JOURNAL OF **DESIGN FOR RESILIENCE** IN ARCHITECTURE & PLANNING

DECEMBER 2025 Issue 03

vol 06

www.drarch.org

info@drarch.org editor@drarch.org

JOURNAL OF DESIGN FOR RESILIENCE
IN ARCHITECTURE & PLANNING

E-ISSN: 2757-6329

Editorial

Mehmet Topçu (Editor in Chief)

With this issue, we collectively have the honor of presenting Journal of Design for Resilience in Architecture & Planning (DRArch), Volume 6, Number 3 (2025), bringing together scholarly contributions that critically engage with contemporary architectural, urban, and spatial challenges.

The issue opens with Mehmet Ali Altın and Özlem Gök Tokgöz, who examine urban resilience through lived experiences of overlapping disasters in "Living through dual crises: Rethinking urban resilience from lived experiences." Focusing on the simultaneous impacts of earthquakes and pandemics in Türkiye, the study foregrounds phenomenological insights into how urban spaces, regulations, and daily practices transform under compounded crises, emphasizing the necessity of integrated and adaptive planning approaches.

Following this, Ayşenur Albayrak critically addresses the evolution of industrial policies in Türkiye in "The transformation of industrial policies in Turkey within the framework of industrial ecology and circular economy." The article interrogates the shift from industrial ecology to circular economy discourse, questioning market-driven sustainability narratives and highlighting the spatial, social, and governance dimensions often overlooked in policy frameworks.

Issues of memory, displacement, and place-making are explored by Elif Vurucular Kesimci in "A comparison of elements establishing the relationship between social memory and space in the cinema of the Turkish Greek population exchange." Through cinematic analysis, the study reveals how forced migration and collective memory are spatially represented, shedding light on the enduring impact of displacement on identity and belonging. This study examines the Greek film Rembetiko, the Turkish film My Grandfather's People (Dedemin İnsanları), and the Turkish-Greek co-production Roza of Smyrna (İsmail ve Roza), all of which address the population exchange.

The experiential dimension of architecture is examined by Sena Işıklar Bengi in "Designing for experience: Exploring user-centered strategies in Selgascano's architecture." By analyzing selected projects of SelgasCano, the article demonstrates how biophilia, materiality, color, and context are systematically employed to enhance user experience and human–space interaction.The study concludes that user-centered and biophilic design strategies significantly contribute to enhancing spatial quality and human–space interaction. In this regard, examining and further developing design approaches that prioritize user experience is of critical importance for generating innovative and human-centered solutions in architectural practice.

Educational practices and design pedagogy form another important layer of this issue. Erdem Köymen and Mhd Feda Bouidani compare physical and virtual learning environments in "Analytical comparison of physical and virtual LEGO modules in architectural design education." Their findings highlight the complementary pedagogical value of tactile and digital tools in fostering spatial literacy, creativity, and adaptability in architectural education.This study examines the role of both physical and virtual LEGO modules in architectural and interior design education through a comparative analysis. Student groups from different levels were tasked with reconstructing a pre-designed architectural plan using both formats. Ultimately, the results highlight the potential of LEGO to serve as a versatile pedagogical medium that cultivates both foundational design skills and adaptability to future technological contexts.

The theme of displacement and resilience continues with Fatma Kürüm Varol Güneş, who proposes a network-based planning model in "Designing sustainable refugee settlements in Türkiye: A prioritized indicator framework and network-based scenario for Kilis." By integrating analytic hierarchy processes with spatial network analysis, the study offers a replicable framework for sustainable and culturally responsive refugee settlement design. Through a comparative evaluation of six international refugee camps and the application of the Analytic Hierarchy Process (AHP) to thirteen key design categories, the research identifies the most critical factors for developing inclusive, adaptive, and environmentally sustainable settlements. This integrative approach offers a replicable model for future refugee settlement planning, aligning humanitarian needs with long-term urban sustainability goals.

Urban cultural dynamics are addressed by Elif Kısar Koramaz, Vedia Dökmeci, and Numan Kılınç in "Growth and spatial distribution of art galleries in Istanbul between 2000 and 2022." The article maps the evolving relationship between cultural infrastructure and urban macroform, revealing patterns of centralization, clustering, and cultural-led urban transformation. This study contributes to the literature on Istanbul's urban growth and cultural

studies by presenting a spatial assessment of the art galleries, which is a relatively underexplored component of cultural infrastructure. Additionally, by analyzing the relationships between the galleries and the urban macroform, specific revitalization and redevelopment projects, and cultural policies, the study highlights the role of art galleries within urban growth processes and the cultural infrastructure.

Adaptive reuse and cultural sustainability are examined by Neslihan Yıldız and Mert Kılıçarslan in “Transformation of historical and spatial identity in the process of repurposing: The case of Cendere Art Museum.” Through a SWOT-based analysis, the study demonstrates how re-functionalized industrial heritage can generate new spatial identities while maintaining continuity with historical and environmental contexts. This study analyses the transformation process of industrial buildings from the perspective of architecture and interior architecture and examines the effects of this transformation on spatial identity through the example of Cendere Art Museum. In the research, the historical and contemporary functions of the space are analysed together with its structural, environmental and architectural dimensions; the results are evaluated in order to provide a methodological contribution to the literature.

The intersection of nature, history, and climate adaptation is explored by Aslı Taş and Mazlum Kalak in “The intersection of history and nature: The transformation of Cebeci Asri Cemetery as urban open space.” The article proposes a landscape-oriented and digitally supported model that repositions cemeteries as cultural routes and active urban open spaces. The purpose of this article is to develop a landscape-focused integration model that addresses spatial re-functionalization and digitally supported cultural route design at Cebeci Asri Cemetery. As a result, this study presents an alternative approach for the urbanization of an old cemetery isolated from the city. Although they are early structures, solutions have been developed to preserve the namazgah and ossuary structures and transfer them to the future. It is envisaged that this study will create an idea/guide for urban administrations.

Historic resilience in the face of climate change is further addressed by Murat Kitir in “Adapting historic sites: Konya-Sille's approach to climate resilience.” Focusing on traditional materials and settlement patterns, the study highlights the challenges and opportunities of balancing heritage conservation with climate adaptation strategies. This is especially pertinent considering their distinctive construction materials and settlement layouts. In this regard, the Sille Neighborhood in Konya, boasting a 5000-year-old history and abundant cultural heritage, emerges as an essential example.

The issue concludes with Helin Bağcıvan and Yenal Akgün, who offer an architectural critique in “Tectonic Character in Tadao Ando’s Church of the Light: Structure, Space, and Form.” Through a tectonic framework, the article examines how structure, materiality, and light converge to produce an experiential and spiritual architectural space. This paper mainly investigates the relationship between structural form, architectural space, tectonic character, materiality, and detailing in the Church of the Light. Particularly, the paper analyzes the use of materials and the interplay between structure and architectural space in Ando's design.

Collectively, the contributions in this issue reaffirm DRArch’s commitment to resilience as a multidimensional concept—one that encompasses crisis response, memory, cultural continuity, pedagogical innovation, and architectural experience. By engaging with diverse contexts and methodologies, this issue not only documents contemporary challenges but also expands the theoretical and spatial horizons of resilience-oriented architectural research. We invite readers to engage with these studies, reflect upon their implications, and contribute to the ongoing dialogue shaping the future of resilient design and planning. We extend our sincere thanks to all contributors for their outstanding work and dedication, and we hope this volume inspires further research, collaboration, and action across our shared fields.

As this volume marks the conclusion of 2025, it also opens a reflective threshold toward the year ahead. In a time when resilience is continually tested, these contributions remind us that architectural knowledge, critical inquiry, and collective imagination remain vital sources of renewal. Looking forward to the coming year, we embrace the potential for new dialogues, solidarities, and design perspectives that can support more just, adaptive, and hopeful spatial futures.

We thank all contributors for their dedication and hope that this issue inspires new research, collaboration, and creative initiatives. By engaging with these studies, readers are invited to enrich the debate on resilience and design and to help shape a more sustainable future for architecture and planning.

Best regards...

E-ISSN: 2757-6329

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Cover photo: Image copyright ©Sena Özfiliz, (2025). The image on the left is detail " A century old Greek house at Northern Aegean island of Cunda, Ayvalık, September 2025"

E-ISSN: 2757-6329

DRArch's objectives are:

- to question how future building technologies are revolutionizing architectural design, city planning, urban design, landscape design, industrial design, interior design and education,

- to catalyze the processes that lean on interdisciplinary and collaborative design thinking, creating a resilient thinking culture,

- to improve the quality of built environment through encouraging greater sharing of academicians, analysts and specialists to share their experience and answer for issues in various areas, which distributes top-level work,

- to discover role of the designers and design disciplines -architecture, city planning, urban design, landscape design, industrial design, interior design, education and art in creating building and urban resilience,

- to retrofit the existing urban fabric to produce resilience appears and to support making and using technology within the building arts,

- to discuss academic issue about the digital life and its built-up environments, internet of space, digital in architecture, digital data in design, digital fabrication, software development in architecture, photogrammetry software, information technology in architecture, Archi-Walks, virtual design, cyber space, experiences through simulations, 3D technology in design, robotic construction, digital fabrication, parametric design and architecture, Building Information Management (BIM), extraterrestrial architecture, , artificial intelligence (AI) systems, Energy efficiency in buildings, digitization of human, the digitization of the construction, manufacturing, collaborative design, design integration, the accessibility of mobile devices and sensors, augmented reality apps, and GPS, emerging materials, new constructions techniques,

-to express new technology in architecture and planning for parametric urban design, real estate development and design, parametric smart planning (PSP), more human-centered products, sustainable development, sustainable cities, smart cities, vertical cities, urban morphology, urban aesthetics and townscape, urban structure and form, urban transformation, local and regional identity, design control and guidance, property development, practice and implementation.

E-ISSN: 2757-6329

Editorial Team

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IN ARCHITECTURE & PLANNING

E-ISSN: 2757-6329

Table of Contents

JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (458-475), 2025
DOI: 10.47818/DRArch.2025.v6i3177

Living through dual crises: Rethinking urban resilience from lived experiences

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Özlem Gök Tokgöz**

Abstract

In recent years, cities have faced increasing pressure from overlapping disasters, exposing critical weaknesses in existing spatial, institutional, and social systems. Numerous decisions made throughout the history of cities are considered in the context of reinforcing the cohesion and adaptability of institutions and communities. Resilient cities adapt to environmental, economic, and social dynamics, demonstrating their ability to withstand pressures and evolve to fulfill various roles over time. Although many crises offer valuable lessons for enhancing urban resilience, this study focuses on how the concurrence of multiple crises alters spatial configurations and usage dynamics within urban environments. The study explores how cities respond and adapt to dual crises, focusing on the intersection of seismic events and pandemic conditions. Using a qualitative, phenomenological research design, the study analyzes official disaster regulations, emergency response plans, media documentation, and in-depth interviews with individuals who experienced both an earthquake and a pandemic simultaneously. The research centers on spatial transformations and shifting urban needs in the aftermath of the October 2020 earthquake, while also reflecting on the broader implications of the February 2023 disaster. Findings highlight the complex, layered nature of urban vulnerability under concurrent crises, emphasizing the need for integrated planning approaches, adaptable public spaces, and cross-sectoral coordination. This paper contributes to the ongoing rethinking of urban resilience strategies by offering grounded insights into the lived realities of navigating dual crises.

Keywords: resilient cities, earthquake, pandemic

1. Introduction

Cities perpetually undergo transformation and adaptation in response to the various shocks and disasters they encounter. Over the course of history, numerous decisions have been taken within urban settings, encompassing aspects such as infrastructure, public spaces, and green areas, all of which factor in the consideration of contemporary crises, shocks, and related eventualities. The concept of urban resilience is widely employed to assess the capacity of cities to withstand and recover from a multitude of diverse impacts and shocks (Meerow et al., 2016; Rezvani et al., 2023). However, there is no single, universally agreed-upon definition of urban resilience. Some studies focus on infrastructural robustness and physical recovery, whereas others argue that urban resilience extends beyond the physical realm to include social, economic, and environmental dimensions (Sanderson et al., 2016). Some other studies argue for a broader perspective that includes social equity (Vale, 2014). This diversity illustrates that urban resilience extends beyond the physical realm to encompass social, economic, environmental, and political dimensions (Meerow et al., 2016; Mouratidis & Yiannakou, 2021; Osman, 2021).

In recent years, the significance of this concept has amplified, driven by the heightened frequency and intensity of natural calamities and the escalating urbanization trends observed across the global population (Osei-Kyei et al., 2024). Urban resilience, as a concept, exhibits a dynamic framework that encompasses a multitude of domains (Osman, 2021). Natural disasters,

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Article history: Received 02 July 2025, Revised 19 September 2025, Accepted 24 November 2025, Published 24 December 2025

global warming, economic crises, political and social upheavals, and various other scenarios serve as litmus tests for urban resilience (Büyüközkan et al., 2022).

Achieving resilient city status necessitates fulfilling several prerequisites, with the spatial dimensions of resilience being among the most crucial. Identifying and cultivating areas that enhance urban resilience is of paramount importance, particularly during natural disasters. One of the important disasters that test urban resilience is earthquakes. Earthquakes, being a substantial natural calamity, inflict extensive damage on urban infrastructure, and they pose the most significant threat to regions situated in seismically active zones. Over the past two decades, earthquakes and tsunamis have proven to be the deadliest among all types of disasters, accounting for 58% of total fatalities (UN Office for Disaster Risk Reduction, 2019). Approximately 3 billion people in the world currently live in regions with high seismic activity.

Situations that increase the destructive effects of earthquakes and particularly test urban resilience include the overlapping of several disasters. In this sense, the epidemic called COVID-19 represents the most recent example of a city's resilience being tested. With COVID-19, which has emerged since the end of 2019, the way urban spaces are used and designed has changed globally. With the social distance rules brought about by the limited access to the public space during the pandemic process, people's staying at home has reduced physical interaction and slowed down or completely stopped practices such as education, economic activities, religious meetings, sports activities, and cultural activities. At the peak of the pandemic, UNESCO reported that over 1.6 billion learners globally were affected by school closures (UNESCO, 2023). Meanwhile, the global economy contracted by about 3 % in 2020, in what has been described as one of the most severe recessions in modern times (International Monetary Fund, 2020). The pandemic led to a re-evaluation of public space with regard to social distancing and health compliance, while simultaneously restricting activities to the home and forcing a reconsideration of resilient city concepts (Amirzadeh et al., 2023; Banai, 2020; Gök Tokgöz et al., 2023).

Utilizing past disaster insights can enhance cities' resilience to future adversities, but it's crucial to consider the possibility of multiple crises. Despite the richness of urban resilience literature, few studies have examined the compounding effects of multiple disasters occurring simultaneously. The concurrent experience of an earthquake and a pandemic represents a rare and underexplored scenario, one that poses unique challenges for urban resilience. This study specifically aims to explore urban resilience in the context of overlapping crises by analyzing the coexistence of the COVID-19 pandemic and the İzmir earthquake. It investigates how these dual shocks have influenced the use of urban space, the lived experiences of affected communities, and the strategies that can strengthen resilience in earthquake-prone areas. By drawing on interviews with disaster-affected individuals, this study contributes to the literature by providing empirical insights into how communities navigate resilience when confronted with overlapping crises. The focus of the study is what we have learned about urban resilience in the coexistence of pandemic and earthquake. The Bayraklı and Bornova districts in İzmir, Turkey, were selected as the study area due to the occurrence of a seismic event with a magnitude of 6.9 in the vicinity. An integral facet within the chosen field of study pertains to the unique circumstance that the disaster under investigation represents; namely, it stands as the inaugural and most devastating earthquake event to transpire within the timeline of the COVID-19 pandemic (30th January 2020 to 5th May 2023 as declared by WHO). This peculiarity confers distinctiveness within the realm of academic inquiry, as it presents a singular scenario characterized by the absence of pre-existing knowledge to inform relief efforts in the face of a dual crisis encompassing both a pandemic and a catastrophic earthquake. This study focuses on resilience, analyzing field investigations and outcomes. It evaluates strategies for enhancing earthquake-prone areas through interviews and literature analysis, evaluating strategies based on insights.

1.1. An Overview of the October 30 Earthquake in Turkey

Turkey is located in the region of seismic activity. Earthquakes are Turkey's most common natural hazard, accounting for the largest share of deaths and economic losses (UNISDR, 2017). Turkey, which has experienced many major earthquakes in its history, is also at risk of earthquakes in the coming years. Since the occurrence of the October 30 earthquake, there has been a significant surge in academic research pertaining to this subject.

The majority of this research can be categorized as pertaining to geological phenomena, while some align more closely with our specific area of interest. Aslan and Şahinöz (2023) examines the experiences of people with disabilities (PWD) during and after disasters. It highlights the impact of factors like inaccessible living environments, inadequate preparedness, evacuation challenges, and limited access to essential services. The study also highlights the exclusion of PWDs from disaster management processes and their psychological resilience (Aslan & Şahinöz, 2023). A study by Akpolat et al. (2021) on the knowledge and awareness of the İzmir earthquake-affected population found that sustained public education and community solidarity are crucial for mitigating potential earthquakes. Women, often indoors, are identified as a key demographic for targeted earthquake awareness programs. The research also advocated for social structural analyses in regions with rapid urbanization to create accurate risk maps and public policies for earthquake preparedness (Akpolat et al., 2021). Çalışkan and Kaya's study on social solidarity practices in Turkey highlights the importance of AFAD (Disaster and Emergency Management Authority in Turkey) institutions and local administrations in addressing earthquake victims' needs and providing psycho-social support. The findings underscore the significant role played by the AFAD institution and local administrations, as evidenced by 78.2% of participants rating their organizational efforts as either good or very good. Participants expressed satisfaction with assistance but also expressed apprehensions about rising housing costs, and emphasizing the emotional impact of earthquakes (Çalışkan & Kaya, 2021). Ağralı et al. (2023) conducted a qualitative study on the İzmir Earthquake using Twitter data and artificial intelligence. The study found that social media posts were primarily well-wishes within the first five days, with subsequent posts focusing on news updates and aid efforts. The sentiment analysis revealed sadness towards those affected, with neutral content being shared when no significant developments occurred (Ağralı et al., 2023).

As observed, the majority of research studies have primarily focused on the impacts of earthquake disasters, with little attention given to the concurrent circumstances of a pandemic. In this context, a study by Aru (2022) conducted a study that comprehensively examined this issue in the broader pandemic. The study surveyed 522 participants to investigate the link between earthquakes and pandemics. Results showed that most participants were at home during the earthquake, with a high rate of visiting assembly areas, indicating a crowded environment. The study revealed inconsistencies in social distancing rules and mask usage during an earthquake, with a significant increase in post-earthquake COVID-19 cases, indicating a potentially higher increase within the participant sample, particularly in earthquake-affected regions (Aru, 2022).

1.2. The Status of the Pandemic Before and After the Earthquake

The first case of COVID-19 in Turkey was reported on March 11, 2020. Shortly after the first case emerged, numerous measures were implemented to control the course of the pandemic. These measures included international travel restrictions by air and land, controlled intercity transportation, spectator-free sports events, and, most notably, the establishment and implementation of the infrastructure for remote education to ensure social distancing. The widespread adoption of remote working by many businesses opened the way for working from home. As the pandemic situation worsened in the following days, curfews were considered and enforced to gain control. With signs of improvement in the situation as of May 2020, some restrictions were gradually relaxed. National testing and isolation of infected individuals were conducted to control the spread of the disease. Home quarantine was implemented for those in

contact. A mobile application, "Hayat Eve Sığar," was launched to monitor and control infected individuals.

At the time of the earthquake, approximately nine months had passed since the onset of the pandemic. Activities such as wearing masks, using sanitizers, maintaining personal distance, remote education, and remote work had become integral components of the daily routine. Each day, the Ministry of Health disseminated daily statistics on the number of cases and fatalities. Efforts towards normalization were periodically disrupted by the emergence of different viral variants, prompting the reevaluation of eased restrictions. At the moment the earthquake struck at 14:51, it can be noted that many healthy individuals who would typically have been in schools or workplaces were in their homes. In an environment where staying at home had been recommended through all government channels, it is evident that numerous individuals were caught in enclosed spaces during the earthquake. Moreover, those who had been in contact with infected individuals were quarantined in their homes as a precaution, assuming they might be potential carriers of the virus. During the earthquake period, it is documented that the number of COVID-19 cases in Izmir had increased by 3.5 times compared to twenty days earlier (Aru, 2022). This situation underscores the severity of the pandemic's impact. While the pandemic persisted, individuals who experienced the earthquake in their homes had, for approximately eight months, navigated life within the confines of pandemic restrictions. They managed to escape from buildings shaken and shattered by the earthquake's force, leaving behind these constraints that had become an integral part of their lives. Given how closely they had walked to the edge of death, the prospect of contracting an illness no longer appeared as a significant threat. Indeed, the increase in disease cases in the aftermath of the earthquake substantiates this assertion.

2. Material and Method

Within this section details the study's geographical boundaries and qualitative research methodology, which includes semi-structured interviews with key informants, focus groups, and ancillary sources like online news outlets and social media platforms, to provide a comprehensive understanding of the seismic event.

2.1. Field Area

On October 30, 2020, a 6.9 magnitude earthquake occurred on the Aegean coasts of Turkey and Greece, one of the most seismically active regions of the world. The earthquake, with its epicenter off the coast of Samos Island in Greece, caused the most damage in the city of Izmir, located 70 km to the northeast in Turkiye (EEFIT, 2021). Figure 1 shows the earthquake area.

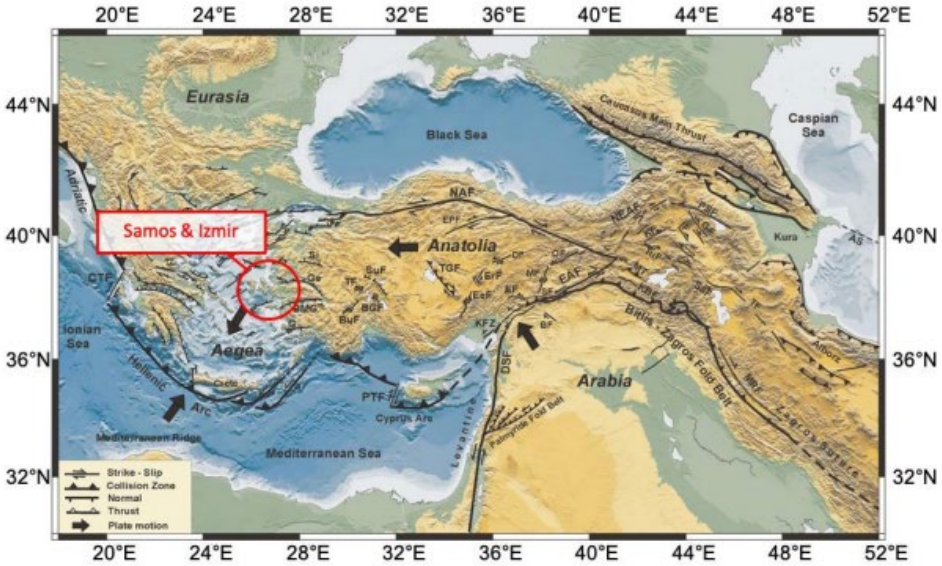

Figure 1 Field area has been circled red (EEFIT, 2021)

İzmir is the third-largest city in Türkiye, boasting a substantial population of approximately 4.4 million residents (TUIK, 2021). It is located in the western part of Türkiye, covers an area of around 12.000 km², and is situated at geographic coordinates 38.42°N, 27.14°E (Republic of Türkiye Ministry of Culture and Tourism, 2025). The earthquake severely affected İzmir's Bayraklı and Bornova districts, leading to the collapse of eight buildings, damage to more than 700 structures, and the tragic loss of 119 lives alongside over 1,000 injuries. Thousands of residents were left unsheltered in the aftermath, corresponding to a significant proportion of the local population. The vulnerability of the affected districts was strongly linked to the characteristics of the building stock, which included a prevalence of mid-rise reinforced concrete structures with inadequate seismic design, as well as some masonry buildings, all of which contributed to the scale of destruction and human loss (EEFIT, 2021). A seismic event caused extensive damage to critical infrastructure and leaving thousands without shelter, causing widespread destruction (Aktas et al., 2022). The study centered its attention on neighborhoods that bore the brunt of this destruction. Although the region usually has a temperate climate, harsh weather during the earthquake—especially at night—made outdoor conditions inhospitable.

2.2. Research Method

This study aims to examine how individuals perceive and interpret their lived experiences during the dual crises of an earthquake and a pandemic in order to gain insights into the social, spatial, and organizational challenges of urban resilience. Accordingly, a qualitative research approach was selected as the foundational methodology for this investigation. The integration of qualitative research methods serves as a valuable instrument for grasping how individuals subjectively experience events "from within" (Flick, 2007). A phenomenological approach was adopted as the guiding framework for this research endeavor. Interviews were conducted with individuals who had encountered the dual challenges of an earthquake and a pandemic concurrently. All data were collected remotely due to pandemic-related restrictions, which shaped both the research process and participants' lived realities.

For analytical purposes, the study's materials were systematically categorized into two distinct groups: interviews and supporting materials. In addition to the interviews, the supporting materials encompassed various sources, including newspaper articles, maps, films, images, and reports. These materials were utilized to corroborate and enrich the insights derived from the interviews, constituting a form of "grey literature." The term "grey literature" refers to content and research produced by entities operating outside the traditional academic or commercial publishing and distribution channels. The inclusion of such sources facilitates a multifaceted examination of the subject matter, allowing for the consideration of diverse perspectives (Haddaway & Bayliss, 2015). As a result, careful consideration was given to the design of the interview protocols and the methods employed in collecting the supporting materials, ensuring their alignment with the overarching objectives of this study.

In this study, both interview transcripts and supporting materials were coded and analyzed using NVivo 12 Pro, which facilitated both the coding process and the subsequent content analysis. The selection of NVivo arises from its capacity to handle extensive amounts of unstructured data, enabling the researcher to code, categorize, and analyze across multiple themes. This ensured a more transparent and replicable analysis process, reducing the risk of researcher bias. In this study, NVivo was particularly useful for identifying recurring themes related to housing, governance, and social interaction during the dual crises, as well as for understanding patterns and connections between earthquake- and pandemic-related experiences.

2.2.1. Interviews

The study's scope was intentionally delimited to exclusively include interviews conducted with residents of Izmir. Priority was given to individuals representing diverse age groups and cultural backgrounds who had experienced both the earthquake and the pandemic concurrently. The interviews were conducted between July and October 2021. Nine participants were engaged in

structured interviews as an integral component of this study. These interviews were conducted remotely, utilizing online platforms, with meticulous records maintained through both audio and video recordings. On average, each interview spanned approximately 40 to 45 minutes, allowing for in-depth exploration of their insights and narratives. The incorporation of supportive materials into the interview process served to enhance and enrich the depth of information obtained from the participants.

Open-ended questions, as employed in this study, refrain from prescribing a predefined set of answer choices, granting participants the freedom to respond in their own words and address the specific aspects they deem most relevant. The interview questions were structured around four distinct themes, each serving a specific research objective. These themes were framed by one or two guiding questions, such as "What are your thoughts on this matter?" "What transpired subsequently?" or "Could you provide further elaboration?" The interview structure made with these objectives was created as shown in Table 1.

Table 1 The Interview's Structural Themes and Information to be Obtained

Themes	Information to be obtain
During and immediately after the earthquake	where did he/she experience the earthquake, where did he/she go after the earthquake, who was on the call, what did he/she witness
Effects of earthquake and pandemic coexistence	Feelings, concerns and effects in the earthquake zone
Post-earthquake needs	Immediately after the earthquake needs like shelter, heating, etc.
How the urban life changed use of the public space	Urban spaces whose use has changed after the earthquake, which areas are safe, which areas are unsafe etc.

The data obtained from these interviews, organized according to these thematic dimensions, underwent a rigorous coding process. Codes, serving as linguistic or symbolic representations, were utilized to attribute semantic meaning to the information. The coding process facilitated the systematic arrangement of the data, preventing the inundation of unprocessed information and representing the initial step in the conceptualization process (Walliman, 2017). In this study, the research team transcribed and systematically coded the interview data.

2.2.2. Supportive Materials

The majority of the supporting materials were sourced from internet news outlets and social media platforms. Over the past few years, there has been a significant surge in social media utilization, with its presence becoming pervasive across various facets of daily life. Due to this circumstance, social media has become a subject of research in many disciplines (Chatziadam et al., 2020). The incidents identified via internet news sources and social media platforms underwent in-depth analysis through the examination of photographs, satellite maps, and videos. This analysis aimed to complement and substantiate the codes derived from the interview data. A content analysis employing qualitative methodology was conducted on the available materials.

News: The process of sourcing information was facilitated by inputting relevant keywords into internet search engines. Initially, preliminary research was conducted on the Internet, utilizing news portals and emphasizing keywords such as "İzmir," "earthquake," "COVID-19," and "pandemic." It was observed that local news sources provided more intricate news coverage compared to mainstream media outlets. Therefore, a comprehensive analysis of local news sources, involving deep data mining, was undertaken to extract relevant information, which was subsequently

collected. In NVivo12 Pro, the news articles were systematically coded with dates and source names, and the news sampling was limited to the period from the date of the earthquake to three months thereafter. Figure 2 presents an overview of news frequency distribution.

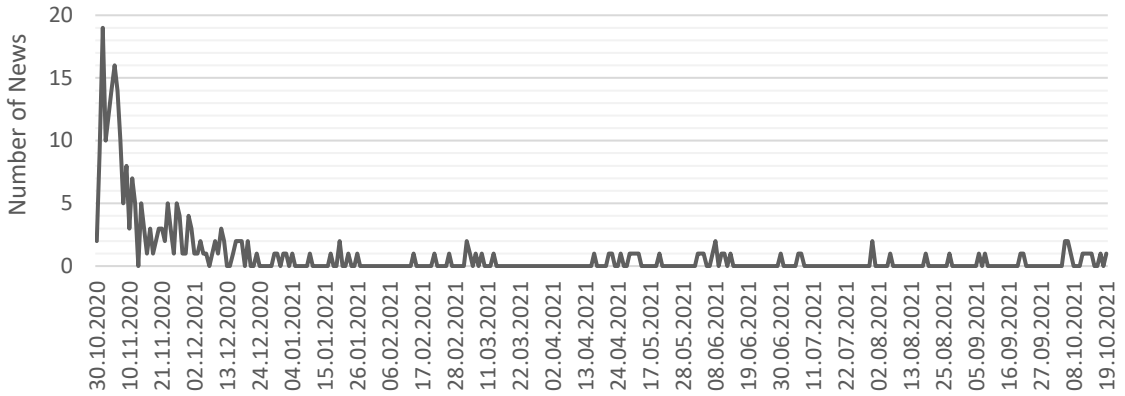

Figure 2 "Earthquake" related news frequencies

The study selected a specific timeframe due to research-related news frequency patterns, with relevant news on the earthquake's first day and until December. Data from interviews and supplementary materials were summarized, with direct quotations coding to mitigate interviewer bias.

Maps: Google Earth possesses an archive of georeferenced satellite photographs incorporated into its mapping interface, serving as a valuable resource for facilitating the orchestration of preparatory measures in response to seismic events. These cartographic representations encompass satellite-derived depictions captured at intervals spanning 7 months preceding the seismic occurrence, the precise day of its incidence, 2 days subsequent to the event, and a comprehensive year post-event. This temporal scope affords the opportunity for discerning alterations transpiring antecedent and subsequent to the seismic event.

Videos: The research uses YouTube videos and interviews with survivors, volunteers, and officials to gather firsthand insights. The analysis of these datasets, including street interviews during walks, aims to establish correlations and uncover new connections. Satellite imagery is used to cross-reference the locations and routes of these interviews.

3. Research Findings

This study investigates the effects of the pandemic and earthquake on the evolving needs of individuals, ascertained through interviews with affected citizens and supportive materials. Salient themes and codes were identified and analyzed. Figure 3 shows the structure of research.

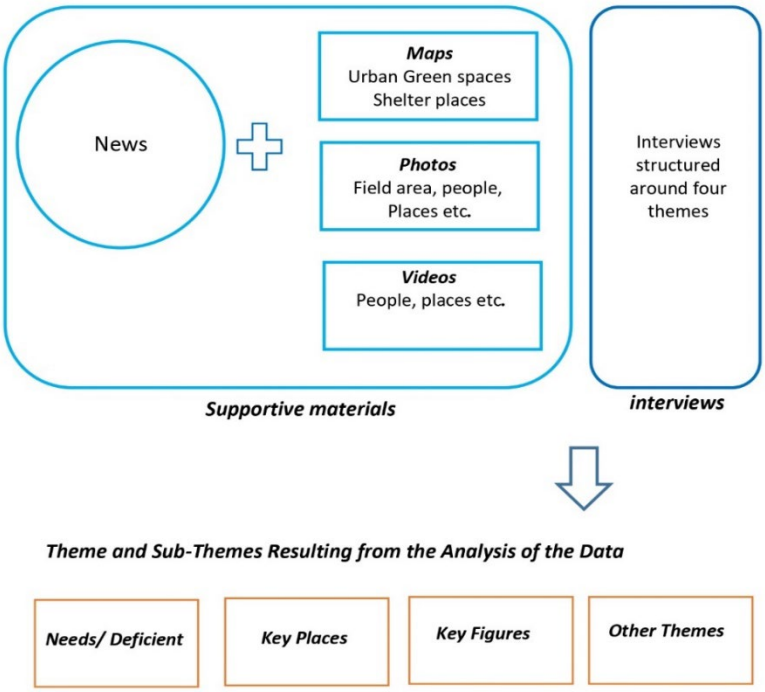

Figure 3 Structure of material research

3.1. Themes and Codes

The data collected from the interviews and supportive materials were organized into themes and sub-thematic categories. The selection of themes and sub-themes was guided by both the literature and the empirical data. Previous studies have consistently recognized housing conditions, government authority, and community support as key elements of urban resilience (Büyüközkan et al., 2022; Cutter et al., 2008; Meerow et al., 2016). Building on these insights, the interview data were coded inductively, which enabled the identification of sub-themes reflecting local experiences during the dual crises. This approach ensured that the analysis remained both theoretically informed and empirically grounded.

The data was categorized **into four primary themes: needs/ deficient, key places, key figures and other codes** having minimal relevance to these. The aforementioned themes and sub-themes were categorized into two branches, namely earthquake-related themes and pandemic-related themes. These themes are discussed in the study first in connection to the earthquake and subsequently in relation to the pandemic. The remarks provided by the interviewees have been coded and are designated as P1 through P9. The Table 2 provides a comprehensive breakdown of the preliminary thematic framework in a more granular manner.

Table 2 Theme and Sub-Themes Resulting from the Analysis of the Data

	Needs/ Deficient	Key Places	Key Figures	Other codes
Earthquake	shelter	emergency assembly areas	earthquake victims	social media
	foods/water	parks /recreation areas	relatives	
	heating	cafes	children	
	internet	courtyards	elderly people	
	electricity	sports halls	pets	
		car parking areas	volunteers	
Pandemic	hygiene social distance	*shelter	people in quarantine	be unorganized
	online education		people who have contact with individual	

To provide readers with a clear overview of the empirical results, the main themes and their associated findings are summarized below. While the detailed analysis is presented in the subsequent sections, Table 3 highlights the most important outcomes across the earthquake and pandemic contexts.

Table 3 Key Findings per Theme

Themes	Key Findings
Needs / Deficient	Post-earthquake, there were significant deficiencies in **shelter, heating, and electricity,** while cleanliness and online education were prominent concerns during the pandemic.
Key Places	**Parks and green areas** became essential locations for post-earthquake shelter and assistance.
Key Figures	**Children and the elderly** were particularly vulnerable, with volunteers providing vital but often disorganized support.
Other Codes	**Social media** was important in coordinating aid and disseminating information, although **disorganization among institutions and volunteers** hindered relief efforts.

While Table 3 provides a concise overview of the key findings across all themes, the following sections offer a more detailed discussion of each theme and its sub-themes. This structure allows the results to be presented in a systematic manner: first outlining the broad patterns that emerged from the data, and then illustrating these patterns with participants' narratives and supporting materials.

3.1.1. Needs/Deficient

The interviews conducted highlighted the prevalent themes of needs and deficiencies. The discussions revolved around the immediate requirements of individuals in the aftermath of the earthquake, as well as those pertaining to the post-disaster period. Additionally, participants addressed pre-existing issues and various administrative shortcomings they perceived. These needs and deficiencies can be categorized into two main groups: daily life necessities and those arising from the pandemic.

The earthquake led to a surge in the need for **shelter**, with many people seeking it due to home damage or awaiting assessments. Participants expressed dissatisfaction with the initial tent setups, which were delayed and inadequately executed, and the scarcity of tents was a major concern.

"During the day, people could spend their time standing or sitting on the grass in parks but at night, this was the biggest problem when talking about children and elderly. The sitting area and sleeping area were the biggest inadequacy. (P1)"

"There weren't enough tents, so many people slept on the ground the first day. (P2)"

"There were many people in the parks around the house, there were tents so for a while, those tents were everywhere, there were too many tents around. (P8)"

The supporting materials particularly emphasize that the need for tents has gradually decreased over time, with an initial shortage on the first night. As victims explored alternatives like hotels, rental accommodations, or moving in with relatives, the need for tents decreased. Many of the 2,578 tents set up in the city remained unoccupied, leading to their relocation towards central areas.

Aid was promptly dispatched from neighboring provinces immediately following the earthquake to provide sustenance in the form of **food and water** to the local population. According to the participants, there were relatively few issues related to food distribution. However, the availability of **electricity** emerged as a critical concern in various areas, given its essential role in both **heating**

and other daily needs. This problem was exacerbated by the earthquake's occurrence in late October, during cold and rainy weather, magnifying the significance of heating. The demand for electric heaters, blankets, and warm clothing garnered widespread attention, particularly on social media, where aid providers were urged to prioritize these essential items. Some participants expressed dissatisfaction with the comfort levels within the provided tents. Insufficient provisions of key necessities, such as heating, electricity, and clean water, were reported. One participant shared their firsthand experience regarding this issue.

"People didn't have a warm place to sleep or shelter outside. It was very cold and the tent was not adequately protected. It tried to warm up by a fire outside. Nearby cafés and restaurants are now whatever, people go there and charge their phones. The electricity demand was too great to provide. The heater was being used, is it better to use the socket for the heater or for the phone in cold weather? That is why people go to any market and it was said that could I charge my phone? (P1)"

The pandemic has heightened concerns about **hygiene, online education, and social distancing,** particularly in areas severely affected by earthquakes. Participants expressed a desire for improved sanitation facilities, including restrooms and washing facilities, and emphasized the importance of maintaining hygiene during food distribution and dining. Volunteers at the Aşık Veysel recreation area (On the 245-acre site in Bornova, there is an Ice Sports Arena, a 5,000-seat amphitheater, basketball and volleyball courts, and relaxation areas, along with a 641-vehicle parking facility) shared observations on restroom and toilet facilities.

"There is the pandemic and the showers opened two days later. Those inside the ice rink were also opened, and while people were taking a shower, their number could be kept up. …There were too many entrances and exits, if 800 tents are mentioned, there are 2500-3000 employees, maybe there with volunteers. There were two toilets in the area we opened, with 3 cabins in each. There were also two on the ice rink. There were 2 entrances each, the cleaning was not enough. We couldn't see enough cleanliness; most of the time we didn't drink enough water because we didn't want to use the toilets. (P9)"

In response to the ongoing pandemic, educational activities that were previously conducted online have been restructured into a mobile learning environment, with a specific emphasis on adhering to stringent social distancing measures. This transition underscores the paramount importance of children's education within this context. Notably, the Turkish Ministry of National Education has established the Education Information Network (EBA), a comprehensive electronic educational content network. EBA, equipped with computers and internet connectivity, has been strategically deployed to facilitate online education for primary school students residing in remote areas. However, many high school and university students are unable to continue their studies due to lack of internet access and computers. Distance education infrastructure was not established until the 8th day after the disaster, with some survivors using mobile phones.

Another topic that came up a lot in the wake of the earthquake was **social distance**. Participants saw that social distancing received insufficient attention in the immediate post-quake period, and the accompanying materials reflected this as well. The participants stated that they could not pay attention to social distances due to the shock of the earthquake.

"We couldn't keep social distance because you came out of the earthquake and you wanted to hug the first person you saw. You see that he/she is alive. Social distancing was very much ignored in this case. (P1)"

Consequently, the spectrum of needs and deficiencies during this period encompasses a wide array of challenges. In the aftermath of the earthquake, various facets of human existence may assume the role of critical necessities. The needs were more complicated as a result of the pandemic and earthquake. In addition to providing for the earthquake's essential needs, the pandemic had to be taken into account.

3.1.2. Key Places

Earthquakes and other natural disasters have a profound impact on urban environments. In the case of the recent earthquake, the already-transformed urban landscape, influenced by the ongoing pandemic, underwent further changes. The participants in the study highlighted various spatial alterations, **including parks, courtyards, sports halls, recreation areas, and parking facilities**.

In the context of the earthquake, significant locations can be analyzed from two perspectives: areas that were immediately identified as safe and protected following the earthquake and locations suitable for shelter and relief efforts. Participants reported evacuating their homes promptly after the earthquake, seeking safety in open areas away from buildings. These safe zones included parks, highway edges, waterfronts, and city squares, where individuals felt secure. Below are some illustrative quotes from the participants to elucidate these findings.

"The only place we can go in an earthquake is the green areas and courtyards near us. There are many houses with courtyards here; people have always gone to the courtyards. (P1)"

"There are no buildings around, just an open space, and there aren't many buildings that could be knocked down and collapsed. For me, the safest areas seem to be those places. The car park next to our house is a really large car park. There may be large parks; there may be such car parking areas. …Aid was always collected in the parks next to our house. Aid was also distributed in the parks. There were many people in the parks. (P8)"

Emergency assembly areas within urban spaces were another notable topic of discussion. Numerous participants expressed their lack of awareness regarding the locations designated for assembly in the city. There is a prevailing opinion that these assembly areas are often chosen from among the urban green spaces. In a study conducted after the earthquake in Elazig, another city in Turkey, it was reported that urban green spaces had been designated as assembly areas (Meral et al., 2021).

"… People gathered in the parks. There was no assembly place. I do not know though. Everyone go to the parks. (P8)"

"First of all, I can talk about the inadequacy of assembly areas. Because, as I said, there were no assembly areas near us, so we had to go out to the courtyards. The assembly areas in the center of the city are generally green areas next to playgrounds. (P1)"

In the aftermath of the earthquake, temporary tents were established on various prominent **green areas** within the city. Analysis of Google Earth imagery of the earthquake-affected region indicates that almost all accessible green spaces were utilized for the placement of these tents, with a notable preference for larger open areas. Among these locations, the Aşık Veysel recreation area stood out prominently as a site where both tents were erected and aid collection took place immediately following the earthquake. During interviews, participants consistently emphasized the significance of this expansive urban green space. For visual reference, Figure 4 provides aerial photographs of this specific region.

Figure 4 Aşık Veysel recreation area (Anadolu Ajansı, 2020)

Post-earthquake relief efforts are coordinated and distributed using indoor facilities, such as **sports halls** and exhibition centers. An ice rink located within the Aşık Veysel recreation area served as one such facility. During interviews, it was reported that relief supplies were gathered and organized at the ice rink before being efficiently distributed to the tents in the adjacent green area.

The social and psychological implications of utilizing urban green areas during a crisis have undergone a significant transformation, particularly in regions where earthquakes are deemed potential threats. These **urban green areas**, typically designated for leisure and relaxation, have demonstrated their potential to serve as gathering points, distribution centers for aid, and temporary shelters during emergencies, thereby enhancing the city's resilience. Consequently, it is imperative to reevaluate design decisions for urban green spaces, considering their utility during times of disaster. The urban green spaces have multifunctional roles in the aftermath of earthquakes, including hosting tent-based relief centers and serving as gathering points. These areas instill a sense of security among people, further underscoring their significance during times of crisis. The situation has been articulated in post-earthquake reports as follows:

"It has been observed that the number of regions and buildings affected by the earthquake is relatively low compared to the urban development; this is due to the significant green spaces in the affected area, enabling the rapid establishment of temporary shelter areas (BUSOS, 2020)."

Cafes situated in close proximity to assembly or shelter areas played a crucial role, particularly in the early days following the earthquake. These establishments served as vital spaces for obtaining warmth, relaxation, restroom facilities, and addressing various needs, including access to electricity and the internet.

The pandemic has also changed the needs for key spaces. In every setting where it is necessary, social distancing must be taken into account. The convergence of a pandemic and an earthquake has juxtaposed two contrasting scenarios. Amidst the pandemic, individuals were encouraged to curtail their social interactions and remain at home. Following the earthquake, pandemic-related considerations were factored into sheltering arrangements, prioritizing warm and enclosed spaces, social distancing measures, and limiting the number of occupants. Early on, the increased demand for tents also serves as an indicator of the pandemic's impact, necessitating a greater quantity of tents than would typically be required.

3.1.3. Key Figures

The key figures of most concern in earthquake-related situations are examined in this section. **Earthquake victims** assume a central role in research and post-disaster recovery endeavors. They can be classified into three groups based on their housing situations and personal relationships with their homes. Survivors of collapsed homes are those who have survived and stay near the debris, focusing on rescuing loved ones and recovering valuable possessions. Uninhabitable homes, standing, are those whose homes are still standing but uninhabitable due to severe damage. They await inspections and evacuation updates, finding outdoor shelter and addressing shelter needs collectively. Residents of habitable homes, despite fearing aftershocks, prefer staying outside due to primary concern, planning to return home once subside, accessing essential needs and temporarily staying in resettlement areas or parks. The above classification provides a comprehensive framework for understanding and anticipating the needs and behaviors of individuals.

Earthquake victims discussed their primary concerns, focusing on individuals like children, the elderly, relatives, and pets. Relatives and friends were crucial first responders, providing support and comfort. Participants reached out to their relatives via social media, phone calls, and internet connectivity.

Following concerns for **relatives**, earthquake victims expressed a heightened sense of worry for children, particularly those residing in tent areas. Given the unique needs of **children**, they require special care and attention during large-scale disasters, which are crucial for their well-being (Ersoy

& Koçak, 2016; Kitayama et al., 2000). To address this concern, an initial volunteer group was organized to tend to the needs of earthquake-affected children. Many volunteers visited tent settlements to engage with children and involve them in recreational activities, aiming to alleviate the psychological impact of the earthquake on these young individuals. The care and well-being of children have been a focus of news reports and videos, with various initiatives involving volunteers, NGOs, and the government. Activities include painting classes, open-air theaters, and sports programs.

"My very closest friend already performs on the street, has organized events there, mostly for children. They played games with the children so that they would not be affected by that situation too much. He went almost every day. A lot of people participated in these events. (P5)"

The elderly constitutes another demographic that is notably vulnerable and requires significant assistance in the face of a severe catastrophe. They are more susceptible to the psychosocial effects stemming from such disasters (Ticehurst et al., 1996; Zhu & Sun, 2017). The earthquake has led to the relocation of elderly individuals to their families, posing challenges in tent settlements and requiring adaptation. Organizations, state-owned social care centers, and specialized professionals worked to address these needs, with special attention given to elderly, disabled, and hospitalized individuals.

Concurrently, individuals are actively deliberating strategies for safeguarding their **pets** in the event of an earthquake. Online news sources reveal that municipal shelters have made extensive provisions to accommodate animals rescued from earthquake debris, with designated sections specifically for these animals. Participant expressed the following concerns.

"I always had such worries after the earthquake. If there is an earthquake at night, which cat will I take first? Should I take the box or carry it on my lap? Can I wear its collar? (P3)"

Volunteers played a crucial role in recovery efforts, including aid transportation, distribution, and care for survivors. However, the abundance of volunteers led to challenges in organization. A large group, known as "disaster tourists," engaged in assistance without a structured approach, distributing food in dispersed tent areas without proper hygiene and pandemic precautions. Within the scope of this study, it is worth noting that social media influencers who conduct documentary-style street interviews and record visual materials comprise an alternative subtype of disaster tourists. The unnecessary congregation of individuals has emerged as a significant contributing factor to the escalation of the pandemic.

The key figures related to the pandemic are those who were under quarantine during the occurrence of the earthquake, as well as those who had direct contact with them. The main focus of pandemic response tactics was to enforce isolation and quarantine measures for those who received a positive diagnosis for the virus. As a result of the earthquake's devastation, these individuals were unable to stay in their homes for the purpose of quarantine. During the chaos of the earthquake, it was impossible to distinguish persons who were under quarantine and who had direct contact with them. Consequently, the action implemented to address one catastrophe was rendered futile by another catastrophe. Hence it is known that following the earthquake, the number of pandemic cases in the area rose.

3.1.4. Other Codes

The other codes encompass issues that were not explicitly queried to the participants, but emerged prominently during the interviews and were subsequently corroborated by supportive materials. **Social media** has played a significant role in this context. In recent years, social media has assumed a pivotal role in crisis management (Houston et al., 2015). It plays a fundamental role in disseminating information to institutions, facilitating interactions, and revealing responses to various issues (Mavi, 2020; Yin et al., 2020). During the interviews, the significance of social media emerged as a recurring theme. All participants unanimously concurred that social media proved to be invaluable for gathering and discerning requirements. Remarkably, despite the absence of

specific social media-related questions in the study's design, participants consistently emphasized the significance of this aspect. Selected participant quotes illustrating this viewpoint are provided below.

"The greatest advantage was social media. Because I think the management was not at all equipped. Thanks to social media, a great deal was arranged. (P3)"

"Help places and needs were constantly shared on social media. I always looked at the lists there, looked at the needs and collected them ...(P6)".

"Social media is something that allows previously blocked traffic to flow... (P7)".

Furthermore, it was noted that individuals or accounts with significant visibility (those boasting a larger number of followers) on social media platforms were often approached for assistance and to disseminate information about the needs in the earthquake-affected area.

"I think, thanks to our people and our social media power, that place has turned into a gathering area and a shelter. Because after most people came there, we used social media very well. To make up for the deficient there. With the power of social media, many companies came to the field before municipal and state aid. There are many brands we have worked with before, brought tea, coffee and even filter coffee. (P9)"

Additional significant issues, beyond those related to social media, included deficiencies in organization and shortcomings in local administrative management. Participants highlighted the being unorganized of the municipal and administrative administration under this subject, which was categorized as **a lack of organization**. The literature covers processes related to post-earthquake recovery, rehabilitation, and reconstruction (Inzulza-Contardo, 2014), often focusing on a brief timeframe, such as the immediate aftermath of the earthquake and the arrival of essential supplies. This crucial period, lasting approximately 72 hours (French et al., 2019), represents the time when people are most in need of assistance and when deficiencies in organizational capacity become most apparent.

Volunteers in tent settlements reported organizational shortcomings, with disorganization being a significant concern. Many found the municipality's assistance insufficient, as evidenced by news reports and street interviews. Content produced after the earthquake supports these comments, with meal distribution processes in densely populated areas like the Aşık Veysel Recreation Area resembling a fairground, characterized by overcrowding, and clothing being haphazardly piled up. City officials were observed visiting tent areas with a large entourage, displaying behavior that appeared disconnected from the realities of the pandemic as they interacted with citizens and even took photographs with those who requested them.

Post-earthquake assessments reveal that volunteers' inadvertent actions compromised pandemic precautions. Individuals affected by the earthquake expressed discomfort as volunteers repeatedly approached them. Organizational inadequacies were primarily due to unregulated volunteer interventions. Established institutions like AFAD, municipal authorities, and the Red Crescent effectively distributed aid and sustenance, while meal service companies and volunteers' unstructured efforts led to unnecessary movement and increased risks of disease transmission. These factors exacerbated pandemic-related risks. This circumstance, in contravention of social distancing measures, heightened the risk of disease transmission within crowded settings, ultimately culminating in a dramatic upswing in COVID-19 cases in Izmir and its surrounding areas.

4. Discussion

Disaster resilience requires the coordinated involvement of multiple actors, including **government institutions, non-governmental organizations (NGOs), community groups, and academic or expert bodies**. Each of these actors has distinct but complementary roles in both the immediate response and the longer-term process of strengthening urban resilience. The findings of this study highlight several critical issues, such as the importance of green areas, social media use,

and the provision of essential services like electricity, clean water, and heating that can be directly linked to these actors' responsibilities. Table 4 summarizes a roadmap that distributes the recommended actions across these different actors, ensuring that the empirical insights derived from the fieldwork are translated into concrete, actionable strategies.

Table 4 Roadmap for Strengthening Urban Resilience

Actors	Recommended Actions
Government	• Make sure that preparations for disaster preparedness include enough space for housing, heating, electricity, and clean water. • Designate and publicize official assembly areas. • Integrate urban green spaces into resilience planning.
NGOs	• Support aid collection and distribution systems. • Provide psychosocial and educational support, especially for children and elderly. • Assist in the organization of volunteers to prevent uncoordinated aid.
Community	• Strengthen self-organization and mutual aid networks. • Use social media effectively for information sharing while avoiding misinformation.
Academia / Experts	• Create policies for incorporating social media and digital tools into crisis management. • Contribute to risk mapping and planning for multifunctional urban green areas.

As summarized in Table 4, the proposed roadmap links the study's key findings to the roles of different actors. The co-occurrence of an earthquake and a pandemic represents a distinctive event warranting in-depth investigation (Gök Tokgöz & Altın, 2023). Upon reevaluating the themes and topics discussed following the tragic event of living through an earthquake and pandemic simultaneously, the following subjects come to light in briefly.

Particular needs and deficiencies; the city collaborated to develop answers when destroyed homes created an immediate demand for shelter. While allocating resources was a significant difficulty, aid providers were encouraged to prioritize vital needs through the use of social media. The city demonstrated flexibility in handling multiple crises simultaneously, utilizing volunteering and community involvement for short-term relief and long-term pandemic evaluations.

The concept of key places should be given particular attention, particularly in significant events that alter spatial dynamics, such as earthquakes. The city faced a complex challenge during the earthquake and pandemic, demonstrating its resilience and adaptability. Residents sought safety in open areas, such as parks, gardens, and waterfronts, and used urban green spaces as assembly areas. These areas served as natural gathering points during disasters, showcasing the community's resourcefulness.

The city's disaster management strategy prioritizes earthquake victims, including vulnerable groups like children, the elderly, pets and disabled individuals. Despite challenges like disaster tourists and lack of coordination, resilience is evident in unforeseen circumstances.

The cited flaws in other codes primarily were around social media and organizational aspects. Social media played a crucial role in disseminating information, coordinating relief efforts, and gathering real-time data on earthquake victims' needs. It has become evident that many issues arising from a lack of organization, compounded by the earthquake and pandemic, find solutions through social media. Interaction and communication are integral aspects of the resilience concept (Crowley et al., 2012). In this context, it can be asserted that the judicious use of social media plays an effective role in enhancing the resilience of cities. However, the city faced challenges in

managing the influx of aid and volunteers, highlighting its capacity for self-improvement and adaptation.

The study emphasizes the importance of earthquake preparedness in regions susceptible to seismic activity, highlighting the impact of a significant earthquake in Turkey in February 2023, which further highlighted the need for ingrained practice in such situations. The magnitude of the February earthquake resulted in heightened demands, as it impacted ten urban centers. In contrast to the Izmir earthquake, assistance was provided to this area not only from nearby cities, but from many locations throughout Turkey. Dedicated facilities for the gathering of necessities and assistance were established in every city, with key places once again assuming a significant role. The role of urban green spaces during the February earthquake was also of paramount importance. Tent facilities for earthquake survivors were once again established in these green areas and sports halls. This reiterated the significance of green spaces as safe havens for the population. The key figures identified in our study once again garnered attention during the February earthquake, as highlighted in news reports. The lack of organization and the role of social media were seen again in this earthquake.

5. Conclusion

Natural disasters like earthquakes and pandemics can severely damage cities, causing resource losses and reduced resilience. Turkey, an earthquake-prone country, is particularly vulnerable to these disasters. In this regard, earthquake-resilient urban designs should be prioritized for implementation in earthquake-prone locations. Buildings and green spaces should be properly planned so that they can serve as shelters in the event of an earthquake and other disasters.

This study emphasizes essential principles, critical urban areas, and deficiencies in urban resilience in the context of the combined impacts of earthquakes and pandemics. Future studies could build upon the findings of this research by examining the coexistence of multiple and overlapping disasters, such as earthquakes, pandemics, and climate-related events. Employing more detailed quantitative methods alongside qualitative approaches would allow for a deeper understanding of urban resilience dynamics. In addition, comprehensive investigations into administrative and organizational structures are needed to reveal existing shortcomings and propose more effective governance models. Such efforts would not only enhance theoretical knowledge but also provide practical guidance for policymakers, local authorities, and community-based organizations.

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CRediT Authorship Contribution Statement

Mehmet Ali Altın: Writing – review & editing, Methodology, Investigation, Analysis, Data curation, Conceptualization. Özlem Gök Tokgöz: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Data curation, Conceptualization, Data visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Ethics Committee Approval

The study was conducted in accordance with the Ethics Committee approval dated 04.10.2021 and numbered 14/1.

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JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (476-490), 2025
DOI: 10.47818/DRArch.2025.v6i3178

The transformation of industrial policies in Turkey within the framework of industrial ecology and circular economy

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Abstract

Since the 1980s, sustainability has become a central theme in industrial and environmental policies, with growing criticism of linear production systems and increasing emphasis on circular production. Unlike linear systems, which rely on one-way resource flows and generate waste, circular models promote reuse, repair, and recycling, aiming to preserve materials and reduce ecological impact. Within this framework, industrial ecology proposes a closed-loop approach that combines economic growth with environmental sustainability and has laid the conceptual foundation for the circular economy. Highlighted in EU industrial policies, this paradigm seeks to minimize waste and extend the life cycle of raw materials. This study examines the transformation of industrial policies in Turkey within the framework of "industrial ecology" and the "circular economy". Since 2010, initiatives centered on industrial symbiosis have been introduced in Turkey, strengthening awareness of a production model based on by-product exchange among producers. During this period, practices were implemented in two main categories: the development of regional industrial symbiosis schemes and the transformation of existing Organized Industrial Zones into Eco-Industrial Parks. After 2020, under the influence of the EU Green Deal, the circular economy discourse has become the dominant narrative in policy documents. By analyzing policy documents over the past 15 years, the study demonstrates both the growing institutionalization of circularity and its structural weaknesses. Notably, insufficient attention to spatial dimensions and the risk of reducing circularity to bureaucratic waste trading emerge as critical challenges. Achieving genuine environmental sustainability requires reframing the circular economy beyond technical or economic efficiency, integrating ecological principles, and embedding it holistically within spatial, social, and governance contexts.

Keywords: circular economy, industrial ecology, industrial symbiosis, sustainability, Türkiye

1. Introduction

Environmental problems have emerged in parallel with industrial development and have increasingly been addressed at a global scale since the 1970s. In response, efforts have focused on developing systems that maintain industrial productivity while minimizing environmental damage, avoiding the overuse of natural resources, and preventing pollution. The concept of sustainability, which emerged in this context, has been a dominant theme in industrial and environmental policies since the 1980s. Following the publication of the United Nations Sustainable Development Goals, the concept of sustainability also gained considerable traction in the business world. As a result, the limitations of linear production systems have increasingly come under scrutiny, and the necessity of transitioning to circular production has become a common theme in both policy frameworks and academic literature. While linear systems are based on a one-way flow of resources that generates waste and environmental pressure, circular production emphasizes reuse, repair, and recycling, aiming to preserve materials and reduce ecological impact. This shift reflects a move from efficiency-oriented improvements toward a more systemic approach to production and consumption.

Within this evolving discourse, it becomes necessary to critically evaluate the actual outcomes of policies built around widely used concepts such as "circularity" and "sustainability," as well as

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Article history: Received 12 May 2025, Revised 17 August 2025, Accepted 10 October 2025, Published 24 December 2025

the concrete practices they generate. The frequent use of these terms in policy documents, corporate strategies, and public statements often serves to promote a greener image; however, this alone does not suffice to address the underlying issues. Consequently, the development of industrial policies capable of sustaining economic productivity while simultaneously tackling environmental challenges has become a pressing need. Many countries are now taking tangible steps toward this goal.

This study aims to contribute to the discussion on evolving industrial policies in Turkey by extending the debate to the "industrial ecology" (IE) approach, which laid the foundation for the concept of the circular economy. For this purpose, an evaluation and criticism at the conceptual level are presented by examining application examples and policy documents. The second chapter presents the conceptual background, beginning with ecological approaches developed in response to the environmental issues brought about by industrialization. This is followed by an exploration of the IE approach, with particular attention to concepts such as industrial symbiosis (IS) and eco-industrial parks (EIPs). Finally, the concept of the circular economy, which emerged from this foundation, is examined. The third chapter focuses on Turkey's experience, addressing the search for circularity in industry and the changes observed in policy documents. It discusses regional IS practices and projects aimed at transforming existing organized industrial zones (OIZs) into EIPs. The fourth chapter reviews national policy and strategy documents shaped around circularity. The final chapter presents the concluding remarks.

2. Conceptual Background

2.1. Environmental Movement

Despite the rise in environmental awareness throughout history, the capitalist system has continued to treat and consume nature as if it were an unlimited resource. This assumption was analytically challenged by the Limits to Growth report, published by the Club of Rome in 1972, which demonstrated the ecological limits of growth-oriented development (Aşıcı, 2012). Scholars have argued that development must also incorporate human and social dimensions, especially in underdeveloped countries (Adelman & Morris, 1973; Myrdal, 1974). Over time, indicators such as wealth distribution, access to education and healthcare, democratic rights, and gender equality have increasingly been considered part of the broader definition of development.

As environmental problems grew too significant to ignore, certain economic regulations became necessary. Environmental economics emerged as a field that evaluates the costs associated with the excessive use of natural resources, which are often deemed "ownerless" and outside traditional market structures. However, this approach tends to treat nature not as something inherently valuable, but merely as a "resource" (Zengin Taşdemir, 2021). It frames environmental damage as an external cost to be priced and charged for (Smith, 2001), but it does not necessarily promote environmental protection or equitable access to resources (Sagoff, 1988).

Considering these limitations, more radical environmental movements began to offer critiques that targeted not just consumption but the broader production system itself. "Deep ecology," for example, emerged as a critique of the dominant economic and social value systems. It positioned humans as part of nature rather than above it and called for a fundamental shift in social paradigms (Naess, 1973; Devall, 1979). This perspective laid the groundwork for discourses centered on principles such as equality, diversity, symbiosis, class opposition, holism, autonomy, and decentralization (Sessions, 1987; Keller, 2008). Throughout the 1970s and 1980s, related approaches, such as radical ecology and feminist ecology, explored various dimensions of the human–nature relationship.

Within this spectrum, the "green economy" approach gained prominence with the rise of sustainable development as a policy goal (Allen, 2012). This approach, more compatible with the existing economic order, advocates for environmental solutions rooted in labor-intensive sectors and renewable energy (Aşıcı, 2012). However, dominant environmental approaches have been

criticized for overlooking the dynamics of industrialization and economic growth, thereby creating tensions with the socio-economic requirements of societies. (Graedel & Allenby, 1995). These debates have led to a reassessment of industrial production models and the development of alternative frameworks. Among them, IE stands out with its emphasis on circularity.

2.2. Industrial Ecology and Circularity

IE suggests that it is possible to achieve economic growth without compromising environmental sustainability. For industrialized countries to maintain their current living standards without environmental degradation, and for developing countries to reach similar levels, consumers and producers must adopt behaviors modeled on natural ecosystems (Frosch & Gallopoulos, 1989). Its five core principles include a systems approach, the analysis of material and energy flows, interdisciplinary collaboration, biomimicry, and a transition from linear to circular production models (Garner & Keoleian, 1995; Erkman, 1997; Graedel, 1997; Lombardi & Laybourn, 2012). This holistic approach seeks to transform industry into a "closed-loop system" where materials are continually reused, minimizing waste and environmental harm (Lowe, 1993).

A key mechanism for implementing IE is IS, which involves the cooperative use of resources, energy, and by-products among firms. The benefits of IS extend to companies, local communities, and the environment. Chertow (1998) defines five forms of symbiotic relationships: One-way waste exchanges, intra-organizational changes, intra-regional exchanges, localized exchanges and regional-scale collaborations. These collaborations can lead to the development of EIPs, where companies operate in clusters to share resources and optimize their collective performance (Lowe, 1997). For IS to emerge, proximity and interaction between firms are crucial (Chertow, 1998; Christensen, 2006; Dai et al., 2021). Supporting infrastructure, such as shared treatment facilities or logistics systems, is also essential for enabling waste and energy loops across firms.

The network structure of IS, when guided by a systems approach, integrates multiple actors, disciplines, and spatial scales (Richards & Frosch, 1997). In this regard, EIPs represent the most prominent application of industrial ecology principles. As businesses collaborate, they create shared value that exceeds individual gains (PCSD, 1997). EIPs aim to replicate natural ecosystems within industrial settings, promoting minimal use of raw materials and energy while creating closed cycles of materials and water (Graedel, 1997; Bai et al., 2014). The components of EIP design are grouped under six headings: natural systems, energy cycle, material cycle, water cycle, park management and support services, and sustainable design and construction (Lowe et al., 1997).

The Kalundborg EIP in Denmark is widely recognized as the first successful industrial symbiosis model (Chertow, 1998). Developed organically over several decades, it demonstrates how firms across different sectors can voluntarily collaborate to achieve both economic and environmental benefits. Its success highlights the role of voluntary cooperation, resource sharing, and mutual trust (Grann, 1997; Ehrenfeld & Gertler, 1997; Ditlevsen, 2014).

Initially widespread in Europe and North America, EIPs are now being adopted as part of industrial and environmental policies in numerous countries, particularly in Korea and China (Park et al., 2016; Chertow et al., 2021). The EIP concept has also been promoted globally through UNIDO's EIP and eco-city projects. Following the United Nations Industrial Development Organization (UNIDO)'s first pilot initiative in India in 2010, two additional projects were launched in Tunisia. In 2012, through growing collaboration with United Nations Environment Programme (UNEP), the Resource Efficient and Cleaner Production (RECP) program was introduced as a joint initiative (UNIDO, 2017). The program emphasizes reducing industrial impacts on nature and promoting social advancement. Thus, EIPs have begun to be implemented as an environmentally friendly industrial model in developing countries under pressure for industrialization. In many countries, such as Egypt, Brazil, and Taiwan, EIP practices have been found to provide both environmental and economic benefits (Pai et al, 2018; Susur et al. 2019; Nessim et al. 2023).

2.3. Circular Economy

The development of IE made it possible to analyze and model closed systems, leading to a broader understanding of circularity beyond production, extending it to the entire economy (Gomez et al., 2018). This conceptual evolution has been enriched by various approaches such as cradle-to-cradle design, industrial metabolism, green accounting, biomimicry, and the blue economy. With the popularization of the term by the Ellen MacArthur Foundation, the circular economy has gained wide acceptance in both business strategies and policymaking. Defined as an industrial system that is restorative or regenerative by design (EMF, 2013), the circular economy aims to minimize resource input, waste, emissions, and energy leakage (Geissdoerfer et al., 2017). Through long-lasting design, reuse, remanufacturing, renewal, and recycling, it offers a business model where waste is reintegrated at the start of the value chain—extending product lifespans and improving resource efficiency (Ekins et al., 2019; EMF, 2013).

The influence of the circular economy on national policies initially emerged through regulations focused on waste recycling and disposal. One of the earliest examples is Japan's "Resource Efficient Law", enacted in 1991, which was followed by several other legal frameworks aimed at waste recovery and product life extension (Ghisellini et al., 2016; Ji et al., 2012). In Germany, circularity was introduced into legislation with the "Closed Substance Cycle and Waste Management Act" of 1996, which notably emphasized producer responsibility (Ogunmakinde, 2019).

In China, significant advancements were made in areas such as cleaner production, pollution and waste management, and energy conservation, starting with the "Cleaner Production Promotion Law" in 2002 and continuing with the "Circular Economy Promotion Law" in 2009. At the micro level, the circular economy is approached through cleaner production practices targeting firms; at the meso level, the development of IS and EIPs is encouraged; and at the macro level, policies promote symbiotic and circular structures across cities and regions (Zhijun & Nailing, 2007). Despite the establishment of numerous EIPs (Lin et al., 2004; Hong & Gasparatos, 2020) and the implementation of various IS initiatives (Bellantuono et al., 2017), critics argue that China's comprehensive approach to the circular economy has not been fully integrated into market mechanisms or public engagement strategies (Liu et al., 2009).

The European Union (EU) introduced its first Circular Economy Strategy in 2015. However, the foundations for this shift were laid earlier, as the EU began reorganizing its policies in the 2000s in response to climate change. In line with this transition, a growth strategy centered on industrial transformation was adopted. The publication of the European Green Deal in 2019 and the declaration of the goal to become the first climate-neutral continent by 2050 marked the beginning of a new era in industrial policy. Anchored in the principles of a circular economy, the strategy aims not only to address the climate crisis but also to transform the economic model from a linear to a circular structure. Its core objectives include achieving net-zero greenhouse gas emissions by 2050, decoupling economic growth from resource use, and ensuring that no person or region is left behind (European Comission, 2019). In this context, the European Commission's 2020 report, A New Industrial Strategy for Europe, highlights key priorities such as climate-neutral industry, circular economy practices, and innovation (European Comission, 2020).

Although the concept of the circular economy has gained widespread attention, it continues to face criticism due to the ambiguity surrounding its practical application. The tendency to conceptualize it primarily through engineering and business case studies has led to a fragