borders once, to Nîmes, which he briefly describes in his treatise [43]. Sinan, on the other hand, particularly after joining the Janissary corps, traveled extensively across different regions. According to his treatises, Sinan visited Belgrade, Rhodes, Mohács, Austria, Baghdad, Corfu, Apulia, and Moldavia during his military campaigns. These travels significantly influenced his architectural vision. This is best exemplified in the following statement: "I worked with determination, like the fixed point of a compass, observing the center and its surroundings. Then, like the moving point of the compass, I was encouraged to travel to other lands" [44].

Travel not only shaped these architects' understanding of architecture but also reflected their broader engagement with cultural and religious contexts. At this point, it becomes necessary to examine how religious perspectives influenced their works and writings. Vasari made important criticisms on religion. According to him, with the acceptance of Christianity, the arts regressed even further [45]. The author criticized the clergy of the era for not being able to fulfill their duties properly. Despite this, the fact that he mentioned that there was not enough religiosity in his time shows that he was criticizing the way religion was lived, not the religion itself. Palladio, on the other hand, did not include his views on religion *in The Four Books on Architecture*. In each of Mimar Sinan's treatises, praise for God and the prophet is at the forefront. The effects of politics are seen even in the relationship with God. For example, in *Tezkiretü'l-Ebniye*, he said that he was "the chief architect who had many sins and hoped for the forgiveness of Allah, the Merciful", while he used the title "the forgiven sultan [46] for Sultan Selim. It was mentioned that architecture was the most difficult art and that the architect had to be religious, and that God's help was needed to find divine guidance for the immortality of the work. Sinan emphasizes the importance of divine guidance for achieving immortality through architectural works, underscoring the spiritual dimension of his craft. He writes that an architect must be devout, as architecture is "the most difficult art" and requires Allah's assistance to endure beyond its creator's lifetime [47]. However, the fact that the universe and the body are not permanent was reiterated in the same work.

When the treatises are compared, it can be said that in the Renaissance treatises, considering the gratitude lists in the preface, the author puts the human being in the foreground and expresses his gratitude to God through relationships and opportunities, while in the treatises of Sinan, he praises God and thanks Him just for the sake of being grateful.

7. CONCLUSION

The systematization of architectural practice, a hallmark of Renaissance Italy, finds no direct equivalent in the context of Classical Ottoman architecture. This divergence stems from fundamental differences in how architectural norms were shaped: while Renaissance architecture was increasingly theorized through formal treatises and framed by humanist ideals, Ottoman architectural practice evolved through cumulative traditions embedded in regional experiences and institutional frameworks. These norms were sustained by the sociopolitical and religious structures of the empire, which provided coherence without enforcing rigid codification. Yet this embeddedness did not exclude individual agency; on the contrary, it allowed for a wide range of local expressions to flourish within a shared civilizational paradigm.

Within this framework, Mimar Sinan's architectural discourse reflects a form of authorship rooted not in Renaissance individualism, but in institutional service and collective memory. As Gülru Necipoğlu argues, Sinan's self-representation is best understood as that of a bureaucratic figure whose professional merit was articulated through loyalty to the Ottoman state and the sultan's ideological agenda [48]. This positionality also shaped the form and content of his treatises. Unlike the extended, theoretically framed, and visually supported narratives of Vasari or Palladio, Sinan's writings are concise and function primarily as records of his professional accomplishments. Although these treatises occasionally reference the architect's career trajectory, the texts do not explicitly engage in political or social commentary. Instead, the structure and tone of Sinan's autobiographical writings reflect the conventions of a court-centered architectural culture, where authorship was subordinated to service and legacy was secured through monumental works rather than theoretical exposition.

This contrast in the structure and tone of Sinan's writings also helps situate them within a broader spectrum of architectural treatises. Positioned between Vasari's biographical-historical narrative and Palladio's technical-didactic treatise, Sinan's texts reflect both an intention to document architectural practice and a desire to record personal and imperial legacy. Sinan's works embody a unified vision of Ottoman architectural culture, in contrast to Vasari and Palladio, who emphasize specific periods while critiquing others. Vasari's writings foreground the social and interpersonal dynamics of the artistic community, while Palladio concentrates on architecture as a discipline. Sinan, by contrast, reflects both his personal role as chief architect and the larger political and cultural framework within which his work was produced.

When considering the role of these treatises in reading the history of architecture today, although it is seen that Sinan learned about individualization from the Renaissance and emphasized only himself (as an architect) while writing his works, it is read from the style of writing that the Ottoman state created Sinan, and that Sinan could not exist if there was no state and no sultan. By contrast, such institutional embeddedness is not as prominent in the works of Vasari and Palladio. As important members of Renaissance society, architects and artists sometimes challenged the person they encountered in *The Lives of the Artists*; for this reason, they sometimes migrated to different cities and sometimes were displaced. The absence of substantial references to power or religion in *The Four Books on Architecture* underscores Palladio's relative autonomy as an individual within his cultural context. In this context, when comparing the treatises, it can be said that the holistic identity of the Ottoman architecture and architectural environment is also reflected in the style of writing of the treatises. The same situation also reveals the effect of the existence of a person as an individual in the Renaissance on the form of literature. Consequently, although the authors may have been aware of each other's works, their treatises must be understood within the specific geographic and cultural contexts that shaped them. Ultimately, these differences in how authorship, individuality, and institutional power are represented underscore the culturally contingent nature of architectural discourse and the treatise as a genre.

The contrasting narrative styles of these treatises reflect broader cultural and institutional differences. The holistic identity of Ottoman architecture and its cultural environment is mirrored in the writing style of Sinan's treatises, just as the emphasis on individualism in Renaissance Italy shaped the narrative approaches of Vasari and Palladio. While these authors may have been aware of other architectural traditions, their treatises are fundamentally shaped by the intellectual and political institutions specific to their own cultural contexts. These treatises, therefore, not only document architectural practice but also serve as reflections of the broader cultural, political, and intellectual landscapes of their respective eras. In this manner comparative framework offers a model for rethinking architectural authorship beyond Eurocentric paradigms, revealing how different civilizational logics generate distinct forms of professional identity. Architecture here speaks not in stone alone, but in sovereignty.

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Review Article GU J Sci, Part B, 13(3): 353-368 (2025)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

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Audibility Assessment of Fire Alarm System Sound Level for Industrial Processes

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Article Info

Received: 06/06/2025
Accepted: 29/07/2025

Keywords

Fire Alarm
Hazard Alarm
Occupational Noise
Industrial Process Noise
Low Frequency Noise (LFN)

Abstract

Fire alarm systems are the first stage of fire evacuation. The audibility of the fire alarm is of vital importance. In industrial buildings, there is almost continuous occupational noise. Variables such as duration, frequency, level and frequency range of this noise may vary depending on the work performed. In this study, the audibility of the fire alarm when it sounds during the process is evaluated. Audibility is based on the sound level. Sound levels for various processes were obtained from the literature.

In our country, the sound levels of audible fire alarm systems are specified in the "Regulation on Fire Protection of Buildings". According to this, the lowest alarm level is 65 dB(A), and the maximum total is 75 dB(A) with +10 dB(A) in places characterized as "noisy". The maximum sound level allowed by the regulation is 120 dB(A). The sound level generated in the environment was calculated by calculating the fire alarm sound level and the sound levels of the processes together. Looking at the audibility of the fire alarm with sound levels based on processes, it was observed that the alarm was generally masked at low sound levels and the process was masked at high sound levels. In other words, the results show that the fire alarm sound level at the lower limit is not sufficient for process noise, while the fire alarm level at the upper limit corresponds to the "pain threshold".

1. INTRODUCTION

Fire is one of the most frequent catastrophic event [1]. Fire accidents can cause major loss of life, economic and ecological damage [2], [3], [4], [5]. Reducing risks is necessary to ensure safety of life and property [6]. Fire safety of buildings and reduction of fire risk are ensured by design or performance-based methods. The "Regulation on the Protection of Buildings from Fire" (BYKHY) in force in our country (BYKHY) [7] is based on the provision and is mandatory [8]. Specify what the measures are and how to implement them [5]. The Regulation describes how the building should be rather than how the building should behave [8], [9]. Article 81 of the BYKHY sets out the limits on fire alarms. Article 81-(5) of the Regulation: "Audible warning devices shall be placed throughout the building, measured at a height of 150 cm from the ground and the sound level shall be at least 15 dBA above the average ambient sound level. In sleeping areas, bathrooms and showers, the sound level must be at least 75 dBA. Audible warning devices must have a sound level of at least 75 dBA and at most 120 dBA at a distance of 3 m. It is not necessary to install a siren system in the volumes with an emergency announcement system speaker." [7].

Separate attention should be paid to fire safety in the design, implementation and operation phases of buildings. Each stage needs separate safety measures [10]. Fire alarm systems are one of the fire safety measures that initiate the escape and the designed fire scenario used in the operation phase of buildings. Fire alarms with different features can be preferred according to the intended use and intensity of use of the building. "Fire alarm system is a system that includes signal-alarm devices that automatically detect and transmit the fire situation." is designed to work in different environments. [11]. They usually consist of thermally sensitive materials that can detect heat. The material senses the heat and converts it into an

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electrical signal and triggers the fire alarm system [11], [12]. The system may give an audible or light warning [12].

Audible warning systems may not always be sufficient in case of fire. Even if the sound is heard and attracts attention, people may ignore the warning [13]. In the literature, the terms "unwanted alarm", "false alarm", "malicious alarm" and "unknown alarm" are used for alarms that sound in a situation that does not require danger or warning: "unwanted alarm", 'false alarm', 'malicious alarm' and 'unknown alarm'. False alarms occur frequently in automatic fire alarm systems. Because of this, people tend to ignore alarms. This has even been identified as a potential hazard by the US National Fire Protection Association (NFPA) [14]. For these reasons, the detection and alarming scenario should be designed and implemented to minimize error. However, the opposite is also true. Even if the fire or hazard alarm works correctly, people may not recognize or hear the alarm and the evacuation process may be delayed. The background noise level of the environment is one of these factors. It can make alarms difficult to hear and pose a safety hazard [15]. Noise is common in environments where industrial activities take place. It is one of the most serious risk factors in industrial environments. Noise control is of great importance for human life [16], [17]. Hearing loss from occupational exposures accounts for around a third of all occupational diseases in Europe [18], [19]. The level and duration of occupational noise exposure is limited in many parts of the world [20]. The American Occupational Noise Exposure Regulations set the noise exposure of industrial workers at 90 dB for 8 hours [20], [21]. In Europe, this value is recommended at 85 dB for 8 hours [22], [23]. Turkiye is in the category of developing countries, and workers and people living near industrial facilities throughout the country are exposed to noise ranging from 70 to 100 dB(A). [24], [25], [26], [27]. These values are higher than the values stipulated in national and international regulations and directives [24], [28].

Industrial plants are a source of noise both internally and for the environment [29], [30]. They may cause various occupational noises depending on the working area and hours. These occupational noises can be constant, intermittent or fluctuating, except for frequency ranges [24], [31]. It can also be defined as regular and irregular according to the number of repetitions and duration of the noise. Each type of noise has a different definition and impact on humans [32]. The production and process in the industrial plant is the main determinant of the type of noise [33]. When there is more than one sound source, the dominant source may overpower or mask the other source [34]. Therefore, the identification of the temporal and physical variables of the noise type plays an important role in characterizing process noise and occupational noise. Several studies have been carried out on the identification of industrial noise and its propagation according to the room in which the process is carried out [35], [36], [37], [38]. The models developed are limited to predicting noise levels only. However, room dimensions, absorption of materials and the reflection time of the room, surface forms and room shapes can affect and change the noise level, frequency ranges and duration of noise to which the worker is exposed [35].

Noise in the low frequency range (LFN) makes up most of the naturally or artificially generated noise we are exposed to in everyday life [24]. Wind noise, sea waves, airport, highway and industrial noise can fall into this category. Industrial areas and activities, compressors, pumps, diesel engines, ventilation and air conditioning systems and many industrial machines are considered sources of LFN [24], [39], [40]. According to the World Health Organization (WHO): *"...health effects from low-frequency components in noise are generally estimated to be more severe than those from community noise."* Since the early 2000s, studies have recognized LFN as a serious public health problem [41].

Studies on LFN can be limited starting from the lowest audible frequency (16 Hz) [24], [42]. In some cases, the lower limit may be started at 10 Hz for operational sensitivity and to calculate the total exposure [24], [39], [43], [44]. As an upper limit, the frequency range of the noise under investigation is considered. Generally, above 310 Hz can be considered as the upper limit of the LFN as it is considered a mid-frequency. However, depending on the noise spectrum, this upper limit can be increased up to 500 Hz. [24]. LFN type noises can reach farther distances than high frequency noises (due to high wavelength and high energy), less loss when passing through any wall [24], [45], [46], is likely to cause further damage to the wall.LFN noises can generate mechanical vibration. It can be categorized as both air-born and solid-born noise. LFN is less conspicuous than high-frequency noise, causing a feeling of relaxation

when the sound stops [24]. It can cause serious health problems in humans and animals. While studying the condition of animals exposed to LFN, Cavacas found severe tooth wear in rats regularly exposed to cotton fabric production process noise (industrial, occupational noise) in a textile factory [47].

This study was conducted to examine the audibility status of the minimum sound level specified in the "TS EN 54-3+A1:2019" standard (TSE 2019) and "TS EN 54 - 14" (TSE 2018) standard, which fire alarm systems must comply with according to the "Regulation on the Protection of Buildings from Fire" (T.R. Presidential Regulation 2007) dated 19/12/2007 official gazette.

2. METHOD

Within the scope of the study, various types of industrial facilities were identified and their existing background noises according to their production processes were obtained from the literature. The sound levels generated in the environment were calculated when the fire alarm in TS EN 54-3+A1:2019 and TS EN 54 - 14 standards operate at minimum sound levels while production continues in the facility (when background noise is present). The "audibility" assessment of the sound levels was made by comparing the results obtained.

3. TYPES OF INDUSTRY AND OCCUPATIONAL NOISE LEVELS

10 industrial types in Turkiye were analyzed. These are: Wood, energy, food, pharmaceutical, construction, chemical, mining, machinery, automotive and textile industries. For each of these industry types, 2 processes were selected.

The wood industry is a long and complex industry, from the extraction of raw materials to the final product. Wood is a biodegradable, renewable, recyclable material. So it is one of the sectors where waste generation is relatively low (compared to plastics or cement, for example) [48]. Production and marketing of raw wood or wood-based products for paper, construction and fuel [49], [50], [51]. In the wood industry, the sound level for the "carpentry" process is between 83.2 - 105.8 dB(A) [52], [53], [54]. The "compressed air blowing" process has a sound level of 104 dB(A) [52], [55].

The energy industry consists of a well-established industrial chain. It mainly consists of mining, processing and chemical industries [56]. It involves different types of processes depending on the raw materials used. Energy is an essential need for large masses of people. Today, China is the world's largest energy consumer [57]. The energy produced by renewable and non-renewable energy sources is transmitted in various ways to living spaces, industrial facilities and areas in need of energy and is used by converting it into different types of energy such as electricity, water and movement. The energy sector is one of the most renovated sectors. Various renovations are needed for both raw materials and the way energy is produced (process) [58], [59]. Energy reform, accelerating the energy transition, reducing the carbon footprint are crucial for the energy industry and economy [56]. In the energy industry, "water treatment" and "generator" processes were evaluated. In water treatment plants, the processes work together in an open area since the flow and progress of water in the plant does not require separate spaces. For this reason, the sound level of the entire water treatment plant was evaluated, not a specific process. Occupational sound level in the water treatment plant is in the range of 60 - 94 dB(A) [60]. Generators are mechanisms that convert energy generated from fossil or renewable energy sources into electrical energy. It has shown many changes and developments until today. Generators are usually operated for certain periods of time. For this reason, the noise level of a generator can be evaluated separately in the start-up phase and separately in the operating phase. The highest noise levels in generators usually occur during the start-up phase. The initial noise level varies between 96.5 and 105 dB(A) [61]. The process noise level evaluated for the generator within the scope of the study is 86 - 105 dB(A).

The food industry is a branch of industry that includes the process from raw material extraction to final product packaging. It is one of the most important business items in our country and in the world. Periodic increase and decrease in production may occur according to raw material density and season. There may be different material productions according to the region where the facility is located. It may

include a different number of processes according to the end product. The duration, sequence, volume and cost of these processes depend on the type of raw material and end product. Closely related to the agriculture sector [62]. The processes “margarine production line with churn, pasteurizer and cooler mixer” for the food industry and “packaging” for the brewery were chosen. The sound level of the margarine production line process is 93 - 95 dB(A) [63], beer packaging sound level is in the range of 60.1 - 61.7 dB(A) [64].

The pharmaceutical industry is one of the fastest growing industries in our country and in the world. It was formed as a sub-branch of the chemical industry and over time became an industry type in its own right. Medicinal chemistry origin [65]. It has an intensive capital. It is an industry with intensive production in both developed and developing countries. [66]. Closely linked to the health sector [67]. Growing in direct proportion to global investments in healthcare [66]. For the pharmaceutical industry, “homogenization” (homogenizer machine) and “packaging” processes were preferred. The sound level of the homogenization process is in the range 73 - 78 dB(A) [63], the sound level of the packaging process is 74.6 - 76.5 dB(A) [64].

The construction industry is a sector where activity intensity and costs increase with population growth [68]. It has a long history [69]. It has a large share of production and consumption in our country and in the world. The construction sector is highly dependent on resource inputs, meaning that activity in the industry depends on regular production [70]. It is one of the largest sources of greenhouse gas emissions worldwide. It consumes 40% of the world's raw materials and accounts for 50% of carbon emissions [69]. It is an area where noisy processes take place at many stages such as demolition, production, logistics, where most of the work is physical [54], [71], [72].In the current Industrial Revolution 4.0 (IR 4.0) period, technological developments and digital transformations in the construction sector are aimed to create developments [73]. It is aimed to reduce manual work, increase efficiency throughout the sector, and identify equipment, procedures and operations with fewer failure problems [69]. Some processes in the sector are planned to be advanced with artificial intelligence: For example, modular and prefabrication production [74]. In this way, occupational health and safety risk factors in the processes can be reduced and any harmful effects in the work process can be reduced to lower levels (including the noise factor). In the construction industry, the sound level for the on-site production process (workshop) is between 61.9 - 91.2 dB(A) [19], [28], [52], [75]. The “packaging machine” process in the cement production plant, one of the construction materials, is 85 dB(A) [76].

The chemical industry is a sector in which various compounds that cannot be decomposed or are difficult to decompose are produced or used as raw materials [77]. It is closely related to many sectors such as food, cleaning, pharmaceuticals, defense [78]. It is also a sector that uses fossil fuel as raw material [79]. Chemical and pharmaceutical industries are the two most inefficient sectors in terms of carbon recycling [67]. The chemical industry can lead to serious environmental problems and has an impact on the increase of environmental pollutants [80]. Causes direct and indirect emissions [81]. In terms of controlling environmental pollution in chemical industry plants, various process additions can be made for the transformation of waste products: Heavy metal separation process, fenton process for wastewater treatment [80], [82]. “Centrifugal pump” process and “granulator” process were preferred in the chemical industry. The double suction volute pump has a sound level of 60 - 75 dB(A) depending on the speed at which it is operated. [83], granulator has a sound level range of 73 - 79 dB(A) [63].

The mining industry is an old industrial branch that proceeds by obtaining raw materials (minerals), processing them and delivering them to the market [84]. Classified as underground and surface mining [85], [86]. The main objective of the sector is to provide raw materials for other types of industry. It also contributes to the national economy by creating new employment areas in rural areas [87]. Mining is a sector closely linked to the supply chain [84]. Arbitrary and unplanned mining activities have led to environmental problems. Examples include topsoil degradation, atmospheric pollution, release of toxic substances, water pollution, vibration [84]. For the mining industry, “ball mill” and “coal mill” processes were preferred from the coal processing stages. The sound level of the ball mill process is 96 dB(A) [88] the coal mill is 102 dB(A) [76].

The machinery industry is a field closely related to almost all sectors where basic actions such as manufacturing, automation and production take place [89]. The products coming out of production are used both in other industries and as end products. Industrial Revolution 4.0 has brought serious developments to the machinery industry [90], [91]. Connectivity and communication standardization in particular have come a long way. Modern industrial machines, devices and processes are equipped with communication systems that support such processes [90]. In the machinery industry, the "annealing furnace and finishing" and "exhaust system" processes were selected for the manufacture of parts for plumbing equipment. The sound level of the annealing furnace and finishing process is 88.7 dB(A) [92], exhaust system (for standard screwdriver) sound level is 96 -108 dB(A) [15].

The automotive industry is one of the largest sub-branches of the manufacturing sector. It is formed by the combination of different sub-disciplines such as mechanics, electricity, materials, logistics and engineering. It has a wide range of human resources [93]. The automotive industry is a complex sector with different processes by which different parts are manufactured and assembled. The automobile industry is important for the development of the country, supporting economic and social progress. Automobile production is very high, especially in developed countries. Some of the materials used in production are serious pollutants for the environment (e.g. paint) [94]. Various research are being carried out to recycle the residual products [95]. In this way, it is planned to increase efficiency and reduce carbon footprint in the automotive industry in the Industrial Revolution 4.0 [93]. According to a sound measurement and calculation study conducted in an automotive factory in Mexico, the sound level for the "wiring harness assembly" process for the automotive industry is 99.41 dB(A) [96]. 95 dB(A) is assumed for the air compressor process [76].

The textile industry is one of the most important manufacturing industries in the world [97]. It includes the processes from raw material to fabric production to the final production. It is known that textile production and trade has been carried out in Anatolia for more than 3000 years. It is one of the sectors with high employment and export capacity in our country. [98]. It consists of three sub-branches: Apparel, home and technical textile [99]. The production process consumes large amounts of water and energy [97], [100]. The rapid expansion of the textile industry and the growth of the market have led to more intensive energy consumption. Accordingly, care is taken to adopt clean production (CP, cleaner production) in the sector. Efforts are made to reduce the carbon footprint of processes [97]. The textile industry is one of the most organized and fastest sectors. Its contribution to the growth of the country's economy is quite high [101]. Accordingly, it is a sector with a high employment and labor force ratio. Due to the use of different chemicals, their transformation and different processes, the majority of textile industry workers are exposed to high noise levels [102], [103]. In the textile industry, 2 processes were selected which are included in the home textile. The sound level of the "weaving loom" process is in the range 85.5 - 98.1 dB(A) [104]. These sound levels are in different ranges for different types of fabric and product weaving. For example, the sound level of the towel loom process is 88 - 95 dB(A), the sheet weaving process is 80 - 87 dB(A) [105]. Conditions such as modification and maintenance of benches may cause changes in sound levels [104].

4. INDUSTRIAL FACILITY INDOOR NOISE LEVELS DURING FIRE ALARM SYSTEM OPERATION

According to TS EN 54-3 + A1: 2019 and TS EN 54 - 14, the minimum sound level for fire alarm systems is 65 dB (A) [106], [107]. This value can be increased by +10 dB(A) for noisy areas. In other words, the minimum sound level for noisy areas can be increased up to 75 dB(A). The maximum sound level is determined as 118 dB(A) in TS EN 54 - 14 [106]. Industrial facilities are categorized as high noise areas [108]. Therefore, in this study, both 65 dB(A), 75 dB(A) and 120 dB(A) were calculated separately as minimum levels.

The sound level resulting from sound emitted simultaneously from two separate sources: It is calculated by the difference in sound level (SPL) between the sources. Accordingly, if the SPL difference between the sound sources is between 0 and 1 dB, 3 dB is added to the larger one, between 2 and 4 dB, 2 dB is added to the larger one, between 5 and 8 dB, 1 dB is added to the larger one, and between 9 and 10 dB,

0.5 dB is added to the larger one to obtain the total sound level. If the difference between them is more than 10 dB, the sound of the source with the lower sound level is masked [109]. Masking: The phenomenon whereby the sound of one of two simultaneously existing sound sources prevents the other from being heard. A sound with a low volume is not heard. In other words, it can be defined as an increase in the lower threshold of hearing [110]. Furthermore, the higher the level of the masking sound, the wider the frequency range in which it is effective.

Table 1 shows the sound levels that occur during the process and the sound levels that occur when the fire alarm operates at the same time. The cases where the sound with a small sound level cannot be heard are written as "masked". It is written according to the masking of the alarm or process. In Table 1, blue and orange colors are used according to the dominance of the alarm sound and process sound. In cells with color transition, the audible dominant sound changes in the process.

Table 1. *Industry Types, Processes, Sound Levels and Sound Levels When the Fire Alarm Sounds (A. Masked: Alarm Sound Masked, P. Masked: Process Sound Masked, *: alarm sound dominant, **: process sound dominant)*

Industry Type	**Process**	**Sound Level (dB(A))**	**Volume When Fire Alarm Sound (dB(A))**		
			Alarm: 65 dB(A)	**Alarm: 75 dB(A)**	**Alarm: 120 dB(A)**
wood industry	carpentry	83.2 – 105.8	A. Masked	84.2** – A. Masked	P. Masked
	compressed air blowing	104	A. Masked	A. Masked	P. Masked
energy industry	water treatment plant	60 – 94	66* – A. Masked	P. Masked – A. Masked	P. Masked
	generators	86 – 105	A. Masked	A. Masked	P. Masked
food industry	margarine production line	93 – 95	A. Masked	A. Masked	P. Masked
	beer packaging	60.1 – 61.7	66* – 67**	P. Masked	P. Masked
pharmaceutical industry	homogenization	73 – 78	74** – A. Masked	77* – 80**	P. Masked
	packaging process	74.6 – 76.5	75.1** – A. Masked	78* – 79.5**	P. Masked
construction industry	on-site production	61.9 – 91.2	67* – A. Masked	A. Masked – P. Masked	P. Masked
	cement packing	85	A. Masked	85,5**	P. Masked
chemical industry	double suction volute pump	60 – 75	66* – 75.5**	P. Masked – 78**	P. Masked
	granulator	73 – 79	74** – A. Masked	77* – 81**	P. Masked
mining industry	ball mill	96	A. Masked	A. Masked	P. Masked
	coal mill	102	A. Masked	A. Masked	P. Masked
machinery industry	annealing furnace and finishing	88.7	A. Masked	A. Masked	P. Masked
	exhaust system	96 – 108	A. Masked	A. Masked	P. Masked
automotive industry	wiring harness assembly	99,41	A. Masked	A. Masked	P. Masked
	air compressor	95	A. Masked	A. Masked	P. Masked
textile industry	towel loom	88 – 95	A. Masked	A. Masked	P. Masked
	sheet weaving process	80 – 87	A. Masked	81** – A. Masked	P. Masked

4.1 Evaluation

In workplaces, audible warnings are used to warn of dangerous situations. Audibility is therefore of vital importance, playing a role in ensuring safety [111]. Reducing noise levels to reasonable levels in production facilities will improve ergonomics and contribute to the audibility of fire and danger signals [112]. If this cannot be done, workers should be protected against noise with personal protective equipment. However, such measures also prevent the audibility of auditory warning systems. The audibility assessment of alarms and background noise varies according to frequency ranges. In this study, the average values of the sounds in the frequency octave band range were used. The rhythm, level and frequency values of the fire alarm to be used affect the audibility because the frequency range in which

the sound is effective increases as the level of the sound increases. Accordingly, the type of industry and process sound (physical condition) should be well evaluated when planning.

All processes in Table 1 except water treatment (energy), packaging (food), homogenizer (pharmaceutical), packaging (pharmaceutical), in-plant production (construction), centrifugal pump (chemical) and granulator (chemical) are fully masked by the fire alarm (65 dB(A)), which sounds at a minimum level while work is in progress. Of these processes, the alarm sound could be louder than the process sound in the water treatment, packaging, in-plant production and centrifugal pump processes. In all other processes, the process sound is dominant. When the processes are compared with the alarm of 75 dB(A), which is the highest value of the minimum sound level according to TS EN 54, masking occurs in all processes except carpentry (wood), water treatment (energy), homogenizer (pharmaceutical), packaging (pharmaceutical), in-plant production (construction), cement packaging (construction), centrifugal pump (chemical), granulator (chemical) and sheet loom (textile) processes. In water treatment and in-plant production there is a range of sound levels where both sounds can be heard (around 75dB(A) both sounds can be heard separately). Only in the packaging (food), water treatment, homogenizer, homogenizer, packaging, in-plant production and granulator processes is the alarm sound more dominant. All processes are masked at an alarm level of 120 dB(A), the maximum value recommended by the regulation for the alarm sound level. However, this sound level is too high for humans and is referred to in the literature as the "pain threshold" [110]. It should be taken into account that this sound level poses a risk to the auditory health of people both inside and near the building and may cause temporary hearing loss.

4. CONCLUSION

The results in Table 1 show that even the sound level of the basic processes in industrial production is higher than the sound levels specified in the "TS EN 54-3+A1:2019" and "TS EN 54-14" standard, which fire alarm systems must comply with according to the "Regulation on Fire Protection of Buildings" (BYKHY). The minimum alarm sound level is insufficient for the processes. Therefore, even if a fire alarm is sounded while the plant is in operation (or while the processes are being processed), the resulting sound level is insufficient in terms of audibility and warning. For this reason, various standards accepted in the world and in our country can also be used when planning the fire alarm.

TS EN ISO 7731: 2008 standard (Ergonomics - Hazard signals for public and work areas. Auditory danger signals) can be considered [113], this can also be included in the current regulation. However, the sound levels determined and recommended by this standard should also be evaluated for each line of work and applied with various limitations and conditions in the regulation. For example, ISO 7731 requires a 15 dB(A) difference between alarm and background noise at A-weighted sound level [111], [113]. Although this difference covers all volume levels, it causes an unnecessary loudness at high background volume. The standard also recommends audible alarms at this level as "sufficient but not always necessary", leaving the door open for other warning methods. In addition to dominating methods, performance-based methods can also be used to enhance the audibility of the alarm sound. One of these is scenario design. By determining different scenarios for the processes in industrial buildings, the alarm sound level can be regulated or alternative solutions can be produced for the most plausible and most risky ones. Thus, fire and alarm levels specific to the structure and process can be obtained and evacuation stages can be facilitated in case of fire. Both audible and visual warning systems can be developed. Such performance-based solutions can be added to or suggested in the regulation for industrial buildings. Such measures can accelerate evacuation in case of a disaster and reduce the loss of life to lower levels. In this context; the audible alarms recommended by the regulation should be reconsidered, further elaborated, limited and, if necessary, developed with other warning systems, especially for workplaces where physical production takes place.

It should be noted that this study was conducted solely on sound levels. It should be noted that audibility decreases at higher frequencies and that the audible frequency range varies with age[114]. Therefore, standards that may be included in the regulations should consider factors such as age and gender on a sectoral basis.

CONFLICTS OF INTEREST

No conflict of interest was declared by the authors.

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Research Article GU J Sci, Part B, 13(3): 369-383 (2025)

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PART B: ART, HUMANITIES, DESIGN AND PLANNING

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Spatial Organization in Traditional Residential Architecture: A Case Study of Lariha House in Iran

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Article Info

Received: 12/05/2025
Accepted: 05/08/2025

Keywords

Iranian architectural principles,
Spatial organization,
Traditional residential architecture.

Abstract

The theoretical framework of this study is based on Pirnia's five principles, which hold a significant place in Iranian architectural literature. These are human-centeredness, introversion, self-sufficiency, simplicity, and structural knowledge/proportion. The study aims to examine the core principles and spatial organization of traditional Iranian residential architecture through the example of the Lariha House, located in a hot-dry climate zone. Using a qualitative research method, the spatial elements (such as courtyard, iwan, room, wind tower, and sardab) are analyzed in relation to these principles. The building's layout prioritizes comfort, privacy, climate adaptability, and flexibility. This reflects the potential of traditional architecture to inform contemporary housing design. Accordingly, the study highlights the importance of preserving and reinterpreting local architectural values in modern design.

1. INTRODUCTION

Traditional architecture is a rich field of knowledge that encompasses not only the structural forms of the past but also the reflections of climatic characteristics and the cultural and social values of society in physical space. Especially the traditional residential architecture of Iran, with its multilayered structure, continues to inspire contemporary architecture on both the formal and conceptual levels. A systematic examination of this architectural heritage offers significant contributions to contemporary design processes.

Understanding the spatial organization of traditional Iranian houses requires a comprehensive perspective on their socio-cultural background and environmental context. Although researchers such as Ghobadian, Memarian, and Qayyoomi Bidhendi have contributed to the literature with cultural, climatic, and critical perspectives, Pirnia's work forms the foundation in defining the elements of Iranian traditional architecture [1, 2, 3, 4, 5]. Mohammad Karim Pirnia's five principles (human-centeredness, introversion, self-sufficiency, avoidance of excess, and construction knowledge/proportions) offer the most systematic theoretical framework.

The main objective of this study is to analyze the spatial organization of traditional Iranian architecture through the example of the Lariha House in the city of Yazd, a representative case of residential architecture in a hot-dry climate. Using Pirnia's principles as the main theoretical perspective, the study examines how these values are embodied in the design elements, spatial hierarchy, and environmental adaptations of the house. In addition, the study includes a brief comparative evaluation between traditional and contemporary housing models, emphasizing how selected traditional spatial strategies can contribute to sustainable and culturally sensitive design today.

In this context, the study focuses on the following key research questions:

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- How are the traditional architectural principles suggested by Pirnia reflected in the spatial organization of the Lariha House?
- How can these principles reinterpret the spatial organization of contemporary housing?
- How can conceptual transitions be established from traditional architecture to contemporary housing design?
-

In this study, the term "contemporary architecture" refers to the post-Islamic Revolution period (1979–present) in Iran, focusing on housing projects developed in recent decades in Yazd.

2. THEORETICAL FRAMEWORK

2.1. Spatial Organization

In an architectural context, the spatial organization refers to the design of space patterns where user behavior occurs, arranged with dimensional and conceptual variety [6]. In this process, social structures and contextual conditions are more influential than the designer's personal choices.

Traditional architecture evolves by adapting to a region's geographical, climatic, and cultural conditions. It is shaped by local materials and traditional methods, focusing more on function than form. Therefore, it reflects both the local culture and the lifestyle of its inhabitants.

Evaluating the spatial organization in traditional buildings requires considering cultural values, social relations, and belief systems. Spatial arrangements influence user behavior and express cultural identity through space [7].

2.2. Pirnia's Principles in Iranian Architecture

The five principles developed by Mohammad Karim Pirnia through a scientific and historical methodology have gained wide acceptance in Iranian architectural literature. These principles have been frequently cited by architects, scholars, and researchers working on traditional architecture. Despite their broad influence, no alternative framework offering a comparably systematic and comprehensive set of design principles has been proposed to date.

For example, Ardalan and Bakhtiar, in their seminal work *The Sense of Unity: The Sufi Tradition in Persian Architecture*, interpret Iranian architecture through the lens of Sufi philosophy, particularly the notion of "unity in multiplicity" [8]. While their approach provides valuable symbolic and philosophical insights, it does not constitute a structural or technical framework equivalent to that of Pirnia.

Similarly, Memarian, an architect and scholar who studied under Pirnia, has produced extensive research on traditional Iranian housing typologies, Islamic architecture, and vernacular design elements. Although he frequently refers to Pirnia's five principles in his writings, he does not propose a new or alternative set of principles but rather elaborates and builds upon Pirnia's foundational ideas [2, 4].

Given this context, the present study adopts Pirnia's five principles as its primary theoretical framework. These principles are explained below, based on Pirnia's original publications and related scholarly interpretations.

2.2.1. Human-Centered Design (Mardomvari)

The term Mardomvari is derived from the Persian word Mardom, meaning "people." It refers to the alignment of design with human scale and needs. In traditional Iranian architecture, this principle extends beyond physical dimensions. It includes user behavior, lifestyle, and social relationships [4, 5]. Design elements are shaped with attention to privacy, neighborly relations, and livability. Architecture is viewed not only as a technical field but also as an art that serves human life. Therefore, creating spaces that adapt to user actions is a primary goal. This principle can be observed in examples such as Persepolis. In this

complex, the king's private areas are small and simple, while ceremonial halls are large and grand, reflecting spatial design based on function [3].

2.1.2. Introverted Design

In traditional Iranian architecture, introversion refers to organizing spaces around a central courtyard. This layout limits visual interaction with the outside while enhancing privacy and climate comfort indoors. The prevalence of hot and dry climates, lack of natural greenery, and harsh sunlight in Iran contributed to the development of courtyard houses. The courtyard, called Hayat-markazi or Miyan-sera, offers visual richness and creates a cooling microclimate [1, 4]. Introversion is shaped not only by climate but also by religious and cultural values. Concepts such as privacy, modesty, and contemplation support inward-focused planning. Spatial divisions based on gender further influence this layout. In traditional Iranian houses, introverted design reflects both physical needs and social structures [2].

2.2.3. Self-Sufficiency

This principle emphasizes the use of local materials and available resources in construction. Architects sourced materials from nearby areas to speed up the building process and enhance harmony with the environment. A strong example is Persepolis (*Takht-e Jamshid*), which was built using stones from its surroundings. Similarly, one of Iran's oldest mosques, the Fahraj Mosque, used local thistles instead of straw for durability, both technically and biologically. However, quality was prioritized over locality, and materials were also sourced from distant areas when necessary. This approach shows that traditional construction was both practical and environmentally responsive [4, 5].

2.2.4. Avoidance of Excess (Simplicity)

This principle promotes simplicity and functional design by avoiding unnecessary decoration and spatial waste. In the traditional Iranian architecture, each element must serve a function, look appealing. Purely visual elements such as statues or reliefs are absent, reflecting both architectural logic and Islamic beliefs. The same idea applies to wall finishes: materials are chosen for durability and purpose rather than appearance. In this approach, every detail meets a need. Unnecessary size or ornamentation is seen as wasteful, and functionality and simplicity are prioritized [9].

2.2.5. Construction Knowledge and Proportional Harmony

Traditional Iranian architecture values aesthetics through technical knowledge, structural balance, and proportional design. The principle of Niyareş and Peymun reflects this approach. Niyareş refers to structural calculations, building techniques, and material knowledge, while Peymun refers to modular proportions used between parts of a building [10]. This proportional system ensured both aesthetic value and structural safety, relying on tested values instead of guesswork. Even builders in small towns could achieve the same quality as architects in large cities. This principle enabled harmony between structure and design, blending technical precision with artistic sensibility [3, 4, 11].
In this study, Pirnia's five principles are used to evaluate how the values embedded in traditional Iranian architecture are reflected in the spatial organization of the Lariha House in Yazd.

2.3. Climatic Context of Traditional Architecture in Iran

Climate is one of the most influential factors shaping spatial organization in traditional architecture. Each climatic region has unique architectural responses and spatial qualities. Iranian traditional architecture, examined in this study, is also strongly shaped by climatic factors [12].

Iran, due to its vast and topographically diverse territory, is divided into four major climatic zones: temperate-humid (north), cold-dry (mountainous areas), hot-dry (central plateau and desert regions), and hot-humid (southern coasts). Each of these zones has developed distinct architectural responses shaped by local environmental conditions, available materials, and cultural practices [1, 13].

Understanding the environmental context of traditional architecture is crucial for analyzing its' spatial organization and design strategies. Climatic factors such as temperature range, humidity, solar radiation, wind patterns, and precipitation directly influence building orientation, massing, material selection, and passive ventilation systems [1, 2]. Accordingly, traditional Iranian architecture showcases a variety of spatial and structural adaptations developed over centuries to ensure environmental comfort and sustainability.

The below table summarizes the main climatic regions of Iran, outlining their dominant environmental features and corresponding architectural responses (Table 1).

Table 1. *Climatic zones of iran and corresponding architectural strategies.*

Climatic Zone	Main Climatic Features	Urban Texture	Architectural Form and Spatial Layout	Passive Cooling Strategies
Temperate-Humid (Southern Caspian Coast)	- High rainfall - High humidity - Low temperature variation	- Open settlements - Wide distance between buildings - Wide streets and open areas	- Outward-facing plans - Elevated buildings - Sloped roofs, wide eaves	- Natural ventilation - Use of sea breeze - Rainwater control via sloped roofs
Cold and Dry (Alborz and Zagros Mountains)	- Long, harsh winters - Heavy snowfall - Low humidity - High temperature variation	- Compact settlements - Attached structures - Narrow streets - Sun orientation	- Inward-facing structures - Cubic/rectangular forms - Thick walls, small openings, low ceilings	- Thick walls for insulation - Snow on flat roofs as insulation - Sun orientation
Hot and Dry (Desert Regions)	- Very low rainfall - Very low humidity - Hot days, cold nights - High temperature variation	- Closed, compact texture - Shaded, winding streets with high walls	- Fully introverted - Central courtyards - High ceilings, windcatchers, basements - Domes/vaults	- Windcatchers (badgir) - Cool basements - Shaded courtyards - Natural airflow
Hot and Humid (Persian Gulf Coast)	- High temperature - High humidity - Low rainfall - Low temperature variation	- Semi-open texture - Controlled gaps between buildings - Settlements parallel to the coast	- Semi-introverted - High ceilings - Iwans and windcatchers - Service areas on ground floor	- Shading iwans - Perforated parapets on flat roofs - Windcatchers - Bidirectional airflow

The hot-dry zone covers a large part of the country and defines the basic characteristics of traditional Iranian architecture. In this zone, sunlight is strong and direct throughout the year. The northern, western, and southern slopes are semi-arid, while the central, eastern, and southeastern plateaus are desert regions. Cities such as Tehran, Mashhad, Isfahan, and Shiraz belong to the semi-arid zone; Zahedan and Yazd are in the desert zone. Clear skies and low humidity lead to sharp temperature differences. Key climatic features of this zone include low rainfall, low humidity, dry summers, cold winters, sparse vegetation, and dust storms [1, 13]. In this study, courtyard houses located in the hot-dry zone, which covers much of the country, are analyzed.

Although the hot and dry climate zone encompasses a vast area of Iran, the city of Yazd has been selected as the focus of this study due to its exceptionally well-preserved historical urban fabric and its' concentration of architecturally significant residential buildings. The selected case study, Lariha House, exemplifies the region's climatic architectural responses in a comprehensive and representative manner.

3. METHOD

This study adopts a qualitative case study approach to investigate the spatial organization of traditional Iranian residential architecture within its cultural and climatic context. The analysis focuses on the Lariha House in Yazd, a representative example of hot-dry climate architecture, selected for its well-preserved historical character and architectural richness.

The research involved a detailed examination of the spatial organization and architectural components of the house, using available plans, historical documentation, and photographic materials. These sources were utilized not only for illustration but also as analytical tools for understanding spatial hierarchy, functional distribution, and environmental strategies.

Following this analysis, the findings were interpreted through Pirnia's five principles to establish a theoretical perspective and assess how these values are reflected in the physical characteristics of the case.

Finally, the study includes a comparative reflection on contemporary housing in Yazd, discussing the differences in spatial organization, climate adaptability, and cultural integration to highlight how traditional strategies can inform sustainable and context-sensitive design today.

4. FINDINGS

As previously emphasized, the climatic conditions, along with cultural and social structures, play a defining role in shaping the spatial organization of traditional Iranian houses. In this context, the Lariha House, characterized by a central courtyard layout and an inward-oriented spatial typology, was selected as the case study. Constructed in 1864 during the Qajar era, this historically and architecturally significant building is listed on Iran's National Heritage Register [14]. Covering a total area of approximately 1,700 square meters, with about 1,200 square meters of enclosed space, it served for many years as a residence for prominent families in the region. The house includes three courtyards, six residential units, iwans (terraces), multifunctional rooms, a main entrance door, and an entrance vestibule (Hashti), all of which are characteristic elements of traditional Iranian architecture. Its design reflects principles such as privacy, functional hierarchy, and balanced transitions between spaces, as well as an emphasis on climatic adaptation.

The analysis presented in this section is organized into three steps. First, the spatial organization and main components of the Lariha House are examined to understand its functional and environmental logic. Second, the findings are evaluated within the framework of Pirnia's five principles, supported by a systematic table and visual references. Finally, a comparative discussion with contemporary housing in Yazd highlights key differences and explores how traditional design strategies can inform sustainable architectural practices today.

4.1. Seasonal Adaptability

Living spaces in the house were deliberately arranged around the courtyard in relation to sunlight and heat. This configuration is a common strategy in residences located in hot-dry climate zones. On the southern side of the courtyard lies the summer living area (*Tabestan-neshin*), which includes high-ceilinged rooms, a semi-open porch (*Eyvan*), a basement, and a windcatcher (*Badgir*), all serving as cooling elements. These areas, due to their deeper placement and shaded conditions, offer cooler interior environments.

In contrast, the northern side accommodates the winter living area (*Zemestan-neshin*), with its shallower depth which receives more direct sunlight and thus provides thermal comfort during the colder months. Additionally, there are seasonal sections located on the eastern and western sides of the courtyard that benefit from morning or afternoon sun exposure, making them suitable for spring and autumn use. While such transitional spaces are observed in some other traditional houses, their usage is generally more limited (Figure 1).

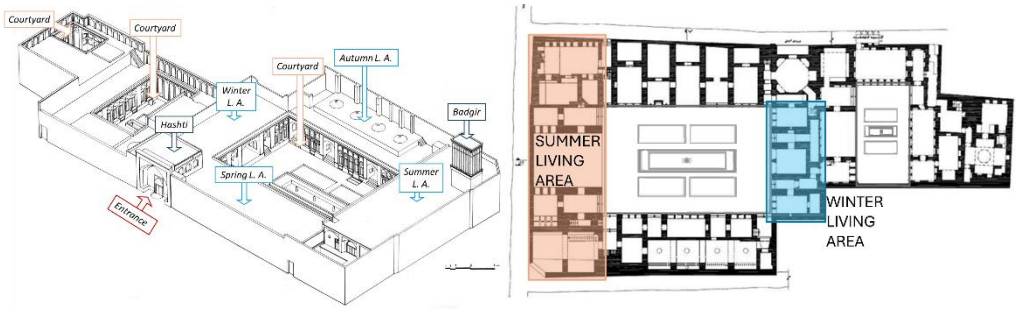


Figure 1. *Aerial perspective and floor plan of Lariha House.*

These shifts in space usage according to different seasons and times of day demonstrate the high adaptability of spaces. For example, during the summer, the southern rooms are used in the morning, the basement at noon, and the roof in the evening; while in winter, the northern rooms and the small, corner spaces with limited openings are preferred.

The hot-dry climate of Yazd has significantly shaped the architectural solutions applied in traditional houses. Figure 2 summarizes the relationship between climatic challenges, the spatial elements used to address them, and the corresponding architectural strategies.

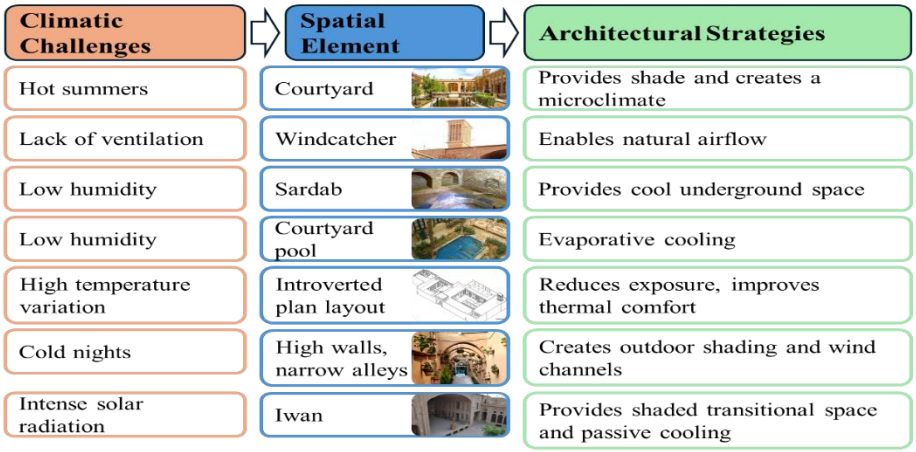


Figure 2. *Climatic challenges of hot-dry regions and corresponding spatial and architectural strategies in traditional Iranian houses.*

4.2. Spatial Planning Scheme

As a cultural reflection of spatial organization, the Enderuni–Biruni system, which separates household members and guests spatially, stands out. Biruni refers to the public areas of the house, located near the entrance, where male guests are hosted, while Enderuni defines the private spaces designated for women and family life. This system not only preserved privacy but also enabled hospitality. To implement this separation, a plan scheme with two or more courtyards was commonly preferred. Clear separation was achieved through distinct access from the entrance to each courtyard (Figure 3).

Figure 3. *Spatial organization of the Lariha House showing main functional zones: courtyard, entrance, public quarters (biruni), private family quarters (enderuni) and wind tower.*

4.2.1. Entrance

In traditional courtyard houses, especially those with central courtyards, all forms of external access were carefully controlled to protect the privacy of family life and to keep women's private spaces out of sight. This strict understanding of privacy directly influenced the entrance arrangement and created a spatial hierarchy. As in the case of the Lariha House, the entrance typically consists of three main elements: the main entrance gate (Sardar), the entrance hall (*Hashti*), and the corridors (*Dalan*). This tripartite system establishes a distinct transition between the exterior and interior spaces of the house.

The exterior façade is composed of brick walls plastered with a mixture of clay, straw, and water. While the façade presents a plain silhouette toward the street, the main entrance features a more elaborate design. Rather than a flat doorway, it is formed as a three-dimensional, semi-enclosed space that creates a sense of volumetric depth. This design breaks the two-dimensional perception of the outer walls and offers an inviting transitional space (Figure 4).

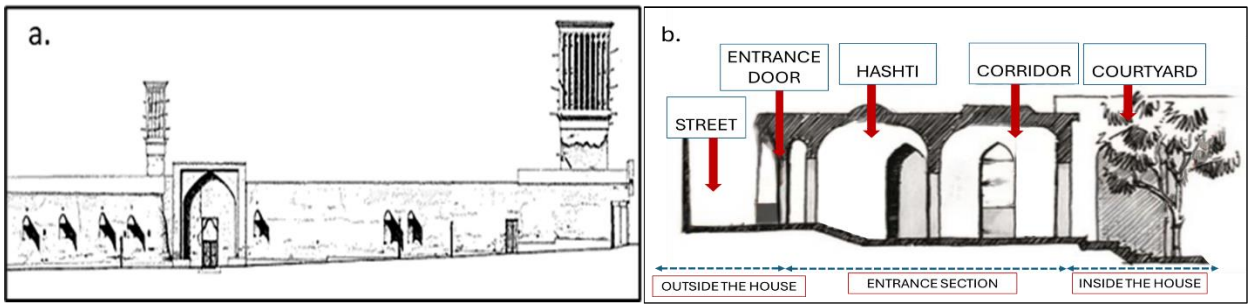


Figure 4. *a. Exterior view of Lariha House, b. Entrance section creating a hierarchical arrangement* [15].

The entrance gate opens into a space known as Hashti, located below street level. Derived from the Persian word Hasht, meaning “eight,” this space is typically octagonal in plan, although variations such as square or rectangular layouts also exist. The Hashti functions as a transitional zone between the outer gate and the corridors, defining the boundary between the exterior and interior of the house. From this space, the courtyard is accessed through narrow and winding corridors called Dalan.

Additionally, the Hashti served as a temporary waiting area or a short-term reception space, with seating niches embedded into the walls for guests. As a significant design feature, there is no direct linear path from the entrance gate to the courtyard; instead, the transition is arranged in an L-shaped configuration (Figure 5). This layout prevents direct visual access to private areas from entering, thus enhancing privacy.

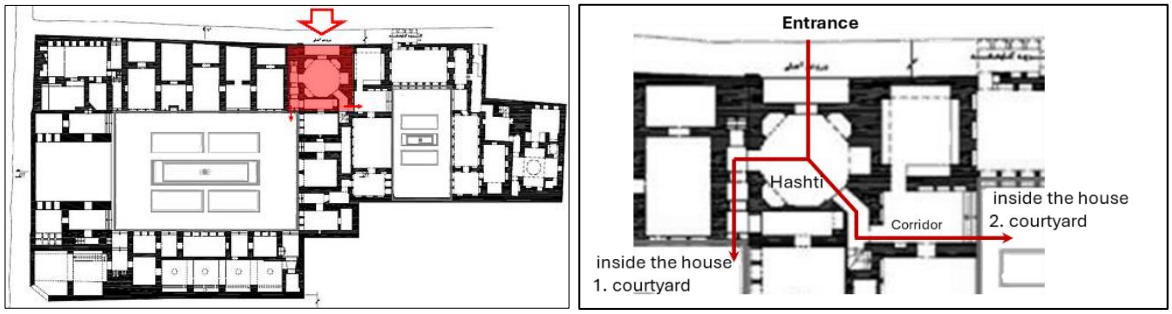


Figure 5. *Entrance of Lariha House.*

4.2.2. Courtyard (Hayat)

Inward-facing houses, which have no connection to the outside world other than the entrance gate, direct all their openings toward the interior courtyard, referred to as Hayat in Persian. These courtyards vary in number, size, the geometry of pools and gardens they contain, and the types of plants selected. In the Lariha House, there are three interior courtyards of different sizes, with enclosed spaces arranged around them (Figure 6).

Figure 6. *From left to right: The largest, middle, and smallest courtyards of Lariha House and their positions on the plan.*

Courtyards are among the key components of traditional houses, enhancing climatic comfort and forming the central core of the structure. As the social center of the house, the courtyard also serves as a visual focal point and a functional transitional space for the surrounding rooms. In terms of circulation, access to many parts of the house is provided directly through the courtyard. Likewise, the natural lighting and ventilation needs of the interior spaces are largely met through the courtyard.

Courtyards also play an important role in the passive cooling. During morning and afternoon hours, the shade cast on the ground and walls, along with the evaporation from soil, plants, and water within the courtyard, helps balance the dry air and improves its thermal performance. This effect becomes especially significant at night, when temperatures drop, turning the courtyard into a natural cooling system.

The central courtyard serves as a multifunctional living space that provides a more livable microclimate in contrast to the harsh desert climate. In the Lariha House, a large wooden platform (*Sedir*) is placed in the center of the largest courtyard, with its legs submerged in the pool. This platform was actively used on summer nights for dining, conversation, and relaxation, benefiting from the cool and humid air. Additionally, placing the platform's legs in water helped protect the occupants from dangerous scorpions, which are commonly found in the region.

4.2.3. Rooms

In traditional domestic architecture of Iran, the rooms (*Otaq*) are enclosed, multifunctional living spaces. Instead of distinct areas such as living rooms, bedrooms, or dining rooms, these rooms were used flexibly to serve various functions depending on the time of day and the needs of the inhabitants. Room names were determined based on the number of double openings, known as Door-Window (*Dar-Panjere*), that opened onto the courtyard. Accordingly, rooms with three doors (*Se-Dari*), five doors (*Panj-Dari*), and

seven doors (*Haft-Dari*) exist. In the Lariha House, there are a total of 22 rooms arranged around three different courtyards. These rooms are positioned approximately three steps above the courtyard level.

The most frequently used rooms, the three-door rooms, served as bedrooms at night and were multifunctional spaces used as living rooms, dining rooms, children's rooms, or guest rooms during the day. This flexible use was made possible by fully carpeting the rooms, avoiding large furniture, and storing space-consuming items in built-in wardrobes (*Pastoo*) or wall niches.

These rooms are designed to be human scaled according to the family's lifestyle and needs. Niches and shelves in the walls are placed at accessible heights, making them easily reachable while seated or standing.

Rooms with five or seven doors were mainly used for receiving guests. While the private three-door rooms of the homeowner feature simple designs, these guest rooms are larger and more elaborate. In the northwest corner of the central courtyard of the Lariha House, a seven-door room and the carved wall opposite it are symmetrically balanced. Similarly, the three-door rooms on the northeast facade and the five-door room positioned between them also exhibit spatial symmetry. The entry and exit to the rooms are not directly through the door-windows; instead, they are typically accessed via side corridors placed along the shorter sides of the room (Figure 7). This arrangement ensures that, especially during crowded gatherings, male and female guests access the room through separate entrances, creating a spatial layout that respects privacy. Additionally, these rooms traditionally feature slightly elevated *Shah-Neshin* areas for elderly individuals.

Figure 7. *The plan, interior, and exterior views of the three-door and five-door rooms of Lariha House.*

In a specific room called *Orosi*, there is a large central rectangular space surrounded by four smaller rectangular areas. These sections can be used together or separately according to the needs. This layout offers multifunctional usage options that cater to different numbers of users and allows for the merging or separation of spaces.

The design of the rooms is based on the golden ratio, with a focus on human scale. This proportion ensures controlled daylight entry into the interior, and the door and ceiling heights are also determined accordingly. When a higher ceiling is required for technical reasons, the height is balanced with a wooden suspended ceiling or an arched vault (*Karbandi*).

4.2.4. Talar, Eyvan

In addition to open spaces such as courtyards and enclosed spaces like rooms, semi-open spaces are also important and characteristic spatial components. In different climatic regions, semi-open spaces in houses vary in depth, height, and location, and are used seasonally for heating or cooling purposes. Semi-open spaces can serve specific functions, such as the Talar, which is an independent and larger area, or transitional spaces, such as the Eyvan, which connects open spaces to enclosed ones.

The Talar, with its high ceiling, depth, and semi-open structure, provides the advantage of natural ventilation as it does not directly receive sunlight under these climatic conditions. Positioned on the south

facade of the courtyard, along the central axis, and opposite the winter rooms, this space has an open, rectangular plan facing the courtyard. The Talar unit is situated approximately one meter above ground. Due to its location and design, it creates a shaded and cool area (Figure 8).

Figure 8. *Talar section of the Lariha House.*

The Eyvan, which is semi-open with three sides enclosed by walls and an open facade facing the courtyard, also maintains a strong spatial relationship with the courtyard, much like the Talar. It has become an important component both functionally and visually.

4.2.5. Basement (Sardab)

The main basement of the house (*Sardab*) is approximately 6 meters deep and is located towards Eyvan and the wind tower, accessible via 38 steps (Figure 9). Its ceiling is constructed in the form of a vault (*Tagh Tavize*) using plaster and reeds. This section, used as a cool living space during the summer months, is effectively ventilated through natural airflow provided by the windcatcher (*Badgir*) placed above it. Due to the higher placement of the upper units, it also receives daylight. Additionally, it functions as a water reservoir, supporting the thermal comfort of the building's interior. A second basement, serving as the *Baharkhane*, is located on the west facade of the house. The basements and storage areas of the house are connected by stairs leading up to the courtyard level, meaning these spaces are not independent or separate, but rather are considered complementary parts extending from the living areas above to the underground. Another use of the *Sardab* was for the storage of food items such as meat and legumes in its small rooms.

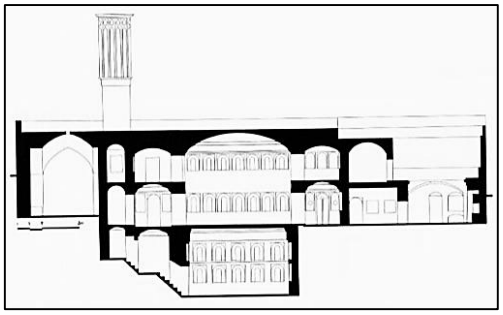


Figure 9. *Section passing through the Talar and Sardab sections of the Lariha House.*

4.2.6. Wind Tower

One of the most important and characteristic elements of Yazd architecture is the wind towers (*Badgir*). Some of these wind towers work solely based on the principle of natural convection (air movement due to temperature differences), while others use both convection and the cooling effect of evaporation together. In this system, the air entering the tower is humidified through a small pool and fountain placed beneath the tower, making it both cooler and more comfortable.

The main wind tower in the Lariha House is not aligned with the main axis of the courtyard but rather positioned at one corner of the Talar (Figure 10). This placement emphasizes the spatial relationship it establishes with the courtyard and Talar, enhancing its functional efficiency. In addition to the largest

wind tower, other wind towers are positioned in various sections of the house, serving the same purpose. These wind towers are in the summer section of the house, contributing to regulating the interior temperature by utilizing clean and renewable energy during the hot season.

In terms of operation, these towers take in the cool outside air and direct it to the lower living areas through internal channels, thus lowering the interior temperature. As a result, the interior temperature could be several degrees lower compared to the external temperature in the shade.

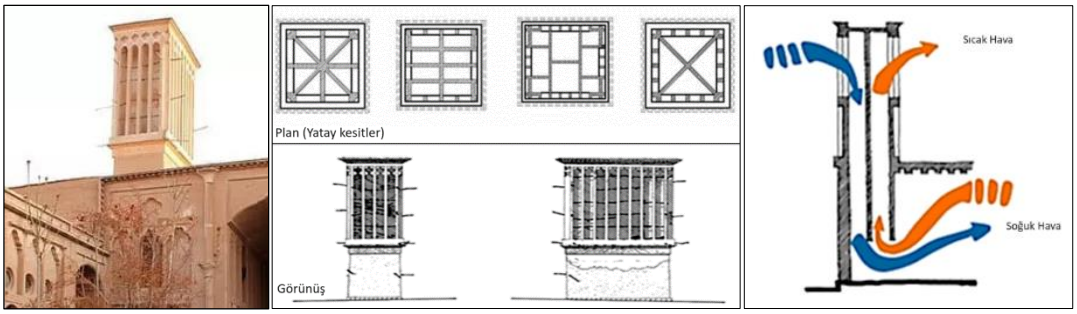
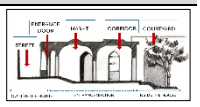
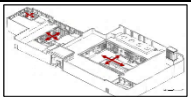
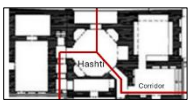


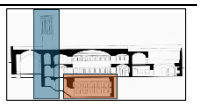
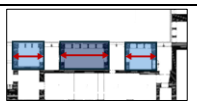
Figure 10. *From left to right: The wind tower of the Lariha House, the appearance, section, and operation system of the wind towers* [16].

4.3. Evaluation of the Lariha House in the Context of the Principles of Pirnia

At this point, it can be observed that the spatial components of the Lariha House are not only physical architectural elements but are also designed based on fundamental principles that shape traditional architectural thinking. The five fundamental principles outlined by Pirnia are concretely reflected in the structure through the spatial organization of the house, its climate adaptation, material selection, and the relationship with the social structure. In the table below, the spatial reflections of these principles in the context of the Lariha House are summarized, and the structure principal relationship is evaluated from a holistic perspective (Table 2).

Table 2. *Evaluation of the Lariha house in the context of the principles of traditional Iranian architecture.*

Iranian Traditional Architectural Principles	Spatial Reflections in Lariha House	
1. Human-Centered Design	• Room dimensions are human-centered, with niches and ceiling heights. • Multi-functional use of rooms. • Entry and exit configurations are suitable for privacy. • Seasonal internal migration between spaces for user comfort.	
2. Inward-Facing Design	• All openings directed towards the courtyard. • Separation of private areas through the Enderuni–Biruni distinction. • Indirect entry configuration (Haşti-Dalan) to block direct visibility. • Enclosed form with high garden walls.	 
3. Self-Sufficiency	• Use of local materials (adobe, plaster, brick, wood) in construction. • Provision of natural climate control through the wind tower. • Use of the Sardab for water and food storage.	

		
4. Avoidance of Excess	• Functional planning and determining the size of the space according to the type of use. • Use of decorations for architectural purposes. • Storing items in wall niches. • Designing circulation areas solely based on functional needs.	
5. Building Knowledge and Proportions	• The spaces are designed based on the golden ratio and with a symmetrical layout. • Establishing climatic balance; wind towers and pools. • Structural proportions based on static calculations.	

4.4. Traditional and Contemporary Housing Architecture

Lariha House, in terms of spatial components, is a residence that largely embodies the characteristics of traditional buildings. However, when reflecting these features in contemporary housing architecture, it is evident that not all components are fully applied today.

In the Iranian context, contemporary architecture generally refers to the period that began after World War II, from the 1940s onward, under the influence of Western modernism and continuing to the present day [17, 18]. This process is divided into two main periods: the Modernist period (1940–1979) and the post-Islamic Revolution period (1979–present). In this study, the term "contemporary architecture" specifically refers to the second period, following the Islamic Revolution. The selected residential example was chosen from among housing projects designed in the last two decades that have been recognized or awarded in this context. Accordingly, the "Yazd Garden House" project, designed by Mehdi Gerami and awarded second place in the residential architecture category in Iran in 2014, was selected as the example [19].

In this context, a brief comparison has been made to evaluate the role of spatial elements in traditional houses and their reflection in contemporary housing architecture. Nevertheless, these types of residences continue to inspire modern design as symbolic and cultural values. Particularly in fields such as sustainable architecture, passive energy use, and culture-focused planning, they serve as guiding examples and are an inspiration for designers (Table 3).

Table 3. *Comparison of spatial elements in traditional and contemporary housing architecture.*

Spatial Element	Role in Traditional Houses	Reflection in Contemporary Houses
Seasonal Adaptability	Usage of spaces such as summer and winter rooms based on the direction and depth of the rooms	Largely abandoned; fixed usage is preferred
Climate-Adaptive Spaces	Natural cooling through elements like Talar, basement, and badgir positioned according to the sun	Re-emerging in sustainable design, but not widespread
Spatial Organization (*Enderuni-Biruni*)	Spatial separation and privacy based on social status and gender of the users	Reduced due to apartment living, but partially preserved; limited to the separation of living room and lounge
Introversion (Spatial Isolation)	High walls and a central courtyard for maintaining privacy and protecting the building from the outside	The goal is maintained, but the form changes; houses with gardens are now outward-facing, with a high wall enclosing the area instead of being inward-facing

Entrance Elements (Visual Isolation)	Preventing direct visual access to the interior and blocking visual transitions	Function is preserved, though the form changes; entryways transform into halls and foyers
Central Courtyard (Hayat)	Creating microclimates, a central social space, and an open area where privacy is preserved	Reduced, but modern interpretations are being made; luxury homes use atriums and modern interior courtyards
Decorative Elements	Visual richness through plaster decorations, mirror works, stained glass, and wooden details	Changing and modernizing; traditional decorations are used in limited fashion in nostalgic and tourist-oriented projects

5. CONCLUSION AND RECOMMENDATIONS

The study of traditional architecture is of great importance, especially for architectural education and research. Recognizing the key principles, spatial components, and concepts that stand out in the architecture of each region is a valuable source for understanding the context and cultural identity from which these structures emerged. Traditional architecture not only provides physical solutions that adapt to climatic conditions but also reflects the values, lifestyles, and historical accumulation of society. Therefore, there is much to learn from this architecture to produce meaningful, sustainable, and contextually appropriate solutions for today's environmental and social issues.

In this study, the spatial organization of Lariha House has been analyzed based on the five fundamental principles identified by Pirnia, and the relationship between the building and these theoretical principles has been explored. The findings show that traditional buildings can serve as an inspiration for contemporary architecture, not only at a formal level but also at a conceptual one.

Based on this, the following recommendations for contemporary residential designs are proposed:

- In the context of spatial flexibility, providing multifunctional spaces instead of single-use rooms.
- Including courtyard-type open spaces or semi-open areas, considering their climatic and social effects in designs.
- Integrating passive climate control elements such as wind towers and basements with modern technologies to create sustainable solutions.
- Ensuring that cultural codes, such as privacy, are not ignored in contemporary designs, providing solutions that align with the user profile at both the formal and functional levels.
- For sustainable design, blending the use of local materials with contemporary materials and techniques.
-

In conclusion, rather than making literal formal copies from traditional architecture, producing responses to contemporary design challenges based on meaningful interpretations of the underlying principles is an important approach for both cultural continuity and architectural identity.
Conducting similar studies in different countries or architectural types will guide in creating creative solutions to contemporary issues based on local context, building a meaningful bridge between the past and the future. Guiding contemporary architectural problems with historical knowledge not only helps in understanding the past but also responsibly constructing the future.

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Research Article GU J Sci, Part B, 13(3): 385-400 (2025)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

http://dergipark.gov.tr/gujsb

Contextual and Participatory Approaches in the Adaptive Reuse of Historical Buildings: Erimtan and CerModern as Contemporary Exhibition Spaces

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Article Info

Received: 16/06/2025
Accepted: 05/08/2025

Keywords

Contemporary Museology, Adaptive Reuse of Historical Building, Public Engagement, CerModern, Erimtan Museum of Archaeology and Art

Abstract

Cities are not merely physical spaces but dynamic environments where historical continuity and social interaction persist. The sustainability of a city depends on the transformation of the built environment being shaped through an integrated relationship with historical accumulation, cultural values, and social dynamics. In this regard, it is important to reintegrate spaces remain unused within the urban fabric back into social life, in order to preserve urban identity and strengthen the sense of belonging. Emphasizing the importance of maintaining the connection between the space and its historical and social context, this approach reveals diverse layers of urban belonging. The aim of the study is to examine the potential of museum spaces to transform into discourse fields within the context of contemporary museology and to investigate the impact of spatial decisions on knowledge and meaning production throughout this process. The aim of addressing adaptive reuse and contemporary museology together in this study is to discuss design and construction strategies that can restore the original identities of historic buildings within a contextual integrity. The analysis examines the conversion of unused culturally valuable buildings into exhibition spaces. This framework investigated the Erimtan Archaeology Museum and CerModern as case studies. These two cases were analyzed in terms of contextual connection, cultural sensitivity, selection of spatial opportunities, and social participation. The study demonstrates that transforming historic spaces into exhibition areas within contemporary museology enhances spatial belonging and strengthens urban memory through their contextual and historical layers, thereby supporting sustainable transformation.

1. INTRODUCTION

Cities are multilayered spatial constructs that transcend their role as mere providers of shelter; they are dense sites of socio-cultural interaction, repositories of historical layers, and formative environments for individuals' sense of belonging. Each street, square, building, and space constitutes a site of memory that bears the traces of the past and evolves. According to Lefebvre [1] , every city becomes a meaningful space in individuals' lives and a constituent of their identity by embodying existing social structures and cultural heritage. The social structures of cities enable individuals to construct their identities and sense of belonging. To belong to a city and to identify with it allows individuals to establish a cultural bond through which they feel a sense of attachment. For instance, an individual who grows up in a built environment where historical and cultural identity has been preserved develops a deeper relationship with the city by internalizing its memory, history, and cultural codes.

1 This study was conducted as part of the course M5101 City and Identity, conducted by Assoc. Prof. Dr. Hilal Aycı during the Spring Term of the 2024–2025 academic year at the Department of Architecture, Graduate School of Natural and Applied Sciences, Gazi University.

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The streets, buildings, and squares of cities are not merely physical spaces but also social and cultural realms that shape and touch people's lives. Moreover, urban landscapes encompass architectural structures from various historical periods, bearing traces of the past. These structures are physical entities and symbols of social transformation, cultural interaction, and historical continuity. The buildings in a city's historic center may coexist with modern structures, symbolizing a dialogue between the past and the future. These buildings and spaces become integrated into the daily lives of urban residents and serve as essential elements in the formation of urban culture. For this reason, the role of historic buildings in society's collective memory is becoming increasingly significant within the urban context. In particular, the adaptive reuse of obsolete historic structures as 'sites of memory' is crucial for preserving and sustaining urban identity. The process of adaptive reuse not only ensures the conservation of these structures and fosters public engagement by transforming them into civic spaces and facilitating their reintegration into the urban fabric. Moreover, adaptive reuse can be seen as a design act that transforms the embedded knowledge of a building its past functions, forms, and meanings into new layers of collective memory. By reconfiguring the building through the creation of a design space, interventions that reinterpret its material, spatial, and contextual dimensions generate what Küçük [2] defines as knowledge in designing a situated and evolving form of knowledge integrated into the very essence of the building. This process also introduces a design input shaped through public reuse, allowing collective engagement to inform new meanings. Therefore, adaptive reuse is not merely a preservation practice, but a speculative act that repositions the building within urban and cultural memory with a renewed identity.

Contemporary museology plays a significant role in this process of adaptive reuse. According to Sandell [3], museums have moved beyond their traditional function as spaces for exhibiting and preserving artifacts, evolving into platforms for social dialogue, learning, and interaction. This transformation enables museums to deepen their relationship with the city and its inhabitants, ultimately becoming active agents in the construction of urban identity. The use of historic spaces as exhibition venues contributes to their preservation and enhances public engagement, thereby supporting the transmission of cultural heritage to future generations. As Vergo [4] says, contemporary museology transforms the traditional museum concept by prioritizing interaction and participation, and incorporates diverse methods that encourage visitors to engage with the museum experience actively. In contemporary museology, interactive exhibitions, workshops, cultural events, and digital technologies enable museums to establish a more dynamic relationship with visitors, transforming the museum into a living space. In this way, the museum functions as a multifaceted cultural center that meets the needs of people of all ages and backgrounds for learning, entertainment, and social interaction.

2. THE USE OF HISTORICAL SPACES AS EXHIBITION VENUES IN CONTEMPORARY MUSEOLOGY

2.1 Adaptive Reuse of Historical Buildings

Historical buildings serve as significant documents that reflect the social life and architectural understanding of the period to which they belong, and as symbols of cultural values [5]. With these characteristics, they act as spatial entities that ensure the sustainability of urban memory by transmitting the life of a past era into the future, thus forming a bridge between the past and the future. French thinker Pierre Nora [6] argues that past values cannot be preserved solely through mental recollection; instead, certain places are needed for this purpose, which he refers to as "memory spaces" (*lieux de mémoire*). According to Nora, any symbolic element belonging to a community's collective memory, whether material or conceptual, that gains meaning either through the will of the people or over time, can be considered a memory space [6]. In this context, the preservation of buildings that have lost their function over time, regardless of their period of construction, due to the symbolic identity they hold in urban memory, is essential for maintaining the continuity of urban identity and collective memory. With this approach, the reintegration of historical buildings that have lost their functions over time into the public realm as memory spaces can be achieved through preservation and reconnecting them with social life. The concept involves transforming buildings that continue to exist physically and maintain a meaningful relationship with the city into public spaces that are accessible to all and foster a sense of belonging. In this way, it contributes to community engagement and the sustainability of the public sphere.

The principles of adaptive reuse and reversibility are emphasized in adaptive reuse processes. Adaptive reuse allows historical buildings to be adapted to contemporary functions while preserving their physical characteristics. This approach ensures not only the continuity of the building within urban memory but also addresses social and environmental needs. According to Eneş and Karabağ [7], achieving the highest level of preservation with the least intervention is essential, ensuring that additions made, especially in interior spaces, are lightweight, flexible, and recyclable. Furthermore, new additions should be designed not to compete with the existing structure or overshadow its identity while expressing a contemporary language. Interventions aligned with the principle of reversibility are compatible with long-term conservation goals because they can be altered without damaging the building. These two approaches are also commonly applied within the context of museology in Turkey, where, according to Mısırlısoy and Günçe [8], historically repurposed buildings are often used as museums, thereby preserving cultural heritage and supporting community engagement.

According to Altınoluk and Yenice [9], one frequently used method in architectural conservation today is preserving buildings through changes in their functions. The primary goals of this approach include preventing the disappearance of structures, preserving their tangible and intangible values as much as possible to enable their reuse, protecting the cityscape from damage, increasing historical awareness, and providing economic benefits to the city. Evaluating these buildings as exhibition spaces is critical in promoting community engagement and ensuring this heritage is preserved and transmitted to future generations. One of the most prominent methods of functional change is the conversion of historical buildings into museums. An essential aspect of this process is the inclusion of informative exhibitions related to the history of the existing structure, which contributes to the preservation of cultural heritage. In this way, the museum building can become part of the exhibition [10]. According to Hooper-Greenhill [11], using historical spaces as exhibition venues ensures the physical preservation of the space. It revitalizes a site that might be forgotten in collective memory over time. Contemporary museology emphasizes the interaction between museums and society, transforming museums into platforms for social dialogue and learning by prioritizing community engagement. This creates a practical context for ensuring social participation. As museum anthropologist Macdonald [12] explains, contemporary museums have transformed from one-way institutions that merely convey information into educational spaces that foster reciprocal learning, community participation, and critical thinking, thus taking on a role quite distinct from the traditional museum concept within everyday life.

2.2. Contemporary Museology and Participation

Historic buildings are not merely heritage assets to be preserved, but also cultural spaces that can be revitalized through contemporary functions and integrated into social life. According to Mısırlısoy and Günçe [8], repurposed historic structures are often adapted for museum use, thereby supporting both the preservation of cultural heritage and the promotion of public participation. These structures are being transformed into living spaces that engage with society in line with contemporary museological approaches. While preserving their authentic architectural identity, interactive exhibition areas, digital applications, and public events are incorporated, establishing a strong link between the past and the present. This transformation process can also be interpreted as the spatial manifestation of a new, participatory museology that does not position the public merely as passive observers but actively involves them in the cultural experience.

The emergence of participatory approaches in museology has transformed the relationship between museums and society, prompting the search for new solutions. According to Hooper-Greenhill [11], the paradigm shift observed in recent years within the field of museology has fundamentally redefined this relationship, bringing with it a need to explore alternative strategies and practices. Thus, a redefinition of the museum's function has also become necessary alongside a spatial and institutional restructuring. The classical understanding of museology has primarily been shaped by fundamental tasks such as collecting, preserving, classifying, and exhibiting artifacts. In this approach, visitors were positioned as passive recipients of knowledge, and museums were regarded as places where information and cultural heritage were transmitted in a one-directional manner [13]. In contrast, contemporary museology particularly shaped by the social and cultural shifts that emerged in the last quarter of the 20th century has evolved into a more participatory, interactive, and experience-oriented model [14].

Through these methods, museums aim to enhance public participation quantitatively and qualitatively by offering opportunities for learning, experience, and multidimensional interaction [15]. In doing so, museums are transformed into dynamic public spaces not only sites for preserving the past, but also venues for debating current social issues, reflecting cultural diversity, and enabling communities to express their identities. Participatory approaches would allow museums to become spaces of dialogue and learning co-constructed with diverse segments of society, facilitating a more inclusive and sustainable practice of cultural heritage [16]. In contemporary museological discourse, it is increasingly vital that museum spaces evolve into multifunctional venues that host permanent exhibitions and temporary displays, provide opportunities for social interaction, and fulfill educational roles. Atagök [17] states, contemporary museums are cultural centers where visitors both enjoy themselves and learn, deriving pleasure from the learning process. Various practices enable public participation, including interactive exhibitions, workshops, hands-on activities, and cultural events. By allowing visitors to explore and interpret exhibited works firsthand, museums create a unique environment supporting formal and informal education. Consequently, they provide opportunities for learning, entertainment, and social interaction for diverse segments of society.

With the rise of contemporary museology, the interior designs of buildings increasingly emphasize flexible spaces that accommodate diverse uses and host various activities. These spaces may be created through functional zoning or designed as adaptable areas that can be transformed according to specific needs. MacLeod [18] points out that one of the prominent spatial pursuits in contemporary museology is the creation of modular and multifunctional spaces that prioritize accessibility and inclusivity, featuring interactive zones and experiential elements instead of fixed exhibition layouts. Digital screens, augmented reality (AR), virtual reality (VR), and touch panels are becoming key methods of spatial presentation. Spatial infrastructures integrated with mobile applications and digital guide systems are developed to enrich the visitor experience. Alongside this, narrative-driven spatial designs come to the forefront, enabling exhibitions to be conceived not merely as displays of objects but as tools for storytelling [14]. This approach organizes exhibitions in chronological or thematic sequences, allowing visitors to experience the space as if following a narrative. Therefore, spatial design assumes an aesthetic or functional role and a guiding and experience-structuring function. Narrative-focused spatial planning enables exhibitions to be arranged around chronological or thematic frameworks, guiding visitors through the museum as if following a story. Consequently, the design of the space facilitates visitor orientation and supports the flow of movement.

The Tate Modern building in London, created through the adaptive reuse of a former power station, can be regarded as an iconic example of contemporary museology [19]. This transformation embodies the principles of modern museology through adaptive reuse, challenging the traditional notion of the ‘museum building’ and offering an extraordinary and compelling atmosphere. The underground galleries known as 'The Tanks' are dedicated to experimental artworks. While they typically host large-scale installations, these spaces also accommodate concerts, forums, and children's activities, serving various purposes. This versatility aligns closely with contemporary museology’s emphasis on flexible spatial design. Museum floors are arranged thematically and based on conceptual narratives, allowing visitors to navigate the space by making meaningful connections. With its visitor-centered, flexible, experience-oriented, socially integrated, sustainable, and participatory spatial approach, Tate Modern exemplifies the core principles of contemporary museology. It demonstrates that adaptive reuse is a means of historical preservation and a powerful tool for social, cultural, and economic transformation, having successfully engaged an inclusive and diverse audience for years [20].

In conclusion, the additional functions introduced by contemporary museology create a space for interaction by bringing together diverse individuals with shared interests through various creative activities such as concerts, seminars, cultural events, film and theater screenings, workshops, and dance performances. This creates a conducive environment for fostering social participation. Whereas in traditional museology, a museum might be experienced in a single visit with little incentive for return, contemporary museology offers multiple avenues for repeated engagement, encouraging visitors to return and interact with the space in diverse ways. In summary, contemporary museology transforms museums from silent exhibition halls into vibrant social interaction spaces. It redefines the visitor from a passive

observer to an active participant, while reshaping the museum space into a living, adaptable, and experience-oriented environment.

3. RESEARCH METHOD

This study adopts a qualitative research method, specifically the case study approach, to conduct a comprehensive and in-depth analysis of two examples of contemporary museology within their own contextual frameworks.The study aims to examine the decisive role of spatial production decisions in shaping the transmission of knowledge and methods of meaning-making within the framework of contemporary museology, and to explore, in contrast to traditional approaches, the potential of the museum space to transform into a discursive domain.In this context, the study addresses the transformation processes of abandoned historical sites—embedded within the urban fabric and bearing historical layers and contextual codes—into exhibition spaces from the perspective of contemporary museology.

In the first phase of the research, the concepts of adaptive reuse, contemporary museology, and participation were examined through a comprehensive literature review. The primary reason for addressing adaptive reuse and contemporary museology in conjunction is to move beyond the mere preservation of historical buildings by converting them into cultural or educational facilities, and instead to open a discussion on design and construction strategies that can reproduce the authentic identity of these structures within their contextual frameworks. In order to ensure that the insights gained from the literature review could be consistently exemplified during the analysis phase, specific criteria were adopted in the selection of the museum spaces to be examined. Accordingly, preference was given to museum spaces that both preserve local identities linked to the historical context and social structure of their respective cities, and respond to contemporary spatial requirements and aesthetic sensibilities.

The selection of case studies analyzed in this research is limited to museum buildings located in the city of Ankara. This limitation is primarily due to the prominent emergence of contemporary museology and participatory approaches within recent adaptive reuse projects in the city. Additionally, the fact that certain museum buildings have become closely associated with Ankara and have acquired symbolic and cultural value as part of the city's identity further supports the selection of this sample.The significant role of museums in Ankara in shaping urban identity and contributing to city branding has been emphasized in various academic studies. For instance, in their 2023 study, Doğu Öztürk and Zeybek analyzed social media posts tagged with #ankaramüzeleri and revealed that events organized by museums enhance Ankara's urban image, while museum visits offer visitors an impression of the city's brand value [21].

The sample of the study consists of the Erimtan Museum of Archaeology and Arts and CerModern, both of which ensure inclusivity through different dynamics within the framework of contemporary museology. The selection of these cases is based on their capacity to cultivate their own communities and to develop recurring experiential practices within Ankara's cultural context. Erimtan Museum of Archaeology and Arts and CerModern represent a process of 'reproduction' that critically engages with traces of the past rather than a mere physical reconstruction. Both museum spaces share a holistic design approach encompassing documentation, design, and utilization phases throughout their spatial production processes. However, the two museum buildings differ in terms of the opportunities they offer for participation, a key concept in contemporary museology discourse. While the Erimtan Museum of Archaeology and Arts responds to the demands and expectations of a user profile considered a minority and situated outside popular culture, CerModern represents a participatory model that addresses the city's multicultural social fabric rather than targeting a specific group. In order to reveal different approaches to participation during the usage phase in contemporary museology examples, these two cases were analyzed in the study. Additionally, the positioning of both buildings as urban landmarks and memory sites within Ankara's social life was a decisive factor in the selection of the sample.

The data collection process in the analysis phase was conducted in two stages: a literature review and on-site observation. In the first stage, literature concerning the use of historical spaces as exhibition venues within contemporary museology was examined under specific conceptual frameworks. Priority was given

to articles and seminars in which designers critically address the production processes of museum spaces. Within the scope of the course M5101 Urban and Identity, offered by Associate Professor Dr. Hilal Aycı at Gazi University, Graduate School of Natural and Applied Sciences, Department of Architecture during the Spring semester of the 2024-2025 academic year, the Erimtan Museum of Archaeology and Arts and CerModern museum buildings were experienced at different times throughout April 2025. During this period, the study participants experienced the temporary exhibitions A Route on the Boundaries of the Mind: Fikret Muallâ, which opened on February 28 at the Erimtan Museum of Archaeology and Arts, and Musto: Layers of Belonging, displayed at CerModern from April 3 to April 27, 2025.On-site observations and the reflections of research participants within the museum spaces were also incorporated into the analysis section alongside data obtained from the literature. The analysis of the case studies was conducted under two main headings: Contextual Connection and Cultural Sensitivity, which examines how continuity of the existing context and historical layers is maintained, and Selection of Spatial Opportunities and Facilitation of Social Participation, which evaluates how the reproduction process of the space responds to contemporary needs through current approaches. The conclusion section presents the findings and recommendations of the study.

4. A STUDY ON CONTEXT, EXHIBITION SPACE AND PARTICIPATION IN CONTEMPORARY MUSEOLOGY

4.1 The Erimtan Archaeology and Art Museum

The Erimtan Archaeology and Art Museum is situated in the southern sector of the Hisar Gate within Ankara Castle, one of the city's oldest settlement areas. The museum was founded to share and exhibit, for public benefit, a collection of approximately two thousand movable archaeological artefacts of Anatolian origin, amassed over many years by the entrepreneur Yüksel Erimtan. The museum building comprises an interior volume formed by preserving the exterior shell-wall traces of three historic house ruins in Ankara Castle Square. The museum's design is attributed to Ayşen Savaş, Can Aker, and Onur Yüncü [22].

The production process of the museum space, as documented by Ayşen Savaş, is explained through the concept of 'praxis,' which emphasizes the dialectical relationship between thought and action and foregrounds the process of production rather than the final product. By employing the concept of praxis, Savaş foregrounds the process of the spatial output itself rather than the final product. This design approach treats the design process as a field of inquiry rather than subjecting the existing structures to restoration, transformation, or conservation; accordingly, the museum space has been reconceived to inaugurate a new discursive realm. This approach entails the development of all design phases by situating them within a rhetorical and theoretical framework. Savaş, notes that the Erimtan Museum's design is approached with a holistic methodology encompassing the documentation, conceptualization, and implementation phases, and that this process embodies a form of "re-production" [23].

Figure 1. *North facade, Duygu Tüntaş Archive -South facade, Oğuz Karakütük Archive [24]*

During the documentation phase, the remains of the three historic residences were deconstructed, with each structural component examined individually and regarded as an autonomous object of knowledge. The spatial and historical analysis obtained from the building elements was not used for physical reconstruction during the design and implementation phases but instead served as a tool to reinterpret the

vestiges of the past critically and to build the museum structure into a new, unified whole [23]. The approach adopted in the museum's design enabled the reintegration of the vestiges of the three historic houses within their own historical contexts and architectural scale through a more holistic understanding; thereby contributing to the preservation of the surrounding environment's historical identity and architectural scale.

4.1.1 Contextual Connection and Cultural Sensitivity

Yüksel Erimtan and his colleagues undertook various initiatives to channel their interest in archaeological artifacts into societal benefit; the first of these was the 1996 establishment of the Association of Cultural Property Collectors, aimed at preventing the removal of Anatolian cultural heritage abroad and ensuring public access to these artifacts. With similar aims, in 2009, the Yüksel Erimtan Foundation for Culture and the Arts was established to support cultural and artistic awareness and to foster the development of Anatolian cultural heritage [25]. Both civil society organizations result from Erimtan's steadfast commitment to preserving Anatolian cultural assets. The private collection that Erimtan began assembling in the 1960s was expanded under the aegis of the foundation, guided by professional archaeologists; the curated selection was subsequently opened to the public in 2015 within the Erimtan Archaeology and Art Museum [22]. In this context, the Erimtan Museum exemplifies the metamorphosis of an individual passion for collecting into a permanent cultural institution serving the public good, while also actively contributing to the cultivation of societal engagement with cultural heritage and the formation of collective consciousness within the city.

The Erimtan Museum is located on a sloping site between the Museum of Anatolian Civilizations and the Rahmi M. Koç Museum, forming an integral part of the historical and cultural fabric envisioned for the surroundings of Ankara Castle. The methodology adopted in the production of the museum space can be defined as the transformation of historical knowledge into an architectural product that generates meaning and value within its context. In pursuit of this goal, the architectural traces documented by architects and restoration experts were considered the primary inspiration for the design decisions. No architectural elements that had lost their physical integrity and could not be documented were reconstructed [23]. The design process progressed concurrently with the dismantling and rebuilding phases, intertwining documentation, design, and implementation, and took on the character of an interpretative intervention, as described by Savaş. Therefore, the designer integrated the existing context and historical layer into the spatial production process as a design element beyond mere preservation. This critical approach defines the building and its collection as a product that establishes its context within the surrounding environment and delivers a novel spatial experience organized according to a different system.

Figure 2. *The State of the Building Before Intervention- Interior space [22] [26]*

Savaş [23] explains the traces obtained during the documentation process under four main categories: ground line, roof line, wall texture, and openings. The ground line, documented at the junctions where historic buildings meet the terrain, revealed the extent to which the structures were embedded; this phenomenon has been characterized as "displacement" due to its role in generating a new urban scale around Hisar Square. The roof line provided visual and proportional cohesion among the buildings, while the visual effect created by the stones on the walls, gradually decreasing in size from bottom to top, was observed to reinforce the relationship with the castle walls. Before the design and implementation phases, the research and documentation process involved deconstructing architectural elements, each gaining independent significance; upon reassembly, these elements created a new entity that critically engages with the original structure. As previously articulated, the preservation and reinterpretation of the traces

revealed during the documentation phase facilitated the reintegration of the existing context and historical layers into a more comprehensive and coherent whole, enabling the structure to acquire a renewed context in conjunction with its function [23]. The design process of the Erimtan Museum should therefore be understood as a reinterpreted representation of the theoretical framework developed by the data, observations, and critiques obtained during the research and documentation phases.

4.1.2 Selection of Spatial Possibilities and Ensuring Community Participation

The museum's architectural form, which is perceived as three separate structures from the exterior [28], provides the designer with constructional flexibility through a continuous, singular, and cohesive interior space. Within the building's interior, the functional subdivision of the exhibition hall has been designed as a flexible and convertible spatial organization that centers on user experience and accommodates interdisciplinary activities. The design of the exhibition hall bears the signature of Ayşen Savaş [22].

The museum's internal spatial capacities have been harnessed in the design process by employing the building mass as a narrative plane, aiming to deliver a multiplicity of versatile experiences within the exhibition hall. For example, the niches carved into the interior faces of the structural walls and the partition elements treated as display surfaces within the exhibition space prompt an interpretation of the space as an exhibition object. To evoke a sense of infinity in the exhibition hall, a perspective vanishing line was created; this line is defined by the mezzanine boundary and is supported by lighting fixtures that become denser toward the floor level, as well as by a spatial form narrowing toward the western façade. This condition directs the visitor's perception from the entrance toward the exhibition hall, constituting a key element that transforms the time spent in the museum into a spatial experience.

Figure 3. *Exhibition space (Personal Archive, 2025)*

The theoretical approach adopted in forming the Erimtan Museum facilitates the re-examination, exhibition, and re-production of the space and collection in various forms. This approach differentiates itself from traditional museums by enabling the creation of new layers of meaning through technological or sensory interactive exhibition methods. For example, the display of archaeological artifacts reflecting everyday "home" life within the exhibition hall, juxtaposed with the building's transformation from a residential function to a museum space, embodies a symbolic experience of temporal displacement within the museum [28]. During the presentation of the collection in the exhibition hall, contextualizing labels and descriptive texts were employed; anamorphic texts inscribed on the walls, letters embedded in leather, writings formed through shadow, and notes conveyed via light collectively served to mitigate the effects of temporal disjunctions and spatial displacements within the museum experience [23]. The primary aim of this approach is to configure spatial possibilities in a way that diversifies individual experiences and contributes to cultural life in a multifaceted manner.

Gül Pulhan and Adrian Saunders have conducted the curatorial work of the museum collection, assisted by Selma Ünal [22]. The exhibited works have been grouped using typical traces within their context; the flow between them has been organized by establishing a narrative structure. Through guidance designed considering visitors' visual and auditory perceptions, the works were presented to the audience based on their respective periods' historical and cultural realities. This approach provides a concrete example of the expectation, prominent in contemporary museology, to individualize the experience based on the observations and perceptions of the individual engaging with the space. The awareness intended to be fostered at the museum scale regarding the cultural heritage of the Anatolian region is being conveyed by

presenting the works within their context to the societal experience. Erimtan Museum, due to the events, educational programs, and social spaces it hosts, holds the identity of a cultural institution. It can be argued that this potential of the museum has gradually contributed to the diversification of the visitor profile in its surrounding area, thereby increasing its visibility.

Figure 4. *Exhibition space (Personal Archive, 2025)*

In this respect, the exhibition hall has been configured with both permanent and temporary spatial components; the permanent exhibition area on the entrance and first basement has been linked in spatial continuity with the temporary exhibition hall on the second basement level. The museum's architectural design allows visitors to engage in repeated experiences; furthermore, incorporating a textual language within the collections of the temporary exhibition hall enhances the museum's unique context, elevating its identity to a distinguished position within the urban setting. For instance, the temporary exhibition A Route at the Boundaries of the Mind: Fikret Muallâ delivers an integrated experience with the permanent exhibition space by incorporating critical texts alongside the artist's works. Meanwhile, exhibitions such as Scent and the City transcend the visual realm through the museum, allowing visitors to perceive and engage with the city in novel sensory and reflective ways [27].

Figure 5. *A Route at the Boundaries of the Mind: Fikret Muallâ (Personal Archive, 2025)*

In the discourse of contemporary museology, the notion of the museum as a space for experiential learning has been taken a step further at the Erimtan Museum of Archaeology and Art through its educational workshops. In addition, the museum serves as a venue for events targeting a specific audience, including concerts focused on classical Turkish music, Western classical music, and jazz, as well as the regularly held Erimtan Archaeology Conference Series [27] . The participants' relationship with the space is aimed to serve as a means for the conscious construction of identity, thereby fostering a sense of awareness regarding the space itself. This process has enabled the site to develop a distinctive visitor profile over time gradually. It has led to its transformation into an urban space identified with a specific social and cultural group. Additionally, unlike other museums in Ankara Castle and its surroundings, the Erimtan Museum of Archaeology and Art has attracted a distinct visitor profile to the area and has facilitated the repeated engagement of this audience with the site. The sense of belonging established with visitors has identified the museum with the region and has contributed to the transformation of the surrounding area's historical identity and socio-cultural dynamics.

4.2 CerModern

Although the Ankara Cer workshops once served as train maintenance and repair facilities, technological advances and changes in production and consumption methods led to their functional obsolescence and eventual abandonment. These workshops remained unused for an extended period before being repurposed in 2010. Uygur Architecture Office completed the restoration and survey projects, and the site was reopened to the public as a modern art museum [29].

These workshops, which hold an essential position in their historical place and function, are one of the architectural elements that fall within the transition from traditional to modern architecture. Located in the middle of the axis between Ankara Castle and Anıtkabir [30], these workshops and the additional sections built onto the structure are situated where Ankara's historical and cultural spaces converge. This location primarily hosts buildings from the Republican Era, highlights the spatial significance of the carriage workshops.

Figure 6. *CerModern -Construction Phase [30]*

The cer workshops, repurposed and revitalized for public use, connect the past with today's modern world, preserving these traces without erasing them and passing them on to future generations. Nowadays, as a modern art museum, the workshops known as "CerModern" can be described as a bridge linking the past and the present, hosting a wide range of contemporary art.

4.2.1 Contextual Connection and Cultural Sensitivity

CerModern takes its name from the Arabic-origin word "Cer." The word "Cer" originally means to pull or drag, and the workshops where trains were maintained and produced are called "cer workshops" by the community [31]. In the Republic's early years, during 1926-27, within the framework of the policy of "weaving the country with iron networks," railways were nationalized, and the ceramics workshops were built in this period. These workshops result from the first railway, constructed in 1892 in Ankara by the Germans during the Ottoman era as part of the Anatolia-Baghdad Line [32]. This historical background demonstrates that CerModern, revitalized and reintegrated into the city and society through adaptive reuse, adopts a culturally sensitive approach in a historical context by carrying the traces of the past into the future.

The cer workshops, consisting of three units and train maintenance hangars, were partially demolished to allow the passage of the railway line. For CerModern, whose primary function is known to be related to trains and railways, transparent façades were used to ensure continuity between the preserved original structure and the newly added buildings. Large spaces such as museums and exhibition halls were placed underground to avoid concerns about scale in the original building. Examining the building's spaces, it can be said that traditional and modern construction methods have been integrated [31]. Today, influenced by contemporary museology and community participation, the additions to CerModern have allowed traditional and modern elements to coexist. In this way, while the museum structure combines the conventional and the contemporary, it remains connected to its environmental context; instead, it aims to reflect both physical and ecological contexts in its spaces.

Figure 7. *Additional Structure and Hangar [30]*

Context is a critical concept that helps to understand the environmental influences existing before the design object, how it becomes part of a whole, how it should adapt to its surroundings, and the effects of the new order brought by the design object [33]. From this perspective, CerModern carries multiple layers of context: physical context due to its location, cultural context through its contemporary museum function, social context as a public art space accessible to all segments of society, and historical contexts by bearing traces of different historical periods. With the redefinition of its spatial functions and the new additions enhancing the building's utility, CerModern has a strong contextual narrative.

In the digital presentation published by Akbank Sanat [34], the design and implementation processes of CerModern were explained, providing information about the architectural applications. During this presentation, Semra Uygur emphasized that the building owes its existence to the trains and the railway. Therefore, when repurposed, it continued without breaking its connection to its original functions. Uygur [34] stated that the old and new parts were designed not to overshadow each other, reflecting a design approach that allows limited interaction between the old and new elements, preventing either from dominating the other. This approach makes the space functional and aesthetic in itself and considers its historical, cultural, and social context, demonstrating a holistic understanding and thereby contributing to the city's identity.

4.2.2 Selection of Spatial Possibilities and Ensuring Community Participation

The possibilities offered by the space during the design process should respond to the users' needs while also demonstrating a sensitive approach to the cultural and social dynamics of the community by ensuring community participation. When examined in the context of the possibilities provided by CerModern, it supports community participation through both temporary and permanent exhibition areas and additional user-oriented features, enabling users to shape the spatial possibilities.

CerModern, offering extensive possibilities regarding exhibition methods, diversifies exhibition practices and increases spatial capacity through permanent and temporary exhibition areas and digital and open exhibition spaces. The unit, which was repurposed and incorporated into the exhibition complex, called the "North Hangar," has become a permanent space within the building for digital exhibitions. Additionally, temporary exhibition arrangements are facilitated, while the active use of online platforms enhances the accessibility and visibility of the exhibitions [35].

Figure 8. *Exhibition Area [30]*

In the exhibition space located on the lower floor of CerModern, visitors are greeted by a glass entrance door, and directly opposite it, an informational panel on the column provides details about the exhibition content, accompanied by an introductory video of the artist. The exhibition space's color scheme is arranged according to the artworks on display; while some works are presented in three dimensions, others remain two-dimensional. Lighting decisions have also been made to incorporate both natural and artificial sources. The exhibition spaces, which generally follow a coherent flow, transform into spacious and comprehensible environments for the visitor. By embracing its historical context and positioning itself as a bridge between past and present, CerModern brings together contemporary art and artists under one roof, fostering the coexistence of differences. These spaces transform their physical environment and impact the broader society and invite participants to engage in unique and diverse experiences [36]. Thus, the exhibition design becomes a crucial element that enhances the function and visibility of the space, adds aesthetic value, and ensures the most effective presentation of artworks. Within the context of CerModern, exhibition methods can be understood as tools that enable a direct dialogue between the artwork and the space, thereby reinforcing the coherence of meaning. Elements such as the color, lighting, and even sound of the environment can directly influence the interpretation of the artwork. In this regard, the multifunctional use of space and the encouragement of community participation contribute to a richer exhibition experience.

Semra Uygur explains that during the design and implementation of the building, the open space between the hangars and the additional structure was initially conceived solely as an open-air exhibition area. However, she notes that today this space hosts evening open-air cinema screenings, jazz nights, and events such as dinners and weddings. Highlighting the adaptability and suitability of the space, Uygur emphasizes that users can utilize the space more enriched from their perspectives [34]. This statement reveals that users can actively participate in the space physically and in terms of usage dynamics. Architectural design defines physical boundaries and offers a flexible spatial infrastructure that evolves through user experience. As Uygur [30] emphasizes, the flexibility that allows for multi-purpose use of the space can exceed the designer’s original intentions. In this context, the relationship between spatial design and everyday practices depends on the architect’s vision and the user's creativity. This creativity enables a space, designed initially as a single-function open-air exhibition area, to acquire diverse functions through user intervention, thereby revealing the transformative nature of the space in response to social participation and demands. As a result, exhibition areas enriched through community engagement acquire new functions and contribute to expanding the space’s potential.

Figure 9. *Outdoor Exhibition Area -Open-Air Cinema (Personal Archive, 2025)*

5. CONCLUSION

In the process of adaptive reuse of historical buildings, it is essential to consider that these structures are integral to the city's physical and cultural identity. Therefore, maintaining historical and cultural sensitivity throughout the design, restoration, and usage phases is of great importance. Adaptive reuse carried out with this approach requires a strategy that goes beyond merely preserving historical buildings by converting them into cultural or educational venues; instead, it aims to reproduce their original identity within their contextual framework. This holistic approach grounded in principles of contextual connection and cultural sensitivity, and emphasizing public participation during the usage phase enables the building to gain the status of a site of memory within the urban fabric. The recognition of such buildings as memory spaces in the city depends not only on their ability to represent former users through historical and cultural layers but also on the development of policies that allow contemporary users to maintain their social practices within these spaces. In doing so, these spaces become integrated into urban life by contributing to public continuity and evolve into environments that embody urban memory and identity within a temporally layered context.

This study highlights the importance of reproducing structures that have lost their function over time, regardless of the period they were built and their original functions, through their qualities as "memory spaces" in the collective memory, for the sake of urban culture and social life. The study suggests that historical structures that have the quality of memory spaces should be repurposed as exhibition spaces within the context of contemporary museology and thus be reintroduced to social life. This approach is exemplified through the examples of Erimtan Archeological Museum and CerModern. Both contemporary museum structures in the sample have been recreated through the new relationships they have established with the city and its actors, without breaking away from their historical and cultural contexts. The museum spaces in question maintain their quality of representing the past by preserving their contextual integrity; and in the process of reproduction, they have become dynamic and transforming cultural areas that respond to today's social needs with the new layers of meaning they have gained in line with the discourse of contemporary museology.

The Erimtan Museum of Archaeology and Art is part of the historical and cultural fabric of Ankara Castle, one of the city's oldest settlement areas. It offers a unique museum model in which a private collection of roughly two thousand Anatolian archaeological artifacts is shared with the public, turning individual accumulation into a social asset. Savaş, focuses on the production process of the museum space rather than viewing it as a final product; he considers the design process as a field of research [23]. The documentation, design, and implementation phases carried out during this process were fundamentally conducted through a critical design approach and interpretive intervention. In the process of transforming the remains of three historic houses into an exhibition space, the context and historical layers of the buildings, along with the spatial traces obtained during the documentation process, were reinterpreted and reproduced as design elements. This critical approach has enabled the structure to be reassembled in its environment in a new and different arrangement, achieving a more comprehensive unity and thus acquiring a new context.

Erimtan Museum, with the events, educational programs, and social spaces it hosts, functions as a cultural institution. The spatial possibilities of the existing structure were arranged in the spatial organization to transform the museum space from merely an exhibition area into an experiential environment, aiming to diversify visitor experiences and provide multifaceted contributions to social culture. The labels attached to the exhibited objects, along with descriptive texts and events and workshops organized in conjunction with temporary exhibitions, provide the opportunity to convey the artist's intended meaning of the object to the audience on multiple levels. This distinguishes the Erimtan Archaeology and Art Museum from other contemporary museum examples by raising user awareness and enabling the conscious construction of a museum-specific identity. By organizing events tailored to specific audience segments including classical Turkish, Western classical, and jazz concerts, as well as regular conference series the museum has broadened its visitor profile and consequently enhanced its visibility within its community. Thus the museum has been identified with the region and has contributed to the transformation of the castle's historical identity with socio cultural dynamics. Therefore, unlike CerModern, the Erimtan Museum has enabled the representation in the public sphere of groups typically excluded from popular culture.

CerModern, which has been reintegrated into the urban fabric and society through adaptive reuse, presents a culturally sensitive approach that carries the traces of the past into the future. By refunctioning its physical infrastructure, CerModern enhances social participation and thus serves as a cultural bridge between the past and the present. The transformation of the former railway workshops into contemporary exhibition spaces has allowed traditional and modern elements to coexist, granting the space a renewed identity that both preserves its environmental context and reflects physical and environmental qualities. CerModern can be defined as a space of memory where physical, social, and historical contexts are reconsidered, functional characteristics are enriched, and traditional and contemporary elements are brought together through a holistic approach. The various opportunities offered to users evolve through public engagement, allowing the space to transcend its physical structure and become an integral part of urban life. This not only promotes the use of public space but also supports cultural continuity and contributes to the formation of urban identity. Moreover, CerModern offers users a unique sense of place through its diverse range of events; this experience, shaped by art, culture, and social interaction, enables various forms of participation and contributes to the transformation of the space into a distinctive public venue recognized within the urban context. Compared to the Erimtan Museum, CerModern appeals to a broader user profile, allowing for a more inclusive form of social engagement with the space.

The methods of literature review and case study employed in this study have provided a comprehensive opportunity to evaluate the impact of the adaptive reuse of historical buildings, while preserving traces of the past, on urban identity and social belonging, through the examples of the Erimtan Archeology Museum and CerModern. The findings obtained through these methods have revealed several essential characteristics of both structures regarding contemporary museology practices and strategies for public engagement. According to the findings, the flexible and adaptable structure of the temporary exhibition spaces observed in both buildings ensures the preservation of the historical fabric without causing damage. It encourages visitors to return to these spaces. This way, the connection these historically significant buildings establish with urban memory is strengthened by increasing community engagement. At the same time, the exhibition methods employed in both buildings offer experiential approaches aligned with the concept of contemporary museology, transforming the visitor from a passive observer into an active participant. Practices such as open workshops for visitors, multifunctional and adaptable event spaces, and digital technologies have strengthened the relationship these spaces establish with the public. In this context, the preservation of the historical setting, multipurpose usage scenarios, temporary exhibitions, event programs, and design choices that prioritize user interaction all contribute to enhancing the role of these structures in urban identity and collective memory.

The most significant finding of this study is that the adaptive reuse of historical buildings with contemporary functions gives rise to a new, more powerful context one that is nourished by the existing setting and historical layers, yet transcends them. This new context does not merely carry traces of the past; instead, it reinterprets those traces, intertwining them with today's cultural and functional expectations. The historical building is no longer just an object of memory; it has transformed into a dynamic interaction space integrated with contemporary life. Thus, by establishing a connection between the layers of time, the building re-creates the past within the present, while simultaneously reshaping the present within the past. In conclusion, the adaptive reuse of historical buildings within the framework of contemporary museology has been addressed through the examples of the Erimtan Archeology Museum and CerModern, to ensure the continuity of urban identity and encourage community engagement. The examined cases demonstrate that it is possible to transform historical structures into living, evolving cultural spaces that promote community engagement by blending traces of the past with the needs of the present.

In this context, the study reveals that, in contemporary museology, the use of historic spaces as exhibition venues carries significant potential during the utilization phase owing to their existing contextual and historical layers. It has been concluded that the individualization of spatial organization in contemporary museum spaces, along with the provision of narrative and experiential participation opportunities in exhibition methods, supports these institutions in defining unique spatial practices and developing distinctive visitor profiles.

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Research Article GU J Sci, Part B, 13(3): 401-414 (2025)

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Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

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Earthquake-Oriented, Generative Artificial Intelligence and Voronoi-Assisted Design Approach

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Article Info

Received: 04/06/2025
Accepted: 09/09/2025

Keywords

Voronoi Diagrams, Earthquake, Modular Design, Generative Artificial Intelligence

Abstract

In the 21st century, earthquakes occurring in regions with high seismic risk result not only in physical destruction but also in prolonged crises at social, economic, and psychological levels. Post-disaster temporary shelter solutions often evolve into permanent uncertainties, giving rise to issues such as social exclusion, disconnection from productive life, and spatial injustice. This study is grounded in the notion that temporary living environments must be not only rapidly deployable but also adaptable, sustainable, and socially restorative.

In the design approach, the nature-inspired organizational logic of Voronoi diagrams is reinterpreted beyond conventional horizontal sprawl and transformed into a modular vertical structural system. Each module is tailored to specific functions—such as housing, healthcare, education, and production—and designed as an independent unit with its own structural and technical infrastructure. By proliferating vertically, these modules allow for spatial flexibility and evolutionary development over time

Developed through generative artificial intelligence-supported design processes, the proposed system is not merely a structure, but a dynamic living organism capable of reorganizing itself in response to environmental and societal needs. The project presents an innovative model for post-disaster reconstruction by addressing spatial, technological, and social dimensions in an integrated manner, thereby contributing a novel perspective to the field of disaster architecture.

1. INTRODUCTION

In recent years, the increasing frequency and severity of natural disasters, particularly earthquakes, have not only caused large-scale physical destruction but also disrupted social systems, economic continuity, and psychological well-being. Especially in countries like Turkey, located on active fault lines, the post-disaster need for shelter remains a long-standing yet inadequately resolved issue. While emergency solutions such as tents and container cities provide initial relief, they often evolve into unsustainable and socially fragmented settlements that lack infrastructure, community integration, and long-term spatial strategy [1], [2].

Recent assessments highlight that the February 2023 earthquakes in Turkey caused direct physical damage of approximately 34.2 billion USD, while recovery costs are estimated at much higher levels [3]. In response, the World Bank and national housing authorities have initiated large-scale reconstruction programs integrating housing, infrastructure, and community resilience [4], [5]. These policy-driven frameworks underline the urgent need for scalable, adaptable models that move beyond short-term shelters.

In the field of disaster architecture, much of the existing literature focuses on emergency response logistics and the technical aspects of shelter provision [6]. However, there is a growing consensus that temporary settlements should be envisioned not just as stopgap solutions but as the initial phases of future communities [7], [8]. Although research on participatory design and community resilience has increased,

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there is still a gap. Few studies offer design-based proposals that are scalable, transformable, and spatially integrated for long-term recovery [9].

Recent studies emphasize sustainable and reusable temporary housing strategies that can evolve into permanent settlements [10], [11]. Similarly, modular construction has been identified as a promising framework, though significant barriers related to logistics, culture, and scalability remain [12].

Recent advances in computational design and artificial intelligence (AI) have introduced transformative possibilities for post-disaster design scenarios [13], [14]. Generative tools—especially large language models and algorithmic form-finding methods—enable real-time feedback, rapid prototyping, and scenario-based organization. However, their application in disaster-specific architecture is still at an early stage. Existing studies often explore AI in conceptual design or form generation [15], but few projects have tackled post-earthquake housing using AI-based design methodologies in a holistic and systematic way.

Systematic reviews of generative AI in architecture confirm its increasing potential to accelerate early-stage design, particularly through iterative, prompt-based workflows [16], [17]. Such methods demonstrate how AI can act as a partner in shaping adaptive housing strategies, though they remain dependent on human curation.

Similarly, Voronoi diagrams, commonly used in fields such as biology, urban planning, and architecture for spatial partitioning, have shown significant potential in creating flexible, adaptive layouts. While Voronoi logic has been applied in some urban and architectural experiments [18], [19], its combination with modular, vertical, and functionally differentiated housing systems in a post-disaster scenario remains largely unexplored. Recent computational studies extend Voronoi logic toward stress-responsive and lightweight lattice structures [20], [21], offering new directions for earthquake-resilient modular systems.

This study positions itself at the intersection of generative artificial intelligence, modular architectural design, and mathematically-driven spatial systems [22]. It proposes a vertical, Voronoi-inspired modular housing system developed through AI-assisted workflows, particularly with ChatGPT as a co-designer. Unlike most works in the field, this study does not only evaluate the spatial consequences of disasters, but also introduces a design proposal that can evolve from emergency shelter to permanent living environments, integrating social, structural, and technological dimensions in a single design language. By bridging digital design methodologies with post-disaster spatial planning, the study offers both a conceptual model and a data-driven design process. It contributes to the academic discourse by filling a gap in the literature: the lack of speculative yet structurally rational, AI-generated modular proposals tailored for earthquake resilience. In doing so, it provides a new design paradigm for architects, planners, and researchers working in extreme conditions.

2. METHOD

This study employs a qualitative and speculative design-research methodology centered on the integration of generative artificial intelligence (AI) into architectural design for post-disaster scenarios. The process includes human–AI interaction, modular and algorithmic system development, and the use of mathematical-logical infrastructure (Voronoi diagrams) in vertical spatial organization. The methodology is divided into five primary phases: Role of Artificial Intelligence as Design Partner, Prompt-Driven Iterative Workflow, Modular Logic and System Constraints, Computational Design Approach and Voronoi Diagrams: Conceptual Foundations And Architectural Applications.

2.1. Role of Artificial Intelligence as Design Partner

The generative design process was conducted with the assistance of ChatGPT, an AI model developed by OpenAI. To initiate the process, a design prompt was formulated to frame the AI's role:

- **Prompt 1:** "You are now an architect. You specialize in designing for extreme conditions such as post-earthquake scenarios."

This statement defined the AI's design identity and set the foundation for all subsequent decision-making. From that point onward, ChatGPT was treated as a co-designer capable of understanding complex architectural language, spatial relationships, structural strategies, and post-disaster needs.

2.2. Prompt-Driven Iterative Workflow

The entire process was built on a sequence of human-generated textual prompts and AI-generated design responses. The following are examples of actual prompts used throughout the study:

- **Prompt 2:** "Using Voronoi logic, generate a modular structure that can grow vertically and adapt to user density."
- **Prompt 3:** "Design a post-disaster shelter system composed of prefabricated core modules with expandable secondary units."
- **Prompt 4:** "Create schematic cross-sections that show vertical growth from a central core using modular elements."
- **Prompt 5:** "Visualize bridges and interconnections between modular towers with environmental add-ons like solar panels."

At each step, the outputs were critically reviewed, and feedback was reintroduced into the system, refining the spatial proposal. Instead of a one-time design generation, the workflow evolved through a circular feedback loop of prompting, critique, and refinement.

2.3. Modular Logic and System Constraints

The study process followed a Voronoi-based growth logic, where each module was defined by center–periphery relationships, functional zoning, and user-specific data. Spatial decisions were made with respect to user density, access requirements, service infrastructure, and topographical constraints. Instead of traditional horizontal sprawl, a vertical expansion strategy was adopted—allowing limited land areas to support scalable, adaptable, and space-efficient construction.

Each module was designed to operate as an independent structural unit, capable of withstanding seismic stress without relying on adjacent modules. This independence provides redundancy and enhances earthquake resilience, ensuring localized failure does not lead to systemic collapse. Structural behavior was conceptualized using lightweight steel frameworks, modular connection nodes, and vibration-dampening joints. However, these systems were not validated through engineering simulations and remain conceptual at this stage.

Generative AI tools were employed not only for spatial organization but also for functional detailing. In the later stages of the working process, ChatGPT began to integrate environmental features such as solar panels, cable cars, and vertical gardens—even though these elements were not explicitly requested. This demonstrated the system's evolving "design memory" based on previous prompt-response cycles. While such creativity can accelerate conceptualization, it also introduces challenges of control and coherence, particularly when multiple layers of spatial logic are generated without strict parametric constraints.

The human designer acted as both facilitator and curator throughout the workflow. AI-generated options were continuously filtered, modified, and redirected according to aesthetic, structural, ethical, and cultural criteria. The process was non-linear, with decision-making emerging through iterative dialogue between human and machine. This hybrid method allowed for rapid ideation, but it also revealed several limitations and constraints:

- **Geometric Irregularity:** While Voronoi cells provide flexible spatial layouts, their irregular forms often resulted in inefficient connections between modules, especially in vertical configurations.
- **Prompt Sensitivity:** The quality and relevance of AI output was highly dependent on precise prompt language. Ambiguous instructions led to abstract or impractical solutions.
- **Structural Assumptions:** AI-generated designs suggested complex geometries and overhangs without considering real-world load paths, material behavior, or construction techniques.
- **Environmental Adaptability:** The AI-generated designs did not automatically adapt to site-specific data (e.g., climate, orientation, solar exposure), unless explicitly defined in the prompt.

2.4. Computatıonal Design Approach

While traditional design methods are mostly based on static, linear, and predictable scenarios, they fall short in situations characterized by high levels of uncertainty, such as post-disaster contexts. The physical, social, and logistical complexities that emerge particularly after earthquakes demand rapid, flexible, and replicable solutions. In this context, computational design — with its rule-based, algorithmic, and parametric approaches — introduces adaptive flexibility into the design process.

Computational design is a process in which numerous variations can be rapidly generated through defined rules and algorithms based on specific inputs [23]. For post-disaster conditions, this approach enables scenario-based system generation for both temporary and permanent shelter solutions, accelerating and diversifying the process. The modular system developed in this study is fundamentally based on computational design. Each module consists of units that can be reshaped according to their function and context. Variables such as user density, functional requirements, access, and service infrastructure have been integrated into the system as parameters that determine the size, location, and connection forms of the modules. Additionally, a Voronoi-based logic of proliferation has been incorporated into the computational framework to enable a systematically organized expansion from the center outward. Through this method, each new module adapts to environmental conditions while maintaining the integrity of the overall system.

2.5. Voronoi Diagrams: Conceptual Foundations And Architectural Applications

Voronoi diagrams are a mathematical concept first developed by Georgy Fedoseevich Voronoi in 1908. These diagrams are formed by determining the areas closest to each of the points (seed points) distributed on a plane. These structures define the competitive relationships between points on a plane and provide effective tools for spatial partitioning [18].

Voronoi diagrams are used in modeling natural organizational processes across many disciplines, from biology to astronomy, urban planning to architecture. In the context of architecture and urban design, Voronoi diagrams are typically used to establish spatial organization, functional separation, and spatial relationships. These diagrams play an important role in creating complex spatial configurations and organic forms, particularly in parametric design processes [18].

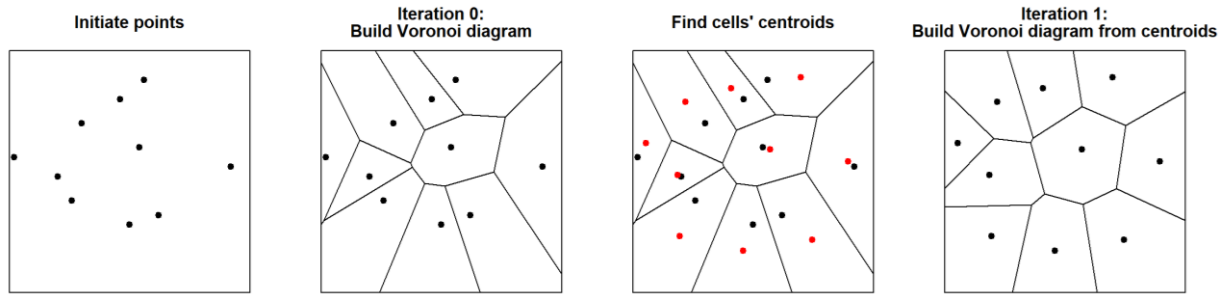

Figure 1. *Voronoi Diagrams [24]*

One of the most powerful aspects of these diagrams is their ability to establish both flexibility and hierarchy. Voronoi cells function as independent units while maintaining their relationship with central seed points. This makes them a suitable infrastructure for modular systems, adaptable architectural solutions, and scalable structures [19].

3. GENERATIVE ARTIFICIAL INTELLIGENCE AND VORONOI-ASSISTED DESIGN PROCESS

This study is based on a modular building system that began with meeting temporary shelter needs after an earthquake and can be transformed into a permanent, flexible, sustainable settlement in the long term. At the heart of the design is a vertically expanding structure based on the organizational logic of Voronoi diagrams. This system offers a structural organization in which each module is structurally and functionally independent but integrated with the entire system. Post-disaster architectural design processes are of great importance not only for the reconstruction of physical structures but also for the reconstruction of communities and the support of psychosocial recovery processes. In this context, a community-based and participatory approach to architecture is one of the most effective ways to produce lasting and sustainable solutions in disaster areas. This approach ensures that users are not merely recipients but active participants in the design and production processes.

Participatory architecture strengthens users' sense of belonging to the spaces they inhabit; it also makes it possible for designs to be more appropriate to local needs, cultural codes, and social dynamics. This participation is particularly important in post-disaster reconstruction processes, as communities need collaborative production processes to recover not only physically but also socially and culturally.

3.1. Defining the Identity and Role of Artificial Intelligence

In the first step of the design process, the role assigned to ChatGPT, one of the artificial intelligence tools, was clearly defined. “You are now an architect. You specialize in designing for extreme conditions.” Work began with this prompt. This statement signifies the designer's transformation into an expert who not only produces spatial solutions but also systematically considers post-disaster reconstruction processes. This identity has determined the direction of the entire design process and has been the fundamental determinant in decision-making stages. Here, the designer is not only designing structural elements but also a living fabric: An approach that interprets the process from the initial response to a disaster to the creation of permanent living spaces within the time-space-function triangle.

3.2. Disaster Scenario and Fictional Setting

The basic extreme scenario of the design is a disaster environment following a large-scale earthquake. A two-stage systematic solution has been developed in line with this scenario. Since the first 24-72 hours after a disaster are critical, core modules that can be set up within this timeframe have been designed. These modules offer a compact yet effective spatial solution to meet basic living needs (shelter, heating, access to clean water, security). These units, which are transported to the site as prefabricated structures, are designed to be assembled with minimal technical equipment and can be modified by the user. After the crisis phase has passed, the system's second phase is activated: Modules with different functions are added around the existing core module. These modules consist of units aimed at rebuilding social life, such as housing, healthcare, education, production, and logistics. Each module has a functional identity, and the system as a whole is formed by the collaboration of these identities.

3.3. Visualizing Post-Disaster Architecture through Generative AI

First, design formation schemes were studied. Key decisions were made for these schemes using keywords such as “voronoi” and “modular design.”

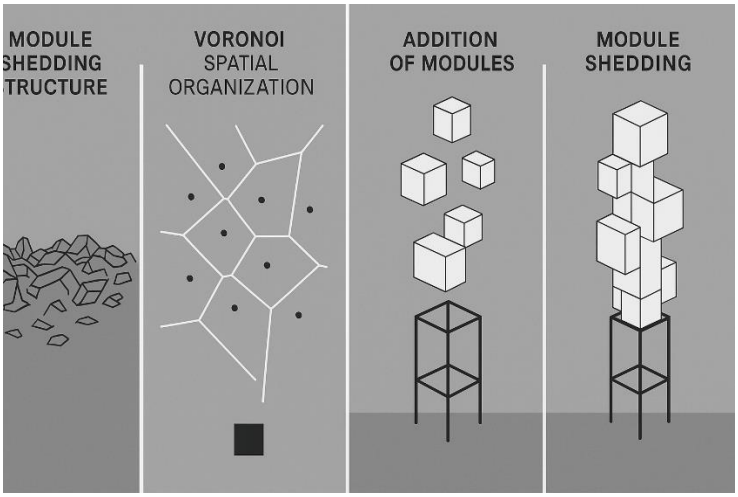

Figure 2. *Formation Diagram Visualized with ChatGPT*

The spatial structure of the design is based on the logical structure of Voronoi diagrams. Unlike common applications, this project focuses on vertical expansion rather than horizontal expansion. This choice, especially in areas with post-earthquake soil deformation, minimizes ground intervention and maximizes space efficiency through stacked modulation. The aim here is to use Voronoi not merely as a formal aesthetic tool but as an organizing and relational system logic [Figure 2]. Each module is treated as a cell growing from the center outward. The fundamental principle of Voronoi—the shortest-distance center-cell relationship—is combined here with functional optimization, ease of access, and structural efficiency.

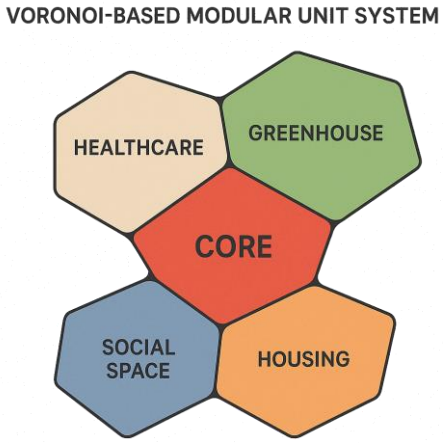

Figure 3. *Center-Spreading Schemes Visualized with ChatGPT*

The system is based on the principle of proliferation according to the functions of peripheral modules, starting from a central module. This central module is considered not only a structural core but also a "collective core" through which the community can carry out its decision-making processes. Each module radiating from the center can be shaped according to the suggestions and needs of different user groups; thus, the structure becomes flexible and adaptable not only physically but also socially. Community participation also continues during the use phase of the structures. For example, while one module may serve as a health unit, another module may function as an education or production area. This flexibility allows the structure to respond to different needs at different times. The post-disaster first response module represents the central cell of the Voronoi system. The entire system develops from this core. Just like in Voronoi diagrams, each new module creates its own "neighborhood boundary." These boundaries are determined based on user needs, accessibility, and functional density. Module sizes are scaled according to usage time, user density, and functional requirements. For example, a residential unit may be 24 m², while a health module may be 60 m². Modules not only touch each other but also become physically interconnected. These connections are provided through both vertical and horizontal links.

After the design schemes and general principles were determined, the visual representation of the design was generated using the information previously stored in the artificial intelligence memory.

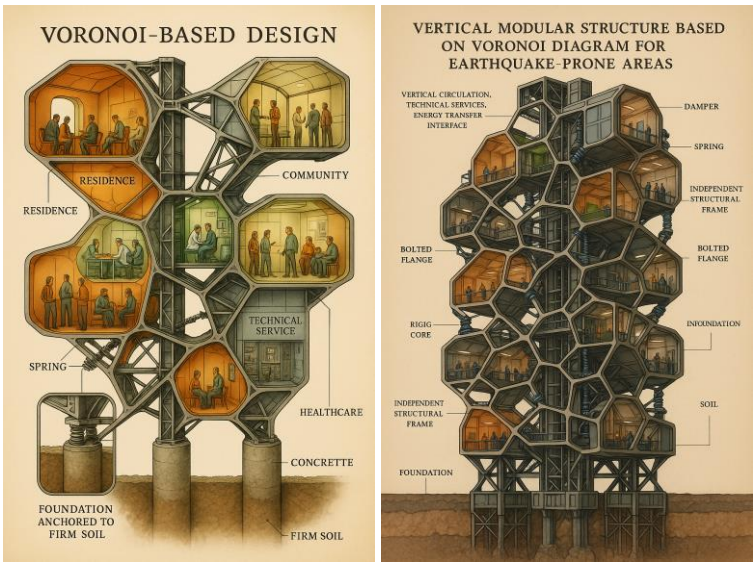

Figure 4-5. *First-Phase Design Visualized with ChatGPT*

However, in the initial stage, ChatGPT used the Voronoi concept in a very formal way and directly reflected it in the design.

Then, starting from the beginning, schematic cross-sections and isometric visual studies were carried out for the structure to be created. Instead of providing all the information and creating visuals for the design at once, the artificial intelligence memory was updated in detail at each step, resulting in healthier design inputs.

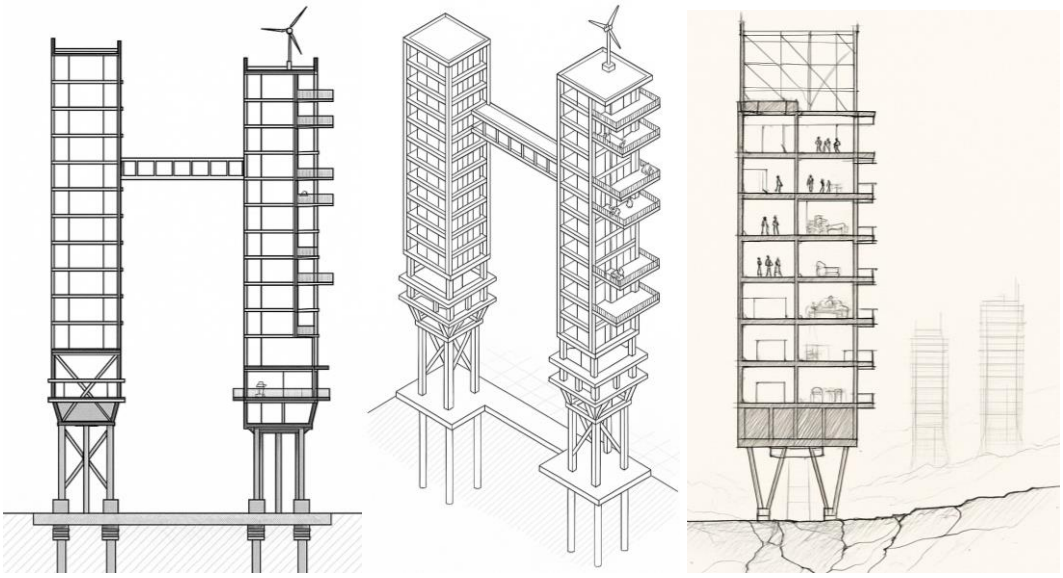

Figure 6-7-8. *Section and Isometric Drawing Works Visualized with ChatGPT*

Following the section studies, the work continued with the addition of new design inputs to the colored section study. As environmental characteristics, it was determined that there were ruins left over from the earthquake and that people remained in the first modules created after the earthquake.

Figure 9. *Post-Disaster Initial Living Modules Visualized with ChatGPT*

Inter-building bridges have been added to the post-disaster initial living modules that have been created. The modules have been raised off the ground to mitigate the risk of continued seismic activity. As a result of all these inputs, ChatGPT has added solar panels and transition elements such as cable cars on its own, even though they were not specified in the prompt, using its own memory.

The next step involves adding modules that can be used for different purposes on top of the existing modules. Each structure has a different number of floors and size depending on its purpose and user density.

Figure 10. *Functionally Diverse Modules Visualized with ChatGPT*

Lightweight steel systems, connection details, and damping elements have been used for wind and earthquake loads. To ensure self-sufficiency, each structural unit is equipped with green gardens, solar panels, wind turbines, and water collection systems. Vertical transition elements are used to facilitate movement between modules. Flexible transitions and semi-open spaces (terraces, balconies, inner courtyards) are available between modules. The safety, flexibility, and sustainability of housing units under extreme conditions such as earthquakes are directly related to the structure's load-bearing system and the materials used. In this context, the proposed modular and reconfigurable structural system within the project has been designed to perform at a high level both in terms of the load-bearing system and the

materials used. As suggested by ChatGPT, each module functions as an independent structure within itself. This ensures that the entire system is not affected in the event of local damage. This structural independence enables rapid, low-cost, and modular post-earthquake interventions.

Figure 11-12. *Render Section Works Visualized with ChatGPT*

The images created were shared again with Chatgpt, and it was requested that the design be developed further. This prevented the design from being developed in different directions or unwanted inputs from being added. It was requested that a more detailed cross-section be created based on the latest images. A cross-section image was created that shows all living units and connections [Figure 13].

Figure 13. *Detailed Section Work Visualized with Chatgpt*

Based on this detailed cross-section study, a design concept was requested in which structures were replicated on different floors and connected to each other by bridges.

Figure 14-15-16. *Interconnected Structure Modules Visualized with ChatGPT*

4. EVALUATION

The design proposal developed in this study introduces a vertically expandable, modular system shaped by Voronoi logic and enhanced through the use of generative artificial intelligence (AI). The system seeks not only to address urgent shelter needs in the immediate aftermath of an earthquake but also to offer a pathway toward the establishment of socially integrated, functionally diverse, and spatially adaptive communities. This aligns with recent disaster recovery literature that stresses functional recovery as a staged, adaptive process, where rapid deployment must be directly linked with long-term resilience metrics [25]. Empirical analyses of large-scale post-earthquake housing in Turkey also reveal the challenges of scaling modular approaches under resource constraints [26]. The two-phase structure—composed of rapidly deployable core modules followed by the gradual addition of secondary, function-specific units—supports a transformative process that shifts the focus from emergency response to long-term recovery and urban resilience. In this respect, the proposal extends beyond conventional approaches to disaster architecture by framing temporary shelter as the foundation for regenerative urban strategies [27].

One of the primary strengths of the proposed model lies in its transformability. Enabled by a Voronoi-based spatial logic, each module operates as an independent yet interrelated unit, capable of evolving in response to shifting user needs, functional demands, and environmental constraints. This bottom-up adaptability ensures not only spatial flexibility but also social inclusivity, as the design allows communities to reconfigure and repurpose modules over time. In addition, the emphasis on vertical scalability makes efficient use of land and offers structural advantages in high-density or geotechnically unstable urban contexts. Modules may expand both upward and outward, maintaining structural autonomy through their individual support systems.

Another notable aspect of the design is its potential for self-sufficiency and environmental integration. During the iterative process, the AI system suggested solar panels, green gardens, wind turbines, and suspended cable systems. These contributions enhanced the environmental performance and sustainability of the proposal. Comparable approaches in recent modular housing research emphasize not only the adaptability of units but also their integration with sustainable energy and water systems, reinforcing the importance of ecological self-sufficiency [28]. These features, while speculative in nature, reflect a growing interest in combining modularity with ecological sensitivity in disaster-prone environments [28].

Despite these strengths, the design remains largely conceptual and carries a number of limitations that must be acknowledged. Most notably, the system’s structural performance has not yet been validated

through engineering simulation or physical prototyping. Emerging computational approaches suggest that Voronoi-based lattice and micro-architectures can improve energy absorption and stress distribution under dynamic loads [29], [30]. However, these remain primarily experimental at material scale and require architectural-scale validation. The feasibility of the proposed vertical connections, intermodular links, and material systems under seismic conditions remains untested. Additionally, economic considerations such as prefabrication logistics, material availability, and cost-efficiency have not been analyzed within the scope of this study, making the design more of a visionary framework than an immediately actionable solution [31].

Another critical limitation relates to the reliance on prompt quality and human intervention in the AI-assisted design process. While ChatGPT provided generative support throughout the workflow, the quality, relevance, and depth of its responses were highly dependent on the clarity and specificity of the user's inputs. This indicates that such systems cannot operate independently but require skilled human curation, interpretation, and decision-making. Furthermore, ethical, cultural, and contextual parameters—critical in any architectural design—were not inherently addressed by the AI, highlighting the continued necessity of human agency in design authorship [32].

Table 1. *Evaluation Table*

Transformability	The ability of the design to evolve from the post-disaster first response phase into a permanent settlement over time.	-Two-phase structural system: The first module starts as a "core," gradually surrounded by functional modules. -Modules can be rearranged according to user needs. -With Voronoi logic, each module can be adapted to its surroundings and reconfigured.
Scalability	The capacity of the modular system to expand horizontally or vertically over time.	-"Vertical expansion" is emphasized; each new module can be added to the existing structure from above. -Each module has an independent support structure, allowing growth at both functional and physical levels. -Module sizes can be scaled according to user density.
Becoming Permanent	The transformation of temporary living spaces into permanent neighborhood structures in the long term.	-Permanent social spaces (health, education, production) that support community life over time. -Modules are made permanent with legs connected to solid ground. -Socio-cultural sustainability is targeted: collective core, community participation.
Artificial Intelligence Contributions	Contributions to the design process such as decision support systems, visualization, and suggestion generation.	-ChatGPT assumed the role of designer: started with the prompt "You are now an architect..." -ChatGPT integrated sustainable elements such as solar panels, cable cars, wind turbines, and green gardens into the design without being specifically requested by the user. -Distribution of Voronoi seed points and module dimensions were optimized with artificial intelligence. -AI-supported material and connection recommendations were provided for wind and earthquake loads.

In summary, the proposed system presents a promising and innovative approach to post-disaster architectural intervention, particularly in its ability to synthesize modularity, generative intelligence, and adaptive spatial strategies. However, its long-term applicability will depend on future work involving structural validation, real-world prototyping, and the development of ethical and methodological frameworks for AI-supported co-creation in architecture.

5. CONCLUSION

This study introduced a speculative yet structured design approach that integrates generative artificial intelligence (AI) and Voronoi-based modular logic into a post-earthquake housing model. Through the iterative co-creation process between human and AI, the research proposed a vertically expandable, functionally differentiated, and socially integrative system that rethinks the transition from emergency shelter to permanent settlement.

The findings demonstrate that AI can support early-stage design processes by generating formal, spatial, and functional ideas in response to well-structured prompts. In particular, ChatGPT's ability to suggest modular relationships, vertical connections, environmental elements (e.g., solar panels, cable systems), and public program distributions proved beneficial to conceptual exploration. However, the process also revealed key limitations: AI struggled with issues requiring engineering judgment, cultural nuance, or ethical reasoning unless these parameters were explicitly encoded into the prompts. Furthermore, AI responses often lacked critical reflection, leading to outputs that required continuous human interpretation and validation.

The role of the human user was central to curating, refining, and steering the AI-generated content. While the system was able to produce design directions, the final articulation of spatial quality, hierarchy, and feasibility depended entirely on human decision-making. Although the prompt-response cycle allowed for a high degree of ideation, the creative agency, contextual sensitivity, and structural logic were ultimately shaped by the designer's intervention. This confirms that the current state of AI-supported design remains dependent on hybrid intelligence rather than full autonomy.

If the proposed system were to be prototyped, several practical challenges would emerge. Structurally, the vertical modular logic requires rigorous validation under seismic loading through simulations or physical testing. Connection strategies between modules, load transfer behavior, and site-specific foundation systems would need to be engineered. Additionally, issues such as transportation of prefabricated parts, on-site assembly logistics, and material durability under long-term use would also require careful consideration. Socially, real-world acceptance of such a system would depend on cultural appropriateness, user participation, and flexibility in post-disaster contexts.

For future research, multiple trajectories can be pursued. Comparative studies may explore how generative design outputs from ChatGPT differ from those produced by visual-based platforms such as Midjourney, Rhino AI, or Revit plugins—each of which offers different representational and parametric capabilities [33]. Usability studies with real users, particularly those who have experienced disaster conditions, would provide invaluable insight into the adaptability and livability of the proposed system. In addition, the structural performance of modular units could be tested through digital simulations (e.g., finite element analysis) to ensure safety and durability. Lastly, the system could be extended beyond earthquakes and adapted to other types of disaster scenarios, such as floods, wildfires, or climate-induced displacement, thereby enhancing its versatility and relevance.

In conclusion, this research contributes not only a design proposal but also a methodological lens for integrating AI into disaster-resilient architectural thinking. By identifying both opportunities and constraints within the human–AI partnership, the study offers a roadmap for future innovation in computational architecture under extreme conditions.

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Research Article GU J Sci, Part B, 13(3): 415-430 (2025)

Gazi University
Journal of Science
PART B: ART, HUMANITIES, DESIGN AND PLANNING
http://dergipark.gov.tr/gujsb

A Process-Based Evaluation of Architecture Students' Perspectives on the Professional Journey

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Article Info

Received: 23/05/2025
Accepted: 12/09/2025

Keywords

Architecture profession, Architecture students, Professional expectations, Professional life challenges, Student views.

Abstract

Architecture has been an attractive career option for many people as a creative and prestigious professional field. However, in recent years, serious concerns and anxieties about the future of the profession have emerged. Particularly, economic difficulties, sector contraction, and disruptions in education are undermining architecture students' hopes for professional life. In this context, understanding the perceptions and expectations about the profession is crucial for laying the foundation for future solutions. This study aims to understand architecture students' professional perceptions and expectations. An online questionnaire was conducted via Google Forms with a group of 69 students from the 7th Term (4th Year) undergraduate class in the ARCH 4031-Construction Management and Economics course at Gazi University, Faculty of Architecture. The students' professional expectations, interest in the profession, and challenges they face regarding professional life were examined. The results of the study reveal that students are concerned about the future of the profession and are keenly aware of its declining prestige. This study, which is a continuation of the series, reveals the extent of these concerns among students over the years. Additionally, disruptions in education, lack of practical experience, and educational processes that are insufficiently integrated with the sector are negatively impacting architecture students' preparation for professional life. Based on the findings, various recommendations have been made to improve professional perceptions. These include enhancing the quality of education, controlling the number of architecture faculties, strengthening the academic staff, and emphasizing the importance of practical education. Furthermore, it is emphasized that professional guidance and societal support are necessary to improve the public's perspective on the profession. This study is part of a series of research aiming to contribute to solving professional issues in the long term on architecture students' perceptions, and raising awareness about the profession by laying the groundwork for an index of professional issues that will be developed through future studies.

1. INTRODUCTION

Architecture is a precious discipline that shapes the urban environment and influences the quality of life. Through their designs, architects address functional necessities while contributing to the cultural identity, economic development, and social cohesion of communities [1]. The role and education of architects have undergone changes throughout history.

The architectural profession emerged around 3000 BC in the Middle East during the process of the urban revolution [2]. At that time, architects functioned as a combination of master craftsman, engineer, and artist, encompassing both physical and intellectual domains. The role of the architect evolved from builder and craftsman in the Middle Ages to a respected professional engaged in both artistic design and technical expertise, with the establishment of architectural offices.

It is evident that changing dynamics, economic conditions, and the quality of education shape students' hopes and concerns [3]. The issues experienced in architectural practice and education are defined as a

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"dual crisis environment," emphasizing the devaluation of design and the increasing pressure for production [4]. Furthermore, in the construction of a professional career, external conditions such as the nature of the job and environmental factors—are as determinative as internal conditions such as the individual's experience and tendencies as previous studies have revealed that careers are shaped by a wide range of cultural, political, individual, sociological, psychological, educational, temporal, physical, economic, gender, and chance-related factors [5]. Below are presented assessments concerning the economic, political and educational factors that influence the environment in which architectural practice takes place in Turkey, along with the consequences of these factors:

The Impact of the Economy on the Architecture Sector in Türkiye:

- In recent years, economic stagnation and rising inflation in Turkey have increasingly affected budgets allocated to architectural and construction projects [6].
- The depreciation of the Turkish lira has impacted firms engaged in foreign currency–based contracts and complicated the procurement of imported construction materials [7].
- Strict governmental policies have reduced public project budgets, potentially slowing the implementation of ongoing projects [8].
- Rapid construction processes and cost-driven, uniform design approaches have contributed to a decline in public appreciation for architectural quality [9].

The Impact of Policies on the Architecture Sector in Türkiye:

- Turkey has long pursued development policies heavily reliant on the construction sector [10], yet a lack of long-term strategic planning has become apparent.
- Uncontrolled urban expansion and unplanned zoning projects have taken place in numerous cities [11].
- The Kahramanmaraş earthquake highlighted delayed preventive measures against natural disasters, undermining public trust in buildings and in the roles of contractors [12].
- The influence of professional chambers of architecture has diminished, reducing professional solidarity.

The Impact of Education Strategies on the Architecture Sector in Türkiye:

- In Turkey, the absence of a "Science and Education Policy" that would provide a concrete legal basis indicates the lack of a common value platform in the field of architecture [13]. Inadequate policies in architectural education have resulted in underprepared graduates entering the profession, alongside an uncontrolled increase in the number of practicing architects.
- The unchecked proliferation of architecture faculties has contributed to the ongoing decline in the architectural sector [5].
- Variations in the quality of education provided have further impacted the profession negatively.

Deficiencies in the curriculum and content have hindered the preparedness of graduates. Under the former conditions, the architecture sector in Turkey has been affected both directly and indirectly. This situation has had a considerable impact on the profession of architecture, led to a decrease in professional motivation, and weakened industry standards. As a result, employment opportunities for architects and engineers in the sector have also been adversely impacted. Since these changes are also observable from outside the profession, they carry the potential to create a perception of an insecure future for prospective architects.

This article aims to identify and analyze the factors that shape architecture students' professional perceptions and expectations, offering a nuanced understanding of how these factors influence their hopes and concerns about the future of the profession. It is part of a broader series of research that seeks to keep the declining interest in architecture on the agenda and to contribute to discussions about its future (Table 1).

- The oldest study was conducted during the 2018–2019 academic year with fourth-year undergraduate students enrolled in the seventh semester ARCH 4031-Construction Management and Economics course in the Department of Architecture at Gazi University. Questions were

posed regarding the factors influencing students' career choices, their preferred fields of work within architecture, the skills they believed would help them secure employment, and their expectations for their first jobs.

- The authors' second study questioned the societal impacts of the shrinking construction sector. It discussed the effects of changes in the construction industry on architecture students. With the study conducted in 2021, the sociological dimension of architecture was also expanded.

- The current paper presents data from 2024, focusing on understanding architecture students' hopes and concerns regarding the profession. By comparing the findings with those from previous years, the study aims to present a portrait of changing perceptions concerning the direction of architectural education and the future of the profession.

Within this framework, the current paper contributes to the longitudinal observation process initiated in earlier studies and builds on their findings and develop a systematic set of indicators to better understand and address professional challenges.

Table 1. *Summary Information on the Research Series*

Period	Explanation
2018-2019 Academic Year	In this study, a questionnaire was conducted with a group of 51 participants, aiming to understand the changing nature of professional practice, to improve architectural education, and to explore students' expectations and aspirations. The students were asked questions regarding the factors influencing their career choice, the specific fields within architecture in which they wish to work, the skills they believe will assist them in finding employment, and their expectations concerning their first professional experiences.
2020-2021 Academic Year	The study focused on exploring the potential consequences of the transformation within the construction sector. Conducted with a participant group of 66 individuals, the research expanded upon the 2018 study by additionally investigating the participants' sociological characteristics and demographic profiles.
2022-2023 Academic Year	The declining interest in the architecture profession—and the resulting drop in the university entrance ranking of architecture schools—was addressed as a critical issue. In this study, conducted with 91 participants, questions were added regarding their university program preference rankings and their alternative choices outside the field of architecture, in addition to the questions used in previous studies.
2024-2025 Academic Year	The study presents the economic and political factors influencing the context in which architectural practice is carried out in Turkey. The data, focusing on understanding the hopes and concerns of architecture students, are presented through a comparative analysis with findings from previous years.

2. ARCHITECTURAL EDUCATION IN TURKEY: HISTORICAL DEVELOPMENT AND STUDENT PROFILES

The establishment of the Royal Institute of British Architects (RIBA) in the mid-1800s in the United Kingdom marked an important step in the regulation of the architectural profession. This initiative brought about a redefinition of roles within the construction sector, and at a conference on architectural education [14]. The establishment of RIBA was significant as it marked the institutionalization of the architectural profession, setting standards for education, ethics, and practice. By redefining the role of the architect within the construction sector, it also provided a model of professionalization that would later find parallels in the institutional development of architectural education in Türkiye.

The historical scope of modern architectural education in Türkiye is defined by fundamental institutional and ideological changes that reshaped the profession. The most significant turning point in this regard can be considered the early Republican period. The transition from state-supported architectural practice in

the Ottoman period to the establishment of modern faculties and subsequent expansion under the auspices of the Council of Higher Education (YÖK) during the early Republican period represents turning points in which the boundaries of 'modern architectural education' were defined. A closer examination of this temporal context is warranted.

During the Ottoman Empire, architectural activities were state-sponsored, and education focused on designing buildings for the sultans; from the late 18th century, Western-modeled engineering schools enabled architects to evolve into professional experts beyond state service [3]. Architectural education in Turkey institutionalized in the early 20th century, with the 1930s marking a shift from Renaissance- and Ottoman-based approaches to modern architecture, supported by foreign architects and the establishment of architecture faculties at Yıldız Technical School (1942) and Istanbul Technical University (1944) [15]. In 1956, METU established the first architecture faculty outside Istanbul, introducing a Bauhaus-inspired model; the 1960s saw new faculties and private schools emerge, and with YÖK's (the Council of Higher Education) establishment in 1981, architectural education expanded nationwide within the formal university system [3]. Since the 2000s, Turkey's economic policies have shifted, with increased investment in the construction sector and a growing share of construction in the Gross Domestic Product (GDP). [10]. As a result, participation in the construction sector grew significantly, and schools of architecture emerged as highly sought-after institutions.

Architectural education in Turkey has undergone a significant transformation in recent years with the increase in student numbers and the spreading of universities. The number of universities providing architectural education reached high levels in the 2000s. While in 1990 architectural education was conducted in 11 institutions, by 2009 the number of faculties of architecture had increased to 41 [16]. By 2024, this figure has undergone a remarkable expansion, reaching 124 institutions, including 69 public universities and 55 foundation universities. This institutional proliferation has been accompanied by a comparable rise in student quotas, which grew from 1,994 in 2003 to 6,500 in 2023, reflecting an increase of 225% [14]. This expansion has significantly influenced the state of architectural education in Turkey. The process of institutionalization resulting from this expansion has had a considerable impact on the quality and effectiveness of architectural education. As a consequence of the increase in quotas, the profile of students admitted to faculties has been changing. According to Köknar et al., as reflected in the presentations at the 2018 annual conference of the European Association for Architectural Education (EAAE), such issues concerning faculties of architecture are not observed in other countries [17]. This transformation has influenced the profile of architecture students, their expectations, and their professional perceptions. In particular, factors such as changing economic conditions, concerns about employment, and professional dissatisfaction have led to notable shifts in students' outlooks on the field of architecture [18]. Köknar et al. define the problem arising in this context within architectural practice and education as a dual crisis. They argue that the production pressure generated by architectural practice has been reflected in education, leading to the devaluation of design [17].

Architectural education is directly linked to professional practice and plays a critical role in shaping architects' knowledge, skills, and competencies. Therefore, architecture students' educational experiences and their perceptions of the profession are of great importance for the future of architectural practice [19]. Several studies have addressed this topic. For instance, academic studies conducted a study aiming to understand architecture students' views on professional practice, improve educational processes, and assess student expectations. These researches examined the factors influencing students' choice of profession, their preferences regarding areas of practice, the skills they consider important for employment, and their expectations about their first professional experiences [20].

In many countries, various systematic methods are employed to better understand higher education students and to identify their needs. For instance, in France, the Observatoire Nationale de la Vie Étudiante (OVE) conducts a comprehensive study every three years to examine student life in detail and to evaluate other research carried out on this subject. In the United Kingdom, Times Higher Education conducts research aimed at understanding student experiences [21]. In Australia, a survey carried out every five years at the University of Melbourne focuses particularly on the experiences of first-year students [22].

In Turkey as well, studies have been conducted on student profiles. For instance, a study carried out in 1968–69 at Hacettepe University's School of Basic Units focused on students' personal characteristics, family backgrounds, personality traits, skills, motivations, and perceptions of the university. Adnan Mazmanoğlu investigated the influence of birthplace, region of residence, and family environment on the academic success of students at Istanbul University. In 1993, the profiles of Hacettepe University students were documented. The Council of Higher Education (YÖK) conducted a study addressing family income, educational expenditures, financial aid, and employment expectations of university students in order to inform educational policies. In 2003, another study on student profiles was carried out at Akdeniz University [23]. In 2005, a study at Middle East Technical University examined the relationship between the problems of senior students and the variables of gender and faculty [24]. At Gazi University, a study was conducted in 2007 to identify student profiles [25]. In 2019, Gencer and Daşlı carried out a study on student profiles and university satisfaction based on students from Sivas Cumhuriyet University. Güngör et al. also published a profile study on Gazi University students in 2007 [23].

When it comes specifically to studies conducted on architecture students, a study carried out by the authors aimed to understand professional practices, improve architectural education, and explore students' expectations and aspirations [20]. In this study, students were asked questions regarding the factors influencing their career choices, the fields in which they wished to work, the skills that could assist them in finding employment, and their expectations for their first jobs. Additionally, a study also conducted in 2022 by the authors examined the declining interest in schools of architecture and, as a result, the drop in their ranking in the university entrance examination. This study also included questions about the order in which students selected their preferred schools and their preferences for programs outside of architecture [18].

In 2021, a study was conducted to analyze the factors influencing architecture students' career choices, stemming from internal and/or external motivations, and to investigate how participants' perceptions of "self-efficacy" in becoming an architect changed in parallel with the skills they acquired during their professional education. The findings revealed that students' reasons for pursuing architectural education were influenced by their self-perceptions aligned with the qualities required in the profession, as well as by the impact of their social environment and families [26]. The study conducted by Demirtaş and Hatıpoğlu aimed to understand students' expectations from the construction sector, their satisfaction, the factors influencing their short-term experiences, and how they behaved in a risky environment. The findings indicated that the nature of the profession and its prestige attracted architecture students in Turkey; however, due to dissatisfaction with salaries and social benefits, their behavioral intention to continue in the sector decreased [14]. In the field of landscape architecture, a study conducted with a 12-year interval posed the same questions to students. The results showed that, while initial career choices were driven by high motivation and conscious decision-making, over time students' confidence decreased due to gaps in education, insufficient practical training, and concerns about the job market. It was also observed that concerns regarding professional competence and employability increased over time [27].
Consequently, adopting a student-centered approach, improving the physical characteristics of educational institutions, and maintaining continuous improvement efforts are essential for a quality educational environment. In addition, focusing on initiatives aimed at enhancing student satisfaction is important. Only through such measures can the expectations of young individuals aspiring to pursue a career in architecture be understood and addressed effectively. In this respect, when studies conducted in Turkey are examined, it is seen that these studies aim to establish a historical framework about students' socio-demographic characteristics, family structures, economic situations, and expectations; however, most of these studies are not specific to architecture students. Increasing the number of studies analyzing architecture students' professional perceptions, short- and long-term expectations, and expectations from education is an important requirement for deepening general student profile studies within the framework of the architecture profession.

3. METHOD

The primary aim of this research is to identify the factors that influence architecture students' professional perceptions and expectations, and to analyze how these factors affect their hopes and concerns regarding

the profession. The methodology of this study adopts a systematic and multifaceted approach to understanding architecture students' perspectives on the profession. The combined use of quantitative and qualitative data collection methods enhances the validity and reliability of the research. The first part of the questionnaire aims to understand students' family backgrounds and socio-economic conditions. These questions were designed to discuss the influence of family on career choices and the relationship between architecture and social capital. The second part covers students' reasons for choosing architecture, their university preferences, and their assessments of the education process. This section provides data on both the quality of architecture education and students' personal orientations. The third section analyzes architecture graduates' perceptions of the job market by asking about their expectations regarding their first job experience (ease of finding a job, salary level, working conditions). These sections were administered to participants as multiple-choice questions. In the final section, open-ended questions were asked about long-term professional goals and views on the position of architecture education in society.

The study group consists of undergraduate students enrolled in the Department of Architecture at Gazi University. Prior to data collection, the necessary approval was obtained from Ethics Committee of Gazi University with the decision numbered E-77082166-604.01-881085 and dated 16.02.2024. Following this, in last part of broader series of research, a questionnaire was conducted in October 2024 with a group of 69 students enrolled in the 7th semester (4th year) undergraduate course titled ARCH 4031-Construction Management and Economics at the Department of Architecture, Gazi University. The questionnaire was conducted online via Google Forms.

The analysis of the questionnaire was conducted through the compilation of data provided by an online platform. In this context, in quantitative section of the study students' responses regarding their demographic characteristics, professional expectations, and educational satisfaction were analyzed. The quantitative data were analyzed using frequency counts and percentage distributions to identify patterns and trends across the sample. In the qualitative section of the study, students' responses to open-ended questions were analyzed using content analysis. Specifically, the analysis focused on two main themes: students' short- and long-term professional expectations and their views regarding the recent decline in university entrance rankings for architecture programs. Responses were systematically categorized to capture students' perspectives on their anticipated career paths and their reflections on the factors influencing the popularity of architecture programs. This approach allowed for a nuanced understanding of how students perceive their future profession and the educational context shaping their career decisions.

Ethical principles were carefully observed throughout the research process. The study commenced after obtaining the necessary permissions. Participants were informed about the purpose and scope of the research, and participation was based on voluntary consent. The anonymity of the students was preserved, and data were used in accordance with the principle of confidentiality. The researcher avoided any form of guidance or influence during the process.

This study was conducted with a limited sample of students. Therefore, the findings cannot be generalized to all architecture students in Turkey. Nonetheless, the results provide valuable insights that contribute to the ongoing discussions on architectural education and professional perceptions.

3. PRESENTATION OF CHANGES IN ARCHITECTURE STUDENTS' HOPES, CONCERNS AND PERCEPTIONS OF EDUCATIONAL EXPERIENCE

The findings of the study organized under the subheadings: Personal Motivation and Professional Attraction, Perspectives on Professional Life, and Awareness of Challenges and the Search for Solutions.

3.1. Professional Motivation

Key general factors play a crucial role in career choice, including the nature of the profession, working conditions in the sector, salary and benefits, professional prestige, and alignment with personal expectations [14]. Students' career choices are shaped by various factors, one of which is professional

motivation. Professional motivation may include one or more of the key factors listed above. The field of architecture offers individuals an opportunity for self-expression, as well as the potential to create lasting works and contribute to society—features that make the profession particularly appealing. The prospect of developing multifaceted skills during architectural education, working in global contexts, and engaging with technological tools can also be attractive to students.

However, it is well known that secondary education and university preference processes in the current system often lack adequate career guidance. As a result, students tend to be influenced by the professions of individuals in their immediate surroundings, leading them to gravitate toward those familiar occupations. Also, in a study it is mentioned studying architecture has revealed that the student candidates are influenced by family members currently working in the construction sector [25]. In this context, participants in the study were asked about the professions of their family members and the factors that influenced their decision to pursue architecture.

Data collected in 2020, 2022, and 2024 indicate that the majority of students did not have family members working as architects, civil engineers, contractors, or construction workers. As shown in the data from 2018, 2020, 2022, and 2024, most students chose architecture based on their personal dreams and the belief that their skills and talents were well suited to the profession (Figures 1).

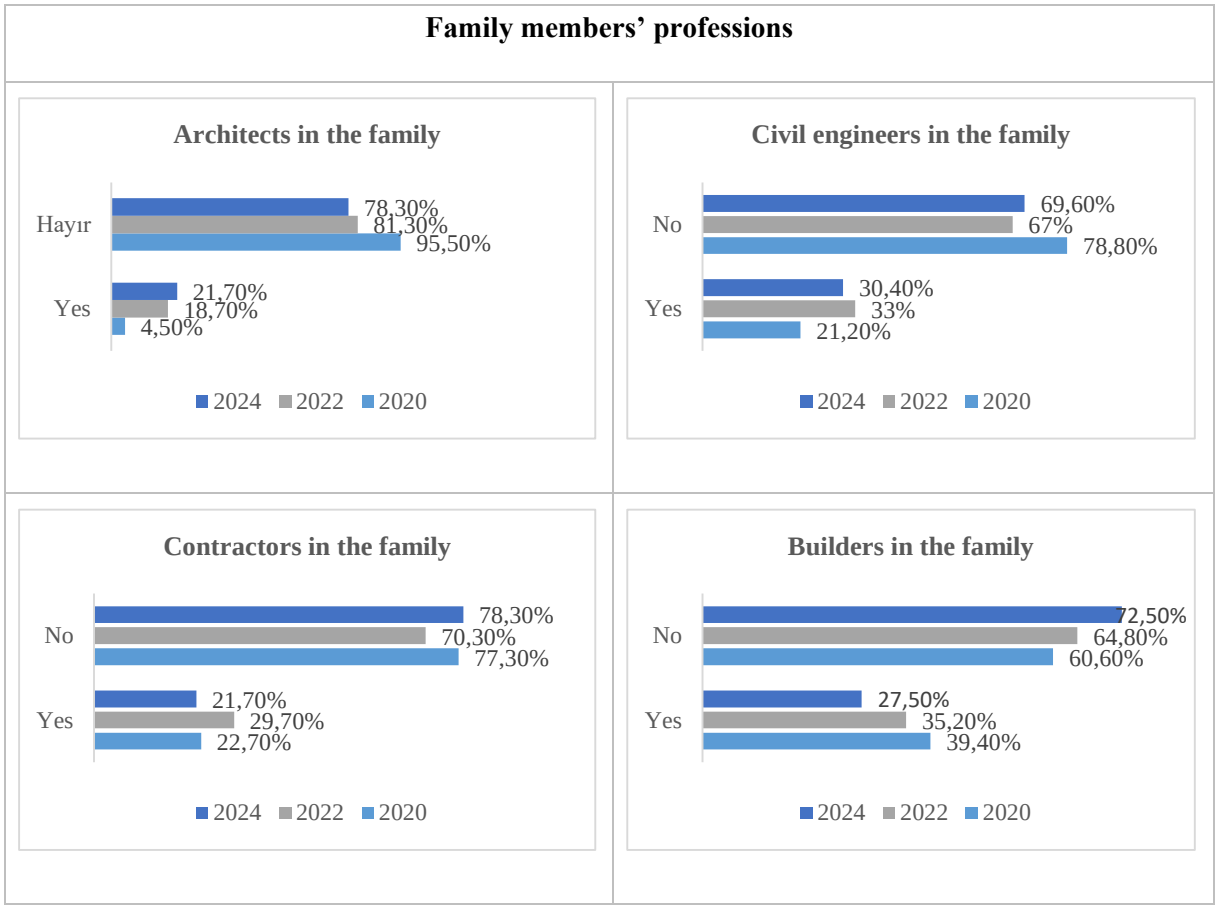

***Figure 1**. Participants' family members engaged in the construction field*

3.2. Perspective on Professional Life

Architecture is a profession that values creativity, aims for social benefit, and allows leaving a lasting contribution to the world. At the same time, it is also tied to capital-driven production, may involve ethically questionable practices, and often exposes employees to low pay and long working hours. The responsibilities and work settings of architects are wide-ranging, and the type of institution or company they work for largely determines the projects they engage in and their working conditions. In this regard,

the career orientations of undergraduate students preparing to enter the profession gain particular importance [14].

In this study, students' perspectives on professional life were explored through questions about their preferred career paths, salary expectations, perceptions of job accessibility, and potential alternative directions in case of unemployment.

In 2022, as in 2020 and 2018, the majority of students (52.9%) stated that they wanted to work in architectural offices. The proportion of those who wished to work in corporate construction firms, on construction sites, or outside the construction sector was similarly recorded as 15.7%. In 2024, a comparable trend was observed, with the majority (55.10%) again expressing a desire to work in architectural offices (Figure 2).

Regarding expected salaries for their first jobs (Figure 3), 42% of students in 2024 indicated they anticipated a salary between 725 and 1000 USD (dollar exchange rate for January 2024: 29,70 TL). Meanwhile, 7.2% expected a salary of 500 USD (approximately equal to the minimum wage in 2024), and 8.8% reported having no salary expectation. In 2022, the majority of students expected a salary between the minimum wage and 8,500 TL (27.5% + 28.6%), 8.8% anticipated earning the minimum wage, and similarly, 8.8% had no salary expectations. For reference, the exchange rates were 5.29 TL/USD in December 2018, 7.38 in December 2020, and 18.70 in December 2022. Accordingly, the equivalent of the minimum wage was approximately 300 USD in 2018 (1,603 TL), 400 USD in 2020 (2,943 TL), and 295 USD in 2022 (5,004 TL).

A significant portion of students—92.8% in 2024 and 94.5% in 2022—believed that finding a job would not be easy. Students expressed similar views in 2020. However, in 2018, the majority (62.7%) believed that they would be able to find a job easily (Figure 4).

Another question about professional life asked whether students would consider pursuing other fields if they could not find employment. In 2018, 62.7% answered affirmatively, with the percentage increasing to 81.2% in 2020, 78% in 2022, and 69.6% in 2024 (Figure 5).

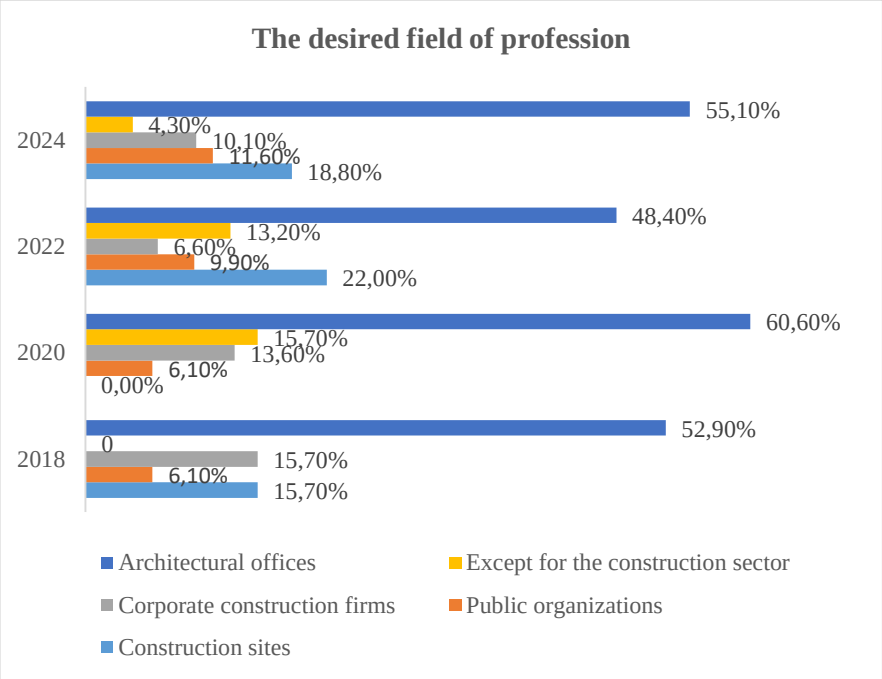

***Figure 2**. The desired field of profession*

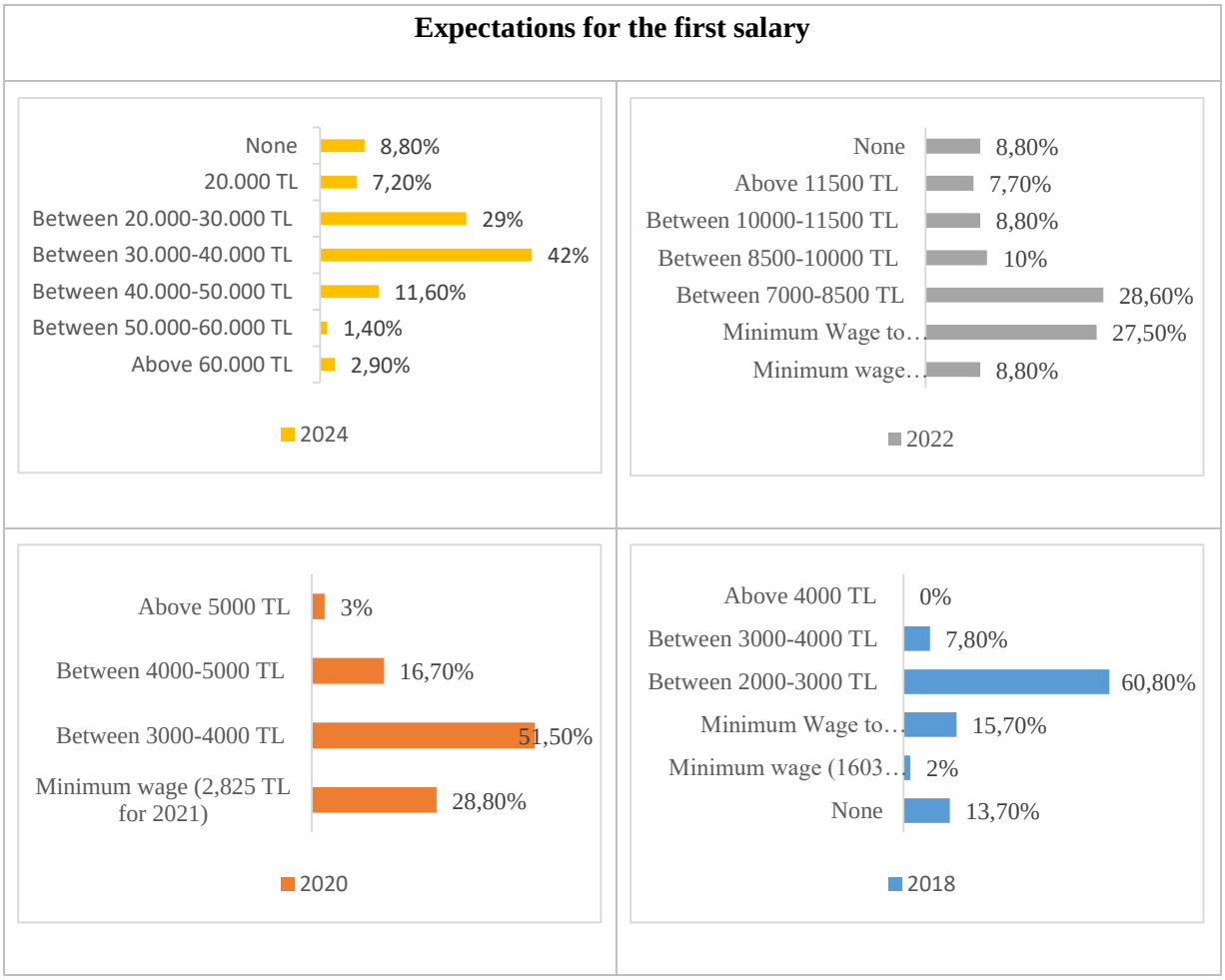

Figure 3. *Expectations for the first salary*

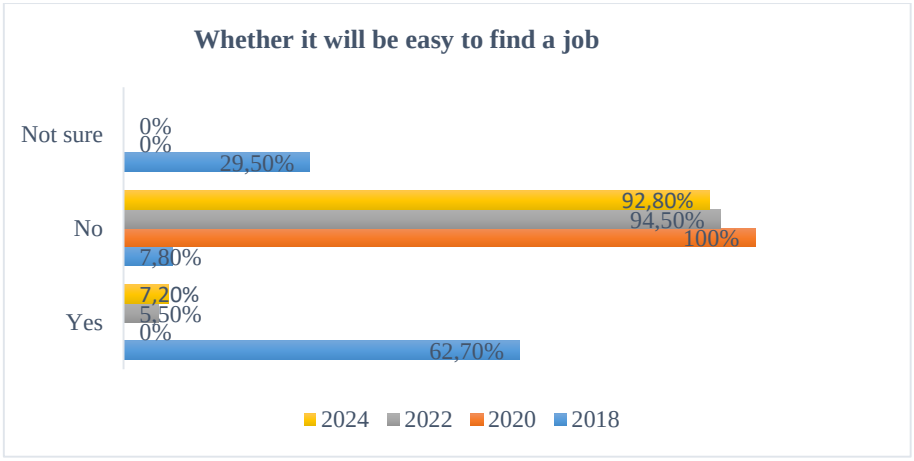

Figure 4. *Whether it will be easy to find a job*

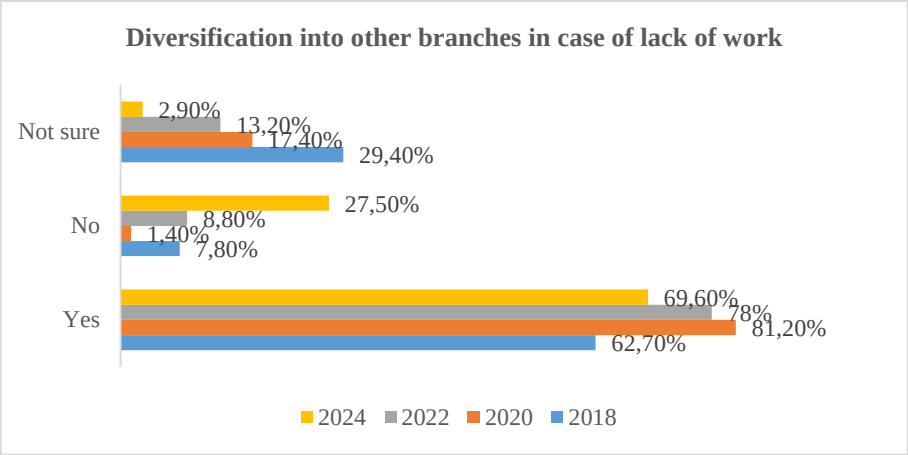

Figure 5. *Diversification into other branches in case of lack of job*

3.3. Awareness of the Issues: Responses to Open-Ended Questions on the Future of the Profession

In order to gather students' opinions on the challenges emerging within the professional field, they were asked open-ended questions regarding their short- and long-term expectations from the profession. In this section, particularly striking responses from students are presented without any alterations.
Students' short- and long-term expectations regarding the future of the profession include:

- "The architectural profession receiving the recognition it deserves, and the supervision of buildings constructed in our country."
- "The creation of job opportunities that can adapt to living conditions."
- "Architects not falling victim to modern slavery in the industry."

Students were asked the question: "There has been a noticeable decline in the university entrance rankings for architecture programs. What are your thoughts on the reasons behind this trend?" Selected responses are presented below:

- "The construction sector has been negatively affected due to the economic crisis."
- "I think people are influenced by factors such as the failure to highlight the positive aspects of architecture, the mostly negative discourse on social media about the profession, and the ongoing narrative that studying architecture ruins a young person's university life."
- "Architecture is not respected enough by the public. People think they can do it themselves, which devalues the profession. Civil engineers also tend to belittle architecture."
- "A temporary search for solutions within the education system."
- "The significant decline in the quality of education is the main factor in the decrease in student quality, which in turn lowers entrance scores."
- "Sometimes, the pressure of university education is unnecessarily high without being instructive or distinctive. There is a lack of appreciation for disciplines outside of architecture, a lack of innovative and instructive studio courses, and overall poor quality."
- "The difficulty of architecture programs could be the primary reason. Since student preferences determine rankings, students may feel they are not capable of coping with such a demanding field."
- "As with many programs, this field is experiencing similar issues. The policy of opening universities in every city has led to rootless institutions. Academics lacking sufficient qualifications have been appointed to these universities, which has caused a collapse in the quality of education. Additionally, the widely acknowledged issue of instructor bullying in some departments might also play a role in this situation."
- "The architecture profession has fallen behind as a modern career path. One of the reasons is that people now prefer professions that offer easier employment opportunities or better life conditions.

Another is the fact that, despite the intense workload, architects are often underpaid. Therefore, students may no longer rank it among their top preferences."

- "In recent years, as part of Turkey's policy to open universities in every province, the quality of architectural education has declined—just as in many other departments. Especially with low entrance scores allowing many to become architects, there has been a serious oversaturation in the field. This has created a labor market imbalance, allowing employers to take advantage of the surplus of unemployed architects. Office managers are easily able to find architects willing to work for low pay under poor conditions, perpetuating a 'you can leave, someone else will come' mentality. Moreover, since success in Turkey is often equated with financial gain, architecture is no longer seen as an attractive career path. Consequently, entrance scores for architecture departments have declined, deepening the quality issue."

Overall, these responses collectively highlight systemic challenges within architectural education and practice, including issues related to education quality, labor market conditions, and professional recognition, which together shape students' perceptions and career choices.

4. DISCUSSION OF FINDINGS

4.1. Discussion of Findings about Professional Motivation

Architecture is often perceived as a creative and prestigious profession, offering individuals the opportunity to design socially beneficial structures and leave lasting works. These characteristics make it an attractive career choice for many. However, personal motivation and the initial appeal of the profession can diminish over the course of architectural education due to various challenges. These challenges often include the demanding nature of studio courses, an excessive workload, insufficient academic guidance, and outdated curricula. In addition, personal motivation and professional appeal may be affected by societal perceptions that increasingly frame architecture not as an art-oriented discipline, but as a part of the service sector. This shift in perception can lead to disappointment among students and diminish their interest in the profession. In line with this perspective, in 2018, the idea that "being an architect sounds appealing" was noted as a significant factor in career choice. However, over the years, this factor appears to have lost its influence on students' decisions. Similarly, expectations regarding high financial returns and the notion of architecture as a popular profession have also declined over time.
These findings suggest that without targeted interventions, students may enter the profession with diminished motivation and unrealistic expectations, potentially affecting their career satisfaction and professional performance. This decline in motivation is not only an individual issue but also reflects a systemic problem: the misalignment between architectural education, labor market realities, and societal perceptions of the profession. As observed in the longitudinal data, factors such as declining university entrance scores and reduced financial expectations reveal that students are gradually internalizing a narrative of professional devaluation, which, if left unaddressed, will further weaken the profession's social standing.

4.2. Discussion of Findings about Perspective on Professional Life

Working conditions include the work environment, duration, colleagues, office resources, and working hours, all of which strongly influence the decision to remain in the sector. However, in architecture these conditions are often unfavorable: long working hours extending into nights and weekends, insecure employment with short-term contracts, lack of health and social benefits, low wages, and even unpaid internships problems that weigh most heavily on young architects. Many architects criticize this situation, arguing that their work and responsibilities deserve fairer recognition and better pay. Today, architectural practice has increasingly been shaped by a market-oriented model of project production, which, in many cases, contributes to projects that threaten the integrity of natural, historical, and social environments [14].

While architecture students' expectations regarding professional life are shaped by a desire to participate in creative and prestigious projects, these aspirations are often undermined by significant challenges such

as unemployment due to the oversupply of architecture graduates in Turkey, low wages, long working hours, workplace bullying, and job insecurity. Furthermore, deficiencies in practical training during their education, limited fieldwork opportunities, delayed exposure to the industry, and insufficient use of technological tools hinder students' preparedness for professional life. Internships being reduced to a formality and the lack of familiarity with real-world industry conditions may lead to a lack of self-confidence among graduates.

These difficulties negatively influence students' hopes and expectations for their professional careers, diminishing the overall appeal of the architecture profession. One of the key findings of this study is the notable decline in students' professional expectations in 2020. That year, students expressed little to no hope of finding employment, and the highest percentage across all years indicated their willingness to accept minimum wage. Similarly, financial gain was cited as a motivation for choosing architecture at the lowest rate compared to other years.

This trend may be partially attributed to the ongoing pandemic in 2020 and its impact on the construction sector, which likely influenced students' perceptions of the profession. Student responses to questions about professional expectations in 2020 reveal a strong sense of pessimism: many indicated a willingness to work outside the construction sector, had no salary expectations, or were willing to accept low wages. A majority also believed they would not find employment easily and stated they would turn to other fields if unable to secure a job in architecture. These responses suggest a significant lack of confidence in both the profession and their future careers.

Moreover, if young architects are forced to seek employment in other sectors, it is likely that similar challenges such as unemployment and low wages, will persist in those fields as well. Nevertheless, by 2024, an increase in salary expectations was observed. This suggests that the changes in the architecture sector between 2018 and 2020, which appear to have significantly influenced students' professional outlooks, warrant further investigation.

Responses to open-ended questions concerning the future of the profession predominantly reflect concerns about entering the professional world. These views must be taken seriously and addressed in a comprehensive manner.

These findings indicate that the transition from education to practice represents a critical bottleneck for architecture students. The repeated concerns about unemployment, low wages, and inadequate practical preparation suggest that professional dissatisfaction is rooted in structural conditions rather than temporary crises such as the pandemic. The longitudinal comparison further shows that while short-term shocks exacerbate pessimism, underlying structural issues—such as an oversupply of graduates and insufficient professional regulation—continue to undermine students' confidence in their career prospects. Therefore, without systemic changes in both education and labor market policies, the slight optimism observed in 2024 may remain fragile and unsustainable.

4.3. Discussion of Findings about Awareness of the Issues: Responses to Open-Ended Questions on the Future of the Profession

The open-ended responses show that architecture students are aware of the key challenges facing their profession and the factors shaping their education and career paths. They emphasized societal recognition, sustainable employment opportunities, and fair working conditions. The decline in entrance scores was attributed to economic constraints, negative public perceptions, gaps in education quality, and under-resourced universities. Students also noted the mismatch between acquired skills and professional demands, as well as low remuneration and heavy workloads. Overall, these responses highlight the interplay of structural, social, and educational factors influencing student aspirations and the status of the profession. This awareness demonstrates that students are not only experiencing the effects of these challenges but also critically analyzing their causes. By explicitly linking issues such as declining entrance scores to broader structural and economic dynamics, students reveal an ability to situate their personal struggles within the larger professional and societal context. This indicates a paradox: while they

feel disempowered regarding their own career prospects, they nonetheless display a strong analytical understanding of the systemic weaknesses of architectural education and practice. Recognizing and incorporating this student awareness into policy-making and curriculum development could provide valuable insights for shaping reforms that address both educational quality and professional sustainability.

5. CONCLUSION AND RECOMMENDATIONS

This study seeks to contribute to discussions that aim to better understand architecture students, while also highlighting persistent shortcomings in architectural education. As a continuation of a broader research series conducted by the authors, several critical insights have emerged. However, the study was conducted with a limited sample consisting solely of students. Therefore, its findings cannot be generalized to represent all architecture students in Turkey. Despite these limitations, the study provides valuable insights into architecture students' motivations, expectations for professional life, and awareness of the future of the profession. The findings can be grouped under three overarching themes: first, students' initial motivations for choosing architecture tend to weaken over the course of their education; second, their expectations regarding professional practice are negatively shaped by structural issues such as unemployment, low wages, and lack of social security; and third, they express strong concerns about both the quality of education and the social position of the profession. These themes offer a structured understanding of students' hopes and anxieties.

As highlighted throughout the study, the devaluation of the profession, the decline in student profiles, and the increasing unemployment among architects are interlinked phenomena that mutually reinforce each other. Breaking this cycle requires coordinated attention from both policy and educational sectors. The students' own words include striking and powerful expressions. It must be remembered that the future of the architectural profession is closely tied to a balance between students' hopes and expectations and the challenges they will face in professional life. Therefore, the following key areas are emphasized as points for further reflection, providing a foundation for future studies to build upon.

Educational Planning:

- Improving the quality of architectural education
- Regulating the number of architecture faculties
- Updating educational content to reflect current professional demands
- Strengthening academic staff through merit-based appointments
- Revising hands-on training to align with professional practice expectations
- Structuring architectural education to integrate with other disciplines

Professional Guidance and Societal Support:

- Raising public awareness to improve perceptions of the architectural profession
- Facilitating closer communication between architects and the public during project development
- Encouraging active engagement of architectural chambers and academic institutions in sectoral advancement
- Providing career counseling and mentorship for students
- Enhancing collaboration between universities and the professional sector

Review of Policy Frameworks:

- Ensuring economic stability to support the architectural profession
- Promoting transparency and competition-based approaches in public project tenders
- Developing long-term strategic planning in the built environment
- Strengthening the role of architects within construction processes
- Increasing awareness of challenges in the field of architecture and fostering solution-oriented approaches

Enhancing architectural education and professional practice through the abovementioned measures will facilitate a more effective transmission and implementation of the discipline. Shedding light on the hopes

and concerns of architecture students is of great importance not only for the future of the profession, but also for the future of society as a whole. Educators, practitioners, professional organizations, and policymakers must collaborate to address students' anxieties, instill a sense of hope, and build a brighter future for the field of architecture.

Future research should build on these insights by examining how targeted improvements in curriculum design, career mentoring, public awareness, and policy implementation influence students' perceptions of the profession and their preparedness for practice. Such studies can generate actionable knowledge to strengthen architectural education and support the career development of future architects.

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Research Article GU J Sci, Part B, 13(3): 431-452 (2025)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

http://dergipark.gov.tr/gujsb

A Game Development Process: From Design Stages to Playability and Usability Analysis

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Article Info

Received: 03/07/2025
Accepted: 16/09/2025

Keywords

Game development process,
Game design document,
Design decisions,
Usability,
Heuristic Evaluation for Playability (HEP)

Abstract

With the advancement of emerging technologies, digital gaming has garnered increasing scholarly and practical interest. The processes of designing and evaluating the games remain a significant area of inquiry for designers and developers. The study includes two different stages. In the first stage, a novel real-time strategy puzzle game design process is introduced with its critical design decisions throughout a game design document format to enlighten game researchers in their similar studies. In the second stage, an experimental study was conducted using qualitative and quantitative data collection tools with 12 participants. The Heuristic Evaluation for Playability (HEP) set was used to evaluate game design, especially for playability and usability features assessments. The study showed that this method can reveal the game's strengths and weaknesses, highlighting key game concepts and suggesting early design considerations, even in the beginning design phases, regarding various game dimensions, including gameplay, story, mechanics and usability. The outcomes offered insights for design decisions to improve playability, user experience and engagement. Based on these findings, recommendations are made to guide future development efforts in similar game design processes to improve digital playing experiences.

1. INTRODUCTION

The perspective on games and game design has changed with the development of technology. With the change in hardware devices and software, expectations from game designs have increased, and better graphics, realistic sound and music usage, and actual experiences where players enter the game world have come to the fore [1, 2]. Since the 2000s, unrealistic stylized approaches that enhance visual efficiency, such as cartoon-style and outline shader effects, have been attracting player attention. Surrealism, along with diverse stylization and design language approaches, is also an important factor in playability, user-player experience, and visual satisfaction. This situation suggests that, contrary to expectations, not only realistic experiences but also stylization are being met with widespread interest by a wider audience [3, 4]. Meanwhile, a game's primary goal has always been entertaining the player and creating an enjoyable experience. Entertaining the player without forcing or tiring has emphasized both usability and playability concepts [5, 6].

In the first stage of this study, the design decisions of a newly designed game are included in the form of a game design document. The development process of a new game design is given. All decisions of this game regarding the game type, narration, objectives, characters, game components and mechanics, storytelling, rules, scoring, gameplay and difficulty adjustments, level design, and user interface design are explained. In addition, research on debugging and testing is included [7-11]. In the second stage, the study reveals how this designed game is evaluated in terms of usability and playability after being played by the players. In the design and development process, playability heuristics play an important role. This research uses the Heuristic Evaluation for Playability (HEP) set [12] to analyze a sample game, Gardiyan, which is newly designed for this study.

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The study's primary purpose is to explain game design process and give further information about a game design documentation. The study also aims to interpret the HEP set with details of gameplay, game story, mechanics, and usability using the same game design product example. The reliability of the HEP set in the categories of gameplay, game story, game mechanics, and game usability is considered important because the reliability of that data guides designers in terms of the strengths or weaknesses of the game and its specific features. Followingly, the research questions are defined below:

- What are the critical design decisions of a mobile game development process?
- What potential playability and usability problems can be encountered regarding a new game?
- In what ways can the HEP set be helpful for designers in evaluating and improving a game design?
-

The importance of this study is to reveal how functionally and purposefully this HEP set can be used through a game example. It also questions the potential of this set to predict and detect positive and negative underlying topics for similar game designs and digital playing experiences.

2. LITERATURE REVIEW

The literature review focuses on games, game design, and how technology affects the experiences of the time. Usability and playability features are also explained as two important aspects.

2.1 Change in Playing Experience and User-Product Interaction

Technology has changed different parts of our lives. As technology improves, the design of industrial products changes, affecting user-product interactions. Technology, culture, and art create innovative solutions that change society, the environment, and prosperity. Innovative solutions add value to new products with the use of digital systems. These products create recent markets and distribution ways to reach new user profiles. With the help of developing technology, video game consoles' form and function have also changed [1, 13].

Until the Wii was designed, game consoles were produced as a fun tool for children. Technology-push and design-driven innovation play an important role in developing video game consoles. Successful firms and products use design-driven innovation as a strategy [5]. When a radical change of meanings is obtained, the product's value becomes higher for the people psychologically, emotionally, sociologically and economically. Innovation can be used in designing industrial products to shift people's attention and interest from usable to more emotional. They all aim at creating deeper positive feelings than the products' functional benefits. Many companies allow radical changes in consumer products to compete against their rivals. The important alterations in the design of game consoles and playing experience critically affected the game business, demographics, hardware, software, opponents and internet connection, story and environment, gameplay, graphics and interaction [14, 15].

The games have infiltrated popular culture and fundamentally changed how people interact with the world [16]. The beginning of gaming starts at the arcades. This social fun enabled them to play with their friend to score higher on their favourite machine. After a while, video games came into the home with personal computers. Internet and mobile systems broke the isolation that had started after playing inside the homes. With social platforms and popular games, the number of players who play with each other has increased. Being a part of the narration and interacting with game elements, actions, stories, or other players made video games engaging. Electronic games were called video games when the development of personal computers allowed downloadable and online games to be played by users worldwide at the same time [17]. These games were first used as video games and became widespread sequentially with arcade games, TV-adaptable entertainment systems and mobile systems. Many people play games on their computers, smartphones, or consoles [18]. The software and hardware of games, including the games themselves, gameplay, user interface and controllers of video games, are altered over time. The

competition between video game console firms resulted in higher-quality gameplay, controls, narration, and visual and graphical elements for home entertainment [19].

Newzoo's 2023 Global Games Market Report states that on a global scale, 3.38 billion people regularly played games in 2023; among them, more than 2.8 billion played on a mobile device. Mobile games constitute the most considerable portion of all games played on any platform, with 52% (a combination of smartphone games at 45% and tablet games at 7%) in 2021, with a growth of +4.4% to $90.7 billion. The report also indicates that by 2026, the game market will have grown by 2.6% to reach a market size of $187.7 billion [20, 21].

2.2 Usability and Playability

Existing studies focus on evaluating game designs concerning the enjoyment of games and players' game experience. The relationship between usability, playability and heuristics is important in human-computer interaction (HCI). A strong relationship exists between computer games' usability/playability issues and HCI. While designing a game, creating a successful user experience focusing on user interface, usability, and user-friendliness is needed, as well as creating a more enjoyable and challenging design [22].

In the context of HCI, usability is associated with user-centred design and iterative design processes. According to the definition of ISO 9241, HCI is like an academic umbrella for studies regarding the user experience and usability, including simplicity in use, output rate, performance, mistake prevention, learning adaptability, and retainability [23,24]. Usability can be defined by learnability, productivity, memorability, error rate, and user satisfaction components [25]. Usability is considered one of the most significant game topics that can be analyzed in interface, mechanics, and gameplay [26]. The game should be consistent in the gameplay, give meaningful feedback and have simple graphical user interfaces (GUI) with clear shortcuts, icons, images and text. According to existing studies, usability increases efficiency and satisfaction. Playing a game should be fun, and the games should give control to the player while competing against other players. If this enjoyment or competition is prevented due to coping with usability problems, this would be a risk to the user experience. Thus, usability problems cause the loss of players. To control the usability of the actual play experiences, a game is suggested to be tested with a target group of players [27].

On the other hand, playability is a multidimensional concept that reflects the quality of a game in different contexts. This concept can be associated with game flow, effectiveness, learnability, social components, and the motivation, satisfaction, and positive emotions it generates personally [28]. Existing studies support the significance of computer game enjoyment [29]. Some existing game-oriented studies emphasise that functionality, usability, and gameplay are related to playability [30]. Existing research has indicated that the concepts of usability and playability are crucial in the context of the player experience. Usability is associated with the speed at which users learn a game, the user interface and feedback mechanisms, and gameplay fluidity [31]. Playability empirically informs game design decisions that underlie player preferences and are crucial for player motivation [32]. While usability focuses on more functional features such as product effectiveness and ease of use, memorability, and error-free operation [25, 31], playability focuses more on components such as the depth of the player experience, emotions, motivation, satisfaction, learning speed, and engagement with the game [28,33]. It has been noted that playability, in particular, is more strongly related to the emotional and motivational dimensions of the experience than usability [34].

Playability and usability are game components that strongly influence each other, with one's weakness compromising the other and directly impacting the user's gaming experience. Therefore, these two concepts and related decisions are frequently emphasized during a game's design and development processes. In this context, designers make game design decisions regarding the balance of mechanics, game flow, menu navigation, screen and control layout, and feedback mechanisms. They investigate heuristics regarding game interface, mechanics, gameplay and narrative to understand player enjoyment. Evaluating game design heuristics for well-structured enjoyment creates a game flow model in game research. Game heuristics overlap with flow elements. Heuristics is also studied to create compelling user

interfaces for three titles: challenge, fantasy, and curiosity. Only if a game makes the player do different activities with unmet expectations can it be classified under the toy category rather than a tool [35]. Game designers focus on the concept of flow, which creates a psychological framework that allows the player to focus on the game and remain intrinsically motivated. Game flow is defined as a mental state of deep immersion and heightened concentration during play, achieved when the game's difficulty is well-matched to the player's abilities. This state is reinforced through clear objectives and instant feedback, fostering intrinsic enjoyment and an altered sense of time. The flow experience represents a smooth progression of gameplay in which clear goals, challenges, and immediate feedback are harmonized to sustain engagement, immersion, and motivation, while preventing boredom or frustration [29, 36, 37]. It gives players deep enjoyment as their different needs are satisfied. Enabling a system with rich concentration, challenge, skills, control, and social interaction keeps players interested in the game longer. In brief, the match between a player's changes and skills should be balanced. Anxiety occurs if the challenge is too much, and the player tends to leave the game. Conversely, boredom occurs if the skill is too much, and the player tends to leave the game again [36]. Thus, a game designer aims to keep players in the flow zone. One of the most famous works is the heuristic evaluation of Nielsen, which studies a set of heuristics to identify usability problems in a game concerning user interface design [38]. However, traditional usability methods, such as Nielsen's heuristics, cannot be directly applied in gaming. Therefore, heuristics have been developed explicitly for evaluating games, focusing on usability and playability. Heuristic Evaluation for Playability (HEP) is also used as a helpful set of heuristics developed with this goal in mind [12].

3. STUDY PROCEDURE

This research explains the design process of a mobile game design and its heuristic evaluation for usability and playability. This section describes two-staged studies as shown in Figure 1, including a game design process and an experimental process.

Figure 1. *Two Stages of the Study*

In the first stage of the study, the game design is explained with all design decisions using a game design document layout because all decisions and developments given for the game can be important both for the game researchers and participants. The second stage of the study includes the methodology section, which identifies the participatory and data collection tools used to test the game design and its features.

3.1 Design Process

The game design documents help identify the design features for software developers while explaining the design process of a new game. These documents include the decisions regarding the game's core components, such as purposes, characters, interface, rules, and winning criteria, besides physics, audio, AI behaviour, narrative flow, level structuring, difficulty tuning, balance mechanisms, and testing and tuning processes. They can also be valuable for designers to control game features, needs, and problematic areas [39, 40]. Thus, this study provides game design documentation for a new game called Gardiyan.

Overview:

The name of the game is Gardiyan. It is a real-time triple-match strategy puzzle game, a single-player game designed for mobile platforms.

The game takes place in a prison. The player uses game mechanics as items to prevent the criminals from escaping. The puzzle in the game uses these game mechanics. When three of the same items are placed together in this grid-platform prison, they build a combo and combine to create a stronger character. The stronger character takes more time to pass through. Moreover, with level upgrades, the number of doors increases, which makes players cover more areas, especially around these doors.

Narration:

The Gardiyan game has an enjoyable background scenario about different types of criminals aiming to escape from the depressing prison life. It has a linear and non-interactive story which begins with an intense earthquake. It takes place in the Prison of Alcatraz Island in 2030. After the earthquake, the criminals rebel to reunite with their families. The walls of the wards are fractured in some parts. During the game, different criminals try to escape through these fractured parts.

Main Objectives:

• The player has a leading role as a prison guardian (Gardiyan) of the prison by preventing different types of criminals from escaping within a limited time.
• The player puts game items in the way of the criminals to prevent escapes.

Supportive Objectives:

• The criminals emerge on the platform one after another and escape only through the wall fractures existing in different parts of the prison. Players should decide strategically to create a combo by using the items together to make the criminal lose much time on obstacles.
• If the player prevents all the escapes in a limited time, he passes a more challenging next level. However, if one of the criminals can escape, that level fails.

Characters:

Heroes: Bad characters play the primary role in the game. They are escaping criminals classified according to their strength and speed to reach the doors and related items. The cartoon-like figures, namely Kapkap, Horhor, Katkat and Sapsap, are drawn as amusing characters (Figure 2).

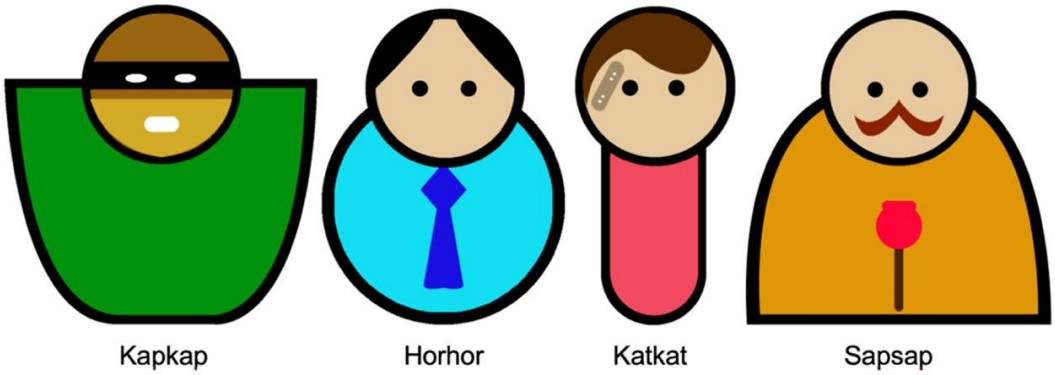


Figure 2. *Game Characters*

Shadows and Items: Game mechanics, as good characters play the second important role in the game. They are the items that the player puts on the grids throughout their escape routes. Each item makes all the characters slow down on the grid cells but affects its related character more than others. In other words, the characters lose time while passing through the grids with items. The interrelated characters and items have the same colour codes, which can be realized by the players quickly as shown in Figure 3. The player uses game mechanics as a puzzle to prevent them from escaping. When three of the same items are put together in this grid-platform prison, they build a combo and combine to create a stronger character. The stronger character takes more time to pass through. For example, two wallets build a telephone (a

more substantial item for Kapkap); two telephones join as a bag of money (a standard item for the four characters).

Figure 3. *Game Items*

Allies: The exit doors, as fractures, are the supportive characters that increase in number and change in place during level upgrades.

Storytelling:

The game starts with a teaser video that includes amusing cartoon characters of an earthquake, a criminal, and a prison, and it mainly uses text-based storytelling. The story in the game is explained by a non-interactive cut-scene to the player. At the beginning of the game, the player can watch the tutorial video to learn about the game. Thus, it triggers the player to play in that ward and level.

Rules:

• Criminals walk towards the fractures horizontally or vertically on the grid. They cannot walk diagonally.
• Players can only put one item on a grid.
• When an item is placed on the grid, it cannot be returned.
• Criminals slow down when they see items as obstacles on the grid.

Scoring:

In this game, completing the levels is the triumphant story. However, if players prevent the criminals by using fewer items on grids, it is calculated as a better score. Thus, the players get stars for each level according to how strategically they play.
Winning conditions: In the given time, the players should prevent all the escapes. It is considered a successful game if the time is completed without escapes. When the level ends, the players can unlock the next level.

Losing the game: If any criminals arrive at the doors within the given time, it is considered a failure, and the game is over.

Game Components:

Physics: There is a panel on the left of the screen on which game mechanics are listed. The players tap one of the items they choose to use and again leave it by tapping the place on the grid. When game mechanics are combined to build a stronger character, criminals lose much time. In the mathematics of the game, the times are calculated depending on the combined items.

Audio: There is a feedback sound when the players put the items on the platform. When a criminal escapes, there is a failure sound. When time ends without escapes, there is a success sound. When time runs out, a related feedback sound occurs again.

Artificial Intelligence Bot: In the gameplay, the criminal can move up, down, right and left. The criminals calculate the best path, which takes the shortest time to reach the door, considering the obstacles the player has put in place.

Gameplay Properties:

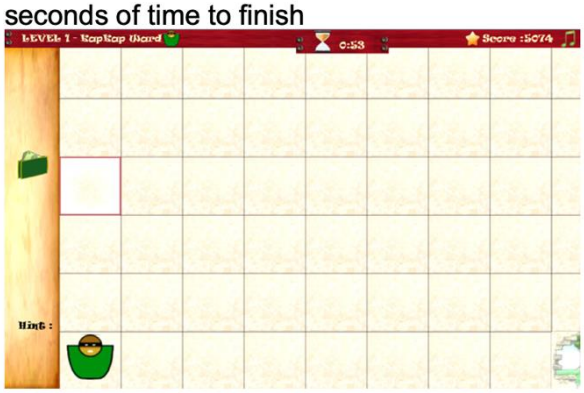
Challenges: The mission hierarchy in the game is as follows:
• Game Completion: The Gardiyan game includes different levels to adjust the difficulty of preventing escapes. The game's primary goal is to complete all missions with a high score within the allotted time.
• Missions: The player aims to use items as game mechanics to prevent criminals from escaping. The game mechanics designate items as obstacles. These items are used to solve puzzles.
• Submissions: Each criminal type has its associated items and only wastes time with these items. If the player places an unrelated item on a grid, the criminal will move directly to the following grid without wasting time. Therefore, the player must strategically consider the criminal-item relationship.
• Atomic challenges: The most important atomic task in the game is time. Players must prevent escapes by controlling the limited time during the game. The second important atomic challenge is the different locations of escape doors. Each level presents a different number of broken doors in different locations. The third atomic challenge is the mixture of characters. The variety of characters and items is less on simpler levels, and the puzzle is easier to solve.
Actions: This includes all the actions players strategically take to overcome the above challenges.

Level Design:

In the game, eight levels are designed according to three essential attributes: the type of characters, the number and placement of doors, and the time given to finish that level. Within levels, the following changes have been designed.

• The game characters increases.
• The criminals are mixed in wards, so the difficulty in stopping them increases.
• The game items increase in number.
• The number of fractures as escape doors increases.
• The places of fractures change, so the difficulty in controlling the doors increases.
• The time for escapes increases, so the guarding time duration increases.
The eight levels are shown in Figure 4.

Level 1: With 1 door, 1 character and 60 seconds of time to finish



Level 2: With 2 doors, 2 characters and 75 seconds of time to finish

Level 3: With 2 doors, 3 characters and 90 seconds of time to finish

Level 4: With 2 doors, 3 characters and 105 seconds of time to finish

Level 5: With 3 doors, 2 characters and 130 seconds of time to finish

Level 6: With 3 doors, 3 characters and 160 seconds of time to finish

Level 7: With 2 doors, 4 characters and 180 seconds of time to finish

Level 8: With 2 doors, 4 characters and 200 seconds of time to finish

Figure 4. *Eight Levels of the Game*

Balancing:

The increased difficulty of the levels increased the need for more players' skills. Thus, rewards are implemented in the game. When players solve puzzles by building walls, they are rewarded with a one-use cuff, which is helpful for the elimination of a criminal. Players need challenges to have fun and not be bored at manageable levels. Time control allows players to think carefully before putting them on grids, creating extra challenges.

To change the game's pace, a combo of items is needed. Two unique items related to each character make the game difficult by increasing the challenge. After combining the previous two special items, two common items are for all characters and give the player time to breathe.

User Interface Design:

The main GUI elements of Gardiyan take place on top of the screen, including level information (the criminal types in this ward, the number and name of the level, with the character types inside) and the remaining time to finish this level. Score, play-pause and sound control options take place on that part. The items are listed on the left side of the screen. The players mostly use that part to control the items by choosing a new item or changing the selected item. Moreover, the item combination's hints are given to the player on that part.

The game platform exists below the GUI. This platform has a rectangular shape divided into grid cells, which are used to put the items on. Some fractures are designed as escape doors in different parts of this rectangle. Since the game is designed as a cartoon fun game, the characters, the items, the tiles of 8 rooms and the fractured walls are designed in a similar design language. It was aimed to obtain the simplicity of shapes and the visual power of cartoons by using vivid colours. Moreover, the font selected for the game is "Ravie", which can be consistent with the game structure.

Debugging:

For the debugging process, the five steps below are followed:
1.Reproducing the problem consistently:
Case 1: The game has an artificial intelligence. While the criminals move towards the walls, it calculates the shortest path. Game developers repeatedly tried to realize that most of the time, criminals do not use these methods.
Case 2: When three items came together, sometimes they did not combine to build a combo. The developers played it repetitively to ensure the problem. It was realized that the first items could combine with others, calculating correctly, but the process did not work on multiple combinations.
Case 3: The developers had issues playing the audio for winning or losing conditions. Thus, different formats of audio were chosen and tested to find their reasons. The continuance of the error proved that the problem was not about the format of that audio.
2.Collecting clues:
Case 4: The developers realized that when the grid was filled with an item, the characters were not affected on this grid in some cases. In other words, they did not lose time on that grid.
3.Pinpointing the error:
The developers proposed a hypothesis that could be useful for printing debugging techniques in order to find the reasons for bugs and problems in the game. Hence, this technique was used to identify the code blocks implemented defectively. Moreover, the events were logged using the Debug.Log() methods of Unity libraries.
4.Repairing the problem:
For Case 1, the artificial intelligence and shortest path algorithm were rechecked. The logs regarding which path players choose and which states calculations are made were examined.
For Case 2, some defaults of item interrelations and the relationship between the same and different items were fixed. The calculation code was controlled after all item events to fix the problem.

For Case 3, the audio play was fixed by removing the playing audio from the On-GUI method and putting it into the Update method.
For Case 4, some grid cells were empty spaces, although they were full. The grid cells were designed to check the items on them by controlling all of them again.
5.Testing the solution:
Finally, the game was tested with the players to further analyze its usability and playability features.

3.2 Experimental Study

The second stage of the study covers the experimental process conducted with participants and data collection tools, including HEP evaluations with playability and usability tests.

Participants:

This research used 12 game designers/developers as professionals in the test group. All the participants have a high level of experience with computers, and 8 have a high level of experience with computer games. The participants (6 females, 6 males) were between 22 and 43 years old. These participants played the Gardiyan game and were observed during their playing, and notes were taken about their experiences to improve the game.

Data Collection Tools:

Data were collected qualitatively using questions to understand users' feelings and opinions about the game and quantitatively using the HEP set. The game was tested in terms of its playability and usability features.

Qualitative data: The players informed the designers about bugs and suggested new attributes to improve the game's usability. Furthermore, designers asked the players the following questions to get a wider idea of their feelings.
• "Is the game enjoyable for you?"
• "Are the characters and items sufficient and easily understandable?"
• "Is the game challenging? How is the difficulty of the levels?"
• "Are puzzles and rewards enjoyable?"

Quantitative data using the HEP set: HCI and computer games have become strongly related in recent years. Heuristics became an important method for interpreting and testing both playability and usability evaluations. Desurvire et al. developed a set of heuristics called Heuristic Evaluation for Playability (HEP), shown in Table 1, which was studied to help game designers interpret the use of each heuristic and playability in the game [12]. Hence, HEP tests can be done as checklists, providing data for a developing game to make it more playable and usable. It can be effectively used in the game design and development process. In this study, the HEP set was selected to evaluate and compare game elements numerically. Its reliability was also analyzed. The participants conducted HEP evaluations based on their game experiences. The heuristic set has 43 issues in total. It is divided into four categories:
• Gameplay is from 1st to 16th
• Game story is from the 17th to 24th
• Mechanics is from 25th to 31st
• Usability is from 32nd to 43rd issues.
For all those issues 3-point scale was used, in which 1 means an unsuccessful feature of the game, 2 is given for the average, and 3 means a successful feature.

Table 1. *Heuristic Evaluation for Playability (HEP) Set. Source: Desurvire et al. (2004)*

	Heuristic and Description
Game Play	
1	Player's fatigue is minimized by varying activities and pacing during game play.
2	Provide consistency between the game elements and the overarching setting and story to suspend disbelief.
3	Provide clear goals, present overriding goal early as well as short-term goals throughout play.
4	There is an interesting and absorbing tutorial that mimics game play.
5	The game is enjoyable to replay.
6	Game play should be balanced with multiple ways to win.
7	Player is taught skills early that you expect the players to use later, or right before the new skill is needed.
8	Players discover the story as part of game play.
9	Even if the game cannot be modeless, it should be perceived as modeless.
10	The game is fun for the Player first, the designer second and the computer third. That is, if the non-expert player's experience isn't put first, excellent game mechanics and graphics programming triumphs are meaningless.
11	Player should not experience being penalized repetitively for the same failure.
12	Player's should perceive a sense of control and impact onto the game world. The game world reacts to the player and remembers their passage through it. Changes the player makes in the game world are persistent and noticeable if they back-track to where they've been before.
13	The first player action is painfully obvious and should result in immediate positive feedback.
14	The game should give rewards that immerse the player more deeply in the game by increasing their capabilities (power-up), and expanding their ability to customize.
15	Pace the game to apply pressure but not frustrate the player. Vary the difficulty level so that the player has greater challenge as they develop mastery. Easy to learn, hard to master.
16	Challenges are positive game experiences, rather than a negative experience (results in their wanting to play more, rather than quitting).
Game Story	
1	Player understands the story line as a single consistent vision.
2	Player is interested in the story line. The story experience relates to their real life and grabs their interest.
3	The Player spends time thinking about possible story outcomes.
4	The Player feels as though the world is going on whether their character is there or not.
5	The Player has a sense of control over their character and is able to use tactics and strategies.
6	Player experiences fairness of outcomes.
7	The game transports the player into a level of personal involvement emotionally (e.g., scare, threat, thrill, reward, punishment) and viscerally (e.g., sounds of environment).
8	Player is interested in the characters because (1) they are like me; (2) they are interesting to me, (3) the characters develop as action occurs.
Mechanics	Game should react in a consistent, challenging, and exciting way to the player's actions (e.g., appropriate music with the action).
1	
2	Make effects of the Artificial Intelligence (AI) clearly visible to the player by ensuring they are consistent with the player's reasonable expectations of the AI actor.
3	A player should always be able to identify their score/status and goal in the game.
4	Mechanics/controller actions have consistently mapped and learnable responses.
5	Shorten the learning curve by following the trends set by the gaming industry to meet user's expectations.
6	Controls should be intuitive, and mapped in a natural way; they should be customizable and default to industry standard settings.
7	Player should be given controls that are basic enough to learn quickly yet expandable for advanced options.
Usability	
1	Provide immediate feedback for user actions.
2	The Player can easily turn the game off and on, and be able to save games in different states.
3	The Player experiences the user interface as consistent (in control, color, typography, and dialog design) but the game play is varied.
4	The Player should experience the menu as a part of the game.
5	Upon initially turning the game on the Player has enough information to get started to play.
6	Players should be given context sensitive help while playing so that they do not get stuck or have to rely on a manual.
7	Sounds from the game provide meaningful feedback or stir a particular emotion.
8	Players do not need to use a manual to play game.
9	The interface should be as non-intrusive to the Player as possible.
10	Make the menu layers well-organized and minimalist to the extent the menu options are intuitive.
11	Get the player involved quickly and easily with tutorials and/or progressive or adjustable difficulty levels.
12	Art should be recognizable to player, and speak to its function.

4. RESULTS

The analysis of the study was conducted qualitatively and quantitatively. This section presents the evaluations regarding game features in terms of usability and playability.

4.1 Qualitative Analysis

The participants' comments obtained qualitatively in this section helped to understand their approaches by focusing on four topics: gameplay, game study, mechanics and usability, which are questioned in detail using the HEP set in the quantitative analysis section.

- Ten players out of twelve commented that they had fun while playing the game.
- Eight thought the game was enjoyable and understandable with the items and characters, and four were confused about the matching relationship between the characters and their items.
- Nine players thought the seventh and eighth levels were challenging to finish. The characters were too varied, and the time was too long to succeed in the levels. Thus, it was considered that suggestions were made by redesigning to ease those levels.
- Most of them asked about the period of validity of the items. They found the game so easy for the first level that they put the items on every grid cell. They thought an indicator was needed to show the validity time for game items. However, by randomly putting these items on each grid, they realized they could not succeed on the second and the following levels.
- Solving puzzles and building walls created a whole grid cell that the characters could not pass. The players enjoyed this feature.
- Solving puzzles by building walls gives a reward to the player. This reward is a cuff that the player can use at a chosen time, and it eliminates the criminal on the grid where it is. The players liked this reward. They tried to play the game in that way to build a wall and take a cuff. However, they were unsuccessful when the only aim was to take a cuff and use it on characters. Then, they changed their strategies to save the exit doors.
- One of the players suggested secret ways or pipes going towards the exit doors, which could change the gameplay critically.

The game development team evaluated this feedback and the players' observations, and some suggestions were considered for redesigning the game, whereas others were eliminated for game purposes.

4.2 Quantitative Analysis

Collected HEP data was taken into consideration during the analysis steps. Since the main goal is to provide a reliable HEP set for that game, its reliability was checked at the first stage. The first reliability statistics obtained by JASP are shown in Table 2.

Table 2. *Frequentist Scale Reliability Statistics*

Estimate	**Cronbach's α**
Point estimate	0.968
95% CI lower bound	0.926
95% CI upper bound	0.989

The table shows that no negatively correlated HEP items are calculated in the 95% confidence interval. Because all HEP questions were evaluated on the same scale from 1 to 3 with the same meaning, each heuristic issue was answered in a standardized form. As there is no need for JASP standardization of items, the analysis considers Cronbach's Alpha value as a reliability value. The value of 0.97 explains that the HEP set issues for that game can be interpreted as reliable (since the value of 1 gives the most reliable score).

When studied deeply, some issues became noticeable to analyze. Some of them were answered similarly, whereas some were scaled distinctively. Similarly, scaled issues increase the reliability of the HEP set for that game. The analysis showed:

- Game Play 1&7, 6&12, 6&14, 12&14
- Game Story 1&4, 3&5
- Usability 1&11, 6&12
- Game Play 16 & Game Story 6
- Game Play 3 & Mechanics 3
- Game Play 15 & Mechanics 4
- Game Play 15 & Usability 3
- Mechanics 4 & Usability 3
- Mechanics 6 & Usability 5
- Game Play 16 & Usability 9
- Game Story 6 & Usability 9

correlated perfectly with each other due to evaluations of the Gardiyan game.

Table 3. *Perfectly Correlated HEP Set Items for Gardiyan Game*

GP1: Player's fatigue is minimized by varying activities and pacing during gameplay.	GP7: Player is taught skills early that you expect the players to use later, or right before the new skill is needed.
GP6: Gameplay should be balanced with multiple ways to win.	GP12: Player's should perceive a sense of control and impact onto the game world. The game world reacts to the player and remembers their passage through it. Changes the player makes in the game world are persistent and noticeable if they back-track to where they've been before.
GP6: Gameplay should be balanced with multiple ways to win.	GP14: The game should give rewards that immerse the player more deeply in the game by increasing their capabilities (power-up), and expanding their ability to customize.
GP12: Players should perceive a sense of control and impact onto the game world. The game world reacts to the player and remembers their passage through it. Changes the player makes in the game world are persistent and noticeable if they back-track to where they've been before.	GP14: The game should give rewards that immerse the player more deeply in the game by increasing their capabilities (power-up), and expanding their ability to customize.
GS1: Player understands the story line as a single consistent vision.	GS4: The player feels as though the world is going on whether their character is there or not.
GS3: The player spends time thinking about possible story outcomes.	GS5: The player has a sense of control over their character and is able to use tactics and strategies.
U1: Provide immediate feedback for user actions.	U11: Get the player involved quickly and easily with tutorials and/or progressive or adjustable difficulty levels.
U6: Players should be given context sensitive help while playing so that they do not get stuck or have to rely on a manual.	U12: Art should be recognizable to player, and speak to its function.
GP16: Challenges are positive game experiences, rather than a negative experience (results in their wanting to play more, rather than quitting).	GS6: Player experiences fairness of outcomes.
GP3: Provide clear goals, present overriding goal early as well as short-term goals throughout play.	M3: A player should always be able to identify their score/status and goal in the game.
GP15: Pace the game to apply pressure but not frustrate the player. Vary the difficulty level so that the player has greater challenge as they develop mastery. Easy to learn, hard to master.	M4: Mechanics/controller actions have consistently mapped and learnable responses.
GP15: Pace the game to apply pressure but not frustrate the player. Vary the difficulty level so that the player has greater challenge as they develop mastery. Easy to learn, hard to master.	U3: The player experiences the user interface as consistent (in control, color, typography, and dialog design) but the gameplay is varied.
M4: Mechanics/controller actions have consistently mapped and learnable responses.	U3: The player experiences the user interface as consistent (in control, color, typography, and dialog

	design) but the gameplay is varied.
M6: Controls should be intuitive and mapped in a natural way; they should be customizable and default to industry standard settings.	U5: Upon initially turning the game on the Player has enough information to get started to play.
GP16: Challenges are positive game experiences, rather than a negative experience (results in their wanting to play more, rather than quitting).	U9: The interface should be as non-intrusive to the player as possible.
GS6: Player experiences fairness of outcomes.	U9: The interface should be as non-intrusive to the player as possible.

Accordingly, the participants emphasized that the game difficulty balance was well-designed considering the parameters such as the player's abilities and fatigue level for the Gardiyan game. The players perceived the game story, the development of the story, the game world and the characters. Players received instant feedback on their actions, understood the functional features and could quickly get involved in the game at every stage. Even if the players had difficulty, they continued to play the game with positive game experiences and stated that they had a fair experience. The players saw their goals and status in the game and stated they could achieve them. The players emphasized that the game mechanics and controls were easy to learn and stated that the consistent and intuitive controls and user interface made their job easier. The rest of the heuristic issues have separate answers. However, there were no reliability problems with the HEP set for that game (see Table 2).

Besides the qualitative evaluations towards game features, Table 4 further shows the mean score of evaluations for each HEP item.

Table 4. *Frequentist Individual Item Reliability Statistics*

Item	Item-rest correlation	sd	mean	Attitudes towards Game Features
GP1	0.920	0.718	1.833	Unsuccessful-Average
GP2	0.502	0.739	2.000	Average
GP3	0.766	0.754	2.250	Average-Successful
GP4	0.856	0.669	1.917	Unsuccessful-Average
GP5	0.213	0.577	2.167	Average-Successful
GP6	0.530	0.669	1.583	Unsuccessful-Average
GP7	0.762	0.669	1.583	Unsuccessful-Average
GP8	0.764	0.603	2.000	Average
GP9	0.567	0.718	1.833	Unsuccessful-Average
GP10	0.709	0.793	1.917	Unsuccessful-Average
GP11	0.762	0.669	1.583	Unsuccessful-Average
GP12	0.725	0.515	1.417	Unsuccessful-Average
GP13	0.544	0.515	1.583	Unsuccessful-Average
GP14	0.643	0.793	1.583	Unsuccessful-Average
GP15	0.563	0.739	2.000	Average
GP16	0.896	0.577	1.833	Unsuccessful-Average
GS1	0.739	0.603	2.000	Average
GS2	0.611	0.669	2.417	Average-Successful
GS3	0.614	0.515	1.917	Unsuccessful-Average
GS4	0.684	0.793	2.083	Average-Successful
GS5	0.664	0.669	2.583	Average-Successful
GS6	0.858	0.793	2.083	Average-Successful
GS7	0.492	0.603	2.000	Average
GS8	0.348	0.866	2.250	Average-Successful
M1	0.445	0.622	2.250	Average-Successful
M2	0.523	0.853	2.000	Average
M3	0.530	0.669	2.583	Average-Successful
M4	0.829	0.669	2.417	Average-Successful
M5	0.495	0.674	2.500	Average-Successful
M6	0.685	0.754	2.250	Average-Successful
M7	0.533	0.603	2.000	Average
U1	0.621	0.622	2.250	Average-Successful

U2	0.458	0.669	1.917	Unsuccessful-Average
U3	0.626	0.669	2.417	Average-Successful
U4	0.339	0.577	2.167	Average-Successful
U5	0.815	0.718	2.167	Average-Successful
U6	0.673	0.603	2.000	Average
U7	0.574	0.603	2.000	Average
U8	0.743	0.492	2.667	Average-Successful
U9	0.871	0.669	1.917	Unsuccessful-Average
U10	0.791	0.718	1.833	Unsuccessful-Average
U11	0.511	0.669	2.083	Average-Successful
U12	0.728	0.669	2.083	Average-Successful

The participants in the Gardiyan game evaluated the HEP set, and some features under four main topics were positively scored as successful (3) features. In contrast, some indicated an additional design touch, being scored as unsuccessful (1). The following evaluations are obtained for the Gardiyan game according to the table.

• For gameplay: 3 and 5 got the highest score, whereas 12 got the lowest.
• For game story: 5 got the highest score, whereas 3 got the lowest.
• For mechanics: 3 got the highest score, whereas 2 and 7 got the lowest.
• For usability: 8 got the highest score, whereas 10 got the lowest.
Figure 5 gives the visualized graphics of the mean values scored by the participant for each four topics and their sub-items.

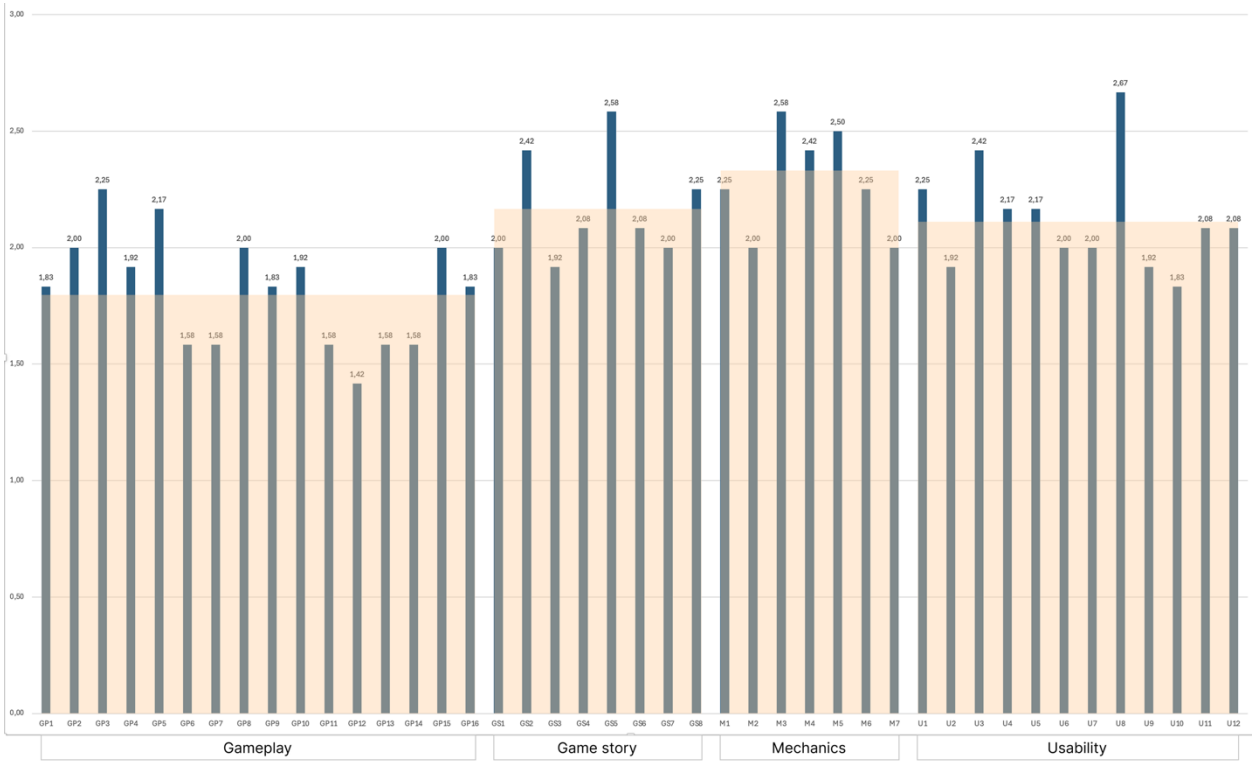


Figure 5. *Mean Score Evaluations for Four Main Topics and Sub-Topics*

Among all the items, U8 (m=2.67, sd=0.49) was evaluated as the most successful feature, indicating that players do not need to use a manual to play the Gardiyan game. It was followed by GS5 (m=2.58, sd=0.67) and M3 (m=2.58, sd=0.67) items of this game, indicating that players had a sense of control over their characters. They were able to use tactics and strategies during the game, and they can always identify their score, status and goal as the game's most positive features. On the contrary, GP12 was scored (m=1.42, sd=0.51) as the least successful feature, as the players considered it important to perceive a sense of control and be successful with alternative designs of ways. While managing the game as a

Gardiyan, the control over the game characters and the development of tactics and strategies were highlighted as a strong element of the game by the players. The lack of multiple ways to pass the levels and win the game, the inability to receive sufficiently impressive, noticeable and permanent reactions from the game world, and the structure of the reward system in the game that is not sufficiently satisfying and cannot be customized for the user were evaluated as weaknesses in the game. Moreover, the gameplay, game story, mechanics and usability features were compared in groups in Table 5.

Table 5. *One-Way ANOVA Regarding Gameplay, Game Story, Mechanics and Usability*

Cases	Sum of Squares	df	Mean Square	F	p
Average Score	1.427	3	0.476	8.588	**< .001**
Residuals	2.161	39	0.055		

Note. Type III Sum of Squares

When the comparison test between the groups was conducted with all the items related to gameplay, game story, mechanics and usability features, it was seen that these four headings were evaluated as statistically significant [F(3,39)=8.59, **p=<0.001**] at the p<0.05 level. The descriptives of groups are given in Table 6.

Table 6. *Descriptives Regarding Gameplay, Game Story, Mechanics and Usability*

Average Score	N	mean	sd	SE	Coefficient of variation
GP	16	1.818	0.240	0.060	0.132
GS	8	2.167	0.231	0.082	0.107
M	7	2.286	0.230	0.087	0.101
U	12	2.125	0.234	0.068	0.110

Table 6 shows the descriptives between groups. Mechanics-related playability features were evaluated more successfully for the Gardiyan game (m=2.29, sd=0.23). Conversely, gameplay features were considered to need more design touch (m=1.82, sd=0.24). An additional post hoc comparison was conducted to obtain the statistically significant differences between groups (Table 7).

Table 7. *Post Hoc Comparisons Regarding Gameplay, Game Story, Mechanics and Usability*

			95% CI for Mean Difference				
		Mean Difference	Lower	Upper	SE	t	p_{tukey}
GP	GS	-0.349	-0.622	-0.075	0.102	-3.424	**0.008**
	M	-0.468	-0.754	-0.182	0.107	-4.388	**< .001**
	U	-0.307	-0.548	-0.066	0.090	-3.419	**0.008**
GS	M	-0.119	-0.446	0.208	0.122	-0.977	0.763
	U	0.042	-0.247	0.330	0.107	0.388	0.980
M	U	0.161	-0.140	0.461	0.112	1.436	0.485

Note. P-value and confidence intervals adjusted for comparing a family of 4 estimates (confidence intervals corrected using the Tukey method).

Post hoc comparisons using the Tukey test showed that the mean score for the "gameplay" features of Gardiyan were evaluated with the lowest scores, which was calculated with statistically significant differences from the game story (**p=0.008**), mechanics (**p=<0.001**) and usability (**p=0.008**) features at the p<0.05 level of confidence interval. As revealing the features regarding gameplay properties was less

successful, further revisions are necessary for the game's success. On the other hand, the design of the game mechanics was evaluated as successful in adding value to the game's playability. Although the other categories differed to an extent, they were not at a statistically significant level.

5. CONCLUSION

This research first explained the Gardiyan game's design decisions throughout a game design document. Since game design documents are important resources [39,40] for the designers, developers, companies, customers and game researchers, the content inside this documentation is given step by step. The study introduced the game's core components, such as purposes, characters, interface, rules, and winning criteria, in the initial phase, structured within a design document. Additional elements were addressed, such as physics, audio, AI behaviour, narrative flow, level structuring, difficulty tuning, and balance mechanisms. Techniques for troubleshooting and conducting prototype tests were also proposed.

The literature suggested that the game be tested with a target group of players [27]. Therefore, this game was evaluated with participant players using qualitative and quantitative tools. Since the literature suggested that traditional usability methods, such as Nielsen's heuristics, cannot be directly applied in gaming [25], this research enlightened the design and development process by providing users with tangible HEP data. Primarily, the reliability of the HEP set was analyzed, and ANOVA tests were conducted to identify and compare the game's features regarding gameplay, game story, mechanics and usability.

The research questions were answered according to the outcomes of this study. The answer to the first research question of the study included the application process of the issues considered in the design processes of the game, also fed by literature [10,11, 22]. In the first stage of that research, it was particularly noteworthy that design decisions and the game's goals were presented by incorporating entertainment elements. Game characters, game items and the gameplay, including challenges specific to the characters, rules, and winning conditions, were the most laborious design decisions of the game. The game's mathematics and balance drew attention as critical processes for players to stay in the game. In addition, the game's aesthetics and the interface design, being easy to understand and responsive, were important design decisions.

The games can be analyzed in two aspects: playability and usability. Therefore, the other goal of the study was to reveal the playability and usability problems raised with the second research question. For this, it was deemed important to conduct debugging processes focusing on different cases and usage scenarios, with tests conducted with players at the end of the first stage. After the fundamental problems encountered by the participants were eliminated, the gameplay, story, mechanics, and usability of the game were questioned in more detail regarding the use of the HEP set. The HEP set was analyzed comparatively within itself to reveal the strong and weak features of the game. The findings obtained through the HEP set used in this study revealed the importance that participants attribute to different dimensions when evaluating the gaming experience. The findings indicate that users primarily focus on game mechanics, followed by game story and usability in almost equal proportions, with gameplay being the least critical aspect. This distribution provides important clues about how players perceive the gaming experience.

The prominence of game mechanics, representing the fundamental building blocks through which players interact with the game world, is a frequently emphasized phenomenon in the literature. Players construct experiences through the game's rules, systems, and interaction styles. Therefore, the robustness and consistency of mechanics are considered critical to the game's overall success [11]. In this study, the participants' prioritization of mechanics aligns with their view that these structures constitute the essence of the gaming experience.

Notably, the game story and usability dimensions ranked second in close scores in this study. Game story is a compelling element that fosters emotional engagement and connection among players. Existing studies show that a story can increase motivation for the game and play a critical role in long-term player

engagement [8-10]. Furthermore, usability is also crucial for a game's accessibility and learnability. User-friendly interfaces, consistent controls, and intuitive navigation allow players to adapt more easily to the game [12]. This study's result suggests that players attach equal importance to both contextual (story) and functional (usability) dimensions.

On the other hand, the findings of this study showed that the gameplay of Gardiyan was evaluated as the weakest and most unsuccessful feature. The fact that the gameplay score was obtained as the lowest compared to game story, mechanics, and usability features seemed surprising at first glance. In the literature, gameplay is generally defined as an integral dimension of the gaming experience, referring to the dynamic process between the player's actions and the game's reactions [29]. Many studies have demonstrated that game flow and immersion directly relate to gameplay [36, 37]. From this perspective, the participants' low emphasis on this dimension can be explained by the specific context of the game. It is likely that, because mechanics and story were prominent in the tested game, the Gardiyan, gameplay elements remained a secondary consideration. Although this situation occurs specifically for this game, it should be emphasized how important the gameplay is for the long-term existence and success of the game, with its critical role in providing intrinsic motivation with the player's skills and challenge balance. However, this finding does not diminish the importance of gameplay; on the contrary, it should be noted that it plays an essential role in sustaining the gaming experience. As emphasised by the game flow model of existing studies, it becomes difficult for players to remain engaged and satisfied without successful gameplay. Therefore, although players in this study found gameplay relatively less critical, this does not change the fact that it is a fundamental focus in game design. On the contrary, this suggests that the Gardiyan game failed to provide sufficient intrinsic motivation for players within the context of gameplay, and that designers, aware of this problem, should take steps to improve it. In fact, the participants' first responses to the qualitative questions in Section 4.1 focused heavily on gameplay features such as having difficulty in the game, enjoying it, or understanding the game easily and correctly. The third research question was related to the efficient use of the HEP set. This study showed that HEP is a point of view when analyzing games, and it is helpful for designers and developers in the early game design stages. Providing a suitable HEP set is important to interpret the game more appropriately. The advantage of HEP data can only be provided by its reliability. Therefore, reliability tests should be conducted before using this set, and if any items disrupt it, they should be excluded. After that, the topics that are seen as successful or problematic should be examined. This study showed that a sample game can be effectively analyzed using a reliable HEP set. HEP may provide a suitable feature set to interpret the game. In a game's design and development process, it can be critical to find the most suitable solution to specific problems, including four main topics: gameplay, game story, mechanics, and usability. This study identified that the HEP set may help designers and developers with the specific focus of the game. As presented in this study, the HEP set is intended to allow designers to quickly raise awareness, even in a game still in the design phase. This method can reveal the game's strengths and weaknesses, highlighting key game concepts and recommended design considerations. Thus, it can find the best solution to specific problems in the development process. Game researchers who want the maximum benefit from HEP should also determine the game's needs and ensure that HEP matches them. This way, it can provide quick and proactive solutions to problems that may result in expensive outcomes.

In conclusion, this study revealed that players consider mechanics as the primary evaluation criterion in the tested game. At the same time, story and usability were almost equally important, and gameplay was relatively less critical. However, when considered in light of game design literature, it becomes clear that gameplay is, in fact, a fundamental element that determines the player experience, integrated with mechanics, story, and usability. Therefore, game developers should prioritize gameplay over mere highlights to create a holistic experience. While this research's most tremendous potential lies in examining the evaluation process of a new game through the Gardiyan game design, its most significant limitation lies in examining the process through its analysis. It is recommended that future studies consider the inherent variability of designed games and the potential for different focus areas. One of the most significant limitations of the study is the number of participants reached. Because this study aimed to ensure that those familiar with game design processes could easily understand and interpret both the game design decisions and the HEP set used, 12 game designers/developers as professionals were recruited. Future game design-focused studies should be conducted in collaboration with experts in the

field, but including more participants could increase the impact of the study and add academic depth. It may also be suggested that the participant group be changed. Unlike the participant group reached in this study, understanding the comments and experiences of participants independent of the subject matter can help game designers develop new perspectives and uncover previously unnoticed issues. This study examined the evaluation process of a casual real-time strategy puzzle game on a mobile platform. However, if a 3D game is being designed at a mid-core level, the process will be different. If a 2D game is being designed, many variables, including animation design, would be involved. The HEP set and player evaluations may differ depending on the game's needs and the designers' perspectives.

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Research Article GU J Sci, Part B, 13(3): 453-465 (2025)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

http://dergipark.gov.tr/gujsb

Beyond Time and Space: Conceptual Traces from Tradition to Contemporaneity in Japanese Residential Architecture

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Article Info

Received: 03/08/2025
Accepted: 19/09/2025

Keywords

Japanese architecture, Traditional principles, Interior furnishing, Cultural continuity,

Abstract

This study investigates the conceptual and spatial continuities between traditional Japanese residential architecture and its contemporary reinterpretations. Drawing upon principles such as spatial permeability, integration with nature, ritual-based spatial use, and material minimalism, the research analyzes how these elements persist and evolve in the works of contemporary architects including Kengo Kuma, Tadao Ando, Kazuyo Sejima, and Sou Fujimoto. Rather than viewing traditional spatial configurations as aesthetic remnants, this study approaches them as dynamic cultural constructs that continue to inform design logic, user experience, and spatial identity in contemporary architecture. Using a comparative architectural analysis method, the study identifies key interior components such as tatami flooring, shoji screens, fusuma partitions, engawa platforms, and tokonoma alcoves, and examines their conceptual transformations in modern projects. These elements, while often visually reinterpreted, preserve their symbolic functions and contribute to the sensory, meditative, and social dimensions of residential space. The findings reveal that the notion of "contemporaneity" in Japanese architecture is not a rupture from tradition, but rather a sustained dialogue with it. This process of reinterpretation offers valuable insights for global architecture, including Turkish residential architecture, where cultural references are often marginalized. The study argues that architectural continuity—rooted in local tradition and recontextualized for present needs—can foster both cultural memory and sustainable spatial innovation. By emphasizing conceptual resilience rather than stylistic mimicry, this research contributes to the discourse on architectural identity and proposes a culturally embedded yet future-oriented design paradigm.

1. INTRODUCTION

Traditional architectural forms offer a valuable foundation for understanding the spatial manifestations of cultural and lifestyle practices. In this context, architectural techniques and interior spatial configurations can be interpreted as tangible reflections of the inhabitants' beliefs and daily rituals [1]. Throughout history, Japanese architecture and interior design have been shaped and reinterpreted through perceptions of nature and spirituality [2]. Architecture, as a cultural career, produces not only physical space but also mental, spiritual, and social domains. In this regard, the Japanese house exemplifies a spatial organization that preserves traces of the past while contributing to the sustainability of contemporary living [3], [4], leaving conceptual imprints in modern architectural practices through generational transmission.

Accordingly, architectural concepts are shaped by the interaction between cultural life and spatial practices, forming a unique design language and functional scheme. Particularly, the modular system defined by *tatami* offers spatial flexibility, while sliding partitions such as *shoji* and *fusuma* define a permeable threshold between interior and exterior boundaries [5]. These components are not mere architectural choices, but expressions of the nature-centered Japanese worldview [6]. Thus, architecture, culture, and interior elements form an integrated and meaningful whole that is continually reshaped in response to societal change and evolving needs.

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The reinterpretation of architectural concepts in contemporary architecture ensures the integration of tradition with modern life. The Japanese house embodies individual identity, spiritual heritage, and everyday habits. This conceptual system—carried from the past—is not a static repetition of forms but a tradition constantly recontextualized in each new design [7], [8]. Instead of imitation, tracing traditional principles in contemporary projects offers a more productive approach for ensuring cultural continuity.
In this sense, the reinterpretation of cultural heritage through contemporary design holds not only aesthetic value but also contributes to social and environmental sustainability [10]. The spatial transformation from past to present imbues modern architectural works with meaning as well as form, thereby rendering cultural continuity visible. The evolving concepts actively shape new architectural understanding and influence the transformation of interiors. Formal authenticity and cultural transmission deepen the contextual relationship of the building and support sustainability. The longevity of a structure is thus also assessed through the user's interaction with the interior environment.

This study aims to identify the core spatial concepts shaping traditional Japanese residential interiors and to examine how these concepts are reinterpreted in contemporary Japanese residential architecture. The research focuses on establishing the relationship between traditional conceptual systems and contemporary architectural understanding. Projects by contemporary architects who reinterpret traditional principles—rather than replicate them—have been selected for analysis.

The study centers not only on architectural formation but also on design principles contributing to cultural continuity. The selected examples highlight how concepts such as integration with nature, spatial permeability, flexibility, and aesthetic simplicity—central to traditional Japanese architecture—are reproduced through contemporary technologies and design approaches. These projects establish conceptual and formal bridges between tradition and modernity, demonstrating how ritual-based spaces are transformed into individualized spatial narratives. This reinterpretation process transcends physical alteration and engages with deeper cultural and spiritual dimensions.

2. METHOD

This study was conducted based on a qualitative research method. Initially, a comprehensive literature review on traditional Japanese residential architecture was performed to identify and analyze the fundamental spatial concepts. Through descriptive analysis, prominent principles such as integration with nature, permeability, simplicity, and spatial flexibility were identified.

To examine how these conceptual principles are reflected in contemporary architecture, the residential projects of Tadao Ando, Kengo Kuma, Kazuyo Sejima, Toyo Ito, Shigeru Ban, and Sou Fujimoto were selected as case studies. In selecting these examples, the primary criterion was the reinterpretation of traditional values through contemporary design rather than the formal imitation of traditional elements. The architects' works were subjected to qualitative content analysis from structural, conceptual, and spatial perspectives.

In this analysis, four fundamental conceptual principles were used to evaluate the selected contemporary buildings: spatial flexibility, integration with nature, ritual use, and aesthetic simplicity (shibui). These principles—drawn from the core design values of traditional Japanese residential architecture—formed the analytical framework through which each project was examined. The spatial organization, material usage, and furnishing systems of the buildings were interpreted within this conceptual framework. In doing so, the study offers a comparative and multilayered evaluation of how traditional concepts are projected into contemporary architectural practice.

This methodology enables detailed exploration of how each architect reinterprets the traditional design logic in their residential projects, tracing a multidimensional architectural analysis from spatial adaptability to nature integration, from ritual spatial arrangements to aesthetic restraint.

3. CONCEPTUAL FRAMEWORK

Traditional Japanese architecture is not merely a means of physical shelter, but a spatial reflection of cultural identity, belief systems, and daily life practices. In this context, space is shaped as an extension of the relationship with nature, serving as a medium for the individual's spiritual and aesthetic connection with their environment [3], [4].

The Japanese house, accordingly, is constructed with a sensibility that exalts the cyclical nature, transience, and simplicity of the natural world. This spatial depth is rooted in a philosophical framework intensified by the influence of Zen Buddhism and embodied in the wabi-sabi aesthetic, which celebrates the ephemeral, the simple, and the natural [5]. Philosophical foundations bring forth concepts such as permeability, adaptability, and ambiguity within space, transforming architecture into a cultural narrative [6]. These values manifest not only in spatial organization but also in interior furnishing systems, shaping architecture as a multilayered medium through which cultural memory is continually re-produced.

Traditional interior furnishings provide tangible expressions of this conceptual system, ensuring both functional flexibility and cultural continuity. These philosophical and aesthetic foundations are reflected not only at the architectural scale but also in interior spatial planning and furnishing systems, redefining architecture as a domain of cultural memory. The modular grid defined by tatami enables spatial transformation based on user needs, while movable partitions such as shoji and fusuma create permeable boundaries between interior and exterior zones [5], [6]. Engawa, the semi-open transitional space, defines a fluid threshold between interior space and nature. These components serve not only functional purposes but also act as carriers of cultural continuity [9]. In this respect, furnishing systems are not merely physical installations, but memory spaces where cultural values are preserved, presented, and transformed.

The relationship between space and belief in Japanese culture becomes particularly evident in ritual zones within the house. Practices such as tea ceremonies, seasonal ornamentation, and rituals of cleanliness and maintenance position the space not only as a site of use but as an atmosphere of meaning production [2], [8]. These rituals, performed in conjunction with the furnishing systems, enrich the user-space interaction with layers of meaning. In this way, the building becomes not only a physical entity but a symbolic and social object of cultural memory. Traditional structures and spatial practices continue to be reinterpreted within contemporary architectural approaches.

Everyday life practices and cultural conventions provide the basis for the reinterpretation of this conceptual structure in contemporary Japanese architecture. Despite modern construction technologies, principles such as integration with nature, permeability, and simplicity are preserved; traditional elements are transmitted not as stylistic replicas, but as conceptual meanings embedded in space [7], [8]. This approach synthesizes the tradition with the contemporary, transforming cultural heritage into a living form of memory.

3.1. Fundamental Principles and Conceptual Formation in Japanese Interior Space

The Japanese approach to interior space is shaped not only to meet physical needs, but also to respond to cultural codes, aesthetic values, and spiritual wholeness. Space is constructed through a multidimensional configuration in which concepts such as harmony with nature, ritual-based usage, and aesthetic simplicity are integrated [1], [2]. Traditional Japanese architecture is formed through spatial expressions that embody the relationship with nature, social norms, and ritual-oriented lifestyles [3].

This understanding is manifested not only in the overall form of the building, but also through interior furnishing elements that define the spatial organization (Figure 1). The **tatami** module determines the

measurable order of interior spaces; this arrangement shapes both the time users spend in the space and the nature of their physical interactions [5]. Tatami is not merely a floor covering, but also functions as a marker of social distance, usage patterns, and spatial hierarchy [6].

Figure 1. *Tatami Module System- Traditional Interior Space Equipment and Design [9][10]*

Movable partition elements such as shoji and fusuma create spatial flexibility by enabling a continuous interplay between privacy and openness. This condition corresponds to the balance established in Japanese life culture between introspection and integration with nature [5], [6]. Such permeability supports the transformability of the structure not only in physical terms but also in conceptual dimensions.

The formative role of furnishing systems allows spatial experience to acquire not only functional but also aesthetic and ritual qualities. The tokonoma alcove, as a focal point where aesthetic presentation and ritual representation are displayed, indicates that the house functions not only as a living environment but also as a mental and artistic space [7]. The engawa (Figure 2), on the other hand, acts as a transitional zone between interior and exterior spaces, providing the physical setting for unity with nature [5].

Figure 2*. The Engawa Place for Interaction [11]*

This spatial threshold element is interpreted as a structural representation of the concepts of impermanence (mujo) and continuity (jo) in Japanese thought [3], [5]. In this sense, space is not merely a structure serving the function of shelter but becomes a carrier of cultural values and a philosophical way of life.

The multilayered relationship that space establishes with nature lies at the core of Japanese interior design philosophy. Buildings are situated with respect for environmental elements; natural components such as water, stone, plants, and light are incorporated into the interior both symbolically and physically [4], [8]. In this regard, interaction with the environment generates not only a visual but also a sensory and ritual experience.

The aesthetic concept of shibui, which emphasizes visual simplicity and naturalness, promotes an uncluttered yet profound spatial order [7]. Moreover, spatial flexibility supported by transparent and movable elements allows for multifunctional living scenarios [2], [6]. When combined with ritual-based

usage patterns, the space transforms into a domain enriched with symbolic and cultural meanings, transcending the boundaries of everyday life [12].

3.2. Interior Furnishing Systems and Cultural Meanings in the Traditional Japanese House

In traditional Japanese houses, interior furnishing systems do not merely offer functional solutions; they also enable the spatial representation of cultural values, aesthetic principles, and ritual practices [1], [2]. Elements such as the **tokonoma** (honorific alcove), **chigai-dana** (staggered shelves), **tenbukuro** and **jibukuro** (storage spaces associated with the tea ceremony) (Figure 3), and **tsuke-shoin** (a built-in desk or study nook), serve not only as structural components enhancing usability, but also as architectonic expressions laden with meaning in relation to one's inner world, social interactions, and mental connection with nature [4], [5], [6].

Figure 3. Traditional Interior Space and Interior Wall Furnishing System [13],[14]

These elements, integrated into the spatial configuration, facilitate the experience of domestic rituals and everyday life within a framework of cultural continuity. For instance, the tokonoma functions as a ritual space that symbolizes respect during guest reception, offering a representational surface for the display of aesthetic and spiritual objects [5]. The chigai-dana serves as a symbolic expression of spatial hierarchy and organization. Hidden storage units such as tenbukuro and jibukuro transcend their utilitarian role by serving the ritual structure of the tea ceremony [6]. The tsuke-shoin, on the other hand, is a spatial arrangement that supports personal actions such as writing, reading, and contemplation—providing an architectural interface for the individual's engagement with nature [1], [4]. Key conceptual principles of traditional Japanese architecture are summarized in Table 1.

Table 1. *Key Conceptual Principles of Traditional Japanese Architecture and Definitions (Table produced by the authors)*

Concept	Definition / Function
Tatami Modulation	Dimensional regulation of space and orientation of use
Shoji / Fusuma	Permeable boundaries enabling interior-exterior connection and flexible privacy control
Tokonoma	Spatial focal point for aesthetic presentation and ritual representation
Engawa	Transitional zone that provides continuity between interior and exterior, enabling unity with nature
Integration with Nature	Harmony with the environment on both physical and spiritual levels
Simplicity (Shibui)	Unexaggerated, natural, and minimal aesthetic approach
Spatial Flexibility	Spatial configuration allowing functional variability
Ritual-Based Usage	Arrangement of space in accordance with cultural and spiritual practices

3.3. Reflections of Japanese Culture and Belief Systems in Interior Design

Japanese culture is grounded in a deep philosophical background that emphasizes harmony with nature, impermanence, simplicity, and ritual-based lifestyles. Shintoism and Zen Buddhism, as the core belief systems of this cultural framework, have played a defining role in shaping not only spatial organization but also the configuration of interior furnishings. In this context, the Japanese house is not merely a living

environment but a symbolic architectural whole that unites sacredness, ritual, and aesthetic simplicity [3], [5], [6].

These belief systems have influenced not only architectural concepts but also the building's relationship with its environment. The animistic nature of Shinto, which considers nature sacred, encourages design principles such as spatial permeability and environmental sensitivity. This approach is manifested in site-specific spatial arrangements, engawa openings to nature, inward-facing courtyards, and lightweight structural elements. Zen Buddhism, on the other hand, prioritizes spiritual purification and mental clarity; this philosophy is embodied in architectural minimalism that reflects simplicity (shibui), impermanence (wabi-sabi), and self-discipline [4], [7].

This philosophical framework exerts its influence not only at the structural scale but also in the configuration of interior furnishing systems. Furnishings used within the interior serve both the flow of daily life and the integration of spiritual and cultural wholeness. Low tables (chabudai), floor cushions (zabuton), and sleeping systems (futon) are not only ergonomic but also embody spiritual and cultural values. These elements enhance physical contact with nature and deepen the individual’s spiritual connection with space [8].

The transformability of space, like a living organism, is also a natural extension of this design philosophy. Movable partitions such as shoji and fusuma increase spatial permeability and adapt to changing user needs. This suggests that space is conceived not as a static entity, but as a dynamic and adaptable organism. In this context, spaces are used multifunctionally: a single room may serve as a dining area, resting space, and ceremonial setting at different times of the day—pointing to a design philosophy that reflects the cyclical nature of life [2], [6].

The interweaving of ritual and aesthetic principles becomes most visible in certain interior elements. In particular, niches such as the tokonoma are symbolic components that integrate the spiritual dimension of Shinto and Zen into the interior. This niche, a sign of respect for guests, serves as a spiritual center where artworks, calligraphies, and natural objects are exhibited. It becomes a focal point not only for aesthetic expression but also for conveying ethical and spiritual values [2].

The integration of symbolic and functional furnishings reveals that interior planning in Japanese houses reflects not only aesthetic but also sociocultural organization. The coexistence of sacred corners, spiritual centers, and ritual spaces with functional layouts transforms Japanese architecture into not only an aesthetic discipline but also a vessel of cultural memory. The irori (sunken hearth) (Figure 4) is not merely a heating element but also a central place for social interaction, ritual sharing, and communal unity. This demonstrates that the Japanese house offers a holistic structure that shapes social dynamics through its furnishing systems [5].

Figure 4. Irori- Traditional Fire Place [15]

In this context, the classification of conceptual furnishing systems further elaborates how this philosophical structure is spatially embodied in interior design. As categorized by Güngör (2019), traditional Japanese furnishing components such as tokonoma, chigai-dana, tenbukuro, jibukuro, and tsuke-shoin possess both functional and symbolic meanings. Systems like the staggered shelving of chigai-dana define visual hierarchy and aesthetic order, while storage units such as tenbukuro and

jibukuro serve to preserve the sanctity of ritual objects. The tsuke-shoin functions as a space for both contemplation and observation of nature, fostering individual awareness.

The multilayered philosophical structure reflected in Japanese interior furnishings offers continuity not only on a formal level but also at conceptual and spiritual dimensions in architectural and interior design. Spaces shaped by the principles of impermanence and simplicity are reinterpreted in the modern era without losing their symbolic depth; this structural and conceptual legacy is sustained in the works of contemporary Japanese architects. (Table 2) outlines the functional and symbolic significance of key furnishing elements within traditional Japanese interiors.

***Table 2**. Functional and Symbolic Significance of Key Furnishing Elements (Table produced by the authors)*

Furnishing Element	Function	Cultural / Ritual Meaning
Tokonoma	Niche for displaying aesthetic objects and artworks	Respect for guests, spiritual center, representation of aesthetic and moral values
Chigai-dana	Staggered shelf system providing visual order	Emphasis on hierarchy and aesthetic order
Tenbukuro / Jibukuro	Storage areas for tea ceremony equipment	Preservation of the sanctity of ritual objects
Tsuke-shoin	Dedicated corner for writing, reading, and observing nature	Personal contemplation, mental simplicity, and connection with nature
Chabudai / Zabuton / Futon	Low-height ergonomic furnishings for sitting, dining, and sleeping	Mental simplicity, contact with nature, mind-body unity
Shoji / Fusuma	Partitions that provide permeability between privacy and openness	Spatial flexibility, transformability, and impermanence
Engawa	Semi-open transition space between interior and exterior	Harmony with nature, permeability, fluidity of boundaries
Irori	Central hearth for heating, socializing, and ritual sharing	Social unity, rituality, and traditional cohesion

4. CONCEPTUAL CONTINUITY IN TRADITIONAL JAPANESE RESIDENTIAL ARCHITECTURE

Traditional Japanese residential architecture is shaped around key conceptual principles such as integration with nature, permeability, simplicity, ritual-based use, and spatial flexibility. These principles materialize through spatial elements that carry meaning not only on a physical level but also on cultural, aesthetic, and spiritual dimensions. Elements such as the tatami layout, shoji and fusuma panels, tokonoma, and engawa exemplify how these concepts are spatially manifested in architecture.

The traditional principles embedded in Japanese residential architecture are reinterpreted in contemporary architectural production not merely as formal references but as layers of meaning that establish a sense of continuity. This continuity is especially evident in the preservation of principles such as integration with nature, spatial flexibility, and aesthetic simplicity in contemporary architectural typologies.

4.1. Tadao Ando's Azuma House (1976)

In this context, Tadao Ando's Azuma House (1976) reinterprets the core principles of traditional Japanese residential architecture—introversion, courtyard-based organization, simplicity, and permeability—within a contemporary framework (Figure 5). The central courtyard does not merely function as an opening to the outside but serves as a medium for establishing a spiritual connection with nature. The smooth and minimal use of concrete reflects the concept of shibui in Japanese aesthetics through a contemporary lens. Despite its closed structural form, the interplay of light and shadow within the interior creates a sensory relationship with the natural environment. This building integrates traditional concepts through contemporary materials and spatial strategies, producing a unique architectural language without resorting to formal imitation [6], [8].

Figure 5. Tadao Ando's Azuma House (1976) Exterior and Interior View [16]

4.2. Kengo Kuma's Water/Glass House (1995)

Another example in which the relationship with nature is reinterpreted on a permeable, sensory, and holistic level is Kengo Kuma's Water/Glass House (1995). The direct interaction between glass, the water surface, and the surrounding landscape proposes a unity with nature that is not merely physical but sensorial (Figure 6). Kuma reimagines transitional spaces—such as the engawa found in traditional Japanese houses—with high-tech materials, producing a spatial language in which boundaries dissolve and permeability prevails [3].

Figure 6. Kengo Kuma's Water/Glass House (1995) Interior Space and Window View [17]

4.3. Sou Fujimoto's House NA (2011)

The principles of permeability and modularity in contemporary Japanese architecture are addressed not only on a formal level but also through innovative spatial organization. A striking example of this approach is Sou Fujimoto's House NA (2011). Through a system of transparent platforms, the layered planes of the house lose their definable boundaries, transforming the interior-exterior relationship into a fully permeable composition (Figure 7). The traditional multifunctional usage observed in Japanese dwellings is reinterpreted through openness, light, and unrestricted circulation. Furthermore, the spatial concept of "edge" (en) is reconfigured beyond physical boundaries as a central strategy for spatial connection [6], [8].

Figure 7. Sou Fujimoto's House NA (2011) Interior Space Design and User Interaction

4.4. Kazuyo Sejima's House in a Plum Grove (2003)

Aesthetic simplicity in Japanese architecture implies not only visual clarity but also mental and ritual purification. In House in a Plum Grove (2003), Kazuyo Sejima emphasizes this notion of simplicity through both formal expression and interior spatial organization (Figure 8). The continuity of white surfaces, the permeation of natural light, and the use of minimal details generate an intuitive spatial experience, reflecting the essence of traditional Japanese aesthetics within a contemporary framework [5], [6].

Figure 8. Kazuyo Sejima's House in a Plum Grove (2003) House Interior Design and Details [19],[20]

4.5. Toyo Ito's White U House (1976)

Concepts such as spiritual intensity and inwardness are articulated through a courtyard-based spatial arrangement in White U House (1976) by Toyo Ito. The house proposes an introverted organization where privacy is prioritized (Figure 9). The way light enters the interior and the use of minimal surfaces recreate the sense of inner tranquility found in traditional Japanese dwellings, reinterpreted within a contemporary context. Rather than replicating traditional forms, Ito adapts the philosophical foundations behind them into a modern architectural language [5], [6].

Figure 9. Toyo Ito's White U House (1976) Exterior View and Interior Space Color and Geometry [20]

4.6. Shigeru Ban's Paper House (1995)

The principles of impermanence, simplicity, and naturalness are synthesized with sustainability in Shigeru Ban's Paper House (1995). The use of cardboard tubes as the primary structural elements is not only an aesthetic choice but also reflects economic and environmental concerns. Ban approaches natural materials not merely as surface treatments but as meaningful architectural components. This project integrates the Japanese cultural notions of transience and reverence for nature with contemporary construction techniques [2], [5].

Figure 10. Shigeru Ban's Paper House (1995), residential project using cardboard tubes as structural elements, reflecting sustainability and the traditional Japanese concepts of impermanence and naturalness. [21].

From the perspective of furnishing systems, traditional spatial elements in contemporary Japanese architecture are not replicated formally but are restructured as meaningful spatial narratives. For instance, in Tadao Ando's Azuma House, the use of a central courtyard creates an inward-facing space that recalls traditional introversion and spatial simplicity. Toyo Ito's White U House reinterprets traditional privacy and ritual-centered use through an enclosed courtyard typology. Shigeru Ban's Paper House integrates natural materials and impermanence into sustainable architecture, aligning with the values of transience and ecological harmony. Kengo Kuma's Water/Glass House employs glass and water to evoke a contemporary reinterpretation of engawa-like permeability. In several of Kuma's residential designs, tokonoma-like niches are reimagined as areas for displaying personal items, while tsuke-shoin-inspired window-side alcoves reconnect occupants with nature and contemplative practices [2], [5]. Kazuyo Sejima's House in a Plum Grove exemplifies spatial transparency and sensory minimalism, where flowing light and neutral surfaces evoke ritual calmness. Sou Fujimoto's House NA transforms modular transparency into an open-ended, multi-functional spatial network that challenges conventional interior boundaries.

Within this scope, traditional spatial and furnishing principles are functionally reevaluated in the works of contemporary Japanese architects, contributing to architectural continuity. Rather than formal repetition, the sustained conceptual reinterpretation of these elements reveals how cultural heritage in Japanese domestic architecture continues to coexist with contemporary life. This relationship is further illustrated in the following table, which summarizes how traditional principles are reimagined in the selected projects of these architects. Table 3. outlines how selected contemporary Japanese architects reinterpret traditional spatial concepts and furnishing systems within their architectural designs.

Table 3. *Contemporary Japanese Architects Reinterpret Traditional Spatial Concepts and Furnishing Systems (Table produced by the authors)*

Architect	Project Name	Architectural Expression	Conceptual Axes
Tadao Ando	Azuma House (1976)	Inward-focused living, psychological connection with nature, courtyard typology	Simplicity, integration with nature, introversion
Toyo Ito	White U House (1976)	Privacy, inward-oriented layout, courtyard form	Ritual use, simplicity
Shigeru Ban	Paper House (1995)	Natural materials, simplicity, ecological design	Impermanence, naturalness, sustainability
Kengo Kuma	Water/Glass House (1995)	Glass and water interface, spatial permeability, nature-technology fusion	Permeability, integration with nature
Kazuyo Sejima	House in a Plum Grove (2003)	Transparency, flexible planning, ephemeral boundaries	Flexibility, simplicity, permeability
Sou Fujimoto	House NA (2011)	Full permeability, modular platforms, individual freedom	Spatial flexibility, permeability, multifunctionality

5.CONCLUSION AND DISCUSSION

In the examined projects, it becomes evident that traditional architectural principles are not merely maintained as nostalgic references or stylistic elements. Rather, they are actively re-contextualized within the dynamics of contemporary architecture, reflecting an ongoing dialogue between past and present. This

reinterpretation does not rely on superficial replication but instead repositions symbolic and experiential values in alignment with today's lifestyles and technological capabilities.

The notion of "permeability," for instance, expands beyond physical transparency to include psychological and experiential openness, as seen in the works of Sou Fujimoto and Kazuyo Sejima. Likewise, "integration with nature" is no longer limited to the visual framing of the landscape but is conceptualized as an immersive environmental engagement that enhances sensory awareness and sustainability. These reinterpretations suggest a paradigm in which spatial flexibility, material authenticity, and ritual continuity are reimagined as critical components of architectural innovation.

This study also reveals that spatial elements such as tokonoma, engawa, and tatami, which traditionally governed social hierarchy, nature appreciation, and bodily orientation—are now being reintroduced not for their original functional roles, but for their ability to encode cultural memory and produce spatial narratives. Contemporary reinterpretations thus become a form of architectural storytelling, in which the material traces of tradition are re-scripted to address the evolving needs and values of society.

In this sense, the selected architectural works contribute not only to the continuation of a cultural identity but also to its transformation. By integrating traditional principles with innovative technologies, these projects present a model of "conceptual continuity" that transcends time. This dual movement—preservation and transformation—positions Japanese contemporary residential architecture as a unique field where heritage and modernity intersect meaningfully.

In conclusion, the reinterpretation of traditional Japanese architectural concepts within contemporary contexts fosters a design ethos grounded in cultural sensitivity, spatial ethics, and aesthetic subtlety. Such an approach offers valuable insights into global architectural discourse, especially in contexts seeking to preserve cultural identity amidst modernization. As demonstrated in the case studies and summarized in Table 4, Japanese architecture serves as a compelling example of how built environments can act as carriers of intangible heritage through thoughtful spatial and conceptual continuity.

Table 4. *Traditional Japanese Architectural Concepts within Contemporary Contexts and Cultural Base (Table produced by the authors)*

Architect	Project	Spatial Flexibility	Integration with Nature	Ritual Practice	Simplicity & Shibui
Tadao Ando	Azuma House (1976)	✓	✓	●	✓
Toyo Ito	White U House (1976)	✓	✓	●	✓
Shigeru Ban	Paper House (1995)	✓	✓	●	✓✓
Kengo Kuma	Water/Glass House (1995)	●	✓✓	●	✓
Kazuyo Sejima	House in a Plum Grove (2003)	✓✓	✓	●	✓
Sou Fujimoto	House NA (2011)	✓✓✓	✓	●	✓

✓ indicates that the principle is clearly reflected in the architectural project.
✓✓ indicates that the principle is strongly emphasized both formally and conceptually.
✓✓✓ indicates that the principle is reinterpreted and positioned as a central design strategy.
● indicates that the principle is suggested through symbolic or spatial expression.

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Review Article GU J Sci, Part B, 13(3): 467-483 (2025)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

http://dergipark.gov.tr/gujsb

Ecological Sustainability in Rural Settlements: A Meta-Analysis of Postgraduate Theses in Architecture from Türkiye

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Article Info

Received: 30/07/2025
Accepted: 22/09/2025

Keywords

Rural settlement,
Village,
Ecological Sustainability,
Architecture,
Meta-analysis

Abstract

The intensifying pressures of urbanization, resource consumption, ecological degradation, and the adverse effects of climate change have significantly influenced rural areas. To prevent rural settlements from contributing to ecological problems, ensuring ecological sustainability has emerged as a fundamental priority. This study aims to establish a theoretical framework through a meta-analysis of postgraduate theses in the department of architecture in Türkiye that address ecological sustainability in rural areas. The theses, obtained from the National Thesis Center database, were examined through bibliometric analysis. Based on the criteria established by the review, 32 theses were selected for inclusion in the meta-analysis. The meta-analysis revealed that the main approaches of the examined theses varied depending on the scale they addressed, such as the building or settlement scale, as well as the type of village selected as a case study. At the same time, the theses revealed commonalities in approaches, problem definitions, and proposed solutions, which could be evaluated under shared categories. These findings also align with trends observed in the international literature. The holistic inter-scale and interdisciplinary perspective, which has been more frequently observed in recent theses, is regarded as significant for advancing future research. By systematically analyzing studies from different disciplines through similar methods, and by ensuring complementarity among future investigations, it could become possible to establish a shared and more comprehensive interdisciplinary outlook. The theoretical framework developed in this study is expected to serve as a valuable reference for future research on ecological sustainability in rural settlements.

1. INTRODUCTION

It is projected that 70-80% of the world's population will live in cities by 2050 [1]. During and after the Industrial Revolution, the social and economic opportunities of the city created an attractive force, while the inadequacies of the countryside created a repulsive force, increasing rural-to-urban migration. The uncontrolled growth of the urban population led to the formation of consumption-oriented metropolises, resulting in carbon emissions, habitat loss, and species extinction. Cities shaped by increasing inequality in society have led to the search for alternative models, especially during times of crisis when existing systems become unsustainable. Increasing environmental pollution, the extinction of species due to ecological degradation, and the devastating effects of climate change have intensified these efforts, bringing the concepts of ecology and sustainability to the forefront as potential solutions.

The term "ecology" was first defined by Ernest Haeckel as a science examining the relationships between living organisms and their environment. After the 1970s, it expanded to encompass human-nature relationships in response to increasing environmental problems [2]. Dawson [3] pointed out that in the mid-1970s, the gross national product in industrialized countries was increasing even as the quality of life declined, and that it was not possible to live sustainably with the planet's finite resources. The concept of sustainability was first defined in the Brundtland Report in the context of development as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” [4]. Emphasizing the importance of preserving biodiversity, Munasinghe [5] interpreted sustainability as

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encompassing all aspects of the biosphere, thereby highlighting the significance of ecological sustainability. In this period, when environmental problems are at the forefront, all sectors, including architecture, have been urged to reassess their production and consumption practices. In cases where urban planning and architectural models failed to address environmental and social problems, societies turned to creating small and self-sufficient settlements as alternatives to cities. This effort has drawn attention to the rural areas and settlements.

Ecological and social concerns have exerted similar influences on rural areas in Türkiye. In particular, the demographic transformation driven by urban-to-rural migration since the pandemic, along with legislative changes, has altered the perception of rural settlements. "Rural settlements" are defined as "settlements where the division of labor has not developed, the economy is based on agriculture, extended families and face-to-face neighborly relations exist, and which, in these respects, differ from areas inhabited by urban communities" [6]. In Village Law No. 442, "village" is defined as settlements with a population of less than 2,000. According to the definition adopted in the First National Rural Development Strategy (2007-2013), provinces and district centers with populations under 20,000, as well as towns and villages, are classified as rural settlements. On the other hand, it has been noted that due to the transformation of villages into neighborhoods by Law No. 6360, existing definitions based on population size have become difficult to apply [7]. The term "rural settlement" used within the scope of this study encompasses villages and small-scale rural settlements formed by groups with ecological concerns, regardless of population-based criteria.

The settlements examined in this study are classified into two main categories based on their mode of formation. Settlements defined as “unplanned settlements”, also referred to as “traditional settlements”, are village settlements that have developed spontaneously and have been sustained over generations. Settlements defined as "planned settlements" are rural settlements established through deliberate planning and design processes by communities coming together with common goals and worldviews, or implemented by the state, for reasons such as disaster response, security concerns, or relocation policies. “Ecovillages” and models in Türkiye, such as “köykent (village-town)” and “Tarımköy (agricultural village)” are examples of these settlements.

Rural area studies, due to their inherent connection to the local context, may yield different outcomes even under similar conditions within the same region, due to the contextual transformations. Therefore, there is a need for a study that reveals the theoretical framework of existing research, to develop and sustain these studies in line with the transformation of the rural areas. Considering the pressure that the built environment exerts on nature, the importance of research on ecological sustainability in rural areas becomes evident.

This study aims to establish a theoretical framework on ecological sustainability in rural settlements by systematically analyzing postgraduate theses conducted in the department of architecture in Türkiye, with a focus on revealing common methodological and conceptual approaches. Furthermore, the classification of theses aims to identify research gaps in the field and guide researchers who will further develop existing studies.

In the analysis conducted, keywords related to the topic were searched in the National Thesis Center (NTC) of the Turkish Council of Higher Education database; the bibliometric data of the results were analyzed, and the theses obtained after applying all relevant limitations were evaluated using the meta-analysis method to create a theoretical framework. The concept of “rural” is inherently tied to its specific geographical context. To avoid expanding the evaluation parameters due to varying cultural and geographical characteristics, the scope of the research was limited to postgraduate theses conducted in the department of architecture in Türkiye.

A review of the national and international literature reveals that no meta-analysis studies have been conducted in the field of architecture addressing the context of rural settlements. This deficiency indicates a significant research gap in the field and underscores the importance of the present study and its potential to guide future research. In addition, there are recent studies that use bibliometric methods and conduct

comprehensive literature reviews on similar topics. The study examining national theses in Türkiye systematically analyzes rural settlements in terms of discipline, subject, and type; however, it does not specifically address ecological sustainability [8]. In another study examining national theses using bibliometric analysis, evaluations were conducted using quantitative data and statistical analysis with a particular focus on the concepts of rural architecture, ecology, sustainability, and local [9]. While the international literature lacks a review specifically addressing the ecological sustainability of rural settlements, there are comprehensive literature reviews and bibliometric analyses linking rural architecture and settlements to ecological sustainability. The literature on Anatolian vernacular architecture between 1983 and August 2021 was examined using the bibliometric method through publications indexed in the Web of Science (WoS) Core Collection database. Although not specifically focusing on ecological sustainability or rural settlements, it is significant as the first bibliometric study within this scope of Anatolian vernacular architecture [10]. Another study analyzing literature indexed in the Web of Science from 2000 to 2022 qualitatively examined vernacular architecture, with particular focus on conservation challenges and solutions, traditional building materials and construction techniques, the reuse of abandoned vernacular buildings, and climate adaptation [11]. In addition, there are studies that include content associated with ecology and the rural built environment, analyzing rural human settlements through a comprehensive literature review [12], analyzing sustainable development in vernacular architecture [13], and systematically examining sustainability strategies for the eco-efficient retrofitting of rural heritage [14].

2. METHOD

Both quantitative and qualitative methods were used in the study. Initially, "rural settlements", the main subject of the research, were defined, followed by definitions of "village", "planned settlement", and "unplanned settlement", which fall under this concept.

Since the scope of the study comprises theses completed in Türkiye, the NTC was selected as the most comprehensive database, encompassing all academic theses in the country. The study conducted a bibliometric analysis of the theses retrieved from the NTC database, and the relevant quantitative data were presented through graphical representations. The meta-analysis method was used in the analysis of the selected theses to establish the theoretical framework. The primary reason for choosing meta-analysis for this study is that it allows the combination of the results of multiple independent studies conducted on a specific topic, analyzing the obtained research findings, and drawing a general conclusion [15, 16], thus enabling a more holistic view of sustainability in rural areas. On the other hand, distinct from conventional meta-analyses, which primarily emphasize quantitative data, the present research applies a qualitative meta-analysis aiming to integrate and interpret qualitative data in order to derive broader insights and patterns. In the meta-analysis process, the criteria for analyzing the theses were initially determined. The relevant sections of the theses were then examined according to these criteria. Based on the common concepts and approaches identified through these examinations, categories were determined, and the theses were classified accordingly. In line with the findings, inferences and evaluations were drawn regarding the similarities, differences, approaches, and trends of the theses within the context of ecological sustainability.

The research process consists of seven basic steps, as shown in Figure 1:

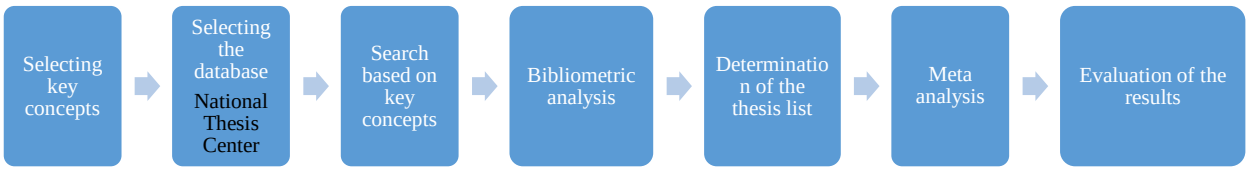

Figure 1. *Research process*

2.1 Bibliometric Analysis

In the literature review, different concepts that define rural settlements, housing, and ecological architecture and that are used in similar contexts, were identified. However, it was observed that some theses did not include keywords, while others, the titles did not adequately express the scope of the thesis. Therefore, to avoid omitting relevant results, the most comprehensive terms, "rural", "village", "ecological", and "sustainable", were selected for the search. Since some theses used the words “environment / environmental science / natural environment” instead of the term ecology, the term “environment” was also added to the selected terms. The search was conducted in the broadest scope by searching the title of the thesis, subject, abstract, and keywords.

All available years, including the first six months of 2025, were considered. The study was limited to theses conducted in the department of architecture. Despite the presence of the words "rural", "village", "sustainable", "ecological", and "environment" in many abstracts, theses that were not directly relevant to the scope were excluded. The search for the term “rural” yielded 297 theses, comprising 67 doctoral and 230 master's theses. The search for the term “village” yielded 189 theses, consisting of 11 doctoral and 178 master’s theses. Theses containing the terms "rural" and/or "village" were compiled, and duplicate studies were eliminated, resulting in a total of 396 theses, consisting of 70 doctoral and 326 master's theses (Figure 2).

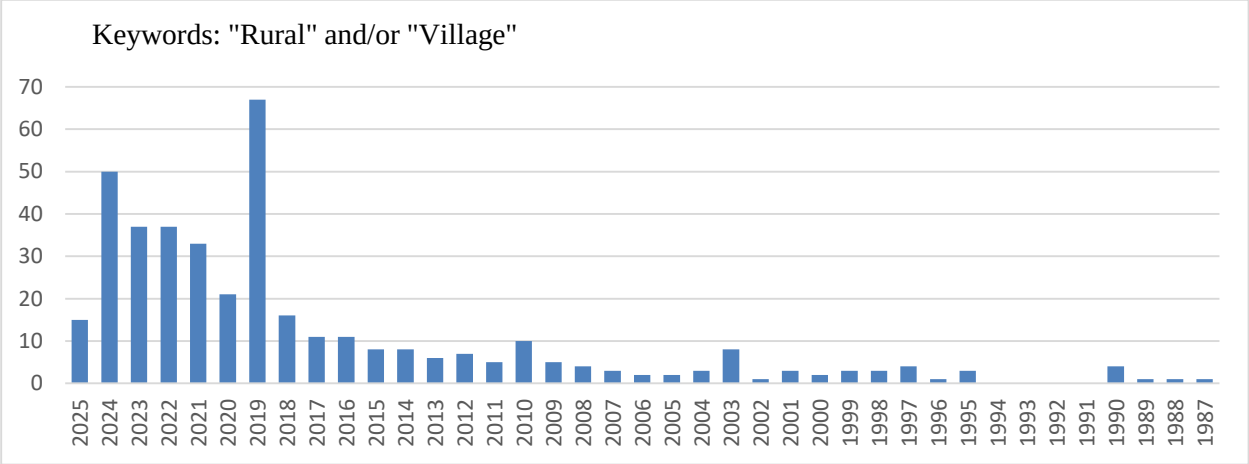

Figure 2. *Distribution of 396 theses by year, identified through the search using the terms "Rural" and/or "Village"*

The distribution reveals a notable increase in 2019. Compared to previous years, the significant rise in subsequent years demonstrates that interest in rural themes has increased within the department of architecture over the last six years. As the NTC search for this research was completed on 3 July 2025, the data for 2025 may be subject to change, as thesis submissions for the year were still ongoing. Among the 12,539 postgraduate theses conducted in the department of architecture to date, those containing the terms “rural” and “village” constitute only 3.15%. This relatively low rate indicates a research gap in the field of rural studies. To narrow the scope of the study within the framework of "ecological sustainability in rural settlements", additional searches were conducted by adding the terms "sustainable", "ecology", and "environment" to the terms "rural" and "village." Theses that were incompatible with the scope of the study or not affiliated with the department of architecture were also excluded from the results. Accordingly, 88 theses were identified, 15 of which were doctoral and 73 were master's theses (Figure 3).

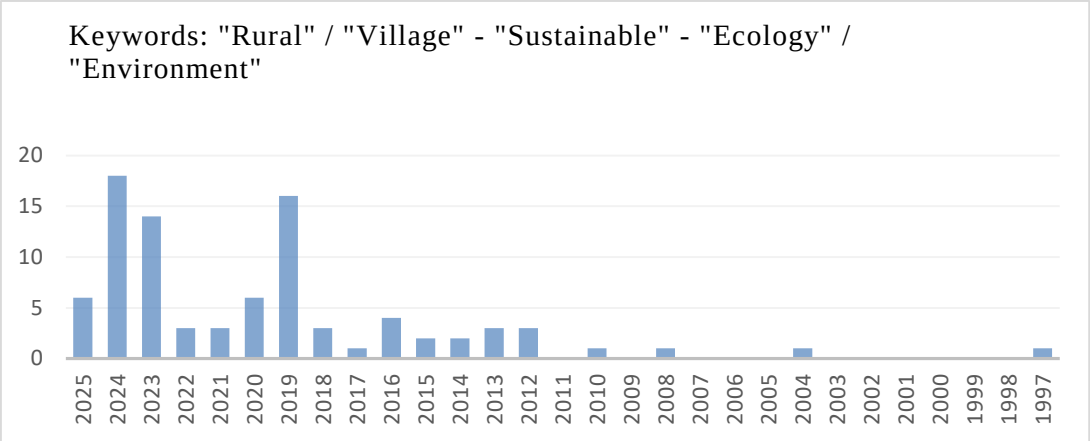

Figure 3. *Distribution of 88 theses by year identified through the search using the keywords "Rural" / "Village" - "Sustainable" - "Ecology" / "Environment"*

The theses to be included in the meta-analysis were selected based on five criteria determined through a review of their titles, abstracts, keywords, and full texts:
1) Studies conducted in the department of architecture, 2) Studies focusing on sustainability principles and sustainable design in rural areas, 3) Studies focusing on ecological design principles in rural areas, 4) Studies focusing on village-scale or smaller rural settlements, 5) Studies focusing on the concept or design of housing in rural areas.

A wide range of factors has an impact on ecological sustainability. Therefore, many studies are indirectly associated with this concept. However, within the scope of this study, only the studies that directly address this concept or that establish a link between ecological sustainability and rural settlement and construction, and those treating ecological sustainability in rural areas as the primary research problem, were included. Accordingly, 32 thesis studies were identified, comprising 26 master's and 6 doctoral theses (Figure 4).

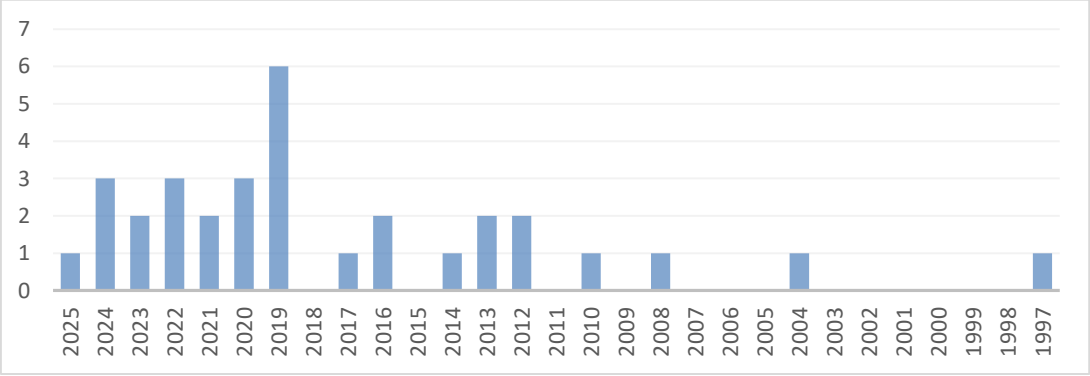

Figure 4. *Distribution of 32 theses by year, identified according to the five criteria*

The content, problem definitions, objectives, scope, and results of the selected theses were examined, and a meta-analysis was conducted to evaluate their approaches to ecological sustainability in rural areas. According to these approaches, categories were determined, and both converging and diverging perspectives were systematically grouped.

3. META-ANALYSIS

The meta-analysis process comprises three main stages. The first stage is the establishment of analysis criteria to define the evaluation framework. The second stage involves examining the theses according to these criteria, identifying categories based on common approaches and concepts, and classifying the

theses accordingly. The final stage is the evaluation of the findings within the context of ecological sustainability.

The criteria determined for analyzing theses are as follows:
1) Type of rural settlement 2) Key concepts 3) Problem definitions related to ecological sustainability and rural settlements 4) Aim– Hypothesis – Solution proposal 5) Results
1) Type of rural settlement

The type of rural settlement is a key factor influencing the research focus of a thesis; accordingly, it was selected as the primary criterion for analysis. The formation characteristics of the rural settlements addressed in the theses vary. They have been categorized as planned and unplanned rural settlements, and the studies were classified according to the type of settlement they covered. Studies that address both types of settlements are placed at the intersection (Table 1). Some of the studies covering both settlement types are proposals that transform unplanned settlements into planned ones through design interventions at the settlement scale, while others focus on each settlement type individually or offer comparative analyses. The case study sections of the theses were reviewed to determine the settlement types covered.

Table 1.*Classification of theses by settlement type (Master's Thesis are abbreviated as M and PhD dissertations are abbreviated as D)*

Unplanned Rural Settlements	**Unplanned and Planned Rural Settlements**	**Planned Rural Settlements**
Uz, 2024 (M) [17], İme, 2024 (M) [18], Zeğerek Akalın, 2024 (M) [19], Acar Bilgin, 2023 (D) [20], Durak, 2021 (D) [21], Sağdıçoğlu, 2020 (M) [22], Sarı, 2019 (M) [23], Paçin, 2019 (M) [24], Altunkaya Uygun, 2019 (M) [25], Okkalıoğlu, 2019 (M) [26], Alim, 2017 (M) [27], Akın Güler, 2016 (M) [28], Güler, 2016 (D) [29], Akgündüz, 2013 (M) [30], Çal, 2012 (M) [31], İnanç, 2010 (M) [32], Yüksek, 2008 (D) [33], Karaosman Kabuloğlu, 2004 (D) [34]	Şireci, 2025 (M) [35], Küçükköse, 2022 (M) [36], Gür Ayyıldız, 2022 (M) [37], Bektaş, 2022 (D) [38], Ekicioğlu, 2019 (M) [39], Özkuvanci, 2019 (M) [40], Uzun, 1997 (M) [41]	Ula, 2023 (M) [42], Cengiz, 2021 (M) [43], Uzaldı, 2020 (M) [44], Bartu, 2020 (M) [45], Kara, 2014 (M) [46], Güleryüz, 2013 (M) [47], Tiryaki, 2012 (M) [48]

2) Key concepts

To determine the key concepts, the abstracts and keywords of the theses were systematically examined. Due to the absence of keywords in many of the theses, the key concepts were identified through content analysis of the full texts. Concepts that appeared in at least 25% of the selected theses were identified, thereby revealing the most common concepts within the scope of the topic (Table 2). Concepts with similar meanings were evaluated together.

Table 2. *Key concepts (Master's Thesis abbreviated as M and PhD dissertations abbreviated as D)*

Ecology	• Uz, 2024 (M) [17], Durak, 2021 (D) [21], Cengiz, 2021 (M) [43], Uzaldı, 2020 (M) [44], Bartu, 2020 (M) [45], Sağdıçoğlu, 2020 (M) [22], Paçin, 2019 (M) [24], Kara, 2014 (M) [46], Altunkaya Uygun, 2019 (M) [25], Okkalıoğlu, 2019 (M) [26], Ekicioğlu, 2019 (M) [39], Güleryüz, 2013 (M) [47], Akgündüz, 2013 (M) [30], Çal, 2012 (M) [31], İnanç, 2010 (M) [32], Karaosman Kabuloğlu, 2004 (D) [34]
Sustainability	• Uz, 2024 (M) [17], İme, 2024 (M) [18], Zeğerek Akalın, 2024 (M) [19], Ula, 2023 (M) [42], Acar Bilgin, 2023 (D) [20], Küçükköse, 2022 (M) [36], Bektaş, 2022 (D) [38], Durak, 2021 (D) [21], Cengiz, 2021 (M) [43], Bartu, 2020 (M) [38], Paçin, 2019 (M) [24], Okkalıoğlu, 2019 (M) [26], Ekicioğlu, 2019 (M) [39], Alim, 2017 (M) [27], Akın Güler, 2016 (M) [28], Kara, 2014 (M) [46], Güleryüz, 2013 (M) [47], Akgündüz, 2013 (M) [30], Tiryaki, 2012 (M) [48], Çal, 2012 (M) [31], İnanç, 2010 (M) [32], Yüksek, 2008 (D) [33], Karaosman Kabuloğlu, 2004 (D) [34]
Ecological Sustainability	• Şireci, 2025 (M) [35], İme, 2024 (M) [18], Küçükköse, 2022 (M) [36], Cengiz, 2021 (M) [43], Bartu, 2020 (M) [45], Kara, 2014 (M) [46], Akgündüz, 2013 (M) [30], İnanç, 2010 (M) [32], Özkuvanci, 2019 (M) [40]
Ecological architecture, Ecological design	• İme, 2024 (M) [18], Durak, 2021 (D) [21], Cengiz, 2021 (M) [43], Bartu, 2020 (M) [45], Altunkaya Uygun, 2019 (M) [25], Okkalıoğlu, 2019 (M) [26], Ekicioğlu, 2019 (M) [39], Güleryüz, 2013 (M) [47], İnanç, 2010 (M) [32], Yüksek, 2008 (D) [33], Karaosman Kabuloğlu, 2004 (D) [34], Uzun, 1997 (M) [41]
Sustainable architecture, Sustainable building, Sustainable design	• Şireci, 2025 (M) [35], İme, 2024 (M) [18], Küçükköse, 2022 (M) [36], Cengiz, 2021 (M) [43], Sağdıçoğlu, 2020 (M) [22], Okkalıoğlu, 2019 (M) [26], Ekicioğlu, 2019 (M) [39], Alim, 2017 (M) [27], Çal, 2012 (M) [31], Uzun, 1997 (M) [41]
Rural settlement Village, Traditional Village	• Şireci, 2025 (M) [35], Uz, 2024 (M) [17], İme, 2024 (M) [18], Zeğerek Akalın, 2024 (M) [19], Acar Bilgin, 2023 (D) [20], Gür Ayyıldız, 2022 (M) [37], Bektaş, 2022 (D) [38], Bartu, 2020 (M) [45], Sarı, 2019 (M) [23], Paçin, 2019 (M) [24], Özkuvanci, 2019 (M) [40], Akın Güler, 2016 (M) [28], Güler, 2016 (D) [29], Tiryaki, 2012 (M) [48], Çal, 2012 (M) [31]
Ecovillage	• Şireci, 2025 (M) [35], Ula, 2023 (M) [42], Küçükköse, 2022 (M) [36], Gür Ayyıldız, 2022 (M) [37], Bektaş, 2022 (D) [38], Cengiz, 2021 (M) [43], Uzaldı, 2020 (M) [44], Bartu, 2020 (M) [45], Sarı, 2019 (M) [23], Ekicioğlu, 2019 (M) [39], Kara, 2014 (M) [46], Güleryüz, 2013 (M) [47], Tiryaki, 2012 (M) [48]
Traditional architecture Vernacular architecture Rural architecture Folk architecture	• Uz, 2024 (M) [17], Zeğerek Akalın, 2024 (M) [19], Ula, 2023 (M) [42], Acar Bilgin, 2023 (D) [20], Durak, 2021 (D) [21], Cengiz, 2021 (M) [43], Bartu, 2020 (M) [45], Sağdıçoğlu, 2020 (M) [22], Paçin, 2019 (M) [24], Altunkaya Uygun, 2019 (M) [25], Okkalıoğlu, 2019 (M) [26], Alim, 2017 (M) [27], Akın Güler, 2016 (M) [28], Güler, 2016 (D) [29], Akgündüz, 2013 (M) [30], Çal, 2012 (M) [31], İnanç, 2010 (M) [32], Yüksek, 2008 (D) [33]

3) Problem definitions related to ecological sustainability and rural settlements

The problem definitions concerning the need for ecological sustainability and ecologically sustainable settlements in rural areas were analyzed. In order to identify these definitions, the problem definition

sections of the theses were reviewed, and for those theses that lacked this section, a content analysis was conducted. The stated problems and their consequences were considered important as they form the conceptual foundations of the research. The problem definitions mentioned in at least 25% of the theses are listed in Table 3.

Table 3. *Problem definitions (Master's Thesis abbreviated as M and PhD dissertations abbreviated as D)*

Production-based Problems, Rapid industrialization, Technological developments	•İme, 2024 (M) [18], Zeğerek Akalın, 2024 (M) [19], Ula, 2023 (M) [42], Küçükköse, 2022 (M) [36], Gür Ayyıldız, 2022 (M) [37], Durak, 2021 (D) [21], Uzaldı, 2020 (M) [44], Paçin, 2019 (M) [24], Altunkaya Uygun, 2019 (M) [25], Okkalıoğlu, 2019 (M) [26], Ekicioğlu, 2019 (M) [39], Alim, 2017 (M) [27], Akın Güler, 2016 (M) [28], Kara, 2014 (M) [46], Çal, 2012 (M) [31], İnanç, 2010 (M) [32], Karaosman Kabuloğlu, 2004 (D) [34]
Consumption-based Problems, Resource depletion, Consumer society	• Şireci, 2025 (M) [35], İme, 2024 (M) [18], Zeğerek Akalın, 2024 (M) [19], Acar Bilgin, 2023 (D) [20], Küçükköse, 2022 (M) [36], Bektaş, 2022 (D) [38], Durak, 2021 (D) [21], Cengiz, 2021 (M) [43], Bartu, 2020 (M) [45], Paçin, 2019 (M) [24], Altunkaya Uygun, 2019 (M) [25], Okkalıoğlu, 2019 (M) [26], Ekicioğlu, 2019 (M) [39], Akın Güler, 2016 (M) [28], Kara, 2014 (M) [46], Güleryüz, 2013 (M) [47], [30], Yüksek, 2008 (D) [33], Uzun, 1997 (M) [41]
Population-based Problems, Excessive population growth, Rural-to-urban migration	•Şireci, 2025 (M) [35], Uz, 2024 (M) [17], İme, 2024 (M) [18], Zeğerek Akalın, 2024 (M) [19], Ula, 2023 (M) [42], Acar Bilgin, 2023 (D) [20], Gür Ayyıldız, 2022 (M) [37], Bektaş, 2022 (D) [38], Durak, 2021 (D) [21], Uzaldı, 2020 (M) [44], Sağdıçoğlu, 2020 (M) [22], Sarı, 2019 (M) [23], Paçin, 2019 (M) [24], Altunkaya Uygun, 2019 (M) [25], Ekicioğlu, 2019 (M) [39], Özkuvanci, 2019 (M) [40], Güler, 2016 (D) [29], Kara, 2014 (M) [46], Çal, 2012 (M) [31], İnanç, 2010 (M) [32], Karaosman Kabuloğlu, 2004 (D) [34], Uzun, 1997 (M) [41]
Ecological Problems, Environmental degradation, Environmental pollution, Disruption of ecological balance, Climate change	•Şireci, 2025 (M) [35], Uz, 2024 (M) [17], İme, 2024 (M) [18], Zeğerek Akalın, 2024 (M) [19], Ula, 2023 (M) [42], Acar Bilgin, 2023 (D) [20], Küçükköse, 2022 (M) [36], Bektaş, 2022 (D) [38], Durak, 2021 (D) [21], Cengiz, 2021 (M) [43], Uzaldı, 2020 (M) [44], Bartu, 2020 (M) [45], Sağdıçoğlu, 2020 (M) [22], Paçin, 2019 (M) [24], Altunkaya Uygun, 2019 (M) [25], Okkalıoğlu, 2019 (M) [26], Alim, 2017 (M) [27], Akın Güler, 2016 (M) [28], Güler, 2016 (D) [29], Kara, 2014 (M) [46], Güleryüz, 2013 (M) [47], Akgündüz, 2013 (M) [30], Tiryaki, 2012 (M) [48], Çal, 2012 (M) [31], İnanç, 2010 (M) [32], Yüksek, 2008 (D) [33], Karaosman Kabuloğlu, 2004 (D) [34], Uzun, 1997 (M) [41]
Built environment-based Problems Rapid / unplanned urbanization Problems of urban life	•Şireci, 2025 (M) [35], Uz, 2024 (M) [17], İme, 2024 (M) [18], Ula, 2023 (M) [42], Küçükköse, 2022 (M) [36], Gür Ayyıldız, 2022 (M) [37], Uzaldı, 2020 (M) [44], Bartu, 2020 (M) [45], Sağdıçoğlu, 2020 (M) [22], Sarı, 2019 (M) [23], Altunkaya Uygun, 2019 (M) [25], Ekicioğlu, 2019 (M) [39], Alim, 2017 (M) [27], Kara, 2014 (M) [46], Güleryüz, 2013 (M) [47], Akgündüz, 2013 (M) [30], Tiryaki, 2012 (M) [48], İnanç, 2010 (M) [32], Yüksek, 2008 (D) [33], Karaosman Kabuloğlu, 2004 (D) [34]
Economic and Social Problems Development problems Increasing poverty and social inequality	•Şireci, 2025 (M) [35], Zeğerek Akalın, 2024 (M) [19], Ula, 2023 (M) [42],Acar Bilgin, 2023 (D) [20], Gür Ayyıldız, 2022 (M) [37], Cengiz, 2021 (M) [43], Bartu, 2020 (M) [45], Sarı, 2019 (M) [23], Özkuvanci, 2019 (M) [40], Akın Güler, 2016 (M) [28], Güler, 2016 (D) [29], Kara, 2014 (M) [46], Tiryaki, 2012 (M) [48]

4) Aim– Hypothesis – Solution proposal

In order to obtain data for this criterion, the aim and scope sections of the theses were primarily reviewed. Since the research questions or hypotheses were not clearly stated in all of the studies, solution proposals were analyzed to comprehend the underlying approach of each thesis. Therefore, a comprehensive assessment encompassing aim, hypothesis, and solution proposal was conducted, and the approaches were classified under common categories (Table 4).

Table 4. *Classification of theses according to Aim-Hypothesis-Solution Proposal (Master's Thesis abbreviated as M and PhD dissertations abbreviated as D)*

Aim– Hypothesis – Solution proposal	**Related Thesis**
It is inferred that ecovillages offer the most appropriate solutions to the identified problems, and serve a framework through which the ecological and sustainability paradigm is discussed. Accordingly, the aim is to establish model proposal by determining the criteria to guide both traditional rural settlements and new rural developments.	Şireci, 2025 (M) [35], Ula, 2023 (M) [42], Gür Ayyıldız, 2022 (M) [37], Bektaş, 2022 (D) [38], Cengiz, 2021 (M) [43], Uzaldı, 2020 (M) [44], Bartu, 2020 (M) [45], Ekicioğlu, 2019 (M) [39], Kara, 2014 (M) [46], Güleryüz, 2013 (M) [47]
The hypothesis proposed that traditional buildings inherently ensure ecological sustainability criteria. Through case studies to test this hypothesis, the aim is to determine the ecological criteria in traditional buildings and to create model proposals as examples for new construction practices. Furthermore, the studies seek to offer solution strategies that integrate contemporary materials and technologies to enhance the sustainability of traditional rural houses, while preserving their authentic character.	İme, 2024 (M) [18], Durak, 2021 (D) [21], Sağdıçoğlu, 2020 (M) [22], Paçin, 2019 (M) [24], Altunkaya Uygun, 2019 (M) [25], Okkalıoğlu, 2019 (M) [26], Alim, 2017 (M) [27], Akın Güler, 2016 (M) [28], Güler, 2016 (D) [29], Akgündüz, 2013 (M) [30], Çal, 2012 (M) [31], İnanç, 2010 (M) [32], Yüksek, 2008 (D) [33], Karaosman Kabuloğlu, 2004 (D) [34]
Preventing rural-to-urban migration is proposed for ensuring the ecological sustainability of rural areas. To achieve this, the transformation of rural settlements is recommended to enhance living comfort. The aim is to develop ecological, energy efficient building models in rural contexts and to create models for traditional villages to support this goal.	Ula, 2023 (M) [42], Bektaş, 2022 (D) [38], Ekicioğlu, 2019 (M) [39], Uzun, 1997 (M) [41]
The aim is to evaluate how rural spatial production practices have been influenced by global ecological sustainability agreements, to examine the sufficiency of housing developments and their potential impacts on the quality of life of rural populations, and to propose alternative strategies for a more sustainable transformation process.	Bektaş, 2022 (D) [38], Özkuvanci, 2019 (M) [40]
The solution to the problem of rural settlement and ecological sustainability is sought in the relationship between the natural and built environments. These approaches aim to prevent ecological disconnection and ensure ecological sustainability. To achieve this goal, methods have been proposed such as creating hybrid formations through the collaboration of natural and artificial layers, shifting conservation approaches from the building scale to the natural environment scale, addressing and preserving the components of the built and natural environment holistically, under the concept of "cultural / rural landscape" through inter-scale relationships.	Uz, 2024 (M) [17], İme, 2024 (M) [18], Zeğerek Akalın, 2024 (M) [19], Acar Bilgin, 2023 (D) [20]
The ecological sustainability of rural settlements is evaluated in terms of their impact on the ecosystem. The aim of this evaluation is to draw conclusions and propose recommendations based on the results of analyses conducted either by quantifying the ecological footprint of rural settlements or by using sustainability/green building assessment systems.	Küçükköse, 2022 (M) [36], Durak, 2021 (D) [21], Çal, 2012 (M) [31]

5) Results of theses

To determine the data for this criterion, the results and research findings sections of the theses were reviewed. The theses structured around the concept of ecovillages, conclude that these settlements fulfill ecological sustainability criteria [35, 42, 43, 44, 45, 46], and that they can be considered as laboratories for improving sustainability-related issues and mitigating environmental impacts, as well as for acquiring the necessary knowledge [35, 48]. On the other hand, a comparison between ecological utopias and technologically driven ecological settlements reveals that ecovillages present contrasting perspectives, particularly regarding the use of technology, within the framework of ecological design principles [44, 45]. It is stated that rather than using ecovillages as independent models, a hybrid system could be developed by integrating them with features derived from local life [35, 37, 39]. In line with this approach, it is identified that traditional architectural elements are interpreted and used in some ecovillage initiatives in Türkiye [47]. Within the transformation and design of traditional or planned rural settlements, the importance of the holistic, multidimensional problem-solving approach of ecovillages, which addresses not only ecological but also economic and social components, is emphasized [35, 42, 37, 43].

It has been emphasized that traditional buildings possess ecological design principles and contribute to ecological sustainability [21, 22, 34, 36, 27, 28, 29, 30, 25, 31, 32, 33, 34]. Based on these principles derived from traditional architecture, studies proposed design strategies for new rural constructions. Additionally, the impact of local data on traditional architecture in both geographical and cultural contexts is highlighted [28, 31]. On the other hand, concerns about the disruption of local architectural identity have been stated, regarding the use of modern materials and techniques to enhance comfort conditions in traditional rural buildings [25]. Therefore, it is argued that architectural interventions to improve the comfort conditions should be guided by ecological sustainability principles while aligning with the original fabric of the rural settlement [25, 26].

The evaluations of rural settlements and buildings underscore the importance of moving beyond simply using existing international ecological sustainability assessment models. Instead, these models should be adapted to local conditions, and each rural settlement should be evaluated in its unique context [21, 31, 33, 34]. Beyond structural factors, the importance of the human factor and maintaining rural populations for achieving ecological sustainability have also been highlighted [24, 29, 34].

Studies proposing new building models within the framework of ecological sustainability to enhance living comfort in rural settlements, aim to transform the settlement scale starting from the housing unit. Highlighting the critical role of energy in ecological sustainability, energy-efficient building envelopes are proposed for new building models that maximize solar gain and generate their own energy through PV panels [42, 38, 23]. It has been stressed that, alongside the use of advanced technological elements, universal ecological architectural principles should be synthesized with traditional principles, in accordance with regional conditions [39, 41].

From a broader perspective, the influence of global ecological sustainability agreements on rural spatial production practices was examined, noting that villages have been relocated due to dam construction or disasters. It was highlighted that these large-scale interventions and Law No. 6360 not only caused extensive ecological degradation but also increased the possibility of the loss of villages and vernacular architectural heritage. Furthermore, the projects of Housing Development Administration of the Republic of Türkiye (TOKİ), such as "Tarımköy" (Agriculture Village), were criticized for their failure to align with the realities of rural life, and alternative approaches were proposed for transformations that are ecologically sustainable and are more compatible with rural life [38, 40].

The studies that consider rural settlements as part of the cultural landscape, highlighting their coexistence with nature, pursue ecological sustainability through co-design and hybrid formations of natural and artificial environments [17]. It is stated that traditional settlements and their associated cultural values can be references for the harmonious coexistence of the natural and built environment [18,20]. Since rural settlements are considered a part of the cultural landscape, an inter-scalar approach that establishes

connections between the regional scale and the settlement scale has been introduced [19]. The importance of Geographical Information Systems (GIS) is emphasized to establish connections between scales and to assess architectural heritage in varying contexts [20]. Findings derived from diverse ecological assessment systems demonstrate that traditional settlements and buildings use contextual data efficiently and contribute to ecological sustainability [36, 21, 31].

3.1 Evaluation of the findings

The research highlights two primary types of rural settlements: planned and unplanned. Unplanned settlements have been the subject of more research. Within the planned category, ecovillages established by environmentally conscious communities constitute the majority, though state-initiated "Tarımköy" (agricultural village) projects are also encompassed. Additionally, at the intersection of these two types, there are studies that analyze them together, as well as studies proposing new housing in traditional villages grounded in sustainability principles. The limited number of ecovillage initiatives in Türkiye, combined with the challenges of sustaining them, substantially constrains the available sample options. Likewise, the limited number of agricultural villages (Tarımköy) and their lack of diversity with respect to local conditions restrict the range of related studies. In contrast, the rural architectural heritage of Anatolia, which exhibits significant regional diversity, provides a substantial research domain. These considerations explain to some extent why planned settlements have received less academic attention than unplanned ones. Moreover, since most transformations in existing villages occur at the building scale and no documented cases exist of transformations designed and implemented at the village-scale, the number of studies at the intersection of these two settlement types remains limited.

The most prominent concepts identified in the theses are Ecology, Sustainability, Ecological Sustainability, Ecological Architecture, Ecological Design, Sustainable Architecture, Sustainable Design, Sustainable Building, Rural Settlement, Village, Traditional Village, Ecovillage, Traditional architecture, Local architecture, Vernacular architecture, and Rural architecture. Although relevant concepts related to the subject such as “rural development”, “global warming”, “ecological footprint”, and “energy efficient design” present in some theses, they were not sufficiently prevalent to be included in the primary classification. Although the international literature emphasizes the urgent need to address climate change because of its detrimental impacts on the natural and rural built environment [11], it appears that this issue has not been sufficiently prioritized in theses conducted in Türkiye. Notably, since 2019, the concept of “Cultural/Rural Landscape” has emerged prominently, indicating a shift toward a more holistic and multi-scalar perspective on rural settlements that extends beyond the building scale. It can be argued that the development of such a holistic perspective may foster village-scale design and planning studies that move beyond building-based transformations and position architecture as an integral part of this perspective.

In the majority of the theses, the core problem is framed around the urban–rural dichotomy, and the socioeconomic and technological developments since the Industrial Revolution were emphasized as key drivers of ecological degradation. Consequently, the urban areas are generally presented as ecologically unsustainable and the sources of environmental problems, whereas rural settlements are inherently depicted as the area of ecological harmony. For this reason, it is frequently emphasized that ecologically conscious migration from urban to rural areas and the preservation of the rural population are crucial for ensuring ecological sustainability. Currently, the blurring of the urban-rural distinction driven by urban expansion and the influence of consumer culture on rural settlements has shifted the debate beyond viewing the two as distinct and opposing poles. The fact that such consumption patterns accompany migration from cities to villages poses a significant obstacle to achieving ecological sustainability in rural areas. The prominence of factors threatening rural areas, such as industrialization, globalization, and urban development pressure, and the decrease in rural population due to the inability of traditional buildings to meet comfort requirements, in the international literature [11,13] shows that similar problems affect the rural built environment in both Türkiye and worldwide.

In research on unplanned settlements, two primary approaches have emerged regarding the relationship between housing and ecological principles. In some of these studies, it is proposed that the ecological

principles identified in traditional architecture could guide contemporary rural housing developments. Conversely, other studies emphasize that designs based on universal ecological principles could serve as references for traditional village buildings. Rather than favoring one of these approaches, developing a perspective that balances the needs of rural life with the demands of contemporary lifestyles, while prioritizing the preservation of local resources, will be crucial for achieving ecological sustainability in rural areas.

Theses address both deductive and inductive approaches to achieve ecological sustainability in rural settlements. Studies such as village design guides and settlement scale conservation proposals represent deductive approaches, where the design process initiates from the settlement or broader scale and progresses to the building scale. Conversely, studies focusing on energy-efficient building design and conservation at the building scale represent inductive approaches, aiming to ensure ecological sustainability from the building scale to the settlement scale. A similar situation is observed in conservation-focused research. While some conservation studies propose building-scale improvements in rural houses to enhance user comfort, others offer settlement-scale conservation proposals aimed at sustaining the village as a whole. The key issue here is achieving a balance between the parts that make up the village and its entirety. While national theses emphasize the need to preserve the original qualities and identity of traditional houses in energy-efficient retrofitting, the international literature additionally highlights the necessity of preserving the agricultural landscape [14].

4. CONCLUSION

This study has established a theoretical framework through a meta-analysis by examining postgraduate theses in Türkiye that address ecological sustainability in villages and smaller-scale rural settlements. Due to the significant ecological footprint of the built environment and new construction activities, the quality of rural development plays a vital role in ecological sustainability. To prevent rural settlements from contributing to ecological problems, it is essential to ensure ecological sustainability in rural areas. In this regard, academic studies in the field of architecture represent significant steps forward. However, despite a notable increase in theses on rural topics in recent years, their proportion remains relatively low compared to the overall number of theses in architecture, indicating a research gap in this area.

This study, by analyzing the approaches, aims, findings, and conclusions of various theses, has facilitated the development of a shared understanding and a holistic perspective. Thus, a foundation has been provided for future researchers to avoid duplicating prior studies, to identify opportunities for building upon existing studies, and to explore new research areas.

This study primarily focuses on ecological sustainability. Within this context, although research on architectural conservation and rural tourism may offer direct or indirect contributions, such studies were excluded from the analysis because they do not address this focus as their primary research problem. However, their potential contributions should also be taken into consideration in future research.

The study is limited to the concept of ecological sustainability. On the other hand, the ecological, economic, social, and cultural dimensions of sustainability influence and transform one another. Therefore, similar analyses should also be conducted to address all these dimensions.

This study is limited to postgraduate theses conducted in Türkiye. Future research that includes international academic studies within the same scope will enhance the perspective of the subject to a global scale.

Studies focusing solely on building materials or building elements were excluded. On the other hand, the environmental impacts of the production of building materials and components play a decisive role in ecological sustainability. Therefore, as a continuation of this study, research on the use of building materials or elements in rural areas will deepen the understanding of ecological sustainability in rural areas.

Although there are significant studies on this topic in various disciplines, particularly in Urban and Regional Planning and Landscape Architecture, this study was limited to the department of architecture. Achieving ecological sustainability in rural areas requires a holistic perspective that links disciplines and scales, as also emphasized by the international literature [12]. Extending the applied method to other disciplines may foster a more comprehensive framework that brings together diverse insights.

The study is limited to rural settlements at the village-scale or smaller. However, ecological sustainability in rural areas is significantly impacted by development interventions at broader spatial scales larger than the village. Therefore, beyond village-scale semi-rural areas and the urban-rural relationship are also important areas of analysis. In this manner, beyond the sharp urban-rural distinction discussed in the evaluation of findings section, it will be possible to develop perspectives on intersections, blurred boundaries, and mutual interactions. This situation also highlights the need to establish relationships between disciplines and scales.

The limited presence of planned settlements in Türkiye suggests that design disciplines have not yet been sufficiently incorporated into rural settlement development practices. The active involvement of design disciplines in rural areas could enhance living comfort within the rural built environment. On the other hand, research studies on unplanned settlements reveal the importance of traditional knowledge in adapting to rural geographies. For designed rural settlements to support ecological sustainability, design disciplines should play a role in shaping the rural built environment by comprehending the relationship between rural settlements and the natural environment and by internalizing traditional knowledge regarding the necessities of rural life.

Field studies have been conducted in various regions and settlements within studies that assess the ecological characteristics of traditional rural settlements and houses, and propose corresponding solutions. These studies have enabled the collection of data on the ecological sustainability characteristics of rural settlements across different climatic zones in Türkiye, contributing to the establishment of guiding principles for future rural developments. Therefore, expanding similar research nationwide and gathering more data is essential. These studies are crucial not only for introducing diverse regional characteristics and architecture into the literature but also for creating a comprehensive national inventory of rural architecture.

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Research Article GU J Sci, Part B, 13(3): 485-511 (2025)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

http://dergipark.gov.tr/gujsb

Material Conservation in Adaptive Reuse: Its Role and Relationship to Sustainability

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Article Info

Received: 12/08/2025
Accepted: 24/09/2025

Keywords

Adaptive Reuse,
Material Conservation,
Sustainability,
Waste Reduction,
Resource Efficiency

Abstract

Adaptive reuse is increasingly becoming a mainstream approach in architecture as a way to preserve cultural heritage, reduce carbon emissions, minimize material use, and promote sustainability in multiple ways. Within adaptive reuse, material conservation is an important but less-explored aspect that supports sustainability. This work examines the relationship between adaptive reuse and material preservation, emphasizing how maintaining original building materials benefits heritage continuity and sustainability. By reviewing published literature and analyzing various local and international case studies, the study considers the strategies, strengths, and challenges of material preservation in adaptive reuse projects. It highlights the substantial environmental benefits of resource efficiency, waste reduction, and energy savings embedded in materials. Furthermore, the research explores the ecological, economic, and cultural impacts of material conservation strategies on the long-term sustainability of adaptive reuse efforts. The paper underscores the essential role of material conservation as a strategic approach in adaptive reuse, aiming to enhance understanding and reinforce the importance of preserving original materials.

1. INTRODUCTION

The most important aspect of heritage conservation is adaptive reuse, which replaces new construction and demolition with reusing existing buildings for different purposes. Adaptive reuse is "any work undertaken on a building above maintenance that attempts to modify its capacity, function or performance," as noted by Douglas [1]. This approach not only preserves architectural heritage but also plays a vital role in environmental sustainability by extending the lifecycle of built assets and conserving the embodied energy of existing materials [2].

Adaptive reuse has been recognized worldwide as a way to reduce energy use, cut down on waste, and support urban renewal amid growing environmental issues [3]. Organizations like Australia's ICOMOS (2013) and the European Commission (2014) now officially see adaptive reuse as a vital part of sustainable development policies, connecting it with cultural preservation and resource conservation. However, even though material preservation is a key part of adaptive reuse, it has often been overlooked.

Gorgolewski acknowledges that using traditional building materials reduces the environmental impact of construction activities while maintaining the aesthetic and historic qualities of buildings [4]. By reusing and recycling materials like brick, stone, and wood, projects can avoid energy-intensive processes involved in creating new materials, thus supporting higher carbon reduction goals [5]. Although this is possible, current literature does not adequately explore the relationship between adaptive reuse, sustainability, and material preservation. While adaptive reuse is often valued for its urban and cultural significance, Velthuis and Spennemann point out that there is no systematic framework to include material preservation in sustainability assessments [6]. Plevoets and Van Cleempoel also argue that material conservation should be regarded as a key environmental approach to sustainable architecture, not

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just a heritage-related activity [7]. Recent research further highlights the various ways in which material conservation contributes to environmental sustainability within adaptive reuse projects.

Mohamed et al. prescribe a framework that covers the three basic dimensions of environmental, economic, and social aspects for sustainability evaluation in adaptive reuse projects [8]. In their study assessing the environmental, economic, and social factors of adaptive reuse, they stated that low carbon emissions, especially through material conservation, are vital to environmental sustainability. Abdulameer and Abbas highlighted that decisions on adaptive reuse increasingly prioritize sustainability, but economic viability often remains the decisive factor; therefore, successful heritage building reuse requires preserving original materials and character, implementing minimal yet compatible interventions, securing government support and funding, and encouraging community involvement to achieve environmental, social, and economic sustainability outcomes [9].

Similarly, Wei et al. emphasize that using original building materials in China's industrial heritage projects maximizes the overall environmental efficiency of the renovated structures while also reducing their carbon footprint. This approach ensures that adaptive reuse techniques meet both ecological and cultural goals, aligning with larger sustainability frameworks that promote minimal interference and maximum preservation of historical fabric [10]. Additionally, adaptive reuse practices in Seoul's urban regeneration areas have demonstrated that conserving materials not only promotes environmental sustainability but also supports social continuity by maintaining residents' connections and collective memories associated with heritage apartment buildings [11].

These findings show that material conservation practices in adaptive reuse projects are not just aesthetic or cultural choices but should also be a core strategy for achieving sustainability goals. While the importance of adaptive reuse in sustainable development is well known, this article aims to highlight the often-overlooked fact that conserving materials is especially crucial for sustainability in adaptive reuse. It examines how preserving original building materials advances environmental objectives beyond just aesthetics and history. This includes how waste reduction, lower carbon emissions, and retained embodied energy benefit the environment. The study is both theoretical and practical: it explores key scholarly frameworks and evaluates four case studies—Gasometer City (Vienna), Tate Modern (London), Salt Galata (Istanbul), and CerModern (Ankara)—to demonstrate different approaches to material conservation in adaptive reuse projects.

The article is organized around the following research questions to direct the investigation:

- How does material conservation help adaptive reuse projects achieve their sustainability goals?
- What are the potential economic, cultural, and environmental advantages of reusing original building materials?
- What can be learned from a few chosen adaptive reuse case studies, and how do they represent material conservation strategies?

By framing the investigation around these questions, the study explores the relationship between material conservation and sustainability outcomes, contributing to an area that remains underexplored in adaptive reuse literature. These questions help establish the analytical framework of the article and ensure alignment between theory, method, and findings.

This article aims to contribute to the sustainable architecture debate by highlighting the importance of material conservation in adaptive reuse processes. In published literature, material conservation is mainly discussed within the context of cultural heritage and is not sufficiently evaluated as an environmental strategy [6]. However, Gorgolewski states that preserving the embodied energy in buildings and avoiding environmental costs associated with the production and transportation of new materials are vital for sustainability goals [4]. Similarly, Powter and Ross also stress the potential of reusing materials like brick, stone, and wood to lower carbon emissions [5].

Recent studies have further advanced this approach, demonstrating that conserving materials directly influences the sustainability performance of adaptive reuse projects. Guidetti and Ferrara showed that

reusing building materials in adaptive reuse can significantly cut life-cycle carbon emissions, thereby improving the overall environmental performance of buildings [12]; Conejos et al. highlighted that adaptive reuse achieves better sustainability results when material conservation strategies are incorporated from the earliest design stages [13].

This study aims to provide a reasoning that is not limited to cultural or aesthetic considerations but recognizes material conservation as part of the environmental bottom line. This helps raise the importance of the environmental aspect of adaptive reuse and is crucial for resource efficiency, reducing carbon footprints, and fostering long-term responsibility within the built environment.

Additionally, the article will help address methodological shortcomings in this field by providing a comprehensive approach to assessing material conservation practices using sustainability criteria. This will inspire new design strategies focused on material conservation and encourage their integration into environmental and cultural sustainability goals. While adaptive reuse is widely discussed in terms of cultural and urban significance, this study specifically highlights material conservation as a critical yet often overlooked strategy for achieving sustainability outcomes in adaptive reuse projects.

2. METHOD

This article's qualitative research methodology combines a comprehensive literature review with a comparative analysis of selected adaptive reuse case studies. The goal is to examine how material conservation techniques are applied and how they support environmental and economic sustainability across various architectural and cultural settings.

Table 1. *Methodological Framework*

Phase	**Description**	**Purpose**
Literature Review	Examination of academic literature to define key concepts, theories, and research gaps	To build a conceptual base and guide case selection criteria
Case Study Selection	Choosing diverse international and local examples based on relevance and reuse potential	To ensure variety in scale, typology, and sustainability Orientation
Data Collection & Analysis	Gathering data from ublications, reports, and documents on material strategies in reuse projects	To understand real-world material conservation strategies and their applications
Comparative Evaluation	Cross-case analysis of environmental, economic, and cultural outcomes of material reuse	To identify patterns, context specific approaches, and effectiveness of conservation efforts

The four successive phases of the methodological framework are as follows:

I. **Literature Review:** A critical analysis of research literature was conducted to identify key concepts, theoretical foundations, and gaps in research on adaptive reuse and material preservation. This step established the conceptual framework of the article and guided the selection of cases to include.

II. **Case Study Selection:** The combination of international and local case studies was selected based on their relevance to the research issue. The selection criteria included project sustainability goals, size, type, and the level of material reuse. The chosen cases represent a variety of historical, architectural, and urban contexts.

III. **Data Collection and Analysis:** Various sources such as institutional records, peer-reviewed articles, sustainability reports, and building documentation were accessed to review each case. This stage aimed to identify specific material conservation techniques like the reuse of steel, brick, stone, and wood, and evaluate how effectively they were being implemented in real situations.

IV. **Comparative Evaluation:** A cross-case comparison of material conservation strategies' cultural, economic, and environmental impacts was conducted. This stage identified similarities, context-dependent solutions, and the extent to which they aligned with sustainability goals. Using this methodological framework, the article aims to provide a comprehensive understanding of how material conservation contributes to adaptive reuse initiatives that both preserve cultural heritage and promote sustainability.

3. LITERATURE REVIEW

The last 20 years have experienced a significant increase in academic interest in adaptive reuse, mainly driven by growing concerns about material shortages, urban regeneration challenges, and environmental deterioration. The importance of adaptive reuse in advancing sustainable architecture is increasingly acknowledged. Adaptive reuse is a vital part of sustainability because it extends the lifespan of existing structures, reduces material waste, conserves embodied energy, and lowers the need for new construction [1] [2].

Current research explored the economic and environmental benefits of recycling old materials through adaptive reuse schemes from a sustainability perspective. It is well known that adaptive reuse can reduce carbon emissions, prevent construction waste, and save the embodied energy of materials. According to Langston et al. and Yung & Chan, adaptive reuse offers advantages such as lowering the environmental footprint and maintaining historical significance [3][14]. Additionally, it is cost-effective by saving labor and materials, repurposing underused urban spaces, and creating commercial and cultural value through heritage-led projects [15]. These advantages have made adaptive reuse a key element of sustainable urban planning worldwide.

Material conservation in adaptive reuse projects is sometimes viewed as an afterthought, usually from a heritage preservation perspective, although these efforts often yield broader sustainability benefits. There is less emphasis on the direct connection between material conservation and larger sustainability goals, although work by Plevoets & Van Cleempoel and Australia ICOMOS (2013) focuses on preserving the historical character of buildings [7]. As Gorgolewski notes, conserving materials like wood, stone, and brick significantly reduces the environmental impact of building interventions [4]. Carbon reduction can also be achieved by adopting measures that lower the energy required to produce new materials through conservation efforts [5].

While not less significant, the economic aspect of material conservation in adaptive reuse is often overlooked. As Bullen and Love mention, projects involving adaptive reuse and material conservation are often linked to lower building costs, shorter timelines, and better project efficiency [16]. Additionally, using high-quality historic materials can boost the marketability and value of the property, especially in developments that blend modern functionality with heritage aesthetics. This results in material conservation in adaptive reuse projects being both economically and environmentally wise.

Still lacking, however, are systematic frameworks in the literature that evaluate the direct effects of material conservation on the environmental and economic performance of adaptive reuse. According to Velthuis & Spennemann, no standard methodologies exist to measure these impacts [6], and recent studies call for an integrated approach where material conservation is a proactive element within sustainability models [17].

Since 2017, additional research has increasingly focused on the link between adaptive reuse and material conservation. Reusing building materials is particularly important for avoiding the environmental impacts

of producing new materials. Guidetti and Ferrara explored how reusing materials reduces environmental impacts and supports sustainability goals throughout a building's life cycle [12]. Recycling materials is beneficial not only for the environment but also for the economy. Because manufacturing new materials consumes a lot of energy, recycling in adaptive reuse projects can significantly save energy and reduce carbon emissions [4] [5].

According to research conducted through 2021, adaptive reuse performs better when material conservation strategies are integrated early in the design process. This approach reduces environmental impacts and enhances the sustainability of projects. Studies show that including these strategies early on not only decreases environmental impacts like carbon emissions and material waste but also supports the socio-cultural sustainability of the built environment. Designing with adaptive reuse potential in mind helps prevent many of the implementation challenges that arise later in the project lifecycle and promotes the development of low- or zero-carbon buildings in urban settings [13].

The cost savings and environmental benefits of adaptive reuse have been more clearly confirmed by studies conducted in 2023, which also showed how material conservation contributes to sustainable design. Material conservation is a key strategy for enhancing long-term sustainability, write Guidetti and Ferrara, and adaptive reuse projects significantly reduce carbon emissions [12]. According to this study, since reused materials tend to be cheaper, adaptive reuse is both economically and environmentally advantageous. Additionally, the elimination of processes related to manufacturing and transporting new materials shortens the project's timeline.

The literature review highlights research connecting measurable sustainability outcomes with material conservation practices. Researchers and practitioners can more effectively implement adaptive reuse solutions if they recognize the reuse of materials as an essential aspect of sustainable design, rather than merely a cultural or heritage-based practice. In addition to providing a better understanding of how material preservation influences adaptive reuse toward long-term sustainability, this approach could lead to more detailed analyses of sustainability. Current research has further explored adaptive reuse and material preservation in relation to supporting ecological and economic sustainability. By 2023, there have been calls to establish systematic methods to implement these measures more efficiently. It has been established that material preservation must be considered part of environmental sustainability goals and within the framework of cultural heritage protection. This study aims to fill such gaps and examine more efficient ways to apply material preservation techniques in adaptive reuse projects.

4. CASE STUDIES

This article explores how material conservation strategies in adaptive reuse influence sustainability through four detailed case studies: Salt Galata (Istanbul, Turkey), CerModern (Ankara, Turkey), Tate Modern (London, United Kingdom), and Gasometer City (Vienna, Austria). The cases were chosen to examine the link between material conservation and sustainability outcomes and to enable a comparative analysis of how such strategies are applied across different cultural, regulatory, and urban settings. Selection criteria included alignment with research goals, focus on sustainability, project size and type, and diversity of historical and urban backgrounds. Each project offers concrete examples of material conservation and sustainable adaptive reuse, including measures such as energy efficiency, material reuse, and reduction of environmental impacts. The case studies cover a wide range of building types, functions, and reuse approaches, from small-scale interventions in industrial heritage sites (Salt Galata) to large-scale projects in cultural and urban institutions (Tate Modern and Gasometer City), representing both local (Turkey) and international (United Kingdom and Austria) contexts.

This method enables a comparative evaluation of material conservation practices across different scales, types, and settings, help deepen the understanding of their effects on sustainability. The article discusses both technical and architectural aspects of material conservation, aiming to offer practical guidelines for common strategies, contextual adjustments, and future adaptive reuse projects. It examines how these strategies impact the social, economic, and environmental aspects of sustainability.

Table 2. *Overview of Case Study Parameters*

Case Study	Location	Original Function	Reused Function	Key Materials Retained	Data Sources
Salt Galata	Istanbul, TR	Bank	Cultural & Research Center	Stone façade, marble flooring	Academic journals, SALT archive
Cer-Modern	Ankara, TR	Railway Workshop	Contemporary Art Center	Steel trusses, brick walls	Museum records, architectural analysis
Tate Modern	London, UK	Power Station	Museum of Modern Art	Brick shell, steel structure	Museum archives, academic literature
Gasometer	City Vienna, AT	Gas Storage Tanks	Mixed-Use (residential, commercial)	Brick exteriors, steel frames	Urban renewal reports, architectural studies

4.1. Case Study 1: Salt Galata – Istanbul, Turkey

4.1.1. Historical and Architectural Background

Salt Galata, which is situated in the Galata neighborhood of Istanbul, was first built in 1892 as the headquarters of the Imperial Ottoman Bank. It was designed by French Ottoman architect Alexandre Vallaury, who is renowned for fusing orientalist ornamental elements with neoclassical design principles, which are typical of Ottoman institutional architecture from the late 19th century [18]. Figure 1 shows A. Vallaury's façade drawing of Bankalar Caddesi. The structure was used for administrative, archival, and financial purposes and was crucial to the Ottoman Empire's financial system's modernization. Figure 2 shows views of the Former Ottoman Bank / SALT Galata.

Initiated by Garanti Bankası Platform Garanti Contemporary Art Center and designed by Mimarlar Tasarım, the adaptive reuse project was finished in 2011 under the auspices of SALT, a cultural organization created to foster artistic creation and research. The historic bank building was converted into a multipurpose cultural center with exhibition areas, a research library, an auditorium, and archive facilities as part of the project [19].

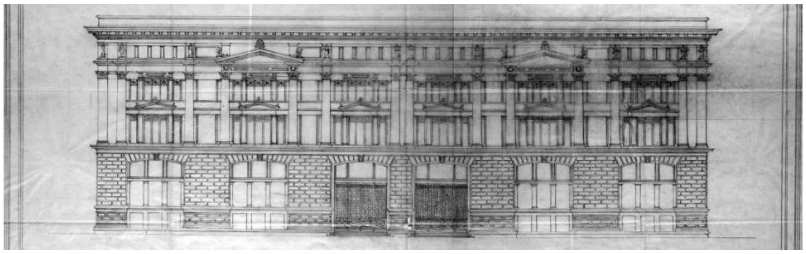


Figure 1. *A. Vallaury's façade drawing of Bankalar Caddesi* [20]

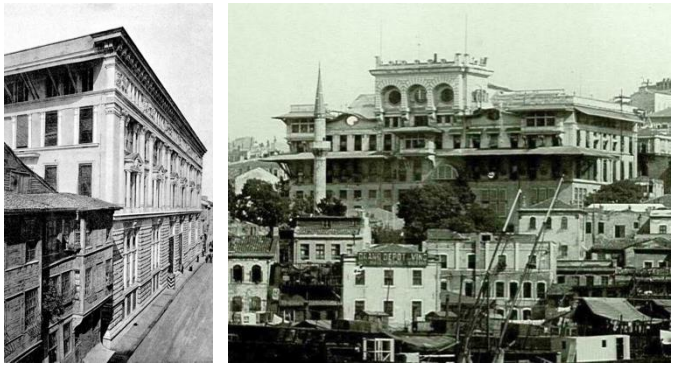


Figure 2. *Views of the Former Ottoman Bank / SALT Galata* [21]

4.1.2. Material Conservation Strategies

The preservation and restoration of original materials and architectural features were given top priority in the Salt Galata project, which used a heritage-sensitive conservation approach. Among the primary materials preserved were:

- Stone masonry walls and facades (local limestone and marble),
- Cast iron structural elements (beams, columns, and balustrades),
- Wooden floors, doors, and staircases,
- Ornamental plasterwork and decorative finishes.

In accordance with international conservation charters like the Venice Charter (1964), the exterior and interior surfaces were cleaned with minimal physical intervention, stabilized mechanically, and repaired using traditional materials that were compatible [22]. Details of the bank's facade are as shown in the Figure 3.

Key strategies included:

- Minimum Intervention: Only what was required for both structural integrity and functional adaptation was addressed.
- Reversibility: Contemporary additions were made to be both reversible and unique from the original structure.
- Material Compatibility: New materials used for additions or repairs were selected based on their ability to work chemically and physically with the original fabric [23].

Additionally, wherever feasible, historic materials were conserved and reused in their original locations. Archival vault doors, for instance, were kept and incorporated into the new spatial arrangement, and the original flooring materials were preserved and strengthened. Figure 4 shows the entrance and gallery hall of the bank before restoration.

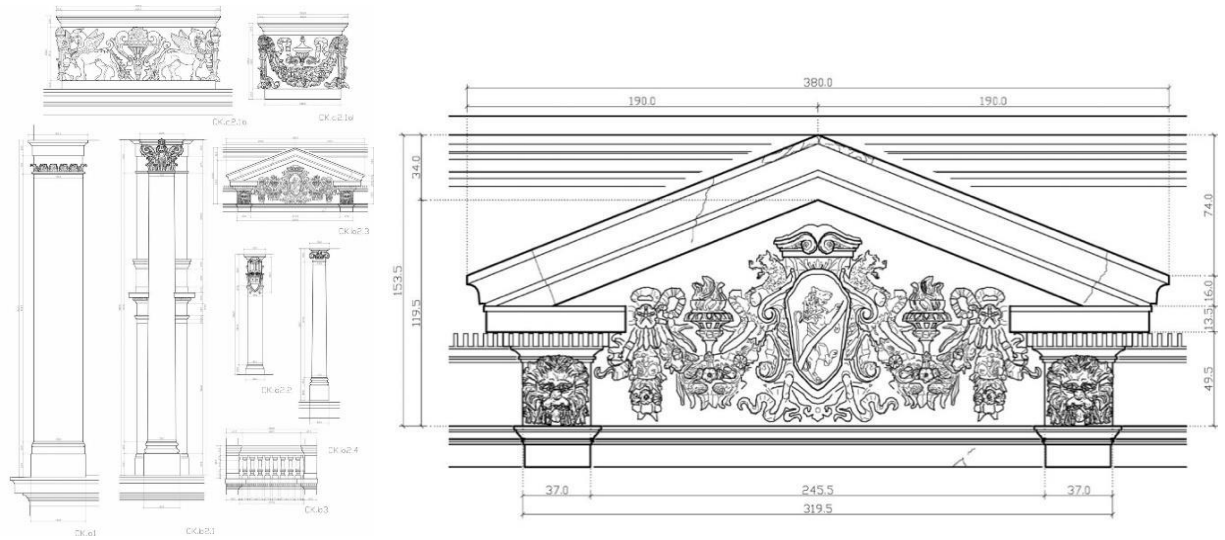


Figure 3. *Facade Details of the Bank* [21]

Figure 4. *Entrance and Gallery Hall of the Bank* [24]

4.1.3. Integration of Modern Systems

Modern mechanical, electrical, and circulation systems had to be integrated for the reuse project, including:

- HVAC systems,
- Elevators and staircases (Figure 5),
- Lighting infrastructure (Figure 6),
- Fire safety systems.

All new components were structurally and aesthetically isolated from the historic shell during these non-intrusive interventions. To reduce the impact on the original masonry and timber structures, for example, the HVAC systems were installed through false floors and ceilings [25]. To distinguish the modern layer from the historical one, new elements were made of steel and glass.

Figure 5. *Entrance Hall Restoration of the Bank* [26]

Figure 6. *Gallery Hall Restoration of the Bank. Re-introducing daylight into the building's interior* [26]

4.1.4. Sustainability Outcomes Related to Material Conservation

The economic and environmental facets of sustainability were directly impacted by material conservation:

a) Environmental Sustainability

- Reducing embodied carbon emissions: The thick stone walls, wooden flooring elements and iron structural elements of the building were preserved and re-functioned. In this way, the need for new material production was reduced, thus reducing embedded energy consumption and carbon emissions.
- In-situ preservation and repair of building materials: Original architectural components (stone walls, joinery, iron parts) were repaired instead of demolished and integrated into the new spatial order. Thus, construction waste from demolition was significantly reduced.
- Preservation and improvement of passive performance: Thanks to the thermal mass provided by thick stone walls, the interior temperature was made more stable and the need for mechanical air conditioning was reduced. The preservation of wide window openings contributed to natural lighting and ventilation [27].

b) Economic and Functional Sustainability

- Cost savings in materials: Preserving and reusing existing original materials (stone walls, poured concrete floors, metal joinery) reduced the need for new building materials and lowered the project cost.
- Extending the life of the structure: The load-bearing system, façade and interior details of the structure were restored and brought into line with contemporary standards. Thus, both physical durability and service life were increased.
- Cultural tourism and public use: Salt Galata was re-functioned as a cultural institution. With this transformation, the structure gained an active public use while preserving its place in urban memory. The project contributed to the survival of cultural heritage not only physically but also socially and economically. The re-functioning of Salt Galata enabled it to become a cultural center in the heart of Istanbul. This process made a significant contribution to urban renewal and cultural economy, and this model inspired other cities [27].

Salt Galata is a well-known illustration of how adaptive reuse initiatives that conserve materials can directly contribute to the objectives of environmental and financial sustainability. The project shows that maintaining original materials while incorporating contemporary systems can coexist in a way that upholds historical integrity and enhances the built heritage's longevity, usability, and ecological performance. Figure 7 shows the interior of SALT Galata after adaptive reuse, transformed into a cultural center in the heart of Istanbul.

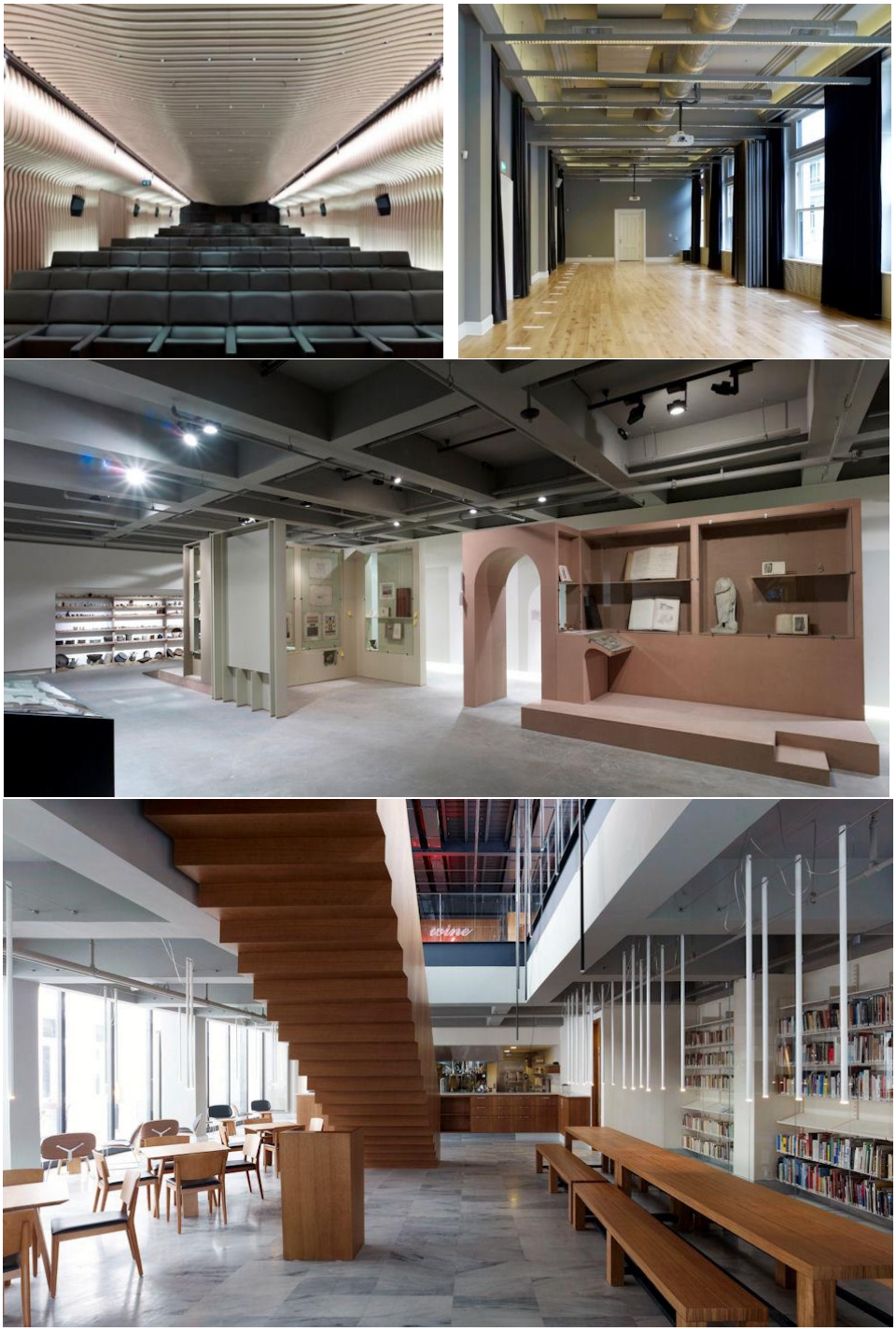


Figure 7. *Adaptive reuse of SALT Galata: A cultural center in the heart of Istanbul* [26]

4.2. Case Study 2: CerModern – Ankara, Turkey

4.2.1. Historical and Architectural Background

Located in the Sıhhiye district of Ankara, CerModern occupies a portion of the former Ankara Railway Workshop Complex, which was first built in 1927 as part of the early industrial modernization initiatives of the Turkish Republic. The Turkish State Railways (TCDD) constructed the complex, which showcased early Republican rationalist architectural tendencies influenced by the Bauhaus movement and German industrial architecture [18]. Figure 8 shows the pre-restoration state of the Hangar.

Beginning in the early 2000s and ending in 2010, the adaptive reuse project turned the defunct maintenance workshop into CerModern, a center for contemporary art. Semra and Özcan Uygur (Uygur Architects) designed the architectural intervention, which prioritized cultural revitalization, preservation, and openness [28].

Figure 8. *The pre-restoration state of Hangar* [29]

4.2.2. Material Conservation Strategies

The preservation and restoration of the original surface and structural materials were given top priority during the adaptive reuse process, and this included:

- Reinforced concrete load-bearing structure,
- Steel roof trusses and support systems,
- Brick infill walls and surfaces,
- Timber window frames and doors,
- Concrete flooring and industrial fittings.

Internationally recognized principles, such as the Venice Charter (1964) and the Burra Charter (1999), were adhered to by conservation strategies, especially with respect to minimal intervention, reversibility, and legibility of interventions [30]. Figure 9 shows the post-restoration view of the hangar structure.
Key practices included:

- Cleaning and stabilizing concrete and steel structural elements without encasing or concealing them,
- Structural components that are selectively reinforced with appropriate materials and methods (e.g., epoxy injection in concrete),
- Preservation of the original fittings, wear marks, and patina wherever possible in order to maintain the industrial character,
- Integration of modern steel and glass components for circulation and display spaces that stand out from the historic structure.

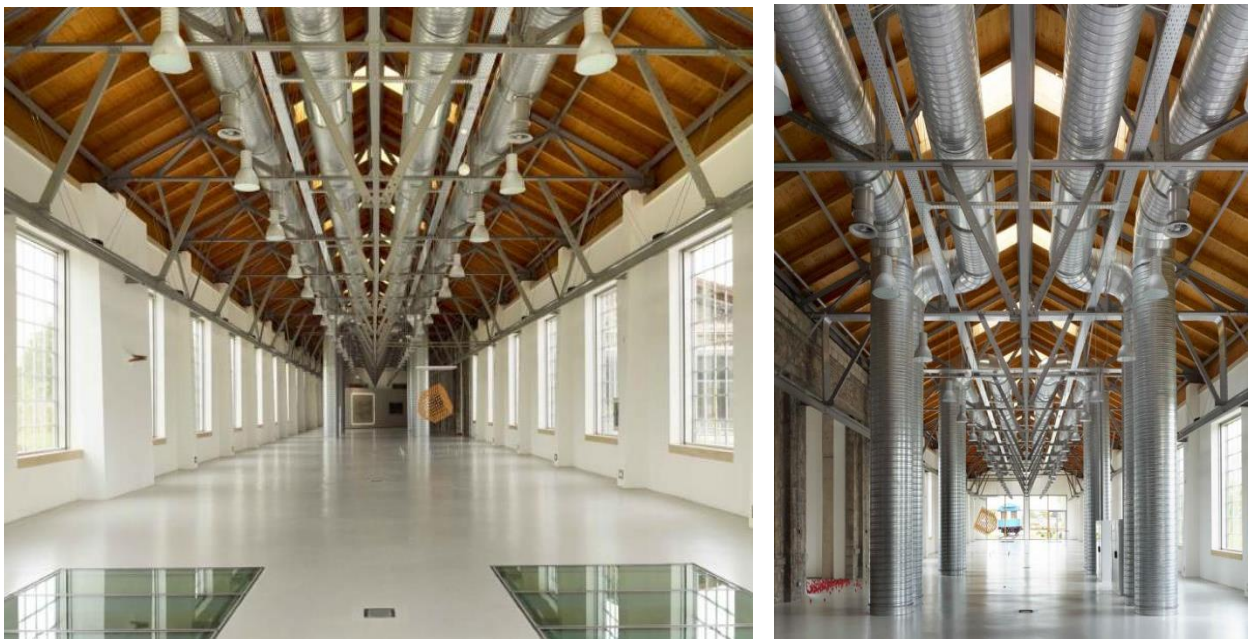


Figure 9. *Post-restoration view of the hangar structure* [29]

4.2.3. Integration of Modern Systems

The building's new cultural purpose required the introduction of modern infrastructure, which includes:

- HVAC systems,
- Lighting and audio-visual equipment,
- Fire safety and emergency systems,
- Accessibility ramps and elevators,
- Exhibition installation infrastructure.

Figure 10 shows the exhibition area and structural details. By integrating these systems in a non-intrusive manner, they were frequently positioned inside newly constructed interior partitions that were intended to be aesthetically secondary to the preserved structure or along existing service routes. Without compromising the original workshop layout's spatial coherence, steel-framed additions and glass curtain walls were utilized to provide circulation and climate control [28].

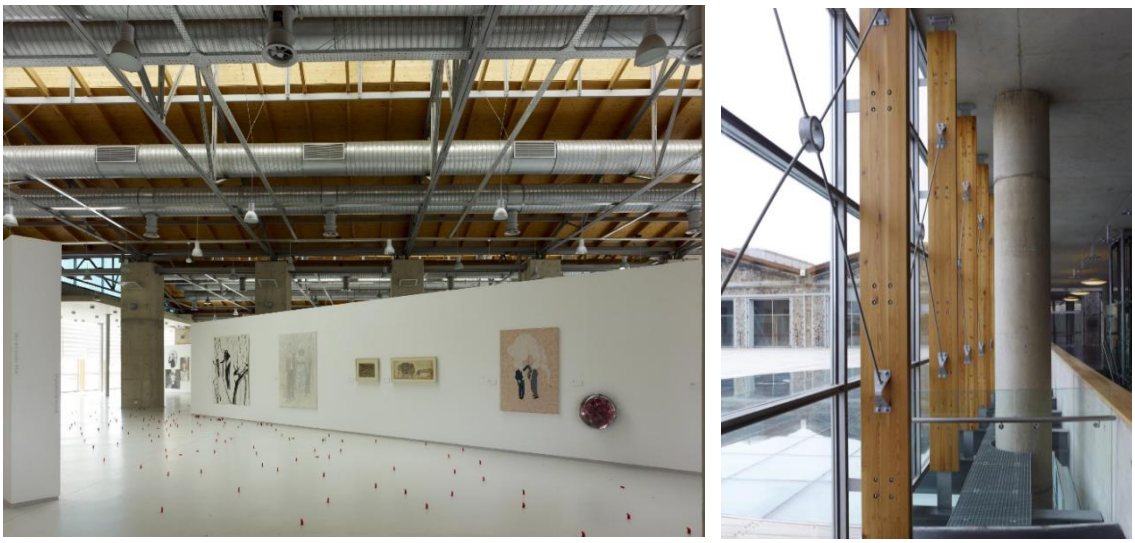


Figure 10. *Exhibition area and structural details* [29]

4.2.4. Sustainability Outcomes Related to Material Conservation

a) Environmental Sustainability

- Reuse of building materials and reduction of embodied carbon: Reinforced concrete carrier system, steel roof trusses and brick-filled walls were preserved and integrated into the structure. Thus, environmental impacts were reduced by reducing the production and transportation of new materials.
- Preservation of passive environmental features: Passive features of the original structure such as high ceilings, openable windows and reinforced concrete thermal mass were preserved and improved. Thus, natural ventilation and energy efficiency were provided.
- Reduction of construction waste by preventing demolition: Thanks to the preservation and reinforcement of historical materials in situ, construction waste that will occur during the transformation process of the structure was kept to a minimum.

b) Economic and Functional Sustainability

- Contribution to Urban Renewal: CerModern has re-functioned the abandoned industrial zone of Ankara, thus increasing the real estate values around it and making a significant contribution to urban renewal. This process has improved the social and economic structure of the region. Figure 11 shows the site plan of CerModern and the Presidential Symphony Orchestra Concert Hall, a cultural landmark in Ankara.
- Self-Sufficient Economic Ecosystem Based on Art, Design and Creative Industries: The preserved architectural identity and unique spatial character have made the region attractive to cultural institutions, artists and tourists, while enabling the development of artistic and cultural activities. In this way, CerModern has become a center where artistic production and cultural heritage meet.
- Reduction in Maintenance Costs: In the CerModern project, maintenance costs have been reduced by preserving and improving old industrial building elements. This process has been achieved by reusing existing materials and the environmental impacts of the construction have been reduced.
- Economic Contributions and Investment Attractiveness: The cultural and artistic environment created by CerModern has become attractive to regional investors. Additionally, the project has provided significant gains in terms of environmental and financial sustainability [31].

The CerModern project serves as an example of how adaptive reuse frameworks combined with material conservation can effectively support economic and environmental sustainability objectives. Without sacrificing the site's ecological performance or historical authenticity, an industrial relic was transformed into a thriving public institution through the careful integration of new systems and functions while maintaining the site's structural and material heritage. Figure 12 shows CerModern Arts Center.

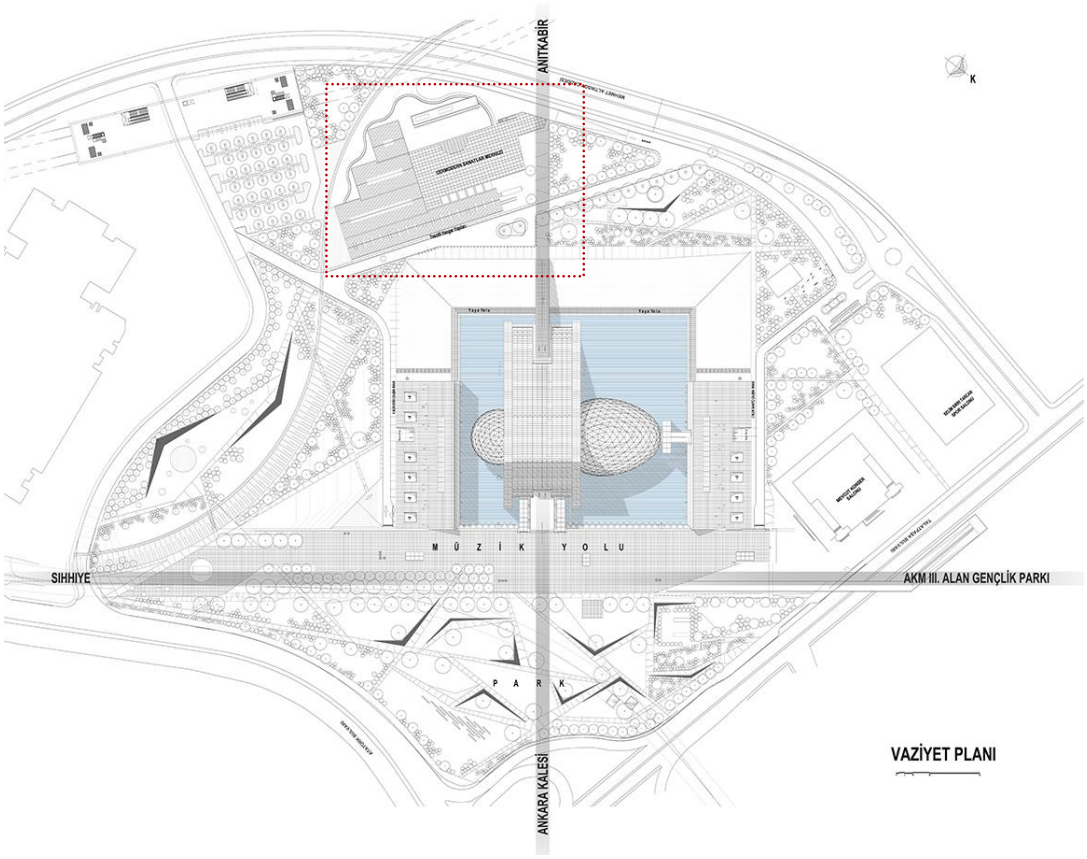


Figure 11. *Site Plan of CerModern and Presidential Symphony Orchestra Concert Hall, A cultural landmark in Ankara* [28]

Figure 12. *CerModern Arts Center* [29]

4.3. Case Study 3: Tate Modern – London, United Kingdom

4.3.1. Historical and Architectural Background

The original structure, designed by Sir Giles Gilbert Scott and constructed in two phases between 1947 and 1963, is notable for its steel frame, central chimney, and monumental brick facade (Figure 13). The structure was left unoccupied for almost two decades after it was decommissioned in 1981.

In 1995, Herzog & de Meuron was chosen by the Tate Gallery to oversee the adaptive reuse of the building into a museum of contemporary art. After the makeover was finished in 2000, a significant addition known as the Blavatnik Building was added in 2016 (Figure 14).

Figure 13. *Steel frame, central chimney and brick facade construction* [32]

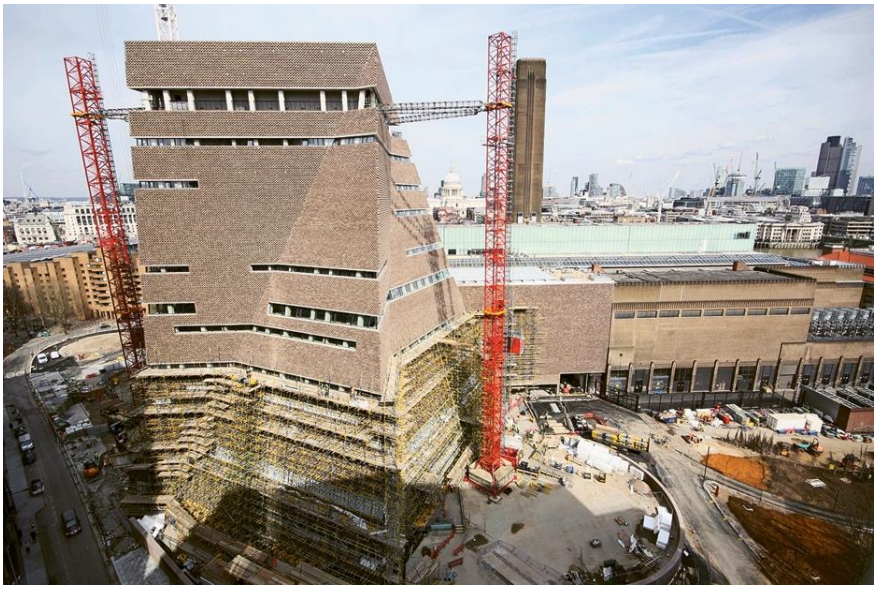


Figure 14. *Blavatnik Building was added in 2016* [32]

4.3.2. Material Conservation Strategies

By preserving the original power station's internal volumes, steel framework, and external brick envelope, the Tate Modern project implemented a conservation-through-reuse strategy.

Key conservation strategies included:

- Maintaining the building's visual identity and the surrounding urban fabric by keeping and cleaning the original brick façade.
- Preservation of the turbine hall, a central public area that was once an industrial void measuring 155 meters in length and 35 meters in height, can be seen in the building section. (Figure 15).
- Restoration of the existing roof and steel framing, including adaptation for new uses and reinforcement for structural integrity.

- Combining new materials that are still easily identifiable with the selective reuse of preexisting materials, such as steel components and staircases.

By avoiding excessive concealment or aesthetic homogenization and preserving the building's raw material character, the design team implemented the principle of minimal intervention (Figures 16).

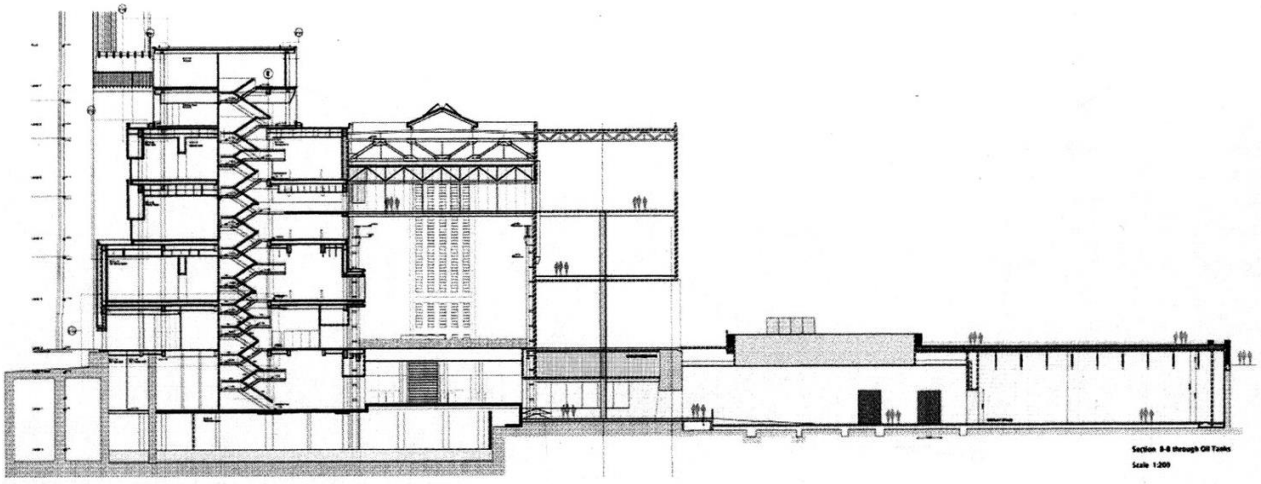
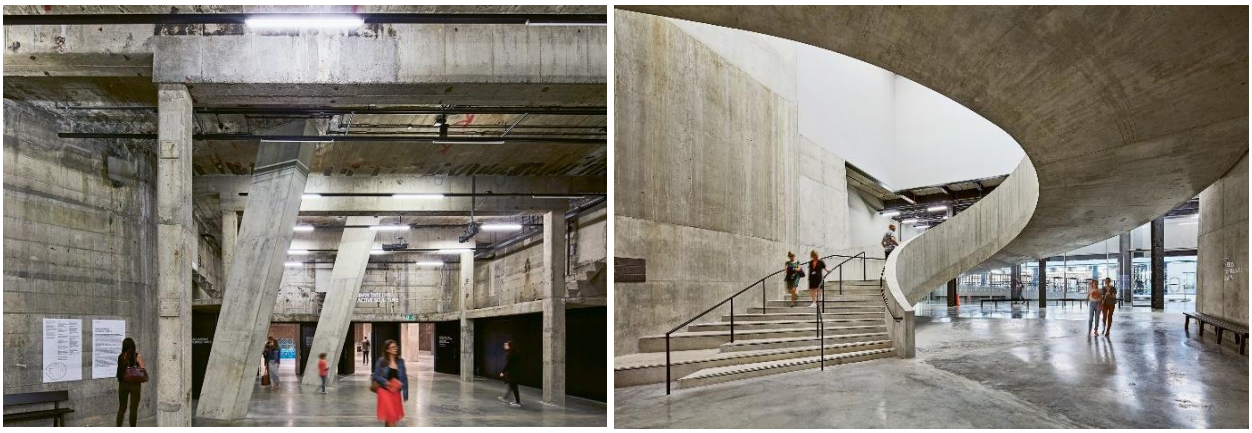


Figure 15. *Section through Boiler House, Turbine Hall, Switch House, and Oil Tanks at Tate Modern* [33]



Figures 16. *Tate Modern Museum* [32]

4.3.3. Integration of Modern Systems

To support its new cultural role, Tate Modern implemented the following:

- Modern climate control systems for preserving artwork,
- Lighting and acoustic systems suitable for flexible exhibition layouts,
- Public access points such as recently added elevators, escalators, and stairs,
- Safety and accessibility systems that meet current codes.

The industrial grandeur of the building was preserved through the integration of these features, which were often installed within the existing structural grid to avoid disruptive spatial changes [34]. Similar concepts were applied in the expansion of the Blavatnik Building, which used textured brickwork to retain architectural character while visually connecting to the original power station. Figure 17 shows brickwork details of the Blavatnik Building.

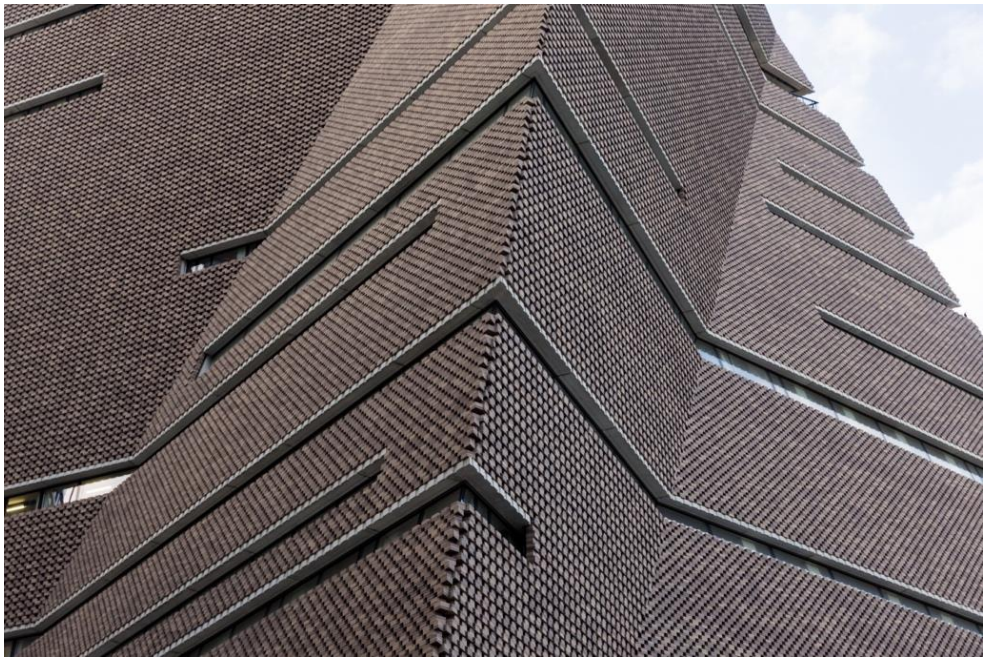


Figure 17. *Brickwork details of Blavatnik Building* [33]

4.3.4. Sustainability Outcomes Related to Material Conservation

a) Environmental Sustainability

- By conserving thousands of tons of steel and brick, material reuse greatly decreased the environmental costs related to demolition and new construction.
- Lower life-cycle carbon emissions resulted from the retention of the structural shell and turbine hall, which decreased embodied energy.
- Passive environmental strategies are used in the building, such as daylighting through existing openings and clerestory windows and natural ventilation in large spaces.
- High environmental standards, including BREEAM Excellent certification, were met in the design of the 2016 expansion.

b) Economic and Functional Sustainability

- Reusing the iconic Bankside Power Station helped revitalize the South Bank by enabling the quick cultural reactivation of a post-industrial area.
- By maintaining sturdy, high-quality materials, material conservation allowed for significant cost savings in both construction and ongoing maintenance.
- The preserved architectural character had a big impact on the museum's branding, increasing public engagement, bringing in millions of visitors annually, and ensuring long-term financial sustainability.

One well-known example of extensive adaptive reuse is Tate Modern, where material preservation is essential to attaining sustainability on all levels—environmental, cultural, and financial. The project effectively incorporated contemporary cultural functions while maintaining the building's sturdy industrial materials and spatial identity, all without sacrificing ecological performance or architectural authenticity (Figure 18).

Figure 18. *Adaptive Reuse of Tate Modern: preservation of industrial materials and spatial identity* [33]

4.4. Case Study 4: Gasometer City – Vienna, Austria

4.4.1. Historical and Architectural Background

Four sizable cylindrical gas tanks that were built as part of the Simmering gasworks between 1896 and 1899 make up Vienna's Gasometers. These buildings, which were designed by Franz Klüpfel and were initially used to store coal gas, are important examples of industrial brick architecture from the late 19th century [35]. Each gasometer has steel-framed internal structures and load-bearing brick façades. They are about 70 meters in diameter and 60 meters high. (Figure 19).

The gasometers had not been used since they were decommissioned in 1984 until the City of Vienna started an adaptive reuse project in the late 1990s. Each gasometer was redesigned by a different architect: Wilhelm Holzbauer (Gasometer D), Manfred Wehdorn (Gasometer C), Coop Himmelb(l)au (Gasometer B), and Jean Nouvel (Gasometer A) after the conversion into a mixed-use residential and commercial complex was finished in 2001.

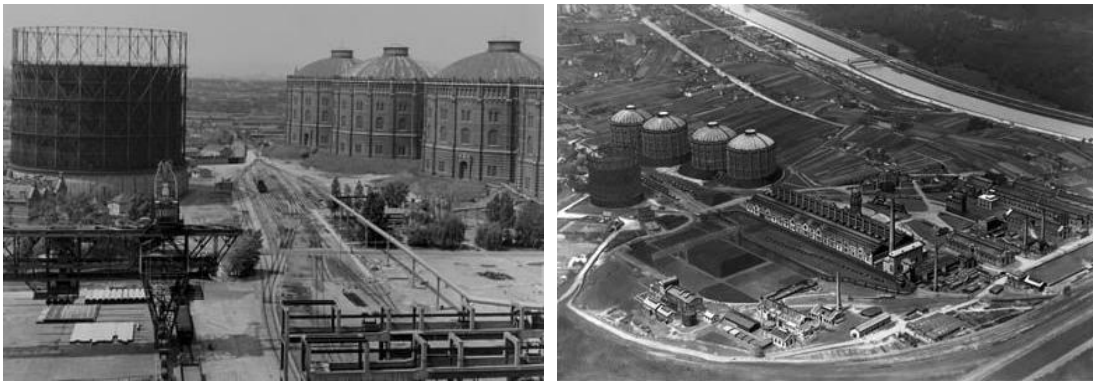


Figure 19. *Four gasometers were built in a period of three years, between 1896 and 1899* [36]

4.4.2. Material Conservation Strategies

The adaptive reuse project allowed for flexibility in internal reconfiguration while preserving the historically protected external brick façades.
Key conservation approaches included:

- The original brick masonry was thoroughly cleaned and restored, kept, and structurally stabilized with anchors and internal reinforcement rings [37].
- Reinforcement and, when practical, partial reuse of the original steel structures, including a few chosen beams and columns.
- New interior structures that are built using modern materials and technologies and are easily identifiable from the historic fabric are inserted within the brick shells.
- Adherence to the Austrian Monument Protection Act, which mandates that renovation and intervention procedures have as little negative impact as possible on protected architectural elements.

The reuse project employed the "building within a building" concept, which enables both modern functionality and heritage protection by preserving the external shell while allowing for internal flexibility (Figure 20).

Figure 20. *Apartment Building Gasometer B, Vienna.* [38]

4.4.3. Integration of Modern Systems

The gasometers were converted into a multipurpose urban complex by the redevelopment project, which consists of:

- Approximately 800 residential units,
- A shopping mall,
- A cinema,
- Offices and event spaces,
- Student housing and cultural venues.

To maintain their integrity and ensure compliance with current building codes and energy standards, modern infrastructure—such as HVAC systems, elevators, emergency access, and acoustic insulation—was installed inside the new buildings separately from the historic walls. Figure 21 illustrate the zones and layouts within this multipurpose urban complex.

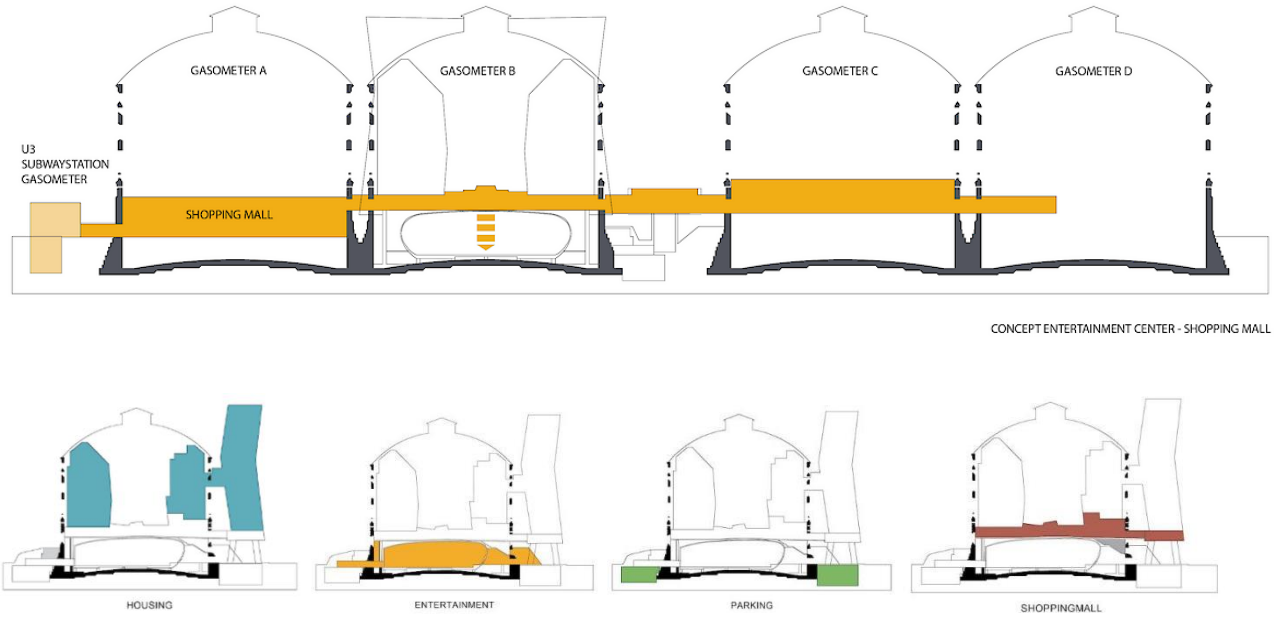


Figure 21. *Multipurpose urban complex zones* [38]

4.4.4. Sustainability Outcomes Related to Material Conservation

a) Environmental Sustainability

- By preserving the brick envelope, the need for new building supplies was greatly decreased, which helped to mitigate construction waste and save embodied energy.
- The environmental costs of demolition and new land use development were avoided by extending the life cycle of industrial heritage materials through adaptive reuse.
- The energy efficiency of the interior spaces was improved by passive techniques like insulation from the thick brick walls and natural thermal mass.
- The project promoted low-carbon urban mobility by integrating with Vienna's public transportation system.

b) Economic and Social Sustainability

- The Gasometer redevelopment revitalized a previously underutilized site and helped to revitalize the Simmering district's urban area.
- The addition of student residence halls and subsidized housing in a historically significant location helped to support housing affordability.
- The area has become a symbol of Vienna's adaptive reuse policies as a result of the preservation of the gasometers' industrial identity, which has improved cultural continuity [39].

The Gasometer City project serves as an example of how adaptive reuse combined with material conservation can successfully promote social, economic, and environmental sustainability in extensive urban redevelopment. The project exemplifies a balanced approach to heritage preservation and modern urban living by conserving industrial architectural heritage through meticulous conservation and creative internal adaptation. Figure 22 shows the Gasometer Complex in Vienna, where the historic gas holders were adaptively reused as a mixed-use urban center.

Figure 22. *Gasometer Complex in Vienna: Adaptive reuse of historic gas holders into a mixed-use urban center.* [40]

5. COMPARATIVE EVALUATION OF CASE STUDIES

Key insights and practical implications on how material conservation in adaptive reuse contributes to environmental, economic, and cultural sustainability are revealed through the comparative analysis of Salt Galata (Istanbul), CerModern (Ankara), Tate Modern (London), and Gasometer City (Vienna). These strategies highlight how material conservation aligns with sustainability objectives and provides guidance for integrating heritage preservation into contemporary adaptive reuse projects.

5.1. Shared Strategies in Material Conservation

A common approach among the four projects is to retain the original façade and structural materials like steel, timber, stone, and brick. The approach reduces embodied carbon associated with the production of new materials and prevents demolition, thereby lowering environmental costs without sacrificing historic authenticity [2][14]. Flexibility in reuse, as seen in examples such as Gasometer City and Tate Modern, has been achieved through reversible and non-invasive interventions, ensuring that original materials remain intact or can be recovered in the future. The use of dry construction systems and modular infills further supported adaptability. When considered together, these approaches suggest that material conservation can inform repeatable strategies balancing heritage preservation with environmental performance.

5.2. Contextual Adaptation and Cultural Integration

The case studies illustrate how material conservation strategies are adapted in response to different cultural and urban contexts. Salt Galata and CerModern focus on local materials and traditional references, which enhances cultural continuity and promotes a sense of place within the urban contexts. In contrast, Tate Modern and Gasometer City employ a more international architectural language, integrating material conservation into large-scale urban renewal projects where heritage value is combined with contemporary development needs [41]. This contrast indicates that the effectiveness of material conservation is not limited to the technical preservation of materials; it is also influenced by the cultural and regulatory contexts in which these projects exist. The results indicate that approaches tailored to their context are crucial for ensuring that material conservation methods not only aid in heritage preservation but also support wider sustainability goals, such as social cohesion and cultural resilience.

5.3. Environmental Sustainability Outcomes

Reduction in carbon emissions, energy efficiency, and waste reduction are some of the ways in which conserving materials benefits the environment. For example, the need for large amounts of new material was avoided in Gasometer City and Tate Modern by preserving the brick envelopes, and operational efficiency was also enhanced through adaptive energy systems like district heating and passive

ventilation. Salt Galata's LEED certification illustrates that historic projects can meet modern sustainability standards without losing their significance [42]. These findings reinforce the environmental benefits of material conservation, providing empirical support for its integration as a key sustainability strategy in adaptive reuse.

5.4. Economic Revitalization and Feasibility

Material conservation-based adaptive reuse has proven to be both economically and socially advantageous. All four projects generated new revenue streams by turning vacant buildings into commercial, cultural, or mixed-use spaces. While Gasometer City and Tate Modern enhanced urban destinations as major attractions, Salt Galata and CerModern boosted the cultural economy by demonstrating that old buildings can be appreciated through modern economic principles [2][43]. These examples show that preserving materials safeguards architectural integrity while simultaneously generating economic benefits, making conservation a viable strategy for sustainable project planning.

5.5. Challenges and Critiques

Such projects reveal flaws despite their success. In Tate Modern and Gasometer City, for example, where adaptive reuse could have disrupted local communities or favored market-driven agendas, issues of gentrification and commercialization arose [44]. Conversely, Salt Galata and CerModern had to make careful design decisions balancing heritage integrity and modern use due to the conflict between functional modernization and authentic preservation. These challenges highlight contextual limitations and the need for tailored strategies, offering insights into potential risks and issues for sustainable adaptive reuse in different urban settings.

This comparative analysis underscores the key benefits of material conservation in adaptive reuse, including measurable environmental and economic gains alongside the safeguarding of architectural heritage. These findings support the main argument of the article, which is that material conservation is one of the most crucial sustainability strategies in architectural transformation.

Table 3. *Comparative Evaluation of Case Studies in Terms of Material Conservation and Sustainability*

Criterias	**Salt Galata**	**CerModern**	**Tate Modern**	**Gasometer City**
1. Material Conservation Approach	The original façade, stone walls and structural elements were preserved and new systems were integrated [27].	The reinforced concrete structure was reused while preserving the industrial identity [31].	The brick façade was preserved, and the interior was rearranged with modular systems [34].	The steel and brick structure was preserved, and recyclable modules were added [37].
2. Integration with Cultural and Urban Context	The Ottoman Bank's past has been integrated with culture, and its place identity has been strengthened [27].	Industrial heritage has contributed to Ankara's cultural life by transforming into an art-focused space [28].	It has been integrated into London's image with an international identity reflecting modern art [41].	Industrial memory has been preserved and integrated into urban growth with residential, cinema and commercial functions [39].

3. Environmental Sustainability Contribution	LEED certified; energy efficiency has been achieved with natural lighting and passive systems [42].	The need for new materials has been reduced, durable structural components have been re-evaluated [31].	Carbon emissions have been reduced by preserving the brick facade, and passive ventilation has been used [34].	The existing shell has been preserved, and energy efficiency has been increased with district heating systems [34].
4. Economic and Functional Sustainability	By re-functioning as a cultural center, economic revitalization was achieved in the city center [27].	A sustainable economic ecosystem was created for art and creative industries [31].	Significant sources of income were created through tourism and art [43].	Long-term economic sustainability was achieved with commercial, social and residential functions [2].
5. Challenges and Criticisms	The need for modern use was balanced while remaining loyal to the historical texture [27].	A balanced intervention was required between functional modernization and identity preservation [28].	Exclusion of local people due to gentrification and commercialization was criticized [44].	The social effects of market-oriented transformation were discussed [39].

6. CONCLUSION

This article examined the role of material conservation in adaptive reuse through four in-depth case studies—Salt Galata (Istanbul), CerModern (Ankara), Tate Modern (London), and Gasometer City (Vienna)—to determine how preserving existing building material is an element in attaining sustainability outcomes. The findings add several significant contributions to the research questions.

The results show that material retention has been identified as making direct contributions to sustainability impacts in adaptive reuse through reducing the demand for new materials, lowering embodied energy, and reducing construction waste and greenhouse gas emissions. Beyond environmental performance, preservation of original materials preserves architectural integrity and cultural continuity, and thereby links adaptive reuse to broader sustainability agendas.

The case studies show that recycling materials bring various benefits in environmental, economic, and cultural aspects. Economically, adaptive reuse for conservation creates new value streams by repurposing outdated buildings as productive ones, as demonstrated by the Turkish and European examples. Culturally, incorporating local materiality and the layering of history helps preserve spatial identity and increases resilience in urban areas. Environmentally, retaining materials improves efficiency and supports low-carbon building practices.

Comparative analysis emphasizes context-specific responses to challenges. Turkish examples illustrate the delicate balance between modernization and preservation where weak regulatory institutions and limited resources are common. In contrast, European examples feature institutional arrangements and policies that facilitate widespread reuse and the systematic integration of sustainability practices. Such differences support the idea that material conservation measures must be understood within their

regulatory and sociocultural contexts. Overall, the analysis shows that material conservation is not just a secondary result of adaptive reuse but a key method for promoting sustainable architectural transformation. By connecting technical preservation with economic, social, and environmental goals, material conservation serves as a practical set of principles for maintaining heritage and supporting long-term adaptability.

This article contributes to adaptive reuse literature by thoroughly exploring the understudied link between material conservation and sustainability. Although based on a small set of case studies, the findings suggest that conservation-focused approaches provide useful insights for future projects, especially regarding integrating cultural heritage within modern sustainability initiatives. Future research can build on this by testing these insights in different regions or measuring long-term sustainability benefits more systematically.

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Research Article GU J Sci, Part B, 13(3): 513-526 (2025)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

http://dergipark.gov.tr/gujsb

Satisfaction and Socio-Spatial Segregation in Urban Transformation: The Case of Mamak-Ankara

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Article Info

Received: 22/12/2024
Accepted: 28/09/2025

Keywords

Socio-Spatial Segregation,
Urban Regeneration,
Mass Housing (TOKI),
Mamak Housing Project,

Abstract

The aim of this study is to measure satisfaction with the urban regeneration project in the Altınoğuz (Yatıkmusluk) neighborhood, Mamak, Ankara, with respect to decreasing socio-spatial segregation and to ascertain whether it was successful or not in enhancing the living conditions and fostering social cohesion of residents. A mixed-method approach was adopted; in addition to qualitative data collection techniques, a survey was conducted in the TOKİ Yatıkmusluk Altınevler area, and the data were analyzed using SPSS.The data were acquired from the questionnaire applied to a total of 161 neighbors. Results have shown that 59.6% of the residents are satisfied with the urban regeneration project. In addition, there was a high rate of satisfaction relating to educational services at 71.4%, healthcare services at 62.1%, children's playgrounds at 55.9%, and social facilities at 46%. However, limitations include a shortage in parking spaces and small-sized residential units. In addition, while satisfaction increased with age and education, no substantial association existed between residents' satisfaction and their employment or income. This can be considered evidence that cultural and social issues outweigh the economic issues regarding the resident's satisfaction in this poor neighborhood, while some still prefer the house they lived in earlier in other settlements as that gives them more social contacts and a traditional way of life. The study concludes that urban regeneration projects would have more significant success if residents' socio-cultural dimensions received more attention and strategies were developed to better adapt them to apartment living.

1. INTRODUCTION

Within the last couple of decades, urban regeneration projects have emerged as a key strategy in addressing social and physical challenges in cities. Most urban regeneration projects around the world seek to enhance the quality of life, reduce socio-spatial segregation, and develop sustainable residential environments in many developing countries [1]. However, when the social and cultural results of such interventions are investigated, it has often been seen that a lack of congruence with the cultural preferences and needs of the residents resulted in dissatisfaction and social problems arising [2]. This problem is most evident in low-income and peripheral areas, as the population here has diverse cultural and social attributes.

In Türkiye, urban regeneration has been a cornerstone of the country's urban development policies since the early 2000s. However, previous studies have shown that the success of these projects depends on various factors, including the socio-cultural characteristics of residents, community participation in the planning process, and the provision of public services [3]. In this context, the present study focuses on the Yatıkmusluk- Altınoluk project to investigate these factors in one of Ankara's largest and most significant informal settlement areas. In 2007, in the Mamak district of Ankara, there was started an urban regeneration project called Yatıkmusluk-Altınoğuz, part of a much larger initiative to improve the urban fabric of the area and provide modern residential infrastructure [4]. This 22-hectare area project has completed 2,000 housing units so far, which were allocated to beneficiaries. The acquisition and construction of the remaining 500 units are continuing along with the completion of cultural, social, and

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commercial facilities [4]. Unlike ordinary residential areas, Mamak's urban regeneration involves transitioning informal settlements (gecekondu) into formal housing, which inherently disrupts existing social networks and spatial hierarchies. This study's focus on such dynamics distinguishes it from analyses of conventional neighborhoods. The above case has been selected for this study as it is one of the projects that have greatly impacted the social and physical transformation of the neighborhood. Once regarded as peripheral settlement, substantial parts of the area were being redeveloped; thus, the assessment of residents' satisfaction was an urgent necessity along with the investigation of socio-spatial changes caused by the regeneration efforts [4].

The Mamak district has been equipped with all facilities and social services that would contribute to improving the standard of living for the citizens of Ankara. It also consists of 3 children's playgrounds within an area of 2,500 square meters, and this means that per capita comes at 1.5 square meters per child, below the national urban planning standards. Besides, Mamak has two healthcare centers that have been established for providing primary healthcare services. The capacity for providing the service is one center per 30,000 residents, and this caters to the basic health needs of the community. Educational facilities are made up of five primary and secondary schools, accommodating about 3,200 students and have a per capita provision of 1.2 square meters of educational space per student, which is a moderate provision. For parking, there is a total of four parking facilities in the neighborhood, able to hold 500 vehicles at one time, and this accounts for 0.8 parking spaces per household, which is highly insufficient due to the growing demand in this area [4].

For the past few decades, Mamak has become an area of informal settlement due to great migration streams between the years 1970-1990; about 90% of the district is unplanned and settlement-like structures [5]. Such conditions and along with structural inadequacies and deficient public services created the need for early urban redevelopment. The formation of Mamak as an independent district in 1983 was a solution to these problems. Since then, large-scaled development projects have been done in this area. So, by 2008, 65 neighborhoods were counted within the district boundaries. It officially became the largest district of Ankara with 607,878 residents according to the 2015 census [4].

The purpose of this research is to explore the satisfaction among residents who have occupied their dwellings in mass housing (TOKI) projects located in the Mamak district, while also analyzing the influence of those projects on the arguments regarding reducing socio-spatial segregation. This study will specifically focus on the TOKI projects in the Altınoğuz (Yatıkmusluk) neighborhood, aiming to examine their social and spatial impacts and provide a general picture of how these interventions affect urban life[6]. While resident satisfaction measures the immediate perceived benefits of the regeneration project, socio-spatial segregation captures its broader societal impact. This study looks at whether better living conditions like easier access to services also help bring down social divides, which is one of the main goals of urban regeneration in neighborhoods like Mamak.".

2. THEORETICAL FRAMEWORK

2.1. Resident satisfaction with housing

Housing satisfaction in urban regeneration contexts reflects both material conditions (e.g., unit size) and symbolic meanings (e.g., cultural displacement). This study focuses on TOKİ projects in the Altınoğuz (Yatıkmusluk) neighborhood, examining their social and spatial effects to provide an overall picture of how these interventions influence urban life [9]. Globally, urban regeneration has been criticized for displacing low-income residents [2] and eroding cultural ties [22]. Although mass evictions were avoided in Mamak, the project still produced socio-cultural consequences, notably the disruption of social networks, reflecting similar challenges observed in Latin America [23] and North Africa [21].

Resident satisfaction with housing and the residential environment is considered one of the most critical issues in urban studies and disciplines alike. It is recognized as a key indicator of the success of urban regeneration projects, and it refers to a multi-dimensional concept involving physical design, neighborhood facilities, quality of neighborly relations, and safety among others [7]. There are many

physical, social, and psychological factors affecting satisfaction, which was discussed extensively in the literature [8-9]. Amerigo and Aragones [9] proposed a conceptual framework for the evaluation of housing satisfaction. The authors emphasized an interaction between individuals and their residential environments. This model involved cognitive and emotional evaluations through comparisons between actual and ideal characteristics of the environment. This model represents housing assessment as based on subjective and social factors that affect the overall satisfaction of an individual.

While TOKİ units are privately owned—unlike rental-based social housing abroad—this research focuses on how ownership models in regeneration affect satisfaction, a gap in existing comparisons. Table 1 contrasts global regeneration challenges (e.g., displacement, cultural erosion) with Ankara's TOKİ model, highlighting gaps in addressing socio-cultural needs— a focus of this study.

Table 1. *Literature review*

Author	Title	Research Approach	Analysis Method	Data Used	Finding
[21]	Cultural heritage tourism and urban regeneration: The case of Fez Medina	Mixed-method (Qualitative-Quantitative)	Content analysis, interviews	Field data, interviews with stakeholders	Urban regeneration without displacing local residents can balance economic and social sustainability.
[22]	The fading light of urban regeneration in a sewing neighborhood in Seoul	Urban anthropology	Ethnographic observations and historical analysis	Ethnographic and cultural analysis	Social and political conflicts between government administration and local cooperatives complicate urban regeneration projects.
[11]	Can financial transactions reveal the change in social fabric triggered by urban regeneration?	Socio-economic	Transaction data analysis and new metrics	Credit card and structural data	Urban regeneration in some areas leads to reduced social mobility and increased demographic segregation.
[23]	Lifestyle migration and socio-spatial segregation in urbanizing landscapes	Comparative-case study	Comparative and cross-sectional analysis	Social, demographic, and geographic data in two Latin American regions	Lifestyle migration to medium-sized cities intensifies socio-spatial segregation and inequality.
[24]	Exploring urban segregation dynamics: A hub-based agent model	Social agent modeling	Simulation and policy-based analysis	Survey data and residential preferences	Individual preferences and varying policies uniquely affect urban segregation and residents' satisfaction.
[25]	Urban transformations in intermediate cities under neoliberal urbanism	Urban analysis	Document analysis and cartography	Spatial data and neoliberal urban policies	Urban development under neoliberal policies exacerbates socio-spatial segregation.
[26]	Has urban expansion alleviated working-residential spaces segregation?	Multi-scalar	Spatial and social data analysis	Location-based social and spatial data	Urban expansion has failed to reduce work-residence segregation and, in some cases, has worsened it.
[27]	Road infrastructure expansion and socio-spatial fragmentation in peri-urban zones	Case study	Mixed methods (qualitative and spatial)	Combined data from infrastructure projects	Road expansion displaces low-income residents and reduces social interactions in peri-urban areas.
[28]	From walking to staying: The impact of spatial qualities on socio-spatial segregation	AI-based GeoAI framework	Deep learning models and spatial data analysis	Spatial data and deep learning models	Context-specific public space design can foster social interactions and reduce segregation.
[29]	Participatory governance for the temporary use of urban abandoned areas	Socio-spatial	Surveys and interviews	Local stakeholder opinions and participatory governance practices	Temporary use of abandoned urban areas with participatory governance enhances social capital.
[30]	Socio-spatial segregation in residents' daily life	Longitudinal	Time-series and spatial data analysis	Activity data of residents in Beijing	Physical environment changes have a greater impact on socio-spatial segregation than traditional policies.

2.2. Housing satisfaction and housing transformation

Improving people's housing satisfaction is a key concept in the context of housing transformation. It refers to how the decisions made by occupants regarding the arrangement of their housing over time

affect their overall satisfaction. This aspect is assessed through post-occupancy evaluation (POE), which contributes to future housing design and housing policy development. In this study, qualitative techniques such as field research, interviews with local headmen (muhtars), and photographic documentation were employed. In addition, a quantitative technique, a structured questionnaire survey, was conducted to evaluate residents' levels of satisfaction and their housing decisions. (Figure1) Previous studies have shown that standard public housing layouts were often restrictive and failed to accommodate residents' individual needs and preferences, which contributed to widespread dissatisfaction. The abovementioned was due to the poor attention given to the societal and economic factors in the layout of the housing. The studies indicate that a lack of identity in public housing design, coupled with the failure to accommodate residents' preferences, is a key factor contributing to dissatisfaction [7, 10].Seyedkazemi et al. [11] reported that residents of Malaysian low-cost housing were generally satisfied with local amenities, yet they expressed dissatisfaction with the condition of their dwellings, a concern not evident in the present study area. Research conducted in Jordan highlights the importance of outdoor spaces in residential design, showing that daily use of these areas forms a fundamental aspect of residents' experiences. In contrast, the self-developed areas of Dhaka have consistently exhibited heterogeneous organization and layout of houses, even during transitions, a characteristic not observed in public housing sectors(Khan, 2014b). These findings reveal the potential link between housing satisfaction and the degree of user involvement or consideration in the housing process [12].

Several studies have been done about the satisfaction of residents in urban renewal activities. For example, a research study conducted by Mohit et al. [7] in Malaysia was an excellent example of demonstrating that the factors, such as the layout of houses, easy access to public transportation, social amenities, and the social environment, significantly determine residents' satisfaction. Waziri et al. [13] inspected the correlation among physical, social, and neighborhood services and residents' satisfaction in Nigeria and got identical findings as to visiting. Cultural differences were the main reasons of the changes in resident satisfaction being explored by Isah et al. [12] in public housing in Nigeria. The study revealed that aspects of family life and interactions within the neighborhood are key factors influencing residents' satisfaction and perceptions of their homes. To this end, the findings derive from the backdrop for cultural and social variables in public housing.

In Turkey, housing satisfaction depends largely on cultural adaptability [12]; however, TOKİ's standardized designs frequently fail to accommodate this [10].This gap exacerbates socio-spatial divides, as seen in Ankara's peripheral neighborhoods [5].

***Figure 1**. Mamak Ankara before housing transformation [4]*

***Figure 2**. Mamak Ankara after housing transformation* [4]

2.3. Socio-spatial segregation

The problem of socio-spatial segregation poses a major challenge in post-socialist and developing cities. Kährik [14] studied Tallinn, Estonia, and discovered that housing privatization and decreased government involvement have worsened socio-spatial segregation. In Lima, de Córdova et al. [15] highlighted the complexity of socio-spatial segregation patterns, noting that while some areas have developed into new urban centers, segregation at the macro level is still clearly visible.

In exploring the relationship between spatial structure and social segregation, Khan [16] concluded that urban decay is associated with increased social segregation. This study, conducted in Famagusta,

Northern Cyprus, demonstrated that cities with more deteriorated spatial patterns face greater social segregation. Similarly, Feldmane [17] analyzed the impact of demographic, economic, and migratory factors on residents' satisfaction in segregated urban environments in Latvia.

2.4. Urban regeneration projects in Ankara

Urban regeneration projects in Ankara, particularly in areas like Mamak, have been implemented to address issues arising from informal settlements and to improve residents' quality of life [18]. These projects have typically focused on areas with high rental values due to public-private partnerships, but there has been significant criticism regarding the prioritization of higher-income groups and the neglect of the needs of low-income classes [5, 19].

Topkaya [20] found that if housing projects focus only on how the area looks, they often miss important social and cultural issues, which can lead to the same problems appearing in other parts of the city. Similarly, in this study, there was no clear link between people's income or jobs and how satisfied they were, likely because TOKİ projects provide uniform housing that makes individual differences less noticeable.Overall, studies suggest that successful interventions require comprehensive approaches that address both the spatial and social dimensions of urban regeneration.

2.5. Research gap

While existing literature has extensively explored urban regeneration projects, including their impacts on socio-spatial segregation and residents' satisfaction, critical gaps remain unaddressed Notably, much of the existing research has concentrated on urban renewal in large metropolitan centers or higher socio-economic areas, leaving the dynamics of informal and low-income neighborhoods relatively underexplored. This gap is particularly important, as neglecting these areas may overlook critical socio-spatial processes that differ from those observed in well-studied urban contexts. Additionally, recent studies highlight the socio-cultural complexities and unintended consequences of regeneration projects, such as displacement, inadequate community engagement, and cultural disconnection, but rarely examine these issues in peripheral areas like Mamak, Ankara.

Earlier research often focused on economic efficiency [5] or the risk of people being displaced [2], but this study looks at how satisfaction and segregation are linked in the outskirts of Ankara, responding to Topkaya's [20] call to study these issues with attention to local culture.Also, prior studies examine segregation [14] or satisfaction [10] in isolation, few explore their interplay in regeneration contexts (e.g., [17]). This study bridges that gap by asking: Does higher resident satisfaction correspond with lower levels of segregation, and if so, under what conditions does this relationship hold?

3. STUDY AND METHODOLOGY

This study employed a quantitative survey-based approach to examine resident satisfaction and the socio-spatial impacts of an urban regeneration project in the Altınoğuz (Yatıkmusluk) neighborhood of Mamak, Ankara. Data were collected through structured, face-to-face questionnaires administered to randomly selected household heads. The survey covered demographic information, satisfaction levels, and residents' perceptions of post-relocation changes. Statistical methods, including ANOVA, regression, and correlation analyses, were used to identify significant patterns and relationships among variables.

3.1Study area

The study area was selected due to its critical urban and social challenges, which made it a priority for one of Ankara's largest urban regeneration projects. Altınoğuz (Yatıkmusluk) neighborhood is located in the Mamak district of Ankara Province (Figure 3). It was formerly one of the city's most extensive informal settlement areas, characterized by unplanned, unregistered, and unzoned housing. It also had one of the highest crime rates in Ankara. The neighborhood lacked basic infrastructure such as water supply, sewage systems, and emergency access routes, making it highly vulnerable in cases of fire or medical

emergencies. Illegal electricity and water usage were widespread, and the absence of public amenities such as parks, mosques, and community facilities further deepened social exclusion. The area presented a visually degraded landscape at the heart of the city, with severely deteriorated housing stock that posed a significant risk in the event of earthquakes or other natural disasters. These conditions not only created a disconnected and marginalized community but also prompted local authorities to implement a large-scale urban transformation initiative to improve living standards and integrate the area into the broader urban fabric.

Figure 3*. Mamak located on Ankara* [4]

3.2Methodology

For the present study, a quantitative research method based on a survey was employed to assess resident satisfaction and the impact of the urban regeneration project on socio-spatial segregation in the Altınoğuz (Yatıkmusluk) neighborhood of Mamak. The target population of this research included all residents of this neighborhood. Data were collected using a structured questionnaire that was completed face-to-face with household heads. The questionnaires consisted of four main sections: (1) demographic information and housing ownership status; (2) level of satisfaction with the urban regeneration project; (3) assessment of positive and negative changes in life after moving to the apartments; and (4) residents' suggestions for improving the project.

Variables Analyzed:

- **Dependent**: Resident satisfaction (Likert scale).
- **Independent**: Age, education, income, ownership status, access to services.

To ensure accurate data collection, random sampling was conducted, and local village heads assisted the researchers in identifying completed houses. The surveys were conducted between September 1, 2015, and May 31, 2016. While data was collected in 2015–2016, recent work (e.g., Seyedkazemi et al., 2024) confirms TOKİ's ongoing affordability issues, suggesting our findings remain pertinent. Future studies should replicate this work with updated datasets. Out of the 170 households surveyed, 9 questionnaires were discarded due to incorrect information, resulting in a final sample of 161 valid questionnaires (equivalent to 94%). This sample size was considered sufficient based on established sampling principles for quantitative research, the population size of the Altınoğuz (Yatıkmusluk) neighborhood, and the expected margin of error, allowing for reliable statistical analysis, including ANOVA, regression, and correlation tests. Random sampling was used to enhance representativeness and reduce potential sampling bias. The demographic characteristics of the sample were thoroughly documented: the average age of

respondents was 49.3 years, with a gender composition of 52.8% female and 47.2% male. In terms of education, 36.6% of respondents had primary education, while 26.7% were illiterate. Additionally, 37.9% of respondents were employed, while 62.1% were unemployed. The average monthly income was reported to be 1,500 Turkish Lira.

For data analysis, several statistical methods were employed, including ANOVA to test differences between group means, regression analysis to examine relationships between dependent and independent variables, and correlation analysis to measure the strength and direction of linear relationships. These analyses were conducted using appropriate statistical software, and all data were recorded and maintained confidentially to ensure participant privacy. This research methodology aims to achieve reliable results in evaluating satisfaction and the socio-spatial effects of the urban regeneration project by considering demographic characteristics and employing statistical tools.

4. RESULTS

This section summarizes the main findings of the study, including both descriptive and statistical analyses. It presents the demographic profile of respondents and examines resident satisfaction with the urban regeneration project. Differences in satisfaction across ownership types and other variables were tested using ANOVA and Pearson correlation. The results highlight key factors affecting satisfaction and provide insights into the socio-spatial outcomes of the project.

The results of the resident satisfaction surveys conducted as part of this study are presented in the table below. These findings provide a quantitative overview of respondents' attitudes toward the urban regeneration project and form the basis for further statistical analysis (Table 2) and also in Figure 2 shows the distribution of respondents by educational level.

***Table 2**. Descriptive statistics*

Characteristic	Number (n)	Percentage (%)
Gender		
Female	85	52.80%
Male	76	47.20%
Average Age	49.3 years	-
Education Level		
Primary Education	43	26.70%
Secondary Education	59	36.60%
Higher Education	38	23.60%
Postgraduate Education	21	13.10%
Employment Status		
Unemployed	61	37.90%
Employed	100	62.10%
Ownership Status		
Tenure Rights	81	50.30%
Owner	60	37.30%
Renter	20	12.40%
Average Monthly Income	1,500 Turkish Lira	-

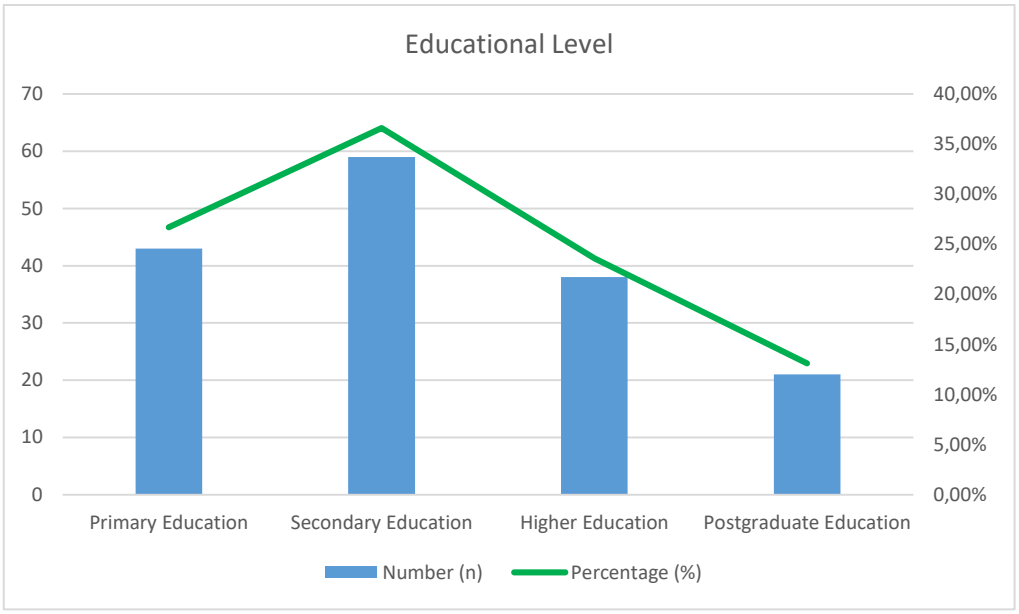

***Figure 4**. Descriptive statistics, educational level*

Among the respondents, 81 individuals (50.3%) had tenure rights, 60 individuals (37.3%) were owners, and 20 individuals (12.4%) were renters. Table 3 presents the overall satisfaction levels of residents based on their housing ownership status.

***Table 3**. Overall resident satisfaction with the urban regeneration project*

Ownership Status	Satisfied	Dissatisfied	Total
Tenure Rights	48 (59.3%)	33 (40.7%)	81 (100%)
Owner	34 (56.7%)	26 (43.3%)	60 (100%)
Renter	14 (70.0%)	6 (30.0%)	20 (100%)
Total	96 (59.6%)	65 (40.4%)	161 (100%)

Overall, 59.6% of residents (96 individuals) expressed satisfaction with the urban regeneration project, while 40.4% (65 individuals) were dissatisfied. A higher percentage of renters (70.0%) reported satisfaction compared to owners (56.7%) and those with tenure rights (59.3%). While 59.6% satisfaction exceeds Istanbul's rates (Ozüekren & Berköz, 2003), this may reflect Mamak's baseline deprivation. Open-ended responses reveal underlying tensions (e.g., 35.4% criticized unit sizes), aligning with Ibem & Amole's (2013) findings on unmet cultural needs in standardized housing.

An analysis of the reasons for dissatisfaction revealed that 35.4% of residents were dissatisfied with the small size (50m^2 and less) of the residential units. Additionally, 16.9% considered the units physically inadequate, and 10.8% rated the construction quality of the apartments as poor. Approximately 37% expressed dissatisfaction for various reasons, including social issues and high maintenance costs (Table 4 and Figure 5).

Open-ended responses cited 'loss of communal spaces' (12%) and 'high utility costs' (9%) as key concerns, aligning with cultural and economic critiques of TOKİ housing.

***Table 4**. Reasons for resident dissatisfaction with the urban regeneration project*

Reasons for Dissatisfaction	Number	Percentage
Small size of apartments	57	35.40%
Physically inadequate	27	16.90%
Poor construction quality	17	10.80%
Other reasons	60	37.00%
Total	161	100%

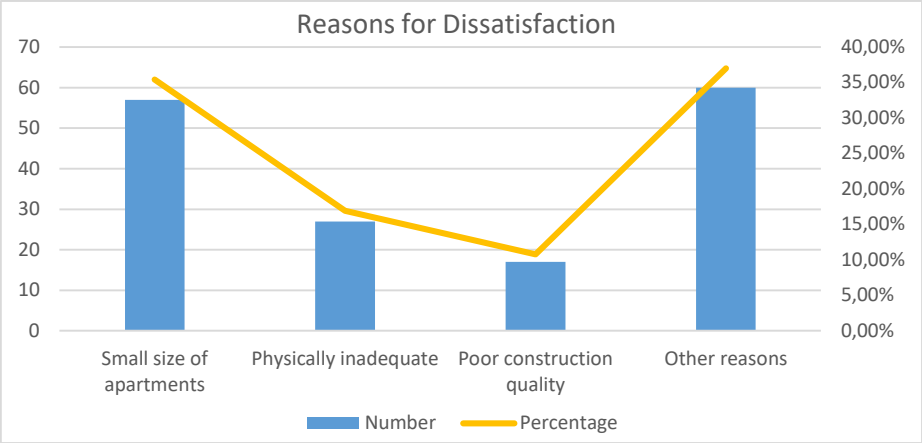

Figure 5. *Reasons for resident dissatisfaction with the urban regeneration project*

More than half of the respondents (61.7%) preferred living in the settlements over living in the new apartments, citing reasons such as greater comfort (18.5%) and stronger social relationships (18.5%). Additionally, 14.8% mentioned more freedom in their previous living situation. On the other hand, the advantages of living in the new apartments included being more modern (25.9%) and having a more orderly environment (17.3%). However, 24.7% of residents mentioned increased costs, and 23.5% cited increased debts as negative consequences.

To examine satisfaction differences among the three ownership groups (tenure rights, owners, renters), a One-Way ANOVA test was employed. The results indicated that there was no significant difference in the mean satisfaction levels among the different groups ($F=1.225$, $p=0.297$), suggesting that ownership status did not have a significant impact on overall resident satisfaction (Table 5).

Table 5. *Comparison of resident satisfaction by ownership status*

Ownership Status	Mean Satisfaction	Standard Deviation	F	Sig.
Tenure Rights	3.58	1.01	1.225	0.297
Owner	3.43	1.1		
Renter	3.8	0.89		
Overall	3.54	1.03		

Pearson correlation analysis was conducted to investigate the relationship between satisfaction and demographic variables. The results revealed a positive and significant correlation between satisfaction and age ($r=0.189$, $p<0.05$) as well as education level ($r=0.223$, $p<0.01$). However, no significant correlation was found with employment status ($r=-0.092$, $p>0.05$) and monthly income ($r=0.071$, $p>0.05$) (Table 6).

Table 6. *Correlation coefficients of satisfaction with demographic variables*

Variable	Pearson Correlation Coefficient (r)	Significance Level (Sig.)
Age	0.189*	0.016
Education Level	0.223**	0.005
Employment Status	-0.092	0.246
Monthly Income	0.071	0.375

Note: $p < 0.05$ indicates statistical significance. $p < 0.01$ indicates high statistical significance.

5. DISCUSSION

Satisfaction disparities (e.g., 71.4% for education vs. 46% for social facilities) reveal persistent spatial inequities. Even though the area is physically integrated, cultural separation continues, as 18.5% of people missed the strong social bonds of their old neighborhoods, similar to what was found in Lima [15]. These results indicate that as age and education increase, resident satisfaction with the urban regeneration project also increases. However, economic factors such as employment status and income do not have a significant impact on the level of satisfaction. These findings highlight the importance of individual characteristics such as age and education in influencing residents' attitudes toward urban regeneration projects.

The project reduced physical segregation by integrating services (e.g., schools, clinics), yet cultural preferences for informal settlements (18.5% cited stronger social ties) reveal lingering socio-spatial divides. This underscores the need for culturally sensitive planning.

The findings of this study revealed that more than half (59.6%) of the residents of the Altınoğuz (Yatıkmusluk) neighborhood were satisfied with the urban regeneration project. This satisfaction level is somewhat higher compared to previous findings in Türkiye. For instance, Ozüekren and Berköz [31] reported approximately 50% satisfaction in their studies on urban regeneration projects in Istanbul. Similarly, Yıldız [32] found a satisfaction rate of 44% in his assessment of an urban regeneration project in Ankara. The difference in satisfaction levels may be related to the unique characteristics of the project examined in this study. While previous research often focused on urban regeneration in major Turkish cities, this study concentrated on a project in a low-income, peripheral area of Ankara. In this neighborhood, the former residents were predominantly from low-income, less-educated backgrounds and had migrated from rural areas, living in settlements -like conditions. Therefore, relocating these individuals to new apartment units significantly improved their quality of life, contributing to a higher level of satisfaction.

Additionally, the analysis indicated that resident satisfaction increased with age and education level. This finding aligns with previous studies that suggest individual characteristics such as age, education, and income can have a substantial impact on housing and residential environment satisfaction [7, 13]. However, unlike previous studies, this research found no significant association between employment status, monthly income, and satisfaction. This may be due to the relative economic homogeneity in this low-income neighborhood, which limited the influence of these variables. It appears that cultural and social characteristics of the residents had a greater impact on their satisfaction levels than economic factors. A recent study in Ankara [11] confirms that post-regeneration financial strains persist, suggesting our 2016 findings on cost-related dissatisfaction remain relevant. Future work should revisit Mamak to assess long-term trends.

Additionally, the results also showed that some people prefer to live in settlements. Topkaya’s [20] study on urban regeneration projects in Ankara has demonstrated that social and cultural reasons often encouraged some residents to prefer something about settlements life.. Observations at the site showed that the neighborhood, mostly made up of former rural migrants, had strong neighborly connections and a familiar social atmosphere carried over from informal settlements. The transition to new apartment housing represented not only a physical relocation but also a significant psychological adjustment, as residents were confronted with the challenges of adapting to a contrasting urban lifestyle.The importance of taking account of the social and cultural dimensions when designing and carrying out urban regeneration projects is highlighted in this finding. In sum, the major contribution of this study was to gain more insight into the factors influencing resident satisfaction and to show the differences with similar projects in large urban centers (in Türkiye). The results of this study may provide urban planners and policymakers a guide in their design and implementation of regeneration projects to enhance the quality of urban residents’ lives.

6. CONCLUSION

This study studied the achievement of urban regeneration project in Mamak, in the Altınoğuz (Yatıkmusluk) neighborhood, Ankara, through the assessment of the project and its impact on the decrease of socio spacial segregation among residents. Our findings showed that 59.6 percent of the residents were satisfied with the project. Particularly elevated were satisfaction levels regarding educational services (71.4%), health care (62.1%), children's play areas (55.9%) and social facilities (46%). In spite of this, it was reported that some deficiencies, namely, the absence of parking and the size of the housing units were poor.

The paradox of high satisfaction amid cultural estrangement underscores regeneration's dual nature: physical improvements may mask unresolved socio-spatial divides. This aligns with [16] assertion that housing policies must prioritize 'living with transformation' over mere infrastructure delivery.

The results suggest that urban regeneration can help enhance the quality of life while reducing the socio-spatial segregation. However, some residents still preferred to live in settlements because of cultural and social differences as well as a difference in lifestyle of residents living in settlements in contrast with life in an apartment. Moreover, the analysis showed that satisfaction increased with age and education attainment, but was not correlated with employment status or income. The finding indicates that in this low-income and peripheral neighborhood, economic factors have a lesser impact on satisfaction than cultural and social factors.

The study area, formerly known as a high-crime zone referred to as 'Çinçin', has undergone a clean-up process. However, it is common for former squatter residents to eventually leave the area in favor of detached housing with gardens, as this lifestyle better aligns with their preferences.

The results suggest overall that urban regeneration projects indeed raise residents' quality of life, thus creating successful projects; however, a more thorough consideration of the social and cultural aspects and residents' adaptation to the new environment is necessary to improve the success rate of urban regeneration projects. These differences need to be understood by urban planners who then have to develop strategies to increase satisfaction and reduce socio-spatial segregation within local communities.

To increase user satisfaction, it is necessary to improve green spaces, bicycle paths, playgrounds, education and health services, public transportation, and the material quality of the housing units. Residential environments can be planned to meet residents' needs and preferences by offering necessary services or through educational and cultural programs which will help residents to adapt to this new lifestyle.

For instance, urban regeneration areas such as Hulme in the UK and Freiburg in Germany feature insulated, energy-efficient, and child-friendly housing. These international examples provide valuable insights for designing more inclusive and sustainable regeneration models.
Although the study included renters and tenure-right holders to capture diverse perspectives, future research could isolate homeowners to assess whether satisfaction trends remain consistent across ownership types, thereby refining policy recommendations.

4.1. Research recommendations

Given residents' dissatisfaction with unit sizes (35.4%) and cultural attachment to settlements, we recommend:

- Prioritizing larger units in future TOKİ projects.
- Community programs to ease transitions into apartment living, as 18.5% valued ancestral social ties.

Future research in the area of urban regeneration projects in low income and peripheral zones of Türkiye ought to deepen its understanding through comparative studies developed at the regional levels. The

studies of such kind can analyze how the locals meet with the regeneration attempts paying attention to the existence and the importance of local socio-economic and cultural features. Also, it is crucial to study the social and cultural responses of regeneration projects. Most informed insights on the structural aspects of cultural difference and on the importance of getting cultural policy right could be provided by understanding how residents adapt to their new environments, including how they cope with lifestyle adjustments and social integration.

Beyond this, the capacity of institutional actors (governmental and non-governmental) should also be considered in order to determine their contribution to enhancing resident participation, and enable the regeneration process. These dimensions may be explored in order to identify mechanisms of building community interaction and promoting equitable benefits distribution. Future studies should focus on the long-term effects of regeneration projects to see how they impact people's quality of life and whether they help reduce social and spatial divides.These evaluations can be useful to build the frameworks of more sustainable and inclusive urban regeneration initiatives.

4.2. Practical recommendations

Some basic measures should be taken so as to better the urban regeneration projects to improve residents' quality of life in a practical manner. Having suitable play areas for children of all ages in regenerated neighborhoods can greatly support their wellbeing and growth. Moreover, because it enhances the quality and capacity of social and welfare matters, they become able to give the needs of their society and quality of life. It encourages social cohesion and a feeling of belonging. The next important step is setting up shops and local markets for residents' daily needs, making life easier and boosting the local economy. And, additionally, green spaces and local gardens like can preserve traditional agricultural practices, continuing social life and preserving cultural heritage for the future.

Educational and cultural programs should then be formulated to help apartment residents to adapt to their new surroundings and to address the socio-cultural adjustments needed in apartment living. If we are to halt regeneration, we need to reduce the housing installment payment to correspond to that of low-income households, in order to prevent financial constraints from triumphing, where regeneration actually renders assistance. Finally, sharing the choice on who is to be residential complex managers with residents might enhance service quality and make communities participate in the processing of their living spaces. Finally, these recommendations provide a total framework for planners and developers designing urban regeneration initiatives that successfully dismantle socio-spatial segregation and foster.

Acknowledgement

We thank the respected reviewers for comments that greatly improved the manuscript.

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Research Article GU J Sci, Part B, 13(3): 527-542 (2025)

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Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

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A Study on the Permanent Housing Expectations of Earthquake Survivors after the February 6, 2023 Kahramanmaraş Earthquakes

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Article Info

Received: 18/08/2025
Accepted: 29/09/2025

Keywords

Earthquake, Earthquake survivors, Post-earthquake permanent housing, Earthquake housing expectations

Abstract

Earthquakes are among the natural disasters whose timing cannot yet be precisely predicted. The extent of casualties and damage caused by earthquakes varies depending on several parameters such as the earthquake's epicenter and its proximity to fault lines, geological and ground conditions, groundwater and soil properties, site selection and land use, population density and building concentration in the affected area, as well as the quality of design and construction. On February 6, 2023, at 04:17 and 13:24 local time in Türkiye, two major earthquakes with magnitudes of Mw 7.7 and Mw 7.6 struck Pazarcık (Kahramanmaraş) and Elbistan (Kahramanmaraş), respectively. As a result of these devastating earthquakes, thousands of people lost their lives, tens of thousands of buildings collapsed, and hundreds of thousands of housing units were rendered uninhabitable due to severe or moderate damage, even if they did not collapse entirely. Following these two major earthquakes, there emerged an urgent need for housing for millions of people. Traditional solutions such as tents and container units were employed to address this need temporarily. This study aims to examine the existing housing conditions and the housing expectations of earthquake survivors in the 11 provinces declared as disaster zones after the February 6, 2023 Kahramanmaraş earthquakes. The research employs a retrospective survey model, one of the general survey models within the scope of quantitative research methods. The study group consists of 203 earthquake survivors residing in the 11 provinces designated as disaster areas following the earthquakes. Data were collected through a questionnaire designed to assess the housing needs and conditions of earthquake survivors before and after the disaster. Findings from the study indicate that participants generally do not prefer the use of reinforced concrete systems in the construction of new permanent housing post-earthquake, do not wish to reside in buildings taller than three stories, and can tolerate a maximum waiting period of six months to access permanent housing. Moreover, the data suggest that survivors value neighborhood relations, prefer buildings consisting of at least three independent units, and believe that container housing does not adequately meet the need for permanent accommodation.

1. INTRODUCTION

Throughout human history, shelter has been one of the most fundamental needs. The nomadic lifestyle, which began with hunter-gatherers, ended with the transition to settled life, leading to the creation of permanent dwelling spaces. Simply put, shelter structures, commonly referred to as housing, have continuously evolved from the past to the present due to changing sociological, technological, and economic needs and possibilities. While life continues, unexpected disasters occurring at unforeseen times and conditions alter these comfort conditions according to general environmental changes and structural damage. Therefore, the concept of disaster directly and negatively affects shelter activities.

A disaster is defined as destruction caused by various natural events (TDK, 2020). According to another source, it is described as a natural or human-induced event that disrupts the functioning of a society, causes loss of life and property, and leads to economic and environmental catastrophes that societies generally cannot cope with (IFCR, 2014). In the broadest sense, a disaster is defined as a disruption or

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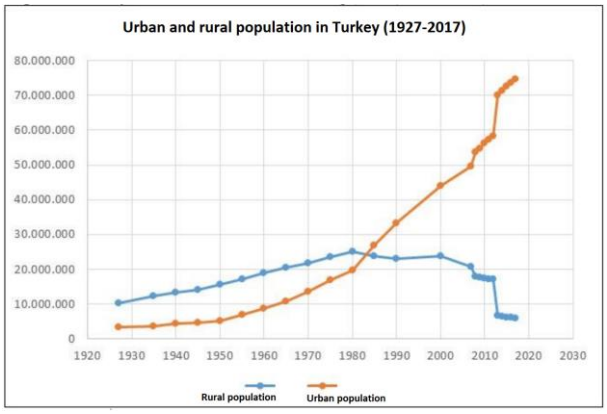
radical change in expectations occurring in the social context where individuals and communities sustain their lives (Songür, 2000).

Disasters cause loss of life and property and negatively affect countries economically and socially. Natural disasters cannot be fully predicted or prevented, but their destructive effects can be mitigated through preventive measures. For an event to be considered a disaster, it must cause loss of life and property in the affected area (Kiper, 2001).

Due to its topography, geological formation, and climatic characteristics, Turkey is a country that experiences many natural disasters causing loss of life and financial damage (Kiper, 2001). Earthquakes constitute 61% of the damage occurring after disasters, followed by landslides at 15%, floods at 14%, rockfalls at 5%, fires at 4%, avalanches, and meteorological events at 1% (Kocaman, 2012). Earthquakes, as one type of disaster, suddenly affect the vital human need for shelter and expose the physical and social vulnerabilities of settlements in full detail (Karaduman, 2002).

Most of the destruction following earthquakes occurs in residential buildings. For instance, in the 1999 Marmara earthquake, nearly 90% of damaged buildings were residential structures (Savaşır, 2008). Following a disaster, shelter needs are often met by tents or temporary shelters. However, it is increasingly recognized that post-disaster sheltering should be regarded as a comprehensive process rather than merely meeting immediate shelter needs. Various parameters such as household preferences, demographics, resources and capacities, service life, and structural safety must be considered independently of the disaster. While roughly one-third of the world's population lived in urban areas in the first half of the 20th century, today, one in every two people lives in cities. Similarly, Turkey has shifted from a predominantly rural population to a majority urban population, with projections indicating that 90% of the population will be urban by 2050 (Yoloğlu, 2020).



Graph 1.1. *Urban and rural population changes in Turkey in 1927-2017 (Yoloğlu, 2020)*

The increase in urban population density also raises the potential loss of life and property in the event of a devastating earthquake.

On February 6, 2023, two earthquakes measuring Mw 7.7 and Mw 7.6 occurred at 04:17 and 13:24 local time, with epicenters in Pazarcık (Kahramanmaraş) and Elbistan (Kahramanmaraş), respectively. Thousands of people lost their lives, tens of thousands of buildings were destroyed, and hundreds of thousands of independent units sustained severe or moderate damage, rendering them unusable. Following these two major earthquakes, millions of people urgently needed housing. Although traditional methods were used to meet these needs, many essential parameters for adequate housing—such as hygiene, privacy, security, insulation, and comfort—were not sufficiently provided. Although the epicenter was Kahramanmaraş, due to the destruction and loss of life, 11 provinces (Adana, Adıyaman, Diyarbakır, Elâzığ, Gaziantep, Hatay, Kahramanmaraş, Kilis, Malatya, Osmaniye, Şanlıurfa) were declared as “Disaster Areas Affecting General Life” (URL-1).

After the earthquakes, sheltering in Turkey began with tent accommodations during emergency response, followed by improvements in temporary shelters and housing in the mid-term. The final phase involves the completion of permanent housing. Among these processes, permanent housing is the most time-consuming in terms of implementation (Karaduman, 2002). Temporary shelter needs occur primarily in emergency and subsequently in recovery phases. Despite using traditional sheltering methods in the 21st century, these methods do not meet optimal living conditions, adversely affecting disaster survivors throughout emergency and recovery phases. Considering Turkey's population, the high-risk status of housing stock, and economic factors, post-earthquake reconstruction requires significant labor, expenditure, and reproduction. Consequently, the organizational structure, preparation process, production variables, and implementation methods are critical. Therefore, addressing the sheltering needs emerging after an earthquake promptly and urgently becomes mandatory.

Traditional methods have been used for many years in Turkey for crisis and risk management after disasters to meet the sheltering needs of survivors. Although traditional approaches offer practical solutions, they are insufficient during the period needed for life to return to normal post-disaster. Solutions provided by traditional methods often become inadequate in the long term, losing functionality and adding economic burdens to the national economy.

Purpose of the Study
This study aims to reveal the current housing situation concerning the shelter needs of earthquake survivors in the 11 provinces declared disaster zones after the February 6, 2023 Kahramanmaraş earthquakes. Within this scope, the study intends to gather data regarding the demographic characteristics of survivors, information about their pre-earthquake housing, housing conditions post-earthquake, demands and expectations for temporary and permanent housing, as well as minimum spatial needs and features of permanent housing.

Research Problem
What are the housing needs and permanent housing expectations of earthquake survivors living in the 11 provinces declared disaster zones after the February 6, 2023 Kahramanmaraş earthquakes in Turkey?

Sub-Problems:
What information is available regarding the housing conditions of earthquake survivors prior to the earthquake?
What are the survivors' conditions related to temporary and permanent housing post-earthquake?
What are the expectations of earthquake survivors from temporary and permanent housing after the earthquake?
What are the survivors' views on minimum space requirements, new construction technologies, material properties, sustainability, and other aspects concerning permanent housing?

2. METHOD

Research Model: This study employs a quantitative research method, specifically the retrospective survey model from general survey models. General survey models are studies conducted on smaller representative samples from large populations to generalize findings. Retrospective survey models examine past situations or events based on the views and statements of individuals who experienced the specific time period under investigation (Karasar, 2006; Büyüköztürk et al., 2013).

Study Group: The study group consists of earthquake survivors residing in the 11 provinces declared disaster zones after the February 6, 2023 Kahramanmaraş earthquakes. Data were collected online via Google Forms from survivors living in these provinces who voluntarily participated in the survey. Frequency and percentage distributions of participants' gender, age, education level, family size, and the provinces they resided in during the earthquake are separately presented in tables. Accordingly, a total of 203 earthquake survivors volunteered to participate in the research, including 103 women and 100 men.

Table 1: *Frequency and Percentage Distribution of Earthquake Survivors by Gender*

Gender	Frequency (f)	Percentage (%)	Total
Female	103	50,7	203
Male	100	49,3	

The age group distribution of earthquake survivors participating in the study is presented in Table 2. Accordingly, 62 participants (30.5%) were aged between 18-23, 42 (20.7%) were aged 24-29, 68 (33.5%) were aged 30-44, 28 (13.8%) were aged 45-64, and 3 (1.5%) were aged 65 and above.

Table 2: *Frequency and Percentage Distribution of Earthquake Survivors by Age Groups*

Age	Frequency (f)	Percentage (%)	Total
18-23	62	30,5	203
24-29	42	20,7	
30-44	68	33,5	
45-64	28	13,8	
65 and over	3	1,5	

The educational levels of the earthquake survivors are shown in Table 3. According to this data, 12 participants (5.9%) had primary education, 34 (16.7%) had secondary education, 131 (64.5%) held undergraduate degrees, and 26 (12.8%) had postgraduate degrees.

Table 3: *Frequency and Percentage Distribution of Earthquake Survivors by Education Level*

Education Level	Frequency (f)	Percentage (%)	Total
Primary Education (Elementary/Middle School)	12	5,9	203
Secondary Education (High School)	34	16,7	
Undergraduate Degree	131	64,5	
Postgraduate Degree	26	12,8	

The family size of the earthquake survivors is presented in Table 4. According to the data, 15 participants (7.4%) had 2 family members, 38 (18.7%) had 3 members, 56 (27.6%) had 4 members, 44 (21.7%) had 5 members, and 50 (24.6%) had 5 or more family members.

Table 4*: Frequency and Percentage Distribution of Earthquake Survivors by Number of Family Members*

Number of Family Members	Frequency (f)	Percentage (%)	Total
2	15	7,4	203
3	38	18,7	
4	56	27,6	
5	44	21,7	
5 and over	50	24,6	

The residential distribution of earthquake survivors is shown in Table 5. According to the data, among the participants, 52 (25.6%) reside in Kahramanmaraş, 58 (28.6%) in Hatay, 20 (9.9%) in Şanlıurfa, 14 (6.9%) in Adıyaman, and the remaining 59 (29.1%) reside in other cities (Adana, Diyarbakır, Elazığ, Gaziantep, Kilis, Malatya, Osmaniye).

Table 5: Frequency and Percentage Distribution of Earthquake Survivors by Residential Cities

Residental City	Frequency (f)	Percentage (%)	Total
Kahramanmaraş	52	25,6	203
Hatay	58	28,6	
Şanlıurfa	20	9,9	
Adıyaman	14	6,9	
Others (Adana,Diyarbakır,Elazığ,Gaziantep,Kilis,Malatya,Osmaniye)	59	29,1	

Data Collection Tool and Data Analysis of the Study

Surveys are lists of questions prepared in accordance with the purpose of a particular research. Among research methods, the survey technique is one of the most frequently used methods. This is because conducting surveys is inexpensive, easy, and suitable for directly collecting information. When preparing a survey, the research hypotheses/research questions within the scope of the study are determined first, the methodology is defined, the question types are decided, and the survey is designed. A pilot application is conducted for the prepared survey form, it is revised based on feedback, and then it is finalized to be administered to the target group. Finally, the obtained data are analyzed and evaluated.

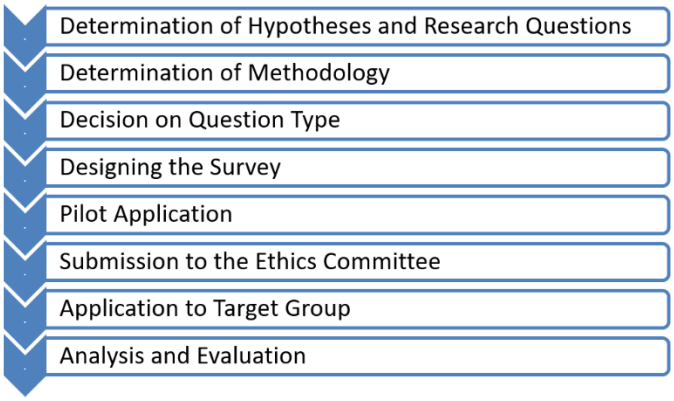
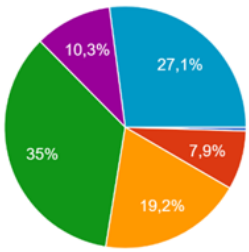


Figure 1. *Survey Preparation and Implementation Diagram*

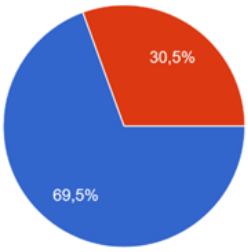
Within the scope of the study, questions forming the survey were created in the question pool, addressing not only the demographic information of the earthquake survivors but also information about their pre-earthquake residences, their housing needs in temporary/permanent accommodations after the earthquake, the housing problems they experienced, and their expectations from permanent housing. An appropriate question type was selected, and the draft version of the survey was prepared by consulting expert opinions. The prepared questionnaire draft has been presented to the three faculty members on the Thesis Monitoring Committee for their approval. A pilot application of the survey was conducted with 20 individuals, and the final version, which has been made clearer, was submitted to the Ethics Committee of Gazi University and approved with the letter number E-77082166-302.08.01-1144549. For data collection the final form was administered to earthquake survivors affected by the Kahramanmaraş-centered earthquakes that occurred in 2023. The data analysis was performed using SPSS 27.0.1 software, and percentage charts were obtained through Google Forms. Since independent responses regarding demographic information and personal opinions were collected from participants, no reliability assessment was conducted.

3. FINDINGS

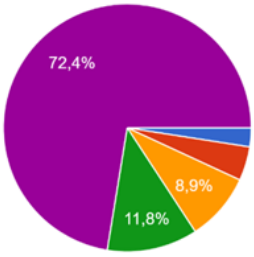
1- Questions aimed at revealing information about the residences where the earthquake survivors lived before the earthquake were calculated separately in percentage charts and presented accordingly. Based on this;

No	Information Regarding Pre-Earthquake Housing	
Graph 1		According to Graph 1, in response to the question regarding the design years of the buildings in which the earthquake survivors were residing during the earthquake, 0.5% stated that their buildings were designed before 1975, 7.9% between 1975 and 1998, 19.2% between 1999 and 2007, 35% between 2007 and 2018, and 10.3% after 2018. Meanwhile, 27.1% reported that they had no information about the design year of their buildings.

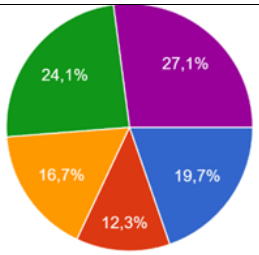
Graph 1 – Year of Design/Construction of Earthquake Survivors' Buildings

Graph 2		According to Graph 2, in response to the question regarding the ownership status of their residences prior to the earthquake, 69.5% of the earthquake survivors stated that they were homeowners, while 30.5% were tenants.

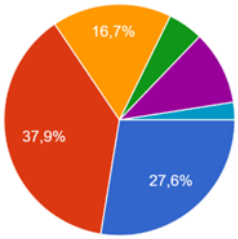
Graph 2 – Ownership Status of the Residences Occupied by Earthquake Survivors

Graph 3		According to Graph 3, regarding the duration of residence in their cities, 2.4% reported having lived there for less than 1 year, 4.5% for 1–3 years, 8.9% for 4–7 years, 11.8% for 8–15 years, and 72.4% for 15 years or more.

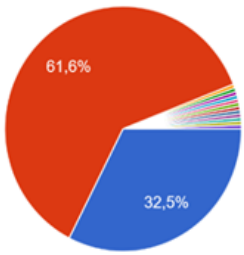
Graph 3 – Length of Residence in the City by Earthquake Survivors

Graph 4		According to Graph 4, in response to the question concerning the number of independent units in the homes they lived in before the earthquake, 19.7% reported 1 unit, 12.3% reported 2 units, 16.7% reported 3 units, 24.1% reported 4 units, and 27.1% reported 5 or more units.

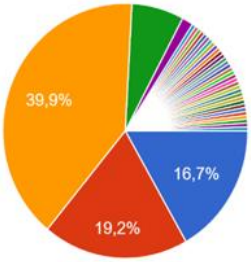
Graph 4 – Number of Independent Units in the Residences of Earthquake Survivors

Graph 5		According to Graph 5, when asked about their perception of the structural resilience of the buildings they were residing in during the earthquake, 27.6% believed their buildings were very durable, 37.9% said partially durable, 19.2% were unsure or had no opinion, 4.9% stated their buildings were not durable at all, and 10.3% indicated their buildings had collapsed.

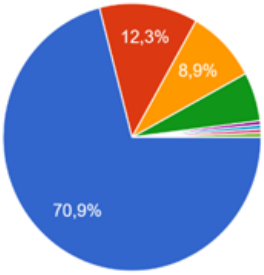
Graph 5 – Earthquake Survivors' Opinions on the Structural Resilience of Their Buildings

Graph 6		According to Graph 6, prior to moving into the residences they were living in during the earthquake, 61.6% of respondents reported not having investigated their building's earthquake resistance, 32.5% said they had, and 5.9% selected "other."

Graph 6 – Whether the Earthquake Resistance of Survivors' Buildings Was Assessed

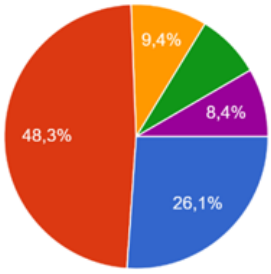
Graph 7		According to Graph 7, in response to the question about the most important factor considered when purchasing or renting their residence, 39.9% cited proximity to the city center, 19.2% affordability, 16.7% proximity to relatives, and 6.9% luxury. Additionally, 17.3% mentioned other factors such as structural safety, being in a quiet area, or proximity to their workplace.

Graph 7 – Factors Considered by Earthquake Survivors When Choosing Their Buildings

Graph 8		According to Graph 8, regarding opinions on the top priority for earthquake preparedness, 70.9% stated that building inspections should be ensured, 12.3% emphasized the need to improve disaster and crisis management, 8.9% highlighted the importance of post-earthquake education, and 5.9% noted the necessity of forming competent rescue teams and personnel. Furthermore, 2% of participants stated that soil and structural assessments should be conducted, and unsafe buildings should be demolished.

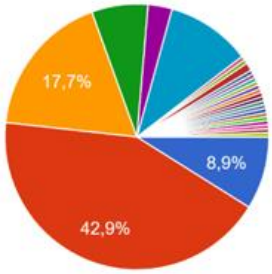
Graph 8 – Earthquake Survivors' Views on the Top Priority for Earthquake Preparedness

2- In order to reveal the information regarding the temporary/permanent housing of the earthquake survivors included in the scope of the study and their sheltering conditions after the earthquake, the responses to the relevant questions were calculated and presented in separate percentage-based graphs. Accordingly;

No	Information on Post-Earthquake Housing and Shelter Conditions	
Graph 9		According to Graph 9, 48.3% reported minor damage, 26.1% of earthquake survivors reported that their houses were undamaged, 9.4% reported moderate damage, 7.9% reported severe damage, and 8.4% stated that their buildings were destroyed.

Graph 9 – Damage Status of Earthquake Survivors' Homes After the Earthquake

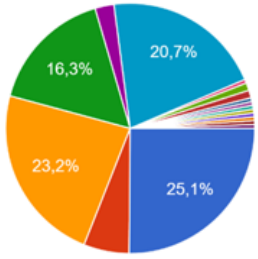
Graph 10



According to Graph 10, regarding where the earthquake survivors spent the first 7 days after the earthquake, 42.9% stated that they stayed outdoors or in vehicles, 17.7% stayed at relatives' or acquaintances' houses, 8.9% stayed in their own homes, 10.3% stayed outside the city, 6.9% stayed in tents, 3% in containers, and 10.3% stated they stayed in other places such as farms, vineyards, workplaces, or greenhouses.

Graph 10 – Shelter Conditions of Earthquake Survivors in the First 7 Days After the Earthquake

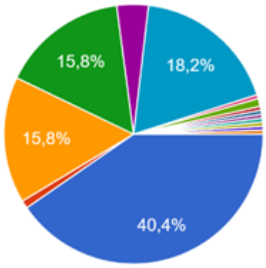
Graph 11



According to Graph 11, regarding where the earthquake survivors spent days 8 to 30 after the earthquake, 25.1% stayed in their own homes, 23.2% stayed at relatives' or acquaintances' homes, 20.7% stayed outside the city, 16.3% in tents, 5.9% in other places such as vineyards, detached houses, and mosques, and 2.5% in containers.

Graph 11 – Shelter Conditions of Earthquake Survivors Between Days 8 and 30 After the Earthquake

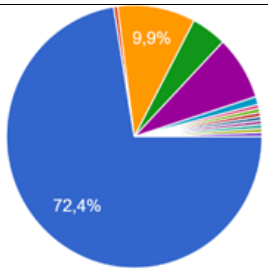
Graph 12



According to Graph 12, regarding where the earthquake survivors stayed one month after the earthquake, 40.4% were in their own homes, 18.2% outside the city, 15.8% in relatives'/acquaintances' homes or tents, 3.9% in containers, and 3.5% in other places such as farmhouses, detached homes, or mosques.

Graph 12 – Shelter Conditions of Earthquake Survivors One Month After the Earthquake

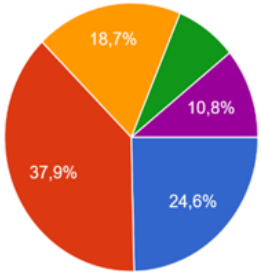
Graph 13



According to Graph 13, regarding the current places of residence of the earthquake survivors, 72.4% are currently living in their own homes, 9.9% in relatives'/acquaintances' homes, 7.9% in containers, 4.4% in tents, and 5.4% in other places.

Graph 13 – Current Shelter Conditions of Earthquake Survivors

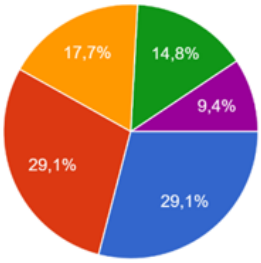
Graph 14



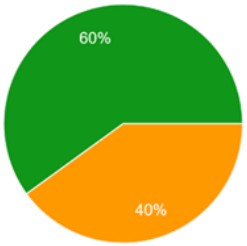
According to Graph 14, 37.9% of the survivors stated that efforts to meet shelter needs began one week after the earthquake, 24.6% said within the first 24 hours, 18.7% said one month later, 10.8% stated the issue is still unresolved, and 7.9% said the efforts started three months after the earthquake.

Graph 14 – Earthquake Survivors' Opinions on the Efforts Made to Address Shelter Needs After the Earthquake

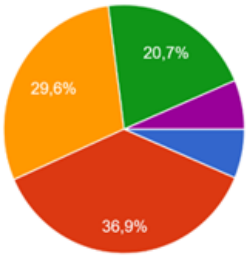
3- Within the scope of the research, questions aimed at revealing earthquake survivors' expectations regarding temporary and permanent housing after the earthquake were calculated separately in percentage graphs and presented. Accordingly;

No	Expectations of earthquake survivors regarding temporary and permanent housing for post-earthquake shelter needs	
Graph 15		According to Graph 15, 29.1% of earthquake survivors stated that they want to live in 1- and 2-story houses, 17.7% in 3-story houses, 14.8% in 4-story houses, and 9.4% in houses with 5 or more stories.

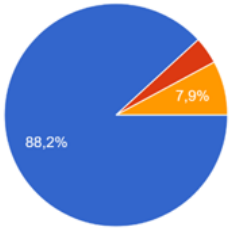
Graph 15 - Number of floors in houses earthquake survivors prefer to live in

Graph 16		According to Graph 16, in response to whether earthquake survivors consider living in buildings with 5 or more floors, 60% said they definitely do not consider it, and 40% said they do not consider it.

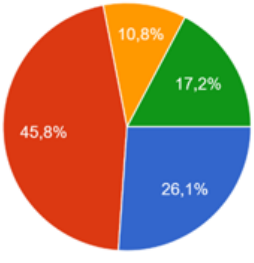
Graph 16 - Earthquake survivors' preferences for living in buildings with 5 or more floors

Graph 17		According to Graph 17, regarding whether earthquake survivors consider living in 2-5 story houses, 6.4% said definitely yes, 36.9% said yes, 29.6% said no, 20.7% said definitely no, and 6.4% said they have no opinion.

Graph 17 - Earthquake survivors' preferences for living in buildings with 2-5 floors

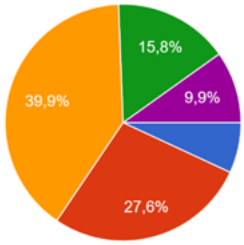
Graph 18		According to Graph 18, 88.2% of earthquake survivors stated that they care about neighborhood relations, 3.9% said they do not care, and 7.9% had no opinion.

Graph 18 - Earthquake survivors' views on neighborhood relations

Graph 19		According to Graph 19, regarding whether earthquake survivors consider building and settling in village or rural areas after the earthquake, 45.8% said yes as an alternative, 26.1% said yes permanently, 17.2% said they do not consider it, and 10.8% were unsure.

Graph 19-Earthquake survivors' preferences for settling in villages/rural areas after the earthquake

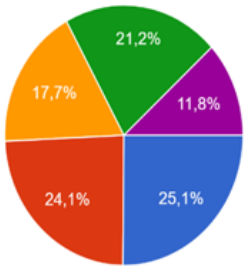
Graph 20



According to Graph 20, regarding whether earthquake survivors consider migrating to other provinces during the transition to permanent housing, 39.9% said no, 15.8% said definitely no, 9.9% had no opinion, 27.6% said yes, and 6.9% said definitely yes.

Graph 20 - Earthquake survivors' preferences for migrating to other provinces during the transition to permanent housing

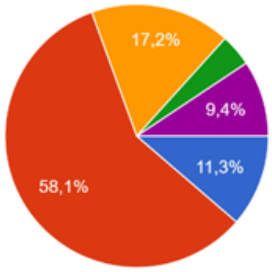
Graph 21



According to Graph 21, regarding the maximum duration earthquake survivors can tolerate living in temporary housing before moving to permanent housing, 25.1% said up to 1 month, 24.1% said 1-3 months, 21.2% said 7-12 months, 17.7% said 4-6 months, and 11.8% said more than 1 year.

Graph 21 - Maximum duration earthquake survivors are willing to stay in temporary housing

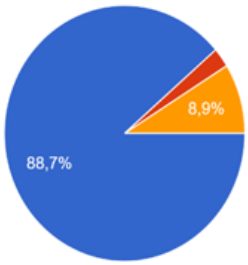
Graph 22



According to Graph 22, regarding earthquake survivors' preference for living in houses with independent units on the same floor, 58.1% said yes, 11.3% said definitely yes, 9.4% had no opinion, 17.2% said no, and 3.9% said definitely no.

Graph 22 - Earthquake survivors' preferences for living in houses composed of independent units on the same floor

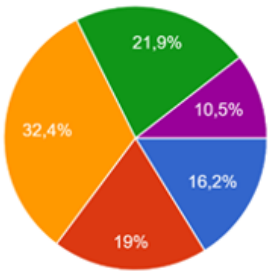
Graph 23



According to Graph 23, 88.7% of earthquake survivors said they definitely prefer detached houses, 8.9% had no opinion, and 2.5% said they definitely do not prefer.

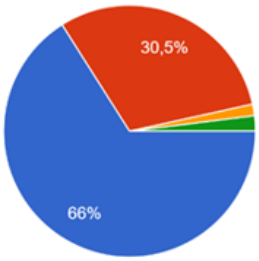
Graph 23 - Earthquake survivors' preferences for detached houses

Graph 24

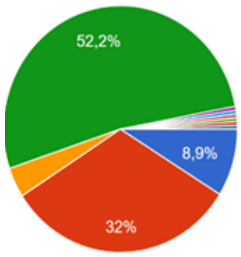


According to Graph 24, regarding the minimum number of independent units in permanent houses, 16.2% said 1 unit, 19% said 2 units, 32.4% said 3 units, 21.9% said 4 units, and 10.5% said 5 units.

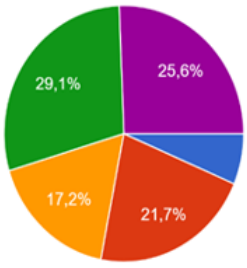
Graph 24 - Earthquake survivors' opinions on the minimum number of independent units that permanent housing should have

Graph 25		According to Graph 25, regarding privacy between buildings in detached permanent housing, 66% said very important, 30.5% important, 1.5% not important, and 2% had no opinion.

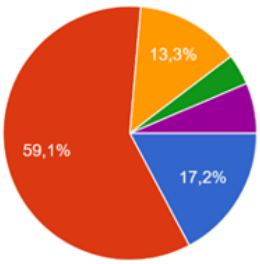
Graph 25 - Earthquake survivors' views on privacy between buildings in detached permanent housing

Graph 26		According to Graph 26, regarding the most important factors other than earthquakes for permanent housing, 52.2% said usability of the house, 32% said proximity to city center, 8.9% said affordability, 3.9% said proximity to relatives/friends, and 3% mentioned safety, solid ground, or all factors.

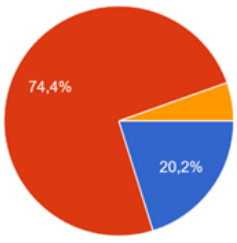
Graph 26 - The most important factors other than the earthquake for earthquake survivors in permanent housing

Graph 27		According to Graph 27, regarding how long earthquake survivors want to live in permanent housing, 6.4% said less than 1 year, 21.7% said 1-3 years, 17.2% said 4-7 years, 29.1% said 8-15 years, and 25.6% said 15 years or more.

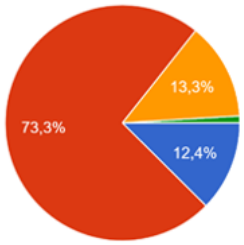
Graph 27 - Duration earthquake survivors want to live in permanent housing

Graph 28		According to Graph 28, regarding earthquake survivors' preference for living far from the city center if permanent housing must be built on solid ground away from the center, 17.2% said definitely yes, 59.1% yes, 13.3% no, 3.9% definitely no, and 6.4% had no opinion.

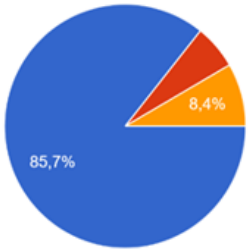
Graph 28 - Earthquake survivors' perspectives on the necessity of building permanent housing away from the city center

Graph 29		According to Graph 29, regarding whether the kitchen and living area in permanent housing should be in the same or separate spaces, 74.4% said separate, 20.2% said same, and 5.4% had no opinion.

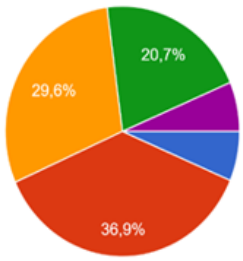
Graph 29 - Earthquake survivors' opinions on whether the kitchen and living area should be adjacent or separate in permanent housing

Graph 30		According to Graph 30, regarding the preferred number of wet areas (toilet, bathroom, shower) in permanent housing, 12.4% said 1, 73.3% said 2, 13.3% said 3, and 1% said 4 or more.

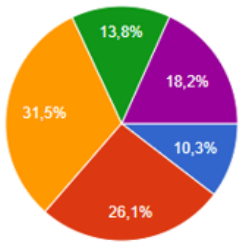
Graph 30 - Earthquake survivors' preferences regarding the number of wet areas in permanent housing

Graph 31		According to Graph 31, regarding whether permanent houses should be detached, 85.7% said yes, 8.4% had no opinion, and 5.9% said they should be multi-story.

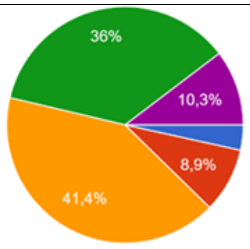
Graph 31 - Earthquake survivors' views on the detached nature of permanent housing

Graph 32		According to Graph 32, regarding thoughts on permanent houses being taller than 2 floors, 6.4% said definitely yes, 36.9% yes, 29.6% no, 20.7% definitely no, and 6.4% had no opinion.

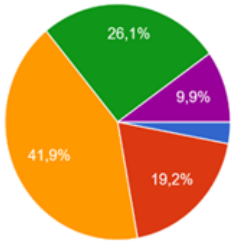
Graph 32 - Earthquake survivors' opinions on permanent housing being built higher than 2 floors

Graph 33		According to Graph 33, regarding opinions on designing temporary houses as permanent housing, 10.3% said definitely yes, 26.1% yes, 31.5% no, 13.8% definitely no, and 18.2% had no opinion.

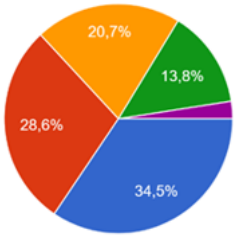
Graph 33 - Earthquake survivors' views on designing temporary housing as permanent housing

Graph 34		According to Graph 34, regarding thoughts on using a single container unit as permanent housing, 3.4% said definitely yes, 8.9% yes, 41.4% no, 36% definitely no, and 10.3% had no opinion.

Graph 34 - Earthquake survivors' opinions on the use of a single container unit as permanent housing

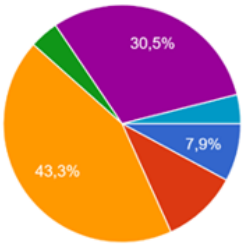
Graph 35		According to Graph 35, regarding whether container units can be stacked or expanded side-by-side to provide permanent housing, 3% said definitely yes, 19.2% yes, 41.9% no, 26.1% definitely no, and 9.9% had no opinion.

Graph 35 - Earthquake survivors' views on whether container units can be enlarged to provide permanent housing

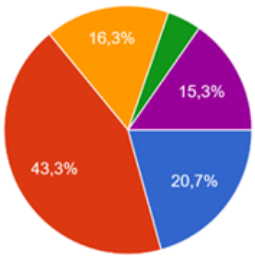
Graph 36		According to Graph 36, regarding the minimum number of floors permanent housing should have, 34.5% said 1 floor, 28.6% said 2 floors, 20.7% said 3 floors, 13.8% said 4 floors, and 2.5% said 5 floors or more.

Graph 36 - Earthquake survivors' opinions on the minimum number of floors permanent housing should have

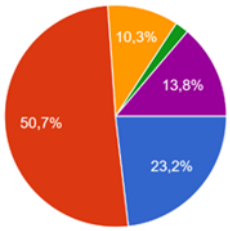
What are the opinions of the earthquake survivors included in the study regarding the minimum required space, new construction technologies for permanent housing, material properties, sustainability, and related issues?

No	Opinions of earthquake survivors regarding certain variables related to temporary and permanent housing	
Graph 37		According to Graph 37, when earthquake survivors were asked about the main building material that should be used in permanent housing, 43.3% responded reinforced concrete + steel, 30.5% new construction systems, 10.3% steel, 7.9% reinforced concrete, 3.9% prefabricated, and 3.9% other options.

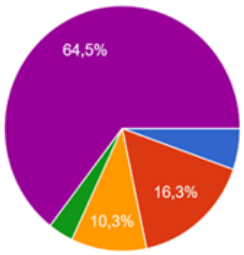
Graph 37 – Earthquake survivors' preferred main building materials to be used in permanent housing

Graph 38		According to Graph 38, regarding the question of whether sustainability can be achieved in temporary settlements/housing, 20.7% said definitely yes, 43.3% said yes, 16.3% said no, 4.4% said definitely no, and 15.3% said they have no opinion.

Graph 38 – Earthquake survivors' opinions on sustainability in temporary housing

Graph 39		According to Graph 39, in response to the question of whether sustainability can be achieved in permanent housing, 23.2% said definitely yes, 50.7% said yes, 10.3% said no, 2% said definitely no, and 13.8% said they have no opinion.

Graph 39 – Earthquake survivors' opinions on sustainability in permanent housing

Graph 40		According to Graph 40, when asked about their thoughts on layered manufacturing (additive manufacturing) in permanent housing, 64.5% said they have no opinion, 5.4% said it should definitely be done, 16.3% said it should be done, 10.3% said it should not be done, and 3.4% said it definitely should not be done.

Graph 40 – Earthquake survivors' opinions on layered manufacturing in permanent housing

4. CONCLUSION AND DISCUSSION

As a result of the housing needs that arise after a disaster, solutions such as emergency response, rehabilitation, and reconstruction are developed to meet these needs. However, housing-related problems emerge that cannot fully address user needs and involve environmental, social, and economic challenges. Addressing these problems requires significant responsibilities from many disciplines, especially architects, to ensure that disaster survivors can adapt to normal life as quickly as possible.

Quantelli (1995) stated that after a disaster, survivors tend to adopt housing solutions by returning to their pre-disaster living conditions, creating temporary shelters, upgrading temporary shelters to permanent housing, or building new homes. Temporary disaster housing should primarily be structures that meet the basic spatial and comfort needs of survivors, be quick and easy to set up, durable, made from recyclable materials, reusable by disassembly or relocation, and low cost (Savaşır, 2008). Considering Turkey's population, the high disaster risk of its housing stock, and prevailing economic factors, post-earthquake reconstruction requires substantial labor, expenditure, and reproduction efforts. Consequently, the organizational structure, preparation process, production variables, and implementation methods gain critical importance. As a result, it becomes imperative to urgently meet the housing needs that arise after an earthquake.

The study found that participants experienced housing-related problems especially during the first month after the earthquake. It was also observed that participants lacked information regarding the earthquake resistance of their pre-earthquake residences. Nearly half of the participants' homes were either damaged or completely destroyed due to the earthquakes. It was noted that emergency interventions did not begin immediately after the earthquake and that traditional methods were used to address housing problems once interventions started. Participants were unable to reside in their own homes even during the first month following the earthquake.

Important findings were reached regarding the earthquake housing needs after the disaster. The results indicated that participants wished to access earthquake housing as soon as possible. Additionally, the majority of participants had households with four or more members, highlighting that the number of rooms based on household size should be a determining factor in post-earthquake spatial planning. The responses to the research question about container and permanent housing formation largely supported this finding.

Most participants were highly educated. It was also found that the majority of participants had lived in their current homes for more than eight years and was homeowners. This suggests that if earthquake housing is constructed with permanence in mind and meets basic needs, residents can live in these homes for many years. Regarding minimum housing requirements, the study concluded that earthquake housing should contain at least three independent units, reflecting the living arrangements of the participants. Furthermore, participants expressed a preference not to live in high-rise buildings after the earthquake; instead, they favored detached or low-rise structures. Thus, it is necessary that permanent housing solutions after the earthquake avoid high-rise constructions. Since neighborhood relations were important to participants, this aspect should also be taken into consideration when providing housing.

The majority of participants indicated that the maximum acceptable transition period to permanent housing was up to six months. This is a significant insight indicating that models developed after disasters should be realizable within a six-month timeframe. Nearly half of the participants reported that they might migrate to other cities during the transition to permanent housing. This could disrupt the sociological balance and lead to challenges related to establishing new communities in other cities. Therefore, the post-disaster housing model must be produced quickly to protect and maintain sociological stability. Although most participants preferred earthquake housing close to city centers, it was also found that if permanent housing must be built on stable ground away from the city center, participants would be willing to relocate to ensure living on solid ground. The findings indicate that it is essential to take into account the living conditions, family structures, neighborhood relations, and housing preferences of the earthquake-affected population in order to ensure socially and culturally responsive post-disaster planning and reconstruction efforts.

While participants generally lacked sufficient knowledge about new construction techniques for permanent earthquake housing, they expressed a positive attitude toward sustainability. The study concluded that earthquake housing constructed with innovative building technologies—quickly built on stable ground, low-rise or detached, capable of accommodating the necessary number of rooms based on household size, maintaining spatial integrity while respecting neighborhood relations, and possessing durability and long service life—would represent the ideal modern earthquake housing model. Therefore, in order to rapidly meet post-earthquake housing needs and to optimize the quality of life for earthquake survivors, the utilization of innovative construction technologies would be highly appropriate. Systems based on innovative construction technologies can be categorized under five main headings: expandable and modular systems, inflatable (air-supported) structural systems, lightweight steel box systems, additive manufacturing technologies, and cross-laminated timber (CLT) structures. Taking into account the specific conditions of the affected region, other local factors, and the needs and expectations of the local population, the selection of the most suitable system among these five—which are advantageous in many respects and possess a high level of adaptability to various contexts—is of critical importance for ensuring post-disaster housing solutions at an optimal level.

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Research Article GU J Sci, Part B, 13(3): 543-569 (2025)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

http://dergipark.gov.tr/gujsb

Design for Brand Identity: A Case of Industrial Design Studio Process by Two Projects

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Article Info

Received: 11/08/2025
Accepted: 30/09/2025

Keywords

Product design,
Design project,
Brand identity,
Designer,
Design studio

Abstract

For industrial design studies, understanding the target market and the company/brand for which the design is being implemented is crucial for the success of new products, given the product design ideas of both design-candidate students and professional designers. This study focuses on the relationship between design, designer, and brand identity. It aims to uncover the relationship between designers' research, understanding, and interpretation of the brand, focusing on form and function, and the final product decisions. As part of the research, 26 prospective design students pursuing industrial design education were given two projects regarding product design and brand identity to observe their approach and design decisions. At the beginning of the process, the lecturers gave students the project topics, goals, and expectations for success. The students' design stages were evaluated as group work for the first project and individually for the second. A comparative analysis was conducted of how they reflected the keywords associated with the brand identity in their final product designs. The identical brands designed in different contexts in these projects, which featured physically and spatially, provided a source of information for students studying brand identity, thus preparing them for the expectations they will encounter in professional practice. The study results were interpreted as a guide for designers who continue professional practice in different sectors or adopt similar brand lines by revealing how the adjectives defined by the designers are reflected in the design language, form and function-oriented design decisions of the products.

1. INTRODUCTION

The design of products can be analyzed in several dimensions, such as functionality, aesthetics, meaning, and message transformation, as well as emotional, cultural, social, and meta-aspects [1, 2]. Industrial design not only defines a product's physical form and function but also shapes its meaning, the emotional connection established with the user, and the brand's strategic direction. Therefore, a product's mere aesthetic or functional success is insufficient; it is also expected to reflect the brand's values, identity, and strategic stance [3-5]. Therefore, product design should be guided not only by aesthetic and technical decisions but also by the concern for accurately reflecting the brand identity to which the designed product belongs. Especially in professional design practice, the designer's accurate analysis and internalization of brand identity during the product development is a critical factor in product success.

The impact of brand identity on the design process is significant not only at the product level but also at the professional practice level. When designers establish long-term collaborations with specific brands, they develop a design language specific to them over time [6]. This language ensures that the products are visually and experientially compatible. In professional design practices, the continuity of such a design language directly contributes to the sustainability of the brand identity. It also creates a sense of familiarity for the user across different product categories. How the designer integrates these identity codes into their design determines the product's consistency with the brand and user perception. The

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design's alignment with the brand identity helps users perceive the product as an object and a brand experience [7, 8]. This integrity supports the brand's position in the market and facilitates user recognition and identification with the brand.

In today's rapidly changing world, the professional practice of designers necessitates dynamic research and interpretation for new design outcomes. During design stages, the relationship between the product, designer and the company/brand crucially affects the end-product designs. At the center of this process, the designer becomes both a creative solution provider and the carrier and transformer of the brand's identity. Designers either create a design language by considering the brand's history, current position, and future vision, or reinterpret it while maintaining the existing language. In this process, the product becomes an aesthetic, functional tool, and visual and experiential representation depending on the brand identity [9, 10]. Therefore, in a designer's professional life, understanding the brand's identity and correctly interpreting and integrating it into the design process is a fundamental prerequisite for creating successful and holistic products. Designers are responsible for producing creative solutions while interpreting the values of the companies/organizations they represent, the target audience, and the brand culture. In this context, a direct connection is established between a product's style-oriented design language and the brand's identity. The brand's values, culture, history, vision, and the relationship it seeks to establish with the user directly influence design decisions [11, 12]. When a designer evaluates a product solely based on formal or technological solutions without understanding this set of values, the emotional and semantic connection that must be established between the brand and the user may be lacking. This context is particularly evident in globally recognized brands, as the brand may represent a lifestyle, a value system, or a sense of belonging for the user. When a product's form language, material selection, color palette, or user interaction holistically reflects the brand's identity, the user's relationship with the brand is strengthened [13, 14]. For instance, an electronic device with simple lines and an intuitive user interface gains value for its functionality and embodies the brand's core principles, such as simplicity, accessibility, or advanced technology [15, 16].

This study emphasizes the growing importance of brand identity in professional product design. The study aims to explore the theoretical and practical connections between the role of product design and designers and the brand identity. This study will examine the design processes of third-grade prospective designers pursuing an undergraduate degree in industrial design at a university. Two projects are focused on revealing the designers' approaches to physical and spatial products, individually and in groups. The primary purpose is to understand their definitions concerning brand identity, investigate their development in the design process and evaluate their final designs and design decisions accordingly. The students' definitions for the compatibility and connection of product designs with brand identity, and how these adjectives are reflected in the products, are also discussed. In this context, the research questions of the study are explored as follows:

- At what points of the design process do designers establish the relationship between a brand's identity and product?
- What keywords do designers uncover regarding the brand and its identity in professional practice?
- How do the keywords that designers define reflect on the designer's aesthetic interpretation and product design language?

These questions aim to be answered according to the results obtained by two projects. While addressing these research questions, the theoretical framework focuses on examining the experiences of designers who create brand-oriented designs through the lens of students who take the first steps of the process. The design elements they focus on during this process and their evaluations of the products they create concerning the brand are central to this study. Although the link between brand identity and product design is frequently acknowledged in the literature, this relationship tends to be reduced solely to formal or superficial aesthetic features. Overemphasis on visual integrity or material selection risks ignoring brand identity's deeper cultural, symbolic, and experiential layers. A more robust theoretical framework that integrates design theory, semiotics, and brand management approaches is needed to move beyond a

purely descriptive framework for brand-oriented design decisions. Thus, in the scope of this research, several dimensions of product design studies and the role of designers in professional practice concerning the companies and brands of design are examined in detail.

2. LITERATURE REVIEW

This literature review examines research on the three-way relationship between design practice, brand identity and designer perception. Existing research highlights the importance of designers acting as bridges between market, company, and brand identities, which affect the design of new products.

2.1 Dimensions of Product Design Practice

Products serve customers/users with both formal and functional properties. Once basic needs such as usability, reliability, and comfort are met, new emphases emerge, such as the product's aesthetics and emotional appeal [17]. Lidwell applied Maslow's hierarchy of needs triangle to product designs to emphasize the importance of aesthetics in products. Accordingly, for product designs to be successful, they must first meet basic needs. The highest-level needs of mastery and creativity transform designs into something different, innovative, and satisfying. At this stage, users' aesthetic judgments about the product play a significant role [18]. A product's positive formal characteristics not only indicate that it looks good but also indicate that it speaks to the user functionally. Finding a clear answer to the visual quest provides the designer with the information they need throughout the process [3]. Bloch correlates consumer reactions with the formal characteristics of products. A well-designed product draws consumers to itself, speaks to them, and adds value by enhancing its quality. To better analyze design, the study developed a conceptual model of product form and consumers' psychological and behavioral responses [19]. Norman argued that designers should create products with immediate visual and tactile appeal. In his triple design model, including visceral, behavioral and reflective behaviors, he emphasized the aesthetic and functional values of the product. Visual properties lead to usability and positive feelings, increasing users' overall experience regarding a product [7]. Many studies claimed that reactions to products are emotional, thus emphasizing that emotions are important in product analysis [4, 20].

Design features include messages from designers or companies that would be meaningful for the users of a product [9, 21]. In the model of Monö, product design communication focuses on transmitting a message from the product designer to the intended recipient through a channel. In this model, the designer conveys messages to the user through the product as they design it. Crilly developed this model in their studies. The encounter between the producer and the consumer begins with the user perceiving the product through their senses. While functionality is presented as an essential feature for the product, visual elements play a significant role in comparing similar products in the marketplace and determining their preference. The consumption context relates to the product's geometry, size, texture, material, color, graphics, details, and the channel through which users perceive these elements through sight, touch, taste, smell, and hearing, as well as the consumer's cognitive, emotional, and behavioral responses [3].

In addition to visual characteristics, the consumer's personality, cultural, and social influences influence consumer decisions [22-25]. It is asserted that consumers buy products due to their symbolic meanings, including their cultural status and ideology emerging from their physical properties and style [26]. Hekkert also claimed that users' cultural and social values, prior knowledge, and expectations play an important role in the aesthetic experience of products [1]. Perspectives from social sciences, cultural context, and marketing disciplines have made concepts such as the social importance of products, consumer behavior, and user research, as well as terminologies such as the commercial dimension of design, target market, and brand identity, vital issues for industrial design studies [2].

2.2 Design's Role for Brand Identity

The design of the products plays a critical role in giving information about brand identity. In a competitive market where functional demands are similarly satisfied, products' aesthetic features and emotional attributes play a significant role in style and experience [27, 28]. The triple design model of Norman is compatible with forming brand identity where users are eager to express or find themselves via their products, giving them an emotional meaning [7, 29, 30]. It is stated that brands must have deep-rooted identities to succeed in today's competitive world, emphasizing the importance of a brand's visual and characteristic elements. Using sincerity, excitement, competence, sophistication, and ruggedness dimensions proposed by Aaker in 1997, the study stated that the desired brand personality perception can be successfully created in consumers based on the design elements used in creating a visual brand identity [12, 30].

Brand identity is strongly linked to product shape. A product's geometric form is crucial in conveying a holistic design identity to end users. Maintaining brand identity across shape changes provides a means of systematizing design principles, as in the case of a unique product family developed under a specific design concept [5]. Visual properties convey messages about the product, its designer and the values of the related company or the brand. Aesthetic elements become part of the brand's tangible entity, creating a difference from the rivals, giving meaning to products, and consumer loyalty [11]. Using aesthetics, users can understand a product and interact with its interface [31]. Product designs are critical to the value of the brands, as they try to position themselves in an identifiable place. Thus, they try to use formal elements besides functional ones as strategic determinants for the brand's success to structure a consistent design language [32]. It is focused on the terminology of design language that emphasizes the unity and repetition of similar visual elements, which can create a relation between users' minds and the products of related brands [6]. When creating products, designers aim to establish a design code as the DNA of products to ensure alignment with the brand identity, which gives its key characteristics, values and individuality [11]. This DNA includes brand-specific guidelines regarding various design decisions for several product categories, such as the use of formal and functional as graphical features, lines, shapes, scales, proportions, surface applications, textures, patterns, colors, material choices, details, interaction and usage steps [8, 13, 33]. That kind of visual elements and signatures of brands through the products make users recognize it even if they do not see the brand's logo [34]. Thus, the products behave as physical aspects and touch points of brands, as in the examples of Apple's minimalistic approaches, Dyson's technological innovations and Alessi's emotional touch on designs [35]. It is also emphasized that the concept of semantic transformation, whereby brand values are defined by consumers through some keywords and adjectives (e.g., "fun", "futuristic", "soft") and translated into product properties such as form, size, color, materials, and interface [6]. To illustrate, Apple's minimalist design language visually depicts the features of simplicity, novelty, and quality inherent in the brand identity [15]. Raposo proposed a design-driven branding method for designing a brand's visual identity. This model aims to improve the brand's visual language by integrating the brand-world-market-people relationship with dynamic design processes such as co-design, testing, and evaluation [16].

A systematic literature review was conducted on brand visual identity and consumer attitudes. This review revealed that academics and practitioners have researched brand visual identity in the context of brand communication and corporate governance. Based on 559 articles published between 2004 and 2024 in the Web of Sciences, ProQuest, Scopus, and Elsevier databases, it was observed that consumers' brand visual identity is based on key elements such as the brand logo, color, name, typography, and font. These visual identity elements influence consumers' perceived brand quality, brand personality, brand satisfaction, loyalty, and liking, as well as their purchase intentions and social perceptions [36]. Another study also focused on brand identity and brand image concepts. The study defined brand identity as the strategic decisions, values, personality traits, visual elements (such as logos and typography), and messages that create emotional connections and differentiate a company from its competitors, which it

aims to create and maintain in the minds of consumers. The brand image was related to reputation, quality, reliability, customer service, and social responsibility efforts [37].

2.3 Designers' Perception of Brand Strategy in a Professional Context

Designers are vital in researching, interpreting, and developing brand identity through product designs. They create a distinguished and consistent design language for the brand that needs to be understood, internalized and recognized by its consumers for a long time. In the modern world, designers' responsibility for developing brand identity is increasing, aligning with a company's values, priorities, and target customers [38]. Brand strategy directly influences new designs. A company's identity determines its product line and design decisions.

Furthermore, by prioritizing aesthetics and product sustainability, a company can utilize more expensive, high-quality materials and advanced technology in new products. In professional practice, designers maintain the company's strategy and brand identity while creating new products. The current market's demand also plays an important role in the designer's ideas and new product selection. Thus, designers need to make design decisions that meet both consumer/market needs and brand expectations, keeping their core values [10].

Moreover, the cultural economy approach interprets the value of brands and designer products through market prices and within the context of cultural and social capital [39,40]. This perspective emphasizes that designers shape user perception by reflecting the brand's cultural values in their products. In this context, designers explore issues related to brand goals, cultural and social sensitivity, and user expectancies to design consistent and engaging brand experiences. According to a study, in professional design practice, designers should support the reliability and recognition of a brand with their design decisions. Designers' responsibilities become higher, especially for brands whose physical products are most attractive, such as consumer goods, electronics and automotives [11]. A study was conducted on brand identity and physical product design using the example of various automobile frontal shape designs. The results showed that inheritance for a brand can be provided by imagery transfer and form aesthetics of products [14]. For this purpose, designers use consistent design elements including line, shape, size, color, typology, materiality and utilization choices.

The consistency in product designs may result in some difficulties, as well. Sometimes brands face problems entering a new market or countering new users due to their strict design language and resistance to innovations [34]. As market needs change depending on the cultural requirements, global brands need to adapt and localize their design elements to maintain identity consistency [41]. In this situation, the designers alter the key design values to protect the brand's uniqueness, so the designers play a critical role. Designers solve this dilemma by using innovative but compatible elements that improve the visual language without giving up the values that preserve the continuity of the brand [9]. As proposed in the literature, brands can identify and position themselves in the market by adopting design-oriented innovation, which causes a critical alteration in the meaning of products [15].

Within the framework of the design practice, brand identity and designer perception triangle developed for the study, a dynamic network of relationships emerged that emphasized not only the physical and functional characteristics of products but also their symbolic and cultural values. While designers encode brand values into products, users interpret these codes according to their cultural and social backgrounds. Thus, the product becomes both a reflection of the brand's identity and a determinant of the user experience. In this way, this study contributes to the literature not only by documenting student projects but also by critically examining the tension between the superficial formal reflections of brand identity and its deeper symbolic layers. While the students' projects demonstrate their ability to capture visible aesthetic codes, they also reveal the challenges of integrating brand identity's cultural, emotional, and

experiential dimensions into design decisions. This analytical approach positions the study as part of broader discussions about the semiotic dimension of design and how institutional dynamics shape design practices.

3. METHODOLOGY

This section explains the study participants, design procedure, and study tools, consisting of two studio projects.

3.1 Participants of Design Studio

This study included students who continue their bachelor's degree education in the Industrial Design department with three years of designing experience. Twenty-six designer-candidate students were analyzed through ID302 Product Design IV, a compulsory and practice-oriented course. In this design studio lecture, the students were expected to carry out, fulfil, and present all the requirements of a design project similar to a simulation of product design processes conducted in professional practice. 17 female and 9 male students with a mean age of 21 participated in the study. Students worked either in groups or individually.

3.2 Study Procedure

Designer-candidates were given two projects throughout the semester, which continued for four months. They were given two project briefs that focus on different design expectations. For 3rd-grade students, researching the brand and having insight about the companies was evaluated as essential for students to be prepared for their professional practice. The study period started with a lecture where the instructors gave information about the brand identity and then covered the process from the students' research to the final product designs.

Thus, two projects were related to the brand identity and its reflections on new product designs developed by the students. Each student was asked to research the given brand to understand the brand's identity. The variety within brands was considered vital to understand different purposes, design patterns, companies' aesthetic approaches, production decisions, consumption properties, and user demands. It was intentionally chosen that the brands should serve in totally different products and services from their existing product line. The brands chosen were Tesla, Ikea, Sketchers, Ford, Bang & Olufsen, Braun, Samsung, Victorinox, and Columbia. The most critical part is to collect designers' keywords about the brands and their impacts on the final design decisions.

The success of the product design and the designers was calculated according to an evaluation criterion including a research sheet, a mood board, an inspiration board, a benchmark, a perspective, technical drawings, problem definition and design solution, usage scenario, material and details, and scaled models of the products.

3.3 Study Tools

Study tools consist of two briefs of the projects below, as shown briefly in Figure 1. Two projects were selected for in-depth analysis due to their distinct design focuses and the approaches expected of designers: one focused on physical product design, the other on spatial design. The goal was to uncover how designers interpreted the same brand identities across product designs with varying outcomes at different scales of design implementation. By comparing individual and group-based outcomes, the study aimed to capture both personal interpretations and collective negotiations of brand values, thereby providing richer insights into the role of brand identity in shaping design decisions.

First Project:

This project required a design regarding brand identity and product family. Within the first project's scope, focusing on brand identity, students were expected to design new products that would carry the same design DNA of the defined brands. When designing the requested product family, students needed to consider certain aspects. First, students should do research regarding "brand" terminology. The chosen products of this brand should have problems related to their aesthetic value, function, usability, etc. Second, the designers should evaluate the related products with design solutions of this brand as if they were this brand's designers, according to these problems. The product family should have a consistent design language, including unity of visual elements according to users' needs. There was no restriction on the materials.

This project was conducted in groups of three students (the last group included two), determined by drawing lots. Each group was assigned a brand chosen by drawing lots from a pool of brands established by the course instructors. Each group is expected to design an electric kitchen appliance family with three products not currently in the brand's product range. The product family need to include a cooker (toaster, grill, deep fryer, etc.), a beverage maker (coffee maker, tea maker, kettle, etc.), and a chopper-mixer (blender, mixer, chopper, etc.).

In total, nine groups designed 26 products, including 9 product families. This project focused on a product family that can be used physically in kitchens. Two lecturers of the design studio evaluated it at the end of the process.

Second Project:

In this project, each student is asked to design a first-class passenger module for an aircraft. Within this project's scope, focusing on brand identity, students were expected to design a living and travel area that would carry the same design identity as the previously defined brands. When designing the requested product, students needed to consider certain aspects. First, students should keep using their knowledge and research regarding their existing brands. The products of this brand should have problems related to their aesthetic value, function, usability, etc. Second, the passenger module should have a consistent design language, including unity of visual elements according to users' needs. There was no restriction on the materials.

This project was individual, requiring each student to continue to design on their existing brands. The single passenger first class module/unit expected to be designed must have many functional features.

- Sitting and locating in the aircraft: First, each unit must be positioned side by side and back-to-back in a section of the aircraft.
- Relaxing and sleeping: Each unit must comfortably meet the needs of people travelling for long periods, including sleeping.
- Eating, working, watching TV and having a business meeting: The passenger must be able to eat and work with their laptop in this unit.
- Storing the bags and accessories: The areas where the cabin baggage will be placed must be designed.

Different from the first project, in the second, 26 individual products were designed at the end of the process. Moreover, this project focused on a spatial application of product design. It was evaluated by four lecturers who participated as guest jury members from three different universities, as illustrated in Figure 1.

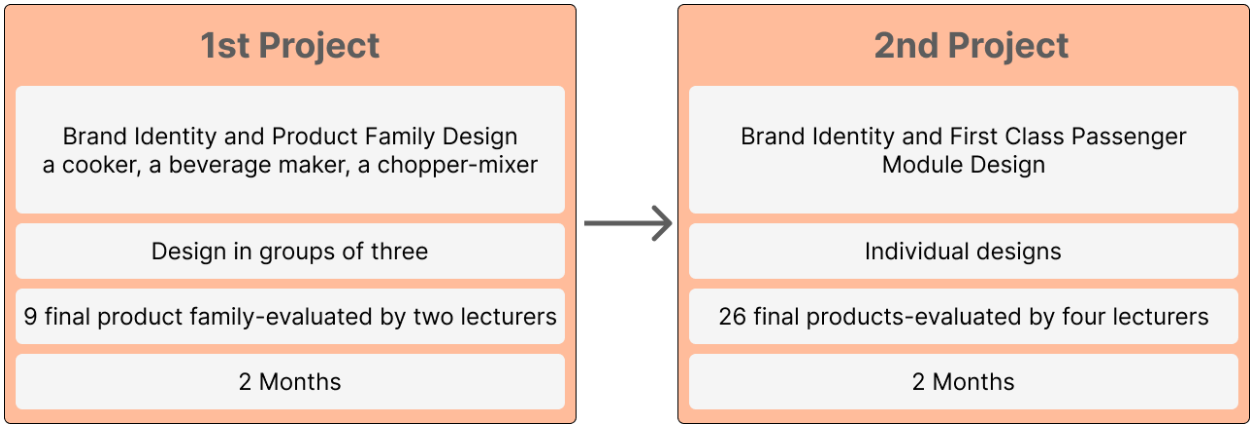


Figure 1. *Flow of Design Process by Two Projects*

4. ANALYSIS

This section includes the outputs of two projects and a thematic synthesis of two product design decisions. How students evaluate brands and apply design decisions accordingly are explained and compared through the product outputs of the first and second projects.

4.1 Designs for the First Project

As part of the first project, designers developed a product family. Each of the three designs included a cooker, beverage maker and chopper-mixer. The designers decided on the product details for the designs developed for the three main functions within the framework of the brand. For instance, one group designed a hand mixer in the mixer category, while another chose a tabletop mixer.

Each group began their projects by analyzing their brands. The designers conducted detailed research analyzing the brand's historical development, purposes and target users. Next, they researched and interpreted the brands' existing products, product line and product families. The brand's design style was analyzed by examining the shapes, lines, textures, and surfaces that create the main form and style. Additionally, each group of designers created the brand's moodboards as given in Figure 2.

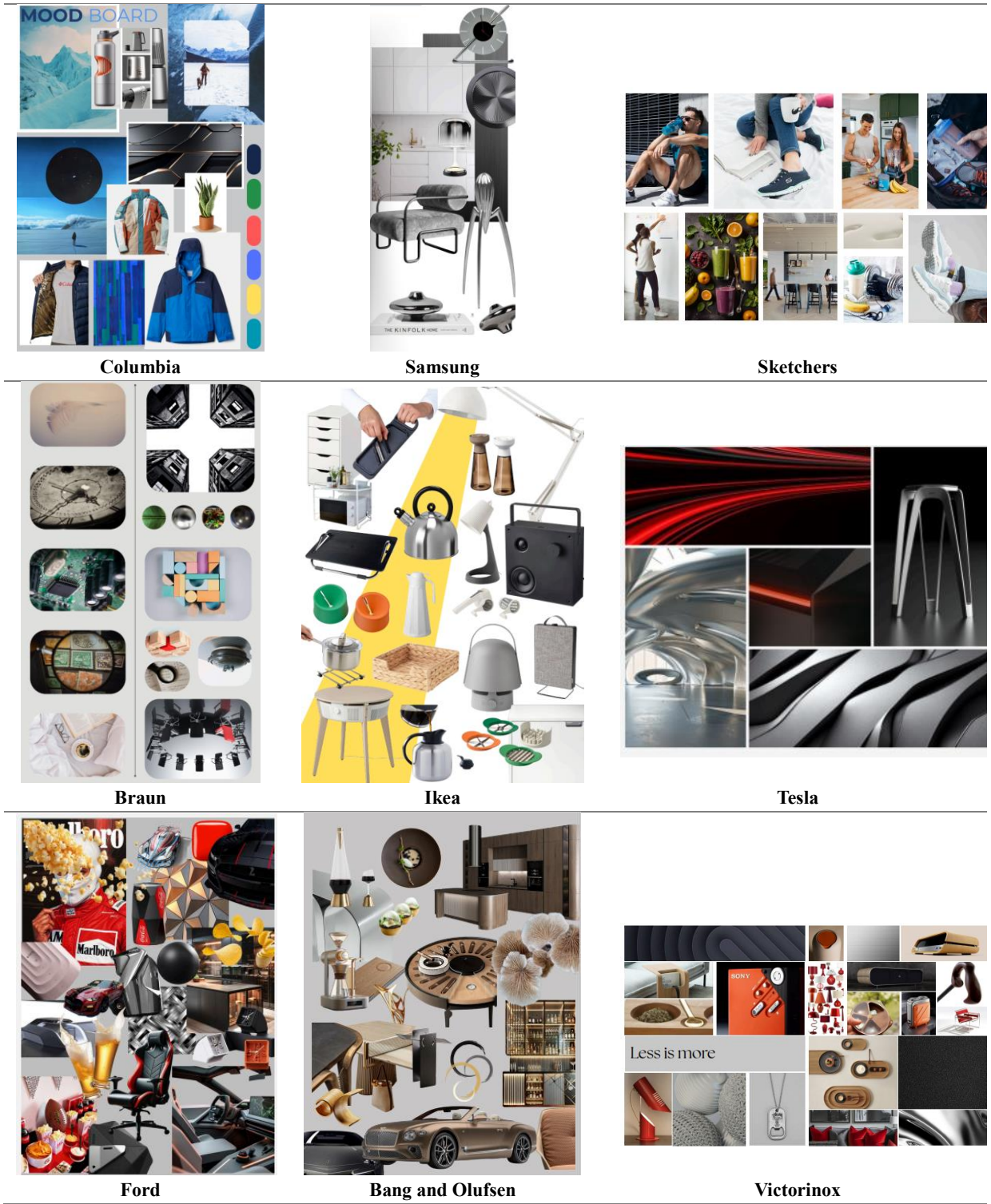


Figure 2. *Moodboard Designs for Nine Brands*

Moodboards, inspiration boards, and benchmarking steps gave students more profound insight into the brand, its target users, and the primary purposes of its products. While conducting brand analysis with visual presentations, the designers determined five keywords that describe the brand and its products. They aimed to develop a product family suitable for the brand by reflecting the analysis on the forms within the framework of the keywords. The design process began with hand sketches. They worked to develop their product designs using hand sketches and the three-dimensional models they developed following the regular critiques in class. The final product families they designed as their first project are demonstrated in Figure 3.

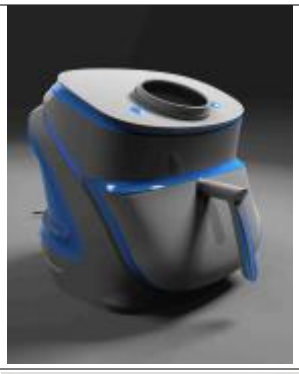
Brand	Cooker	Beverage Maker	Chopper-Mixer
Columbia			
Samsung			
Sketchers			
Braun			
Ikea			

Figure 3. *Final Kitchen Product Family Designs of Nine Groups Based on Their Brands*

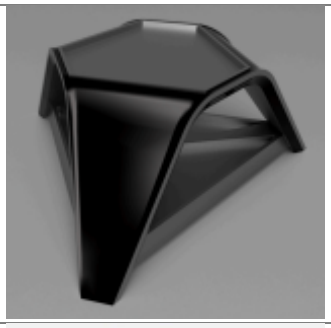
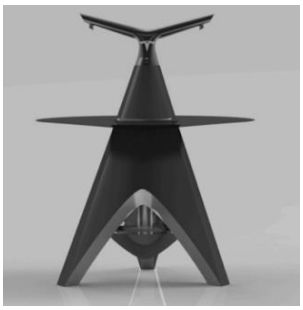
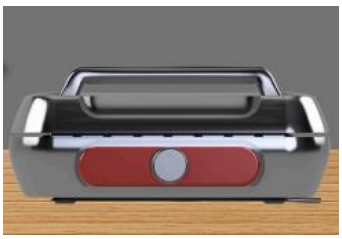
Brand	Cooker	Beverage Maker	Chopper-Mixer
Tesla			
Ford			
Bang & Olufsen	Not Designed		
Victorinox			

Figure 3. (continued) *Final Kitchen Product Family Designs of Nine Groups Based on Their Brands*

Columbia: The group, which designed a product family for the Columbia brand, chose smoothie blenders, steam cookers and hand mixers. Brand keywords were defined as simple and functional, durable, practical, dynamic, rhythmic, and open to exploration and adventure. The designers aimed to reflect the five keywords they identified, both aesthetically and in line with the brand's design language, with their hand drawings, which are exemplified in Figure 4. While developing the product family, the designers' aimed to design the three products that comprise the family to be consistent and part of the Columbia brand for each product. The products for Columbia, an outdoor and sports brand, were

designed with sharper lines and vibrant colors. While there was a quest for a dynamic form, they also strived to achieve simple forms with sharp, defined lines. Combining different materials and the selected textures comprising the brand line strengthened the designs.

Samsung: Designers in the second group designed an air fryer, coffee machine, and blender for Samsung. The five keywords they chose to reflect the design identity of the Samsung brand were innovator, simple, premium, technological and functional. Samsung's infinity display technology has strongly inspired designers. They created their forms using simple and minimalist lines and surfaces. At the same time, they aimed to emphasize Samsung lines in their forms by adding dynamic surface structures that reflect today's production technology to these simple forms. They used similar curves in the three products they designed for the product family and aimed to create a style for the brand by prioritizing function and technology. They referred to Samsung's technological products using black and grey colors in their designs.

Sketchers: The Sketcher group designed an air fryer, a coffee maker and a smoothie blender. Their five keywords were ease of use, compatibility, dynamism, comfort, and health, which could describe the design language of the Sketchers brand. The brand's fluid lines inspired the designers mostly. The flowing lines in the Sketchers brand's overall identity reference comfort and foot health. Applying these fluid and dynamic lines to their product forms resulted in sculptural designs. While applying these lines to kitchen appliances, designers also prioritized functional features. Figure 4 shows the hand-drawing examples of the Sketchers group.

Figure 4. *Hand Sketch Examples: The Upper One-Columbia; the Lower One-Sketchers*

Shoe lines inspired the hand-drawing process of a kitchen appliance. Each line in the kitchen appliance was designed to reference a design function. Additionally, designers who designed for the Sketchers brand aimed to underline the sporty atmosphere of the brand by using white and blue colors as the final touch on their products.

Braun: The Braun group designed the sous vide, espresso machine and hand mixer as a product family. This group of designers identified precision and quality, minimalist and functional, reliable and innovative, smart and intuitive, and sustainable and durable as five keywords. Designers developed their forms using straight and simple lines to emphasize Braun's minimalist brand identity. To create orderly and defined designs, they ensured that each line served as a reference point. They approached their products holistically, creating them with well-defined lines. Each component and surface design element of the product were harmoniously integrated into a whole. Their minimalist and straightforward approach ensured the designs could be produced with today's technology, ensuring a modern feel. Emphasis was placed on product details and finishes to ensure the design of the product family was aligned with Braun's brand identity.

IKEA: The IKEA group designed the toaster, espresso machine and blender as a product family. Their five keywords were minimalist, affordable, sustainable, innovative and user-centric. The first thing designers who developed products for the IKEA brand paid attention to is that IKEA has modular products, which is its most important feature. Designers' focus on its modular products was a key feature of IKEA. Second, they ensured that the designs were as simple as possible regarding materials and form, while remaining as minimalist as possible. Each modular component was carefully designed to be functional and stylish. In order to achieve this simplicity, the designers aimed to obtain easy-to-use products based on basic geometric forms. In addition, using different vibrant colors in the products references IKEA's fun and straightforward design.

All groups incorporated 3D model making into their industrial design processes as part of the project requirements. The IKEA group contributed to their processes by revising each part of their modular designs by 3D printing them multiple times to check the problematic design points and develop them further, as demonstrated in Figure 5.

Figure 5. *3D Print Model Examples of IKEA Group*

Tesla: The Tesla group designed a raclette machine, a moka pot, and a coffee grinder as part of its product family. Their five keywords were smart, futuristic, minimalist, aerodynamic and innovative. It was considered vital for the Tesla brand to target early adopter personas. The brand's futuristic products were emphasized as a strength for the brand's identity and served as a significant source of inspiration for the designers. The group members who designed for Tesla paid close attention to these technological

improvements of the brand, which were in line with users ' expectations. Curved surfaces and unusual forms that could be produced with high technology significantly shaped the designs. Five keywords identified by the group members were found to direct the designs toward sculptural structures. The designers tried to support the futuristic perception by finishing the products only in grey while creating as dynamic forms as possible.

Ford: Designers in the Ford group designed a popcorn machine, a beer brewer, and a veggie processor. The five keywords that the designers chose to reflect the design identity of the Ford brand were durability, performance, reliability, American heritage, and innovation. Because surfaces reflect the design identity of Ford, being an automobile manufacturer, designers in this group emphasized surface movement in their products using vibrant and bright colors. They gravitated toward more crude and ostentatious forms, drawing inspiration from American culture.

Bang & Olufsen: Since this group consisted of two designers, there were two product designs, a soda maker and an ice maker, in the product family. Five keywords of designers were identified as premium, high quality, luxury, sculptural, and ergonomic. Being a premium brand, Bang & Olufsen had inspired designers with its sculptural forms reminiscent of works of art. Another key focus for the designers was the high-quality of existing brand products, joining various materials. In addition, the efficient functional use of the products was also considered while searching for a sculptural form.

Victorinox: The last group designed a product family for the Victorinox brand. These designs were a toaster, a coffee maker and a chopper, and their keywords were functionality, durability, flawlessness, timelessness, and stylishness. Designers were mostly inspired by the brand’s identity, serving multifunctional and timeless products. A search for the product forms was made with simple and timeless lines. The red color that depicts the brand was frequently used in the details of the designs.

After completing this project, the second project's outputs were examined in a diverse context, where the brand value was questioned in a more spatial-focused product form.

4.2 Designs for the Second Project

Each student designed a first-class cabin using the same brands as part of the second project. The brands were kept the same for each student, except for Sketchers. The Sketchers group asked for a different brand, which was decided as Razer at the last step. The final designs developed by the students individually are given in Figure 6.

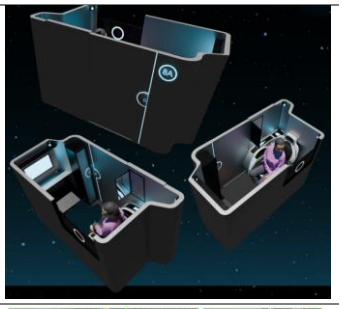
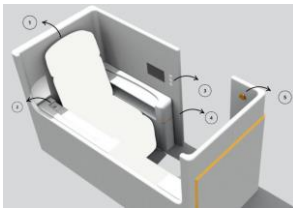
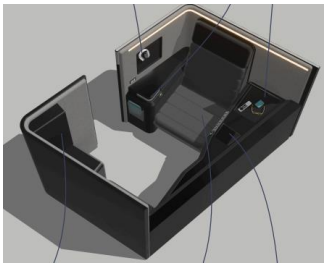
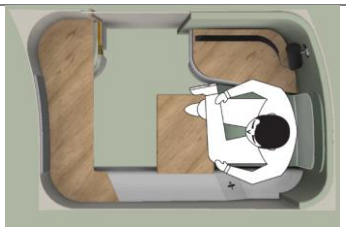
Brand	Designer1	Designer 2	Designer 3
Columbia			
Samsung			
Razer			
Braun			
Ikea			

Figure 6. *Final First-Class Cabin Designs of Individual Designers Based on Their Brands*

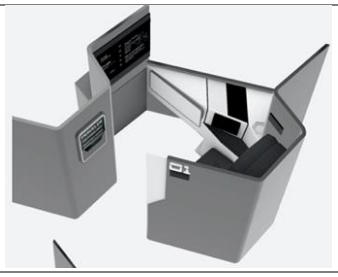
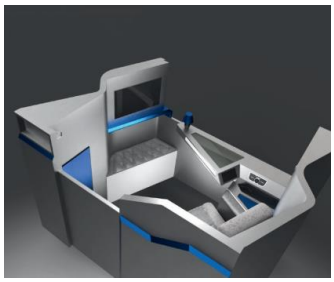
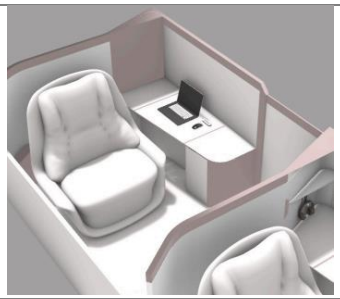
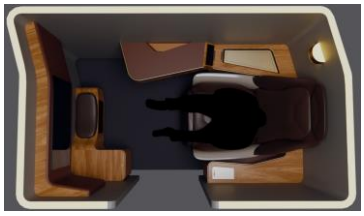
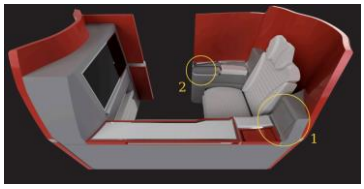
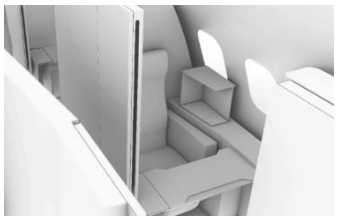
Brand	Designer1	Designer 2	Designer 3
Tesla			
Ford			
Bang & Olufsen			
Victorinox			

Figure 6. (continued) *Final First-Class Cabin Designs of Individual Designers Based on Their Brands*

Columbia: The designers used hard and sharp lines in the second project, as in the kitchen appliances. They chose to use tones of blue and green in the interior so as not to disturb the user. Due to air travel safety standards and the cabin's functionality, they tried to design ideal units by distorting the harsh lines of the brand identity. Additionally, the units they designed in a segmented structure, with metal joining details, ensured that the sporty feel of the brand identity was preserved.

Samsung: Although the designers worked independently throughout this project, they each gravitated toward curved lines and scalloped elements to keep Samsung's brand identity. They shaped their cabinets with continuous lines and defined geometric shapes. Drawing inspiration primarily from Samsung's latest mobile phones, they sought to combine both technological and luxurious perceptions. Possessing a futuristic approach, the designers emphasized the sense of luxury with metal details, metal shades throughout the cabinets.

Razer: The design group developing products for Sketchers asked to change their brand and chose Razer as a new brand for their second project. Each designer worked independently to design a cabinet for Razer. However, they were not given additional time for research and analysis on the new brand, which increased the time pressure for detailed brand research to catch the remaining designers. In their independent designs, they did not deviate from one another. All designers used the dominant black and green LED lighting elements of the Razer brand identity. While each designer chose different keywords, the following were the most common: performance, power, aggressive, customizable and futuristic. Due to the dominant character of the brand identity, the first-class cabin designed by each designer was somewhat reminiscent of gamers' rooms.

Braun: The individual designers of Braun's first-class cabin maintained the brand's style, which was established in their first project. They brought the style of their first products to their second designs. They shaped their cabinets by blending the same minimalist design with ornate details. They finalized their cabinets with a smaller variety in colors and textures, prioritizing the function. While reflecting the Braun style in space, they created their units with simple and defined lines. While all three designers generally exhibited a similar approach, they differed in the space's layout.

IKEA: Unlike others, the IKEA group had a unique experience designing a first-class cabin for the furniture brand. While they could easily incorporate IKEA's modular structure into kitchen appliances, they could not do the same functionally due to airline safety protocols. Therefore, they aimed to design functional, easy-to-use units with simpler lines. The diversity of IKEA's extensive product range allowed each designer to differentiate their designs. This situation resulted in three distinct cabinet design projects. Designers either highlighted the colorful and playful aspects of IKEA's brand identity or opted for completely minimalist lines. The designers did not differ in color use. Generally, they complemented their designs with simple cream and white tones, aiming to create spacious interiors.

Tesla: Although the designers worked independently, the three resulting cabins shared similar characteristics. The distinctive, sharp, and futuristic lines of Tesla inspired the final designs. While Tesla's more curvy lines were prominent in the first project, the straighter and sharper lines were highly used in the first-class cabins. Tesla's futuristic brand identity was also functionally reflected in the cabin designs. The designs used touchscreens, sensor-controlled doors, and cabinet doors as technological accents. As a final touch, emphasis was placed on grey and black colors.

Ford: While Ford's designers were inspired mainly by the surfaces of cars in the first project as a group, they individually started this project by taking inspiration from the interior lines of existing products and car seats: functional configurations and buttons on the dashboard, in particular, guided cabin designs. Ford's fluid lines and comfort-focused units were reflected in the cabin designs.

Bang & Olufsen: The designers started their project to keep the premium perception, which was the central element of the brand identity. The key focuses for designers were the high-quality materials and elegantly crafted details that define the luxury brand's image. They incorporated wood and metal into their cabin designs. Functionally, the designs were sleeker and larger than other brands' products.

Victorinox: As in the first one, the designers prioritized multifunctionality and timeless lines in this project. Each designer interpreted the brand identity differently, seeking inspiration from existing product lines. They referenced the brand identity by focusing on the functionality of the cabin's units.

4.3 Thematic Synthesis of Two Design Projects

This section presents a thematic synthesis of how students transformed brand identity into final design outcomes through two projects they designed in groups and individually.

Table 1. *Thematic Synthesis of Brand Identity and Product Design Decisions by Two Projects*

Brand	Brand Focus (by designers)	Project	Design Decisions	Designer Purposes
Columbia	Simple/functional, durable, practical, dynamic/rhythmic, adventurous	Kitchen Product Family	Sharp and dynamic lines, high use of vibrant colors, material and textural contrasts	Group of designers conveyed a sporty and dynamic brand image through lines, surface movements, and colors, but integration of the cultural narrative was limited.
		First-Class Cabin	Segmented units, blue and green tones, sharp lines softened for comfort	Individual designers maintained the brand's sporty character with sharp lines but faced a dilemma between formal consistency and experiential comfort. While the cultural and symbolic brand dimensions were partially integrated, spatial constraints limited the full cultural narrative.
Samsung	Innovative, simple, premium, technological, functional	Kitchen Product Family	Minimalist lines, geometric shapes with technological references, dynamic surfaces, grey and black palette	Designers in a group reflected the brand's technological identity through a minimalist visual language. Formal consistency was achieved through the pursuit of a futuristic aesthetic. However, user interaction and the experiential aspects of the products were more limited in their focus.
		First-Class Cabin	Curved lines, scalloped surface movements, metal accents, futuristic elements	Designers individually focused on surface elements using curved and distinct lines. While the technological emphasis was maintained, experiential consistency was partially reflected through touch and interaction.
Sketchers **Razer**	Ease of use, compatibility, dynamism, comfort, health Performance, power, aggressive, customizable, futuristic	Kitchen Product Family First-Class Cabin	Flowing, dynamic lines Black and green colors, LED lighting, exaggerated surface elements	In the initial design reviewed by the group, the designers used fluid, sculptural lines to balance between aesthetic elements, dynamism, and comfort. From Sketchers to Razer, the cultural context also changed. Designers consistently used LED lighting and color. Surface elements were used extensively to emphasize the strong brand signature of cultural identity regarding gaming aesthetic, while designers' interpretation remained limited.
Braun	Precision/quality, minimalist, functional, intuitive/reliable, sustainable/durable	Kitchen Product Family	Minimalist straight lines, simple forms, geometrically defined surfaces, material precision	Within the group, designers focused on strong visual consistency using straight lines and minimal forms. Surface touches preserved brand codes, but experiential interaction remained more subordinate.
		First-Class Cabin	Simple, defined lines, visually apparent forms, functional layout, subtle textures	While designers focused on a formally consistent design language, they adopted a minimalist approach to aesthetics. Individual designers focused more on user experience, striving to balance between spatial arrangements and functional constraints.
IKEA	Minimalist, affordable, sustainable, innovative, user-centric	Kitchen Product Family	Modular units, geometric forms, playful colors	Designers working within the group emphasized the brand's modularity and playful aspects, striving to balance functional and visual consistency. However, the cultural understanding of the brand's philosophy and deeper symbolic meanings were less explored.
		First-Class Cabin	Minimalist design elements, bright colors as white and cream tones	Designing individually, the designers partially preserved the brand's formal consistency and playful identity. User experience came to the fore, depending on the designers' interpretation. Modular designs adapted for airline safety attracted attention. Cultural meaning was limited by context.

Table 1.(continued) *Thematic Synthesis of Brand Identity and Product Design Decisions by Two Projects*

Brand	Brand Focus (by designers)	Project	Design Decisions	Designer Purposes
Tesla	Smart, futuristic, minimalist, aerodynamic, innovative	Kitchen Product Family	Curved lines, technological forms, grey finishes	Designers' futuristic focus and innovative form elements in the products were noteworthy within the group's work. The brand's identity was preserved through an emphasis on surface aesthetics. However, cultural interpretation remained limited.
		First-Class Cabin	Futuristic forms, metallic colors	Designers deeply integrated the brand's visionary spirit with the product, utilizing strong visual and futuristic elements to create a culturally integrated experience. Formal consistency was maintained by combining curved and sharp forms. Experiential diversity was also prioritized using technology in the product.
Ford	Durability, performance, reliability, innovation American heritage	Kitchen Product Family	Surface design elements, partially integrated cultural lines	Designer group focused on American heritage in its brand research and used the brand's existing vehicle surfaces as visual references. However, the focus on user experience remained limited.
		First-Class Cabin	Car-inspired interior lines, curves and dynamic lines, comfort-oriented units and interactive dashboard	Working individually, the designers emphasized spatial interaction and experiential coherence in the cabin design. Cultural symbolism was more evident in this product. The brand identity, focused on automotive design, was conveyed through surface design elements in the seating and cabin layout.
Bang & Olufsen	Premium, high-quality, luxury, sculptural, ergonomic	Kitchen Product Family	Sculptural forms, premium materials	Working within the group, designers focused largely on the relationship between aesthetics and materials. They were superficial in reflecting the brand culture on the product and inadequate in achieving functionality.
		First-Class Cabin	Premium materials, especially wood and metal choices, elegant forms, functional units	When designing individual cabins, designers were able to partially embody the brand's cultural story within the spatial experience. High aesthetic pursuits, formal consistency, appropriate material selection, and luxury were prominent features of the designs. User experience remained a secondary concern.
Victorinox	Functional, durable, flawless, timeless, stylish	Kitchen Product Family	Timeless forms with soft and curly transitions, functional modularity	Designers focused on the brand's symbolic and historical significance. Cultural storytelling through product designs was emphasized through timeless and functional design elements.
		First-Class Cabin	Multifunctional details, contrast in design elements with different shapes and colors	In the designers' individual cabin designs, the cultural context of the brand and product was limited to brand awareness. User experience was prioritized. Multifunctionality, along with aesthetic and stylistic consistency, was the goal.

The table shows that, based on the designers' identified brand keywords, product design decisions, and deeper-level design objectives, the designers could reflect the visible elements of brand identity mostly successfully. In both projects, the designers' efforts to maintain the brand-form relationship through their products in a familiar way (familiar to the brand or "familiar" enough to keep them safe) and their focus on formal aesthetic harmony were particularly noteworthy.

A thematic synthesis of the project outcomes revealed the designers' focus when making product design decisions. Five distinct dynamics, listed below, were particularly noteworthy in the designer's objectives:

1. *Individual or collaborative work:* Collaboration in group projects and independent thinking in individual projects influenced their creativity, interpretation of the brand-product connection, and final product decisions.

2. *Kitchen appliances or spatial-based product:* Designers faced significant challenges when designing a product that was not yet in the range of brands they were familiar with. Some brands were more helpful in utilizing the physical product in the first project, while many others found it easier to design the spatial-based product in the second project.
3. *Cultural and symbolic integration:* Designers more readily incorporated the brand's formal values into their work, while using cultural and symbolic meanings to a limited extent in final product design decisions. Users, cultural expectations, and symbolic brand values influenced product designs to a lesser extent.
4. *User experience:* While designers strived to reflect the brand identity in most designs, the impact of the product's usage context varied depending on the project type and the brand. While basic user needs such as efficient, easy, and fast use were prioritized, the use of design elements such as interactive interaction, intelligent systems, and technologically driven screen designs was emphasized.
5. *Time pressure:* Because this was their first time with a product design project for the brand, the designers' primary focus, and therefore their longest time spent, on the first project was on brand research, visual analysis, and product selection. In the first project, they felt significant time pressure during design processes such as sketching, three-dimensional product rendering, prototyping, and detailing. Conversely, in the second project, they had more time for the design process due to their greater familiarity with the brand but could not address the level of detail required for spatial products.

These themes indicated that although students demonstrated proficiency in visualizing brand codes within a given product focus, both individually and in groups, their engagement with the broader cultural and experiential dimensions of brand identity within the given timeframe remained limited.

5. DISCUSSION AND CONCLUSION

This study investigated designers' decisions when designing products based on brand identities. It included the design process of two different design projects to encourage the designers, as third-grade industrial design students, to develop brand-new visions for future brands. Designers started with deep research regarding brand identity and determined it with five keywords. Throughout the transformation journey from words to lines and from lines to objects, all industrial design processes were explored within the projects. This work, which operates in reverse, transforming qualitative data into visual outputs, led to numerous product designs within brand identities. The designers completed their two-stage designs for the brands. In the first project, they designed three kitchen appliances as a product family in groups of three, and in the second, they designed individual first-class cabins for the same brands. Designing products that could reflect the brand identity in the first project proved more challenging than in the second. This situation was because it was easier to incorporate the brand identity into a spatial design consisting of multiple units that form a whole. Representing the brand identity through lines in a single product required more precise decisions and was more challenging. For example, when designing a coffee machine, all brand identity elements must be present in a single product. However, multiple objects can be arranged in a space to reflect the brand from a holistic design perspective. Ultimately, the outcomes of both projects demonstrated designers' ability to convey the brand identities.

The study highlighted the importance of integrating aesthetics, functionality, cultural meaning, and experiential quality in product design for brands through the decisions made by designers. Designers act as intermediaries between brand strategy and designed products. Their role is to shape a brand's values and address potential conflicts between innovation, market expectations, and brand strategies. Thus, the design is not only a reflection of brand identity but also a discipline where commercial imperatives, cultural narratives, and user expectations intersect [15, 42]. This study sought to highlight the positioning

of designers at the intersection of creativity and institutional constraints. Such a critical approach can enable a more holistic evaluation of product design practices by revealing both the designer's creative autonomy and the structural limitations of brand strategies.

Maintaining brand identity across form changes provides a means of systematizing design principles, as in the case of a unique product family developed under a specific design concept [5]. Designers had used many elements to bring brand identities to their products, including the brand's form, surface textures, colors, and materials. These elements essentially attempted to visually convey the brand's identity and aesthetics simultaneously. Visual aesthetics was important for a brand that created a design language with several design elements such as lines, shapes, scales, proportions, surface applications, textures, patterns, colors, and materials [6, 33]. In this study, the Columbia design team emphasized the brand's sporty nature, incorporating harsher, sharper lines into their designs with vibrant colors. In contrast, the designers developing Samsung's products employed simpler, clearer geometric structures. The Sketchers and Razer design groups emphasized the dynamic nature of existing brands' products in their designs. On the other hand, the students designing for Braun adopted a minimalist approach, ensuring their products were aesthetically pleasing and straightforward. Meanwhile, the IKEA team emphasized functional modularity while drawing inspiration from IKEA's simplicity and playful design approach. On the other hand, Tesla designers sought to create truly futuristic and technologically unconventional designs based on the brand's vision. Unlike Tesla, those designing for Ford were heavily influenced by the lines and surface textures that have become an American icon. The Bang & Olufsen group, while shaping their forms based on the brand's expertise in materials and production methods, did not neglect sculptural flair. Bang & Olufsen's use of anodized aluminum, sharp contours, and tactile interfaces conveys values of precision, elegance, and high fidelity—defining the sensory and symbolic identity of the brand [6]. Designers aimed to reflect its aesthetics and functional technology in their new products, although the related brand was not industrially feasible to produce kitchen appliances. Thus, in addition to the brand's aesthetic approach and sculptural premium products, designers needed to explore what it would be like if the brand produced kitchen appliances or a first-person aircraft cabin, and the design offered a visual answer to this question. As a result, the designed products carried the DNA of this brand. Finally, the team that designed for Victorinox aimed to create timeless and multifunctional designs based on the brand's historical past and today's technology.

Existing studies also note that designers are not passive executors of marketing strategy but active participants who interpret abstract brand values into tangible design elements, even if it is challenging [13, 34]. It can be inferred that designers can design and reshape products that brands have never had, in line with the brand identity. In this study, designers faced constraints when innovating within rigid brand guidelines. To illustrate, creating a colorful, curvy form for a minimalist brand would not be appropriate. For example, this may be why the team designing for Braun completed their projects with simple lines and forms.

The research questions asked at the beginning of the study were answered, along with the experiences gained after the analyses were conducted.

- *At what points of the design process do designers establish the relationship between a brand's identity and product?*

The study revealed how designers transformed brand identity into design outcomes through two projects conducted individually and in groups. This study revealed that brand identity is a crucial research topic that influences many stages of the design process and touches upon the product in various ways. Research and concept development constituted the first stages in the design process, leading to the final product design. Examining the brand's history and product range and understanding its historical development also created significant awareness for the designers. The designers' initial questions were: "What is this brand, and what was its purpose? What was the brand's historical development? What are the brand's

products, and why were they designed? How did the evolving designs propel the brand from one point to another, and what is the brand's future goal?" More importantly, "For whom does the brand produce these products?" The answers to all these questions formed the bridges the designer built during the design journey to build product design on brand identity.

In this study, designers emphasized the strong connection between brand identity and product shape, and the crucial role of a product's geometric form in conveying a holistic design identity to end users. Each line representing the brand revealed the product's function, material, production technique, color, texture, and shape. The relationship between brand identity and the product encompasses the designer's processes of creating a product concept, searching for lines appropriate for the brand, creating a surface and object using these lines, then selecting materials appropriate for the production method, creating detailed designs, and applying colors and textures to the right surfaces. While designers who set out with these goals generally successfully reflect the visible elements of a brand's language, they remain superficial when addressing the deeper symbolic and cultural layers of identity. As the literature emphasizes, products are carriers of meaning and cultural codes. [9] The findings of this study showed that students successfully applied visual and more familiar brand codes while prioritizing formal consistency. However, product decisions regarding brand identity's deeper cultural, symbolic, and experiential dimensions were more limited. Integrating cultural, experiential, and symbolic dimensions remains an area of development. Designers (whether students or professionals) who systematically engage in brand research, keyword extraction, and thematic interpretation can create products that not only look and feel aligned with a brand but also convey its deeper values and narratives.

- *What keywords do designers uncover regarding the brand and its identity in professional practice?*

In professional design practice, designers need specific filters to simplify their research, divide it into central themes, obtain visual clues, or create a starting point. In this study, when developing keywords related to a brand and its identity, they first examined its target audience and product design styles. Then they identified keywords to define and position the brand. Keyword selection was an attempt to capture the brand's spirit and image visually. This stage was concerned with documenting perception during the design process. For instance, questions such as "Does the brand appeal to active individuals who prefer a sporty lifestyle, or a brand with more premium but ostentatious products?" were used to generate keywords.

This study showed that when defining brand identities, designers generally used keywords consisting of clear and descriptive single words such as simple, innovative, futuristic, or technological. Furthermore, they highlighted concepts such as functionality, durability, and user-centricity. While they focused on qualities such as minimalist, premium, luxury, or ergonomic to emphasize the aesthetic and emotional aspects of brands, at the same time, more technical elements such as performance, strength, reliability, and compatibility were also considered as a crucial part of the identity. Furthermore, the designers referenced cultural and historical references (e.g., American heritage) that differentiated the brand, demonstrating that the brand is identified not only by its product features but also by its origins and story. In this context, the discovered keywords were used to present a holistic expression of both the brand's functional and symbolic values.

- *How do the keywords that designers define reflect on the designer's aesthetic interpretation and product design language?*

The study found that the keywords identified by the designers strongly reflected their aesthetic interpretation and design language in their final product decisions. For example, a designer who chose the keyword "minimalist" used simpler, cleaner lines, while a designer who chose "futuristic" created designs with sharp angles and dynamic surfaces that were more costly. Pastel tones, white, and cream colors dominated the minimalist designs, while shiny metal surfaces and grey tones dominated the futuristic

products. Moreover, designers used sharp lines and contrasts in color, form and materials in the product designs, which reflected “dynamic/rhythmic” products. On the other hand, they chose clear and distinct geometric shapes with appropriate materials to evoke more “premium” products.

The answers to the research questions and the analytical implications of the study are presented in Table 2.

Table 2. *Answers to Research Questions and Insights*

Research Questions	Findings	Insights
RQ1	Students primarily engaged with brand identity in the early concept stage (research, moodboards, benchmarking, keyword generation), but less so in finishing the design, detailing or prototyping.	The remaining of brand identity at the research and idea stage without deep synthesis, and the weakness of the integration of cultural and symbolic brand meanings into functional product features
RQ2	Keywords were often descriptive adjectives (e.g., "durable", "dynamic", “smart”, etc.) and focused mainly on the visual properties of the brand.	When defining a brand in the minds of designers, the mention of definitions and adjectives that generally involve superficial contact, and the ignorance of brand values such as user habits, needs and interaction
RQ3	Keywords were translated to final product designs mainly in the style of the product, form language, color palettes, and material choices. Aesthetic interpretation was less evident in user interaction or emotional dimensions. Designers tended to equate brand identity with formal coherence rather than holistic user experience.	The tendency for designers to equate brand identity with formal consistency rather than the overall user experience

Beyond the descriptive findings of the projects, this study highlights the importance of understanding brand identity when designing products, while also revealing important insights and limitations for shaping design education and practice. In this context, the key takeaways from the study are as follows:

The transfer of brand identity to products occurred primarily through visual output. Students successfully reflected brand keywords through lines, shapes, materials, and colors. However, the deeper cultural, symbolic, and experiential dimensions of brand identity were less integrated into the products. Furthermore, formal consistency often took precedence over experiential needs. User interaction and sensory experience were observed to take a back seat, particularly in spatial applications constrained by functionality and safety requirements. This situation demonstrated a gap between superficial visual translation and holistic brand interaction. This gap highlights the need for a stronger integration of sociocultural perspectives in design education. A critical understanding of how design outcomes embody power relations, lifestyle associations, and symbolic narratives can enhance a designer’s ability to move beyond surface aesthetics to achieve more meaningful and context-sensitive design outcomes. Furthermore, individual and group work shaped the final product designs. In particular, individual interpretations facilitated the second project’s explorations of futurism, luxury, or modularity.

A key limitation of this study is its focus on two projects, limiting generalizability, and its use with third-year industrial design students whose professional experience was still developing. This narrow scope allowed for an in-depth examination of interpretative processes. Future research could incorporate multiple cross-institutional case studies, incorporating user evaluations to assess experiential alignment with brand identity and exploring how design education can foster critical engagement with the cultural and symbolic dimensions of branding. Thus, the field could move beyond descriptive analyses toward a more comprehensive and critical theory of brand-focused design practice. Furthermore, because this was the first project in which students analyzed the product and brand together, they found the time constraints and challenges challenging. Because the projects were limited by semester length, the brand

design processes could not include user testing or market feedback. Future research would be expanded to include user research methods that integrate user experience research, cultural context, and brand narrative, supporting more efficient use of time. This proposal could explore methods for developing students' holistic brand interpretation, integrating user experience, and examining cross-cultural influences. Furthermore, while the thematic synthesis provided high-level insights, this study would be expanded to assess how students' approaches evolve with professional experience. Expanding the research to include experienced professional designers could validate and diversify the thematic findings.

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Research Article GU J Sci, Part B, 13(3): 571-587 (2025)

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The Status of Color-Oriented Courses in Undergraduate Interior Architecture Curricula: A Curriculum-Based Analysis

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Article Info

Received: 05/08/2025
Accepted: 30/09/2025

Keywords

Interior Architecture Education,
Color Education,
Curriculum Analysis

Abstract

Interior architecture is a professional field frequently engaged by users in the process of creating spaces, and it has become an indispensable practice of contemporary life. In line with this growing demand, the number of higher education institutions offering interior architecture programs has also rapidly increased. This study focuses on the role of color, one of the fundamental design tools in interior architecture, within interior architecture education. The aim is to conduct a quantitative analysis of curricula and determine the current status of courses focusing on color in interior architecture programs in Türkiye. While each discipline requires its own unique educational content and qualifications, individuals working within the same professional field are expected to acquire similar fundamental knowledge and skills. In this context, the primary objective of the study is to emphasize the importance of color in undergraduate education programs, given its pivotal role in the interior architecture discipline.
To this end, the study examined factors such as the presence of color courses in the programs, their status as elective or required, and the semesters in which they are offered, and evaluated course content within the framework of accreditation criteria and relevant literature. The data were analyzed using qualitative research methods and document analysis techniques. Based on information from the Higher Education Council of Türkiye (YÖK) Undergraduate Atlas, official university websites, and course information packages, the study aims to propose a shared educational framework aligned with contemporary requirements.

1. INTRODUCTION

Interior architecture encompasses the arrangement of spaces to meet user needs, the provision of spatial comfort, and the creative design process of form, texture, color, material, lighting, furnishings, and accessories by the interior architect [1]. In this context, interior architecture is not merely a physical arrangement but a design discipline that guides user experience and perception. The designer shapes the space by considering the user's perception, emotions, and behaviors; thus, the interior architect's work is not a single object but the entirety of the space.

Interior architecture education is also shaped by this holistic perspective. Emphasizing creativity, the discipline is strongly linked to art education and is supported by foundational art courses in the early years. These are delivered within an integrated curriculum alongside core design courses. This structure places interior architecture education on common ground with other disciplines in the field of art and design.

In Türkiye, undergraduate programs in Interior Architecture or Interior Architecture and Environmental Design admit students through a centralized placement system, based on quantitative or equal-weight scores [2]. However, the profession and educational content are closely related to design and fine arts. Therefore, a lack of knowledge and engagement with the arts can be considered a significant deficiency in the professional competence of an interior architect. Historically, interior architecture education has developed in close connection with art and craft, evolving into its current academic structure [3].

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In this framework, color emerges as a fundamental component in both art education and the profession and education of interior architecture. The subject of color is not limited to basic education or foundational art and design courses; it is also a key element in studio courses, which are central to interior architecture education. This is because color is one of the core design elements that directly affect spatial perception and user experience. Therefore, including color education in the undergraduate interior architecture curriculum is essential for professional qualification. However, courses do not always aim solely to teach color; rather, color is often addressed as one component within a broader design process. In studio and design courses, color is considered as part of the design development, but this is often limited to the context of the project, without sufficient emphasis on theoretical knowledge and methods [4]. This highlights the necessity of addressing color as a distinct and focused course. Accordingly, this study examines the role of color education in undergraduate interior architecture programs by analyzing only the courses specifically titled with “color.”

Although color is widely recognized as a fundamental element in design education, there is limited research systematically examining how it is incorporated into undergraduate interior architecture curricula in Türkiye. Existing studies have primarily focused on general design principles or studio practices, leaving the role of color education underexplored. This study addresses this gap by conducting a systematic analysis of 106 programs and 99 courses, providing a comprehensive overview of the current status of color education. By mapping the presence, type, and content of color-related courses across interior architecture programs, the research offers an original contribution that can guide curriculum development in line with contemporary needs and accreditation standards.

In this study, undergraduate curricula of Interior Architecture and Interior Architecture and Environmental Design programs in Türkiye were systematically examined, and these departments were evaluated together and are collectively referred to throughout the text as 'interior architecture departments.' Courses related to the theme of “color” were identified, and their presence, status as required or elective, and the semester in which they are offered were determined. Data were collected from the Higher Education Council of Türkiye (YÖK) Undergraduate Atlas, official university websites, and course catalogs. Courses containing the term “color” were identified and classified as compulsory or elective. The data were analyzed quantitatively using tables and graphics, and course contents were evaluated qualitatively through document analysis, based on accreditation criteria and relevant literature. This comprehensive study aims to support the development of a common educational framework that aligns with contemporary needs.

2. METHOD

This research is a qualitative case study that aims to analyze the current status of color-focused courses in the curricula of interior architecture departments undergraduate programs in Türkiye. A qualitative research method was adopted, using document analysis as the primary technique. Additionally, certain data were classified quantitatively and supported through visualizations such as tables and graphs.
The data were collected from the YÖK Undergraduate Atlas and from course catalogs, curricula, and syllabi published on the official websites of universities. Color-related courses were identified through the presence of the term “color” in their titles. The objectives and learning outcomes of these courses were analyzed using content analysis, guided by predefined key concepts (e.g., color knowledge and theory, color perception, color harmony). To ensure reliability, the data was recoded by the researchers after a two-week interval, and discrepancies were resolved. Following the coding process, the courses were classified and visualized based on their status as required, elective, or major elective, as well as the semesters in which they were offered, using tables and graphs. This structured process, summarized in Table 1, enabled the identification of trends and patterns in the integration of color education across interior architecture programs.

Table 1. *Research Process and Steps*

Step	Title	Description
1	Identification of Relevant Undergraduate Programs	Identification of Interior Architecture / Interior Architecture and Environmental Design undergraduate programs in Türkiye, based on data from the YÖK Undergraduate Atlas.
2	Identification of Color-Themed Courses Based on Curricula	Examination of course information forms, curricula, and syllabi available on the official websites of universities; inclusion of courses with the explicit term "color" in their titles.
3	Classification and Visualization of Data	Visualization of the collected data through tables and graphs according to course status (required/elective) and semester; analysis of course content within the framework of accreditation criteria and relevant literature.
4	Coding of Course Data	Analysis of course objectives and learning outcomes using content analysis; coding based on predefined key concepts (e.g., color knowledge, color perception, color harmony, color-space relationship).
5	Ensuring Coding Reliability	Coding carried out by the researchers and subsequently reviewed to ensure consistency.
6	Interpretation of Results and Proposal of an Educational Framework	Proposal of a common educational framework for color instruction in line with contemporary requirements, based on the findings.

The collected data were analyzed in two dimensions. First, the distribution of color-related courses by university, their elective or required status, and their placement within the curriculum were evaluated through quantitative methods. Second, the content of these courses was analyzed qualitatively based on accreditation criteria and relevant literature. This analysis aimed to reveal the role and adequacy of these courses within interior architecture education.
The study was conducted to contribute to the development of a unified educational framework that meets contemporary needs and promotes interdisciplinary coherence.

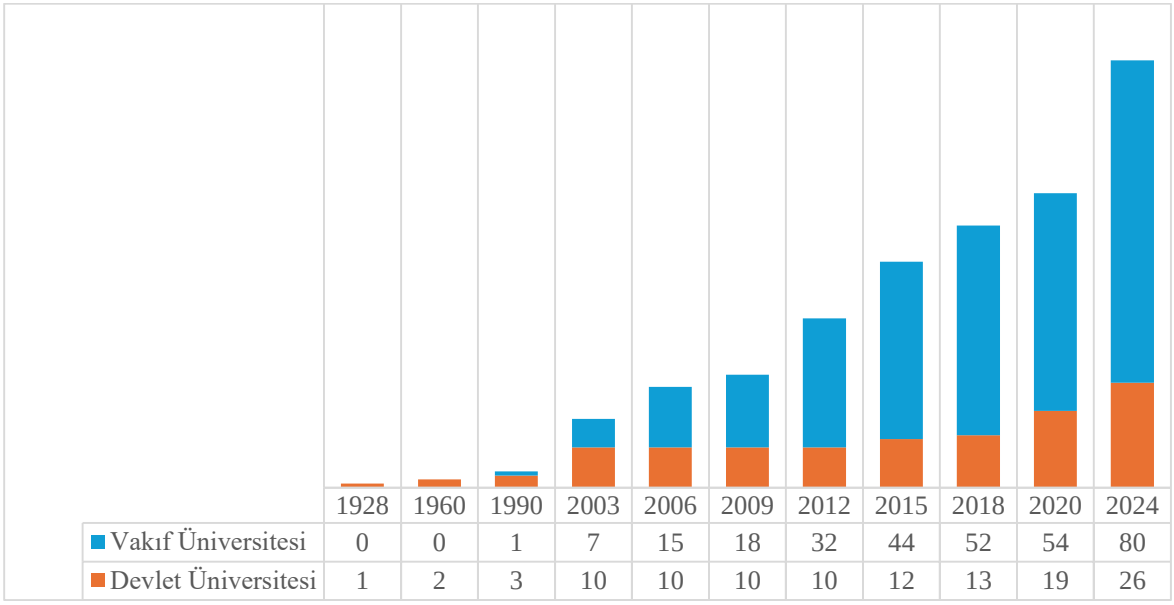
3. THE STATUS OF COLOR-ORIENTED COURSES IN UNDERGRADUATE INTERIOR ARCHITECTURE CURRICULA

Before formal interior architecture education, vocational training was provided through a traditional Turkish guild system known as Ahilik, which relied on a hands-on approach through apprenticeship (*çıraklık*) and journeyman (*kalfalık*) stages. After an apprenticeship period lasting five to seven years, individuals could advance to the journeyman level upon passing a practical examination [5]. What is considered the beginning of today's formal interior architecture education in Türkiye is the establishment of the Department of Interior Decoration (Dâhili Tezyinat Bölümü) in 1923, within the School of Fine Arts Academy (Güzel Sanatlar Akademisi)—then known as *Mekteb-i Sanâyi-i Nefîse-i Şâhâne*, which was renamed in 1928 and is today called Mimar Sinan Fine Arts University. This department was built upon the foundations of the Decoration Department (Tezyinat Bölümü), established in 1914 [3]. In 1955, the Applied Fine Arts School (Tatbiki Güzel Sanatlar Yüksekokulu), affiliated with Marmara University, became the second major institution to offer interior architecture education, following the Fine Arts Academy. Until the 1980s, these two institutions were the only ones providing such education. Later developments included the establishment of programs at Hacettepe University in 1985 and at İhsan Doğramacı Bilkent University—Türkiye's first foundation university—in 1987 [6].

With the increase in the number of higher education institutions in Türkiye, undergraduate programs in interior architecture have expanded rapidly. Today, interior architecture education is offered under the departments of "Interior Architecture" and "Interior Architecture and Environmental Design." As of the official directive issued by the Higher Education Council of Türkiye (YÖK) on September 5, 2016 (Ref. No: 75850160-301.01.04-56126), student admissions to these programs—including those at Mimar Sinan Fine Arts University and Marmara University—have shifted from special talent examinations to the centralized university entrance system. Under this system, students are placed into Interior Architecture programs based on their quantitative (MF-4) scores, while those applying to Interior Architecture and Environmental Design programs are admitted based on their equal-weight (TM-1) scores [7].

According to the 2017 Undergraduate Programs and Quotas Guide of the Student Selection and Placement Examination (ÖSYS), there were 57 undergraduate programs in interior architecture departments—13 at public universities and 44 at foundation (private) universities. By 2020, this number had increased to 70. Alongside this, the presence of both "interior architecture" and "interior architecture and environmental design" programs within either the same or different faculties at some institutions raised the total number of departments to 73 [5,6].

An examination of the 2024 Undergraduate Programs and Quotas Guide of the Higher Education Institutions Examination (YKS) shows that the number of undergraduate programs offering interior architecture education continues to rise rapidly. As of 2024, there are 106 such programs offered by 88 universities (Figure 1). Of these, 49 are titled "Interior Architecture." Among them, 20 are offered by public universities and 29 by foundation (private) universities. The remaining 57 programs are titled "Interior Architecture and Environmental Design," of which 6 are housed in public universities and 51 in foundation (private) universities. In total, of the 106 programs, 26 are offered at public universities and 80 at foundation (private) universities [2].



	1928	1960	1990	2003	2006	2009	2012	2015	2018	2020	2024
Vakıf Üniversitesi	0	0	1	7	15	18	32	44	52	54	80
Devlet Üniversitesi	1	2	3	10	10	10	10	12	13	19	26

Figure 1. *Distribution of Higher Education Institutions Offering Interior Architecture Programs in Türkiye up to 2024*

When comparing the 2020 data obtained by Erbay and Ulusoy (2021) with the data from 2024, it is concluded that the number of interior architecture departments increased by 45.21% over the four-year period. The rate of increase over the years indicates that the number of these departments is likely to continue growing in the coming years.

An examination of the faculties to which the interior architecture departments are affiliated reveals that these departments are grouped under 14 different faculties. Table 2 shows the faculties to which these departments belong, indicating that the majority of interior architecture departments are housed within the Faculty of Architecture. This is followed by the Faculty of Architecture and Design with 15 departments, and the Faculty of Engineering and Architecture with 12 departments. When the "Faculty of Fine Arts, Design and Architecture" and the "Faculty of Architecture, Design and Fine Arts" are considered together, these faculties also rank among those with a high number of related departments, totaling 15.

Tablo 2. *Faculties Affiliated with Interior Architecture Departments*

	Faculty Name	Number of Departments
1	Faculty of Architecture	23
2	Faculty of Architecture and Design	15
3	Faculty of Art, Design and Architecture	7
4	Faculty of Fine Arts	9
5	Faculty of Art and Design	8
6	Faculty of Engineering and Architecture	12
7	Faculty of Fine Arts and Design	6
8	Faculty of Fine Arts, Design and Architecture	11
9	Faculty of Architecture, Design and Fine Arts	4
10	Faculty of Fine Arts and Architecture	3
11	Faculty of Engineering and Natural Sciences	4
12	Faculty of Arts and Social Sciences	2
13	Faculty of Design	1
14	Education and Research Campus (Famagusta)	1
	Total	106

In Özsavaş's (2015) study, the number of departments within the Faculty of Architecture was reported as 12. Compared to the data from 2015, it is observed that by 2024, the number of interior architecture departments within the Faculty of Architecture has increased by 91.67%. Conversely, the number of departments within the Faculty of Fine Arts has decreased by 2024.

Although the Higher Education Council of Türkiye (YÖK) proposed in 2019 that Interior Architecture—along with departments such as Fashion Design, Stage Design, Industrial Product Design, and Textile—should be placed under the Faculty of Arts and Humanities [8], recent data from 2024 reveal that Interior Architecture departments continue to exist under different faculties. This reflects an ongoing institutional diversity in how the discipline is positioned, which may, in turn, shape the way educational content—such as color-related courses—is framed within various programs.

The presence of interior architecture departments under various faculties highlights the multidisciplinary nature of the field. Until 2016, differences were observed in student admission types and faculty affiliations for interior architecture departments. It will be examined whether these structural variations also contribute to diversity in the current status of color courses. Accordingly, the study first investigates color courses within interior architecture education.

3.1. The Role and Importance of Color Education in Undergraduate Interior Architecture Programs

Interior architecture programs in Türkiye admit students through the centralized placement exam using quantitative and equal-weight score types; however, the field is also defined in relation to design and fine arts in terms of education and professional practice. For an interior architect as a designer, being disconnected from the arts and its knowledge means lacking essential information needed for the profession. Interior architecture education has evolved intertwined with art and craft to reach its current academic structure.

Since the 19th century, with the establishment of modern art schools such as the École des Beaux-Arts—which began dividing art education into disciplines like painting, sculpture, and architecture—and the Bauhaus—which combined art, craft, and architecture and centered the creative process—interior architecture education has become more systematic. The Bauhaus pedagogy was supported by color theories and composition studies practiced in Johannes Itten's workshops, demonstrating that art education and design processes are inseparable [4].

The topic of color holds a significant place as a fundamental component in undergraduate interior architecture education. Consequently, it is included either directly or indirectly in the curricula of many interior architecture programs. Color is addressed not only within the content of various courses but also

as an important design element in project courses, which are among the most comprehensive in the field. As one of the basic design elements used in the design process, color plays a decisive role in the formal, functional, and perceptual unity of interior architecture projects. This importance arises because color is a core design element in the design process and constitutes a substantial part of interior architectural projects.

However, the primary aim of these courses is often not solely to teach color; rather, color is integrated as a component within the overall design process. Therefore, in this study, the role of color in interior architecture undergraduate education has been examined exclusively by focusing on courses explicitly titled under the subject of "color."

Organizations such as the Interior Design Educators Council (IDEC), the Council for Interior Design Accreditation (CIDA), the Union of Chambers of Turkish Engineers and Architects (TMMOB) Chamber of Interior Architects, and TAPLAK (Design and Planning Accreditation Association) serve as international and national bodies dedicated to education, profession, and accreditation in the field of interior architecture and design. Their mission is to develop interior architecture as a profession and discipline, establish standards, and improve professional practice.

The important role of color in undergraduate interior architecture education is also supported by international education standards. In particular, color is addressed as a separate criterion within the standards set by CIDA—an international organization established to assure the quality of educational programs and professional competencies—and TAPLAK, which serves at the national level.

CIDA, established to accredit educational programs, aims to define and enhance standards for interior architecture education. In line with this mission, CIDA updated and published its professional standards in 2024, presenting them under the headings "Program Identity and Context" and "Knowledge Acquisition and Application." The topic of color appears as criterion 12 under the "Knowledge Acquisition and Application" category, encompassing both light and color (Table 3). This standard seeks to ensure that graduates understand the art and science of light and color and are able to integrate these elements into the design process to enhance human experience [9].

Table 3. *CIDA Professional Standards 2024* [9]

Section I. Program Identity and Context
1. Program Identity and Curriculum
2. Faculty and Administration
3. Learning Environments and Resources
Section II. Knowledge Acquisition and Application
4. Global Context
5. Collaboration
6. Business Practices and Professionalism
7. Human-Centered Design
8. Design Process
9. Communication
10. History
11. Design Elements and Principles
12. Light and Color
13. Products and Materials
14. Environmental Systems and Human Wellbeing
15. Construction
16. Regulations and Guidelines

According to TAPLAK, although the mission, objectives, educational goals, social and sectoral expectations, and the characteristic features of the geographical region where the program is located may cause differences among interior architecture departments' undergraduate programs, there are minimum required educational areas that these programs must cover. One of these areas is the field of color and light, listed as the ninth category (Table 4). The inclusion of color as a minimum requirement for

accreditation of interior architecture departments undergraduate programs emphasizes the importance of this subject for interior architecture education and profession [10].

Table 4. *TAPLAK Minimum Educational Areas for Interior Architecture Departments* [10]

a. International Context
b. Collaboration
c. Professional Practice and Professionalism
d. Human-Centered Design
e. Design Process
f. Communication
g. History
h. Design Elements and Principles
i. Light and Color
j. Products and Materials
k. Environmental Systems and Comfort
l. Construction/Building/Manufacturing
m. Regulations and Legislation

The inclusion of color courses in the educational curriculum is not only a requirement of professional training and practice but also a reflection of client expectations. In a study titled "A Proposed Model for the Design and Development of Interior Architecture Education Programs," a survey was conducted with clients, who were asked to evaluate essential areas of knowledge for interior architects. Color knowledge was ranked among the most important by 84% of the participants [11]. This result highlights that color knowledge is one of the most expected competencies in the interior architecture profession.

In conclusion, color knowledge in undergraduate interior architecture education clearly stands out due to the discipline's art-based nature and its importance in international accreditation standards. Interior architecture education should aim not only to provide students with technical knowledge but also to cultivate aesthetic and artistic sensitivity. Thus, future interior architects will be equipped to design spaces that are both functional and aesthetically compelling. Color knowledge is an indispensable and fundamental part of this process.

3.2. Identification and Analysis of Color Courses in Undergraduate Interior Architecture Education

As of the 2024–2025 academic year, interior architecture education is offered in a total of 106 departments across Türkiye. Within the scope of this study, the faculties to which the interior architecture departments are affiliated were identified. Subsequently, course information forms, curricula, and course schedules published on the official websites of the relevant universities were searched using the keyword "color" and its variations. As a result of the review, color-focused courses could not be identified in 23 of the 106 programs examined. Therefore, only the departments with identified color-focused courses were analyzed and included in Table 5. Additionally, the analysis considered whether the relevant courses were required or elective, as well as the faculties to which these departments belonged. The obtained data are presented in the mentioned table. In the table, the course types are abbreviated as follows: R = Required, E = Elective, and ME = Major Elective.

Table 5. *Interior Architecture Departments' Color Courses*

Universities Offering Interior Architecture Programs and Their Color Courses				
	University Name	**Affiliated Faculty**	**Course Title**	**Course Type**
1	Akdeniz University	Faculty of Architecture	İç Mekânda Renk ve Işık (Color and Light in Interior Space)	E
2	Çukurova University	Faculty of Architecture	Görsel Anlatım Teknikleri (Visual Representation Techniques)	E
3	Eskişehir Technical University	Faculty of Architecture and Design	İç Mekânda Renk ve Tekstil Bilgisi (Color and Textile Knowledge in Interior Space)	ME
4	İskenderun Technical University	Faculty of Architecture	İç Mekânda Işık ve Renk (Light and Color in Interior Space)	R
5	İstanbul Technical University	Faculty of Architecture	İç Mimarlıkta Renk ve Işık (Color and Light in Interior Architecture)	R
6	İstanbul Technical University (ENG)	ITU-TRNC Education and Research Campus (Famagusta)	Invstg.Colr&Light in Int.Arch	R
7	İstanbul University	Faculty of Architecture	Işık ve Renk (Light and Color)	R
8	Karadeniz Technical University	Faculty of Architecture	İç Mekân Tasarımında Renk Kullanımı (Use of Color in Interior Space Design)	E
9	Kocaeli University	Faculty of Architecture and Design	Mekânda Renk Kullanımı (Use of Color in Space)	R
10	Konya Technical University	Faculty of Architecture and Design	İç Mekânda Işık Renk ve Doku (Light, Color, and Texture in Interior Space)	E
11	Marmara University	Faculty of Fine Arts	Tekstilde Renk Uygulamaları (Color Applications in Textiles)	E
12	Mimar Sinan Fine Arts University	Faculty of Architecture	Renk ve Anlatım Teknikleri (Color and Representation Techniques)	E
13	Nevşehir Hacı Bektaş Veli University	Faculty of Fine Arts	İç Mekânda Işık ve Renk (Light and Color in Interior Space)	E
14	Ondokuz Mayıs University	Faculty of Architecture	Mekân Tasarımında Renk (Color in Spatial Design)	E
15	Yalova University	Faculty of Art and Design	Renk Bilgisi (Color Knowledge)	E
16	Çankaya University (İngilizce)	Faculty of Architecture	Renk İlkeleri (Principles of Color)	R
17	Fatih Sultan Mehmet Vakıf University	Faculty of Architecture and Design	Mekânda Renk ve Malzeme (Color and Material in Space)	E
			Mimaride Renk (Color in Architecture)	E
18	İstanbul Aydın University	Faculty of Architecture and Design	Biçim, Işık ve Renk (Form, Light, and Color)	R
19	İstanbul Beykent University (ENG)	Faculty of Engineering and Architecture	Color and Light in Space	R
20	İstanbul Beykent University	Faculty of Engineering and Architecture	Mekânda Renk ve Işık (Color and Light in Space)	R
21	İstanbul Bilgi University (ENG)	Faculty of Architecture	İç Mekânda Yüzeyler: Renk, Malzeme, Doku (Interior Surfaces: Color, Material, and Texture)	R
22	İstanbul Esenyurt University	Faculty of Engineering and Architecture	Mekânda Renk Analizi (Color Analysis in Space)	R
			Renk Kuramı (Color Theory)	E
23	İstanbul Gelişim University	Faculty of Fine Arts	Renk Bilgisi (Color Knowledge)	E
			İç Mimaride Renk ve Kullanımı (Color and Its Use in Interior Architecture)	E
24	İstanbul Nişantaşı University	Faculty of Art and Design	Mekânda Renk (Color in Space)	E
25	İstanbul Nişantaşı University (ENG)	Faculty of Art and Design	Color in Space	E
26	İstanbul Rumeli University	Faculty of Art, Design and Architecture	İç Mekânda Renk (Color in Interior Space)	E
			İç Mekân Tasarımında Renk Doku Tekstil (Color, Texture, and Textile in Interior Space Design)	E
27	Konya Food and Agriculture University	Faculty of Engineering and Architecture	Renk Bilgisi (Color Knowledge)	E
28	Kto Karatay University	Faculty of Fine Arts and Design	İç Mekânda Işık-Renk-Doku (Light, Color, and Texture in Interior Space)	E

29	Mef University (ENG)	Faculty of Art, Design and Architecture	Practicing Color Theory	E
30	Toros University	Faculty of Fine Arts, Design and Architecture	İç Mekânda Renk Kuramı ve Uygulamaları (Color Theory and Applications in Interior Space)	E
			Renk Kuramı ve Uygulama (Color Theory and Practice)	E
31	Eastern Mediterranean University	Faculty of Architecture	İç Mekânlarda Renk ve Işık (Color and Light in Interior Spaces)	R
32	Eastern Mediterranean University (ENG)	Faculty of Architecture	İç Mekânda Renk ve Aydınlatma (Color and Lighting in Interior Space)	R
33	Girne American University	Faculty of Architecture, Design and Fine Arts	Renk Teorisi ve Uygulamaları (Color Theory and Applications)	R
34	Girne American University (ENG)	Faculty of Architecture, Design and Fine Arts	Color Theory and Practice (Color Theory and Practice)	R
35	International Cyprus University	Faculty of Fine Arts, Design and Architecture	Renk Bilgisi (Color Knowledge)	E
36	International Cyprus University (ENG)	Faculty of Fine Arts, Design and Architecture	Colour Culture	E
37	Near East University	Faculty of Architecture	Renk Teorisi ve Sunumu (Color Theory and Presentation)	R
			İç Mekânda, Işık Renk ve Doku (Light, Color, and Texture in Interior Space)	E
			Mimaride Renk Kavramı (Color Concept in Architecture)	E
38	Near East University (ENG)	Faculty of Architecture	Colour Theory and Presentation	R
			Colour Concept in Architecture	E

Universities Offering Interior Architecture and Environmental Design Programs and Their Color Courses

	University Name	**Affiliated Faculty**	**Course Title**	**Course Type**
39	Afyon Kocatepe University	Faculty of Fine Arts	Renk ve Doku (Color and Texture)	R
40	Bilecik Şeyh Edebali University	Faculty of Fine Arts and Design	İç Mekânda Renk ve Işık (Color and Light in Interior Space)	E
41	Hacettepe University	Faculty of Fine Arts	İç Mekânda Işık, Renk ve Doku (Light, Color, and Texture in Interior Space)	E
42	Kırıkkale University	Faculty of Fine Arts	Renk Psikolojisi (Color Psychology)	R
43	Necmettin Erbakan University	Faculty of Fine Arts and Architecture	İç Mekânda Işık Renk ve Doku (Light, Color, and Texture in Interior Space)	E
44	Osmaniye Korkut Ata University	Faculty of Architecture, Design and Fine Arts	Renk ve Anlatım Teknikleri I (Color and Expression Techniques I)	R
			Renk ve Anlatım Teknikleri II (Color and Expression Techniques II)	R
45	Altınbaş University	Faculty of Engineering and Architecture	Renk Teorisi ve Uygulamaları (Color Theory and Applications)	E
46	Altınbaş University (ENG)	Faculty of Engineering and Architecture	Color Theory and Applications	E
47	Ankara Medipol University	Faculty of Fine Arts, Design and Architecture	Renk ve Işık (Color and Light)	R
48	Antalya Bilim University (ENG)	Faculty of Fine Arts and Architecture	İç Mekânda Renk ve Doku (Color and Texture in Interior Space)	R
49	Atılım University	Faculty of Fine Arts, Design and Architecture	Renk Teorisi ve Uygulamaları (Color Theory and Applications)	R
			Işık ve Renk Teorisi (Light and Color Theory)	E
50	Avrasya University	Faculty of Engineering and Architecture	İç Mimaride Renk (Color in Interior Architecture)	E
51	Bahçeşehir University (ENG)	Faculty of Architecture and Design	Aydınlatma ve Renk Uygulamaları (Lighting and Color Applications)	E
52	Başkent University	Faculty of Fine Arts, Design and Architecture	İç Mekân ve Renk (Interior Space and Color)	R
53	Beykoz University	Faculty of Art and Design	Mekânda Renk Kullanımı (Use of Color in Space)	R
54	Biruni University	Faculty of Engineering and Natural Sciences	Serbest Resim ve Renklendirme Teknikleri (Freehand Drawing and Coloring Techniques)	E
55	Fenerbahçe University	Faculty of Engineering and	Renk Kuramı ve Uygulamalar (Color Theory and	R

		Architecture	Applications)	
56	Fenerbahçe University (ENG)	Faculty of Engineering and Architecture	Color Theory and Practices	R
57	Hasan Kalyoncu University	Faculty of Fine Arts and Architecture	İç Mimaride Renk Uyumu (Color Harmony in Interior Architecture)	E
58	Işık University	Faculty of Art, Design and Architecture	İçmimaride Form Doku Renk (Form, Texture, and Color in Interior Architecture)	E
59	Işık University (ENG)	Faculty of Art, Design and Architecture	Form, Texture, Colour in Interior Architecture	E
60	İhsan Doğramacı Bilkent University (ENG)	Faculty of Fine Arts, Design and Architecture	Color Theory and Applications	E
			Lighting and Color	E
61	İstanbul Atlas University	Faculty of Engineering and Natural Sciences	Renk ve Işık (Color and Light)	E
62	İstanbul Esenyurt University	Faculty of Engineering and Architecture	Renk Kuramı (Color Theory)	E
			Mekânda Renk Analizi (Color Analysis in Space)	E
63	İstanbul Galata University	Faculty of Arts and Social Sciences	İç Mekanlarda Aydınlatma ve Renk (Lighting and Color in Interior Spaces)	R
			Işık ve Renk Teorisi (Light and Color Theory)	E
64	İstanbul Galata University (ENG)	Faculty of Arts and Social Sciences	İç Mekanlarda Aydınlatma ve Renk (Lighting and Color in Interior Spaces)	R
			Işık ve Renk Teorisi (Light and Color Theory)	E
65	İstanbul Gedik University	Faculty of Architecture and Design	İç Mekânda Renk (Color in Interior Space)	E
66	İstanbul Gelişim University	Faculty of Fine Arts	İç Mimaride Renk ve Kullanımı (Color and Its Use in Interior Architecture)	E
			Renk Bilgisi (Color Knowledge)	E
67	İstanbul Kültür University	Faculty of Architecture	Form Doku Renk (Form, Texture, and Color)	E
68	İstanbul Kültür University (ENG)	Faculty of Architecture	Renk Kullanımı ve Sunum Teknikleri (Use of Color and Presentation Techniques)	E
69	İstanbul Medipol University	Faculty of Fine Arts, Design and Architecture	İç Mekânda Işık ve Renk (Light and Color in Interior Space)	R
70	İstanbul Medipol University (ENG)	Faculty of Fine Arts, Design and Architecture	İç Mekânda Işık ve Renk (Light and Color in Interior Space)	R
71	İstanbul Okan University	Faculty of Art, Design and Architecture	Aydınlatma-Renk-Işık (Lighting-Color-Light)	E
72	İstanbul Sabahattin Zaim University	Faculty of Engineering and Natural Sciences	İç Mekânda Işık, Renk ve Doku (Light, Color, and Texture in Interior Space)	E
73	İstanbul Ticaret University	Faculty of Architecture and Design	Renk Kuramı (Color Theory)	E
74	İstanbul Topkapı University	Faculty of Fine Arts, Design and Architecture	İçmimari ve Renk (Interior Architecture and Color)	R
75	İstanbul Yeni Yüzyıl University	Faculty of Engineering and Architecture	Renk ve Armoni (Color and Harmony)	R
76	Izmir University of Economics	Faculty of Fine Arts and Design	İç Mekanlarda Renkler ve Dokular (Colors and Textures in Interior Spaces)	E
77	Kadir Has University	Faculty of Art and Design	Renk, Tasarım ve İletişim (Color, Design, and Communication)	E
78	Ostim Technical University	Faculty of Architecture and Design	Aydınlatma ve Renk (Lighting and Color)	R
79	Özyeğin University	Faculty of Architecture and Design	İç Mimarlar İçin Renk (Color for Interior Architects)	E
80	Ted University	Faculty of Architecture and Design	Işık ve Renk (Light and Color)	R
			İç Mimarlıkta Renk, Kuram ve Uygulama (Color, Theory, and Practice in Interior Design)	E
81	TOBB University of Economics and Technology	Faculty of Architecture and Design	İç Mekânda Işık, Renk, Doku (Light, Color, and Texture in Interior Space)	E
82	Yaşar University	Faculty of Architecture	İç Mimarlıkta Renk ve Tekstil (Color and Textile in Interior Architecture)	R
83	Cyprus American University	Faculty of Fine Arts	Renk Teorisi ve Uygulamaları (Color Theory and Applications)	R

As of the 2024–2025 academic year, interior architecture departments education is provided in 106 departments. Among these, 49 are titled “Interior Architecture,” while 57 are titled “Interior Architecture and Environmental Design.” Of these departments, 27 are at public universities, 68 are at foundation (private) universities, and 13 are located in the Turkish Republic of Northern Cyprus (TRNC).

When the curricula of the “Interior Architecture” departments are examined, it is found that 38 of them include a course related to color, whereas 11 do not. According to these results, 71.51% of the curricula include a course covering the subject of color, while 24.49% do not include any course on this subject (Figure 2). Among the 46 identified courses, 17 are required, 28 are elective, and 1 is a major elective course.

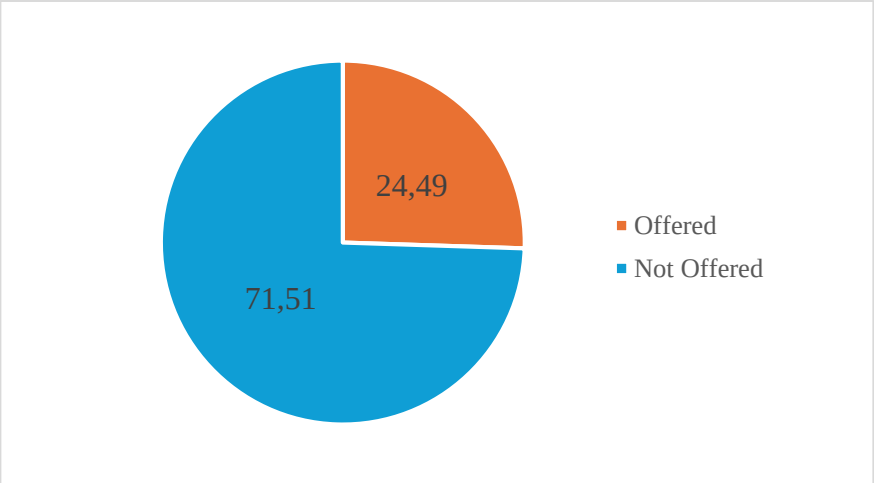


Figure 2. *Distribution of Color Courses in Interior Architecture Undergraduate Programs*

In the “Interior Architecture and Environmental Design” departments, 45 include a color course, whereas 12 do not. According to these results, 78.95% of the curricula include a course covering the subject of color, while 21.05% do not include any course on this subject (Figure 3). Among the 53 identified courses, 21 are required and 32 are elective.

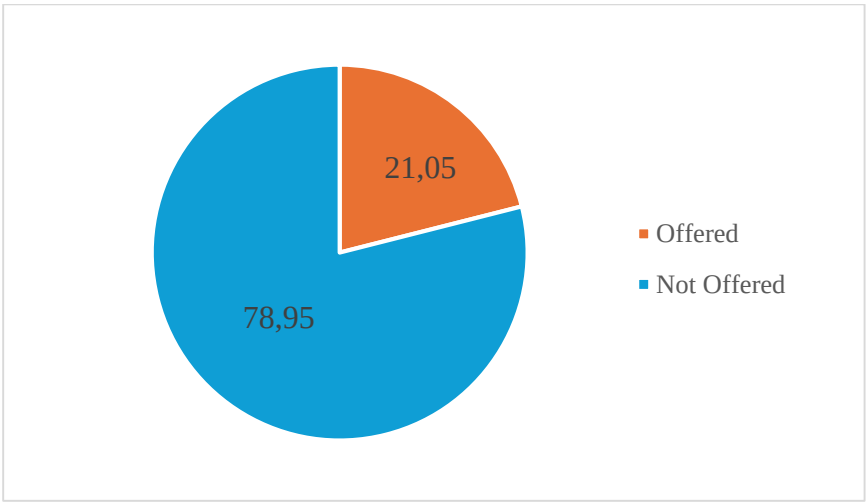


Figure 3. *Distribution of Color Courses in Interior Architecture and Environmental Design Undergraduate Programs*

In total, at least one course primarily focused on color is included in the curricula of 83 departments, while no such course could be identified in the curricula of 23 departments. These findings indicate that 77.36% of undergraduate programs offering interior architecture education include a color-related course, whereas 22.64% do not (Figure 4). When comparing the availability of color courses in "Interior

Architecture" and "Interior Architecture and Environmental Design" programs, a difference of 3.44% is observed between them.

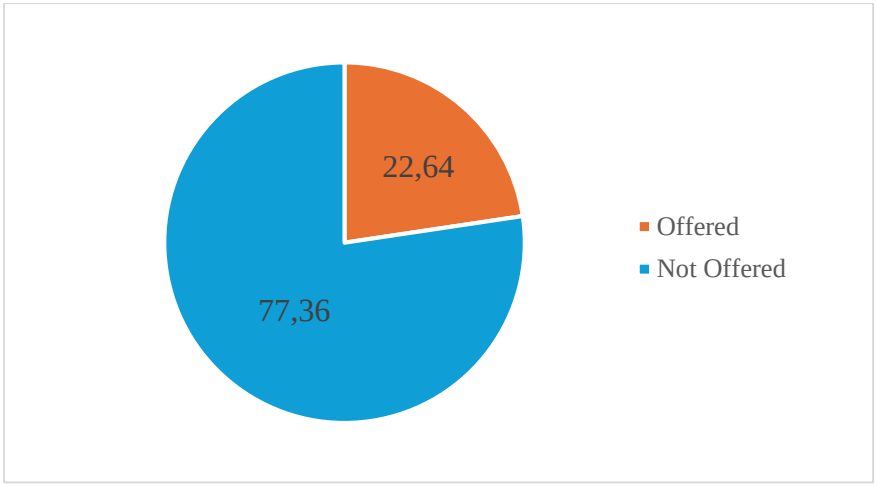


Figure 4. *Distribution of Color Courses in Interior Architecture Departments Undergraduate Programs*

A total of 99 color-related courses were identified across the interior architecture departments. Of these courses, 38% are required, 61% are elective, and 1% is a major elective course (Figure 5).

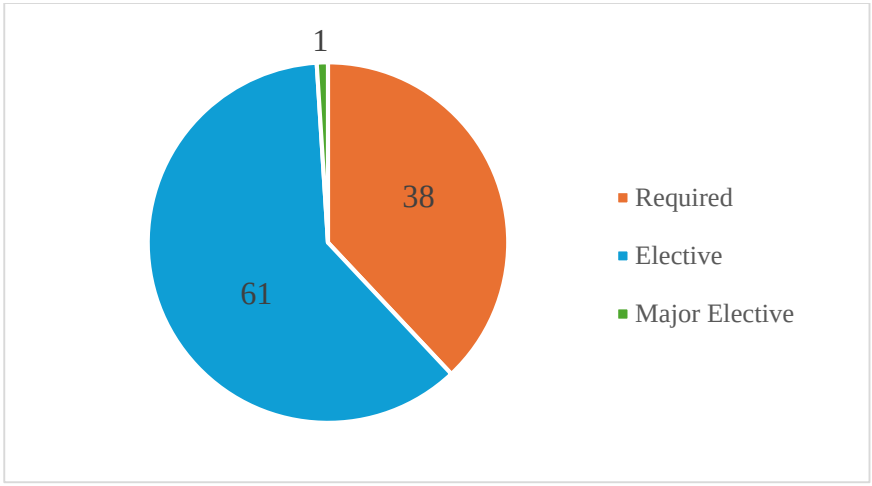


Figure 5. *Distribution of Color Courses by Required / Elective / Major Elective Status*

When examining the distribution of required and elective courses, it is evident that the majority of color courses are offered as electives. This situation suggests that the number of programs that actually provide color education may be lower, especially when departments without any color courses are also considered. Although some programs do include a color course in their curricula, offering it as an elective allows students to graduate without taking it. As such, elective courses are those taken based on student preference and are not mandatory for graduation.

When the color courses are examined in terms of the semesters in which they are offered, data from 86 courses were obtained. It was found that 7% of these courses are offered in the first semester, with four of them categorized as required and two as elective (Table 6). 8% of the color courses are offered in the second semester, and all six courses in this group are required. Accordingly, considering the total number of courses offered in the first and second semesters, 15.12% of color courses are presented during the first year of education. The fact that 10 of these are required highlights the significance of introducing color knowledge at an early stage of design education.

Table 6. *Semesters in Which Color Courses Are Offered*

Academic Year	Semester	Courses (%) – Semester	Courses (%) – Year
1st Year	1st Semester	7	15,12
	2nd Semester	8	
2nd Year	3rd Semester	19	38,37
	4th Semester	20	
3rd Year	5th Semester	24	38,37
	6th Semester	14	
4th Year	7th Semester	6	8,14
	8th Semester	2	

19% of the courses are offered in the third semester, 20% in the fourth semester, 24% in the fifth semester, 14% in the sixth semester, 6% in the seventh semester, and 2% in the eighth semester. The courses are predominantly offered at the second- and third-year levels.

3.3. Analysis of the Content and Teaching Methods of Color Courses in Undergraduate Interior Architecture Education

In order to define the objectives and learning outcomes of color courses in interior architecture departments, the educational criteria set by accreditation programs were first examined. Subsequently, the objectives and learning outcomes of color courses offered in relevant departments of universities were analyzed.

According to the accreditation standards of the Design and Planning Accreditation Association (TAPLAK) for undergraduate programs in interior architecture departments, it is required that the subjects of light and color be included at a minimum level in the curriculum. This criterion is stated as follows:

"Interior architects apply the principles and theories of light and color, taking into account their impact on the environment, human health, and safety."
TAPLAK explains that, through this criterion, the goal is to ensure that graduates of interior architecture programs understand the art and science of light and color. It emphasizes the necessity for graduates to integrate their knowledge and skills regarding light and color into design processes in order to enhance the quality of human life and experience [10].

The Council for Interior Design Accreditation (CIDA) also addresses light and color as the 12th criterion in its professional standards document. Through this criterion, it aims for graduates to understand the art and science of light and color and to integrate them into the design process [9]. Within this scope, student expectations and outcomes are listed (Table 7). When compared to CIDA criteria, TAPLAK accreditation standards are explained in less detail.

Table 7. *CIDA Lighting and Color Standards* [9]

Student Learning Expectations
a) Students are aware of the impact of illumination strategies and decisions.
Students understand:
b) the principles of natural and artificial lighting design.
c) strategies for using and modulating natural light.
d) Students appropriately select and apply luminaires and light sources.
e) Students understand how light and color impact health, safety, and wellbeing in the interior
Student work demonstrates understanding of:
f) color principles, theories, systems, and terminology.
g) color in relation to materials, textures, light, and form.
Student work demonstrates the ability to appropriately:
h) select and apply color to support design purposes
i) use color solutions across different modes of design communication

Color-focused courses in undergraduate interior architecture programs not only aim to provide students with theoretical knowledge of color, but also teach them how to integrate this knowledge into the design process. When course contents are examined, the nature of the knowledge and skills intended to be conveyed to students becomes clear through the defined objectives, learning outcomes, and the methods and techniques used. The scope of color education is shaped by both professional requirements and theoretical and practical components.

As seen in Table 5, when the course titles from the curricula of interior architecture departments are reviewed, it becomes apparent that concepts such as color, light, material, theory, application, and analysis are addressed together. This multidimensional approach indicates that color knowledge is conveyed not only on a theoretical level but also through practical applications.
The listed courses reveal that the topic of color in interior architecture education is addressed through various contents:

- Courses such as “Color Theory and Practice”, “Renk Bilgisi” (Color Knowledge), and “Renk Kuramı” (Color Theory) emphasize fundamental color knowledge and theoretical approaches.
- Courses like “İç Mekânda Işık ve Renk” (Light and Color in Interior Spaces), “Mekânda Renk Kullanımı” (Use of Color in Space), “İç Mekânda Yüzeyler: Renk, Malzeme, Doku” (Surfaces in Interiors: Color, Material, Texture), and “Renk ve Anlatım Teknikleri” (Color and Visual Representation Techniques) highlight the relationship between color, light, and material, addressing their contributions to spatial perception.
- Additionally, certain courses include more specialized topics such as color psychology, color culture, color harmony, and coloring techniques.

This demonstrates that the subject of color holds significant importance in education through both its theoretical and practical dimensions. However, it also reveals a lack of standardization in course naming. Considering that these courses are required in some programs and elective in others, it can be said that color education varies from one program to another.

Within the relevant fields, course descriptions, curricula, and syllabi shared on university websites were reviewed, and the objectives and learning outcomes of 59 out of 99 identified color-related courses were accessed. These objectives and outcomes were analyzed using keywords to determine the shared goals of the color courses. The keywords were diversified based on accreditation programs and the topics of light and color, including terms such as: color, light, material, texture, form, color principles, color theories, color systems, color terminology, environment, health, safety, well-being, lighting, natural lighting, and artificial lighting, along with their derivatives. The common components of the accessed objectives and learning outcomes were listed through a keyword analysis (Table 8).

The keyword analysis revealed four main themes: color knowledge and theory, material-texture-form relationship, color and perception, and lighting. Each theme includes sub-keywords that indicate the specific focus areas of the courses.

Color Knowledge and Theory includes 53 occurrences of keywords such as color theories (17), color principles (15), color systems (11), and color harmony (7), highlighting a strong emphasis on theoretical foundations. The inclusion of tools like the color wheel and terminology also reflects a practical aspect of color knowledge.

Material, Texture, and Form is the most frequently referenced theme, with 64 occurrences. Sub-keywords such as material (14), form (21), and texture (19) emphasize tangible design elements. References to areas like textiles and surface materials indicate a hands-on, application-oriented approach in these courses.

***Table 8**. Keyword Analysis of Course Objectives and Learning Outcomes*

Keywords	Sub-keywords	Frequency	Total
Color Knowledge and Theory	Color Theories	17	53
	Principles of Color	15	
	Color Terminology	2	
	Color Systems	11	
	Color Wheel	1	
	Color Harmony	7	
Material, Texture, and Form	Material	14	64
	Form and Texture	2+21+19	
	Textile	7	
	Surface Materials	1	
Color and Perception	Environment	8	53
	Health	2	
	Safety	1	
	Well-being	1	
	Psychological	16	
	Socio-cultural Effects	1	
	Perception	24	
Lighting	Lighting	11	16
	Natural and Artificial Lighting	5	
Light	Light	24	24

In the Color and Perception theme, 53 references were identified. Keywords like perception (24) and psychological (16) suggest a focus on cognitive and emotional aspects. Contextual terms like environment, health, well-being, and socio-cultural effects show that color is also addressed in broader environmental and societal contexts.

Lighting had the fewest direct keyword matches. Course content with this keyword tends to focus more on lighting education than on color itself. These courses aim to teach lighting strategies, natural/artificial lighting principles, and the correct use of light fixtures. For example, in courses like “Form, Light and Color” or “Color and Light”, color is discussed but not as a core focus.

Overall, the keyword analysis shows that course content largely revolves around fundamental design elements such as color theory, perception, material, and form. These themes point to a holistic learning approach that connects theory with practice. In contrast, lighting is treated more technically and functionally, suggesting that it occupies a more specialized and independent role in the curriculum. While the program outcomes show a general consistency, some thematic differences in content are evident.

5. DISCUSSION AND CONCLUSION

This study aimed to investigate the presence, scope, and diversity of color education in undergraduate interior architecture and interior architecture and environmental design programs in Turkey. The findings show that while most programs include color-focused courses, there are significant variations in course format, content, and semester placement. Among 106 programs, 83 offered at least one color course, while 23 programs did not, indicating considerable differences in curriculum content across institutions. In programs with color education, courses were offered as required, elective, or major elective, with the majority being elective.

Color courses are predominantly placed in the second and third years, with only 15% offered in the first year, despite the critical role of early color education in developing foundational design skills. Course

titles and contents reveal that color knowledge is delivered both theoretically and practically; however, naming conventions and instructional approaches vary widely across programs. Some courses focus on "Color Theory," "Color and Material," or "Color in Space," whereas others integrate broader topics such as light, material, psychology, and culture.

Accreditation standards emphasize the inclusion of color and light in interior architecture education. Therefore, a common educational framework should ensure that all students acquire core competencies in color principles, theories, systems, and terminology; color application in relation to material, texture, form, and light; color selection to support design objectives; development of color solutions in communication tools; and understanding and interpreting the color-space relationship.

Based on the findings, the following recommendations are proposed for a common educational framework:

- Core competencies in color principles, theories, systems, and terminology can be ensured for all students. This would guarantee equal access to foundational knowledge, so that graduates of the same profession share a minimum level of competence.
- Color applications may be integrated in relation to material, texture, form, and light. Such integration can reflect the real design process and allow students to understand color in direct relation to other design elements.
- Each program could include at least one required color course, complemented by elective options for advanced study. Since students may choose not to take electives, a required course can ensure that everyone receives basic color education, while electives may provide opportunities for deeper exploration.
- Learning outcomes such as color knowledge, perception, harmony, and integration with spatial design and materials may be covered. These outcomes can reflect the multifaceted role of color in design and prepare students for professional practice.
- Theoretical and practical components can be balanced, while multidisciplinary perspectives (e.g., psychology, culture, lighting design) may be encouraged. A combination of approaches could help students develop both conceptual understanding and applied skills, while also broadening their perspective beyond a purely aesthetic focus.
- A structured progression of color education could be provided across semesters. Such a step-by-step framework may ensure continuity in learning, prevent fragmentation, and allow students to build complexity over time.

By implementing these measures, color education, a critical component of interior architecture, can be delivered consistently and comprehensively across all undergraduate programs, ensuring both breadth and depth of knowledge for every student.

Limitations

This study is based on information publicly available on university websites, which may not fully capture the most current course details. Direct interviews with instructors were not conducted, so actual course delivery could vary in practice. Additionally, the study focuses on Turkey, and international comparisons were not included. These considerations should be taken into account when interpreting the findings.

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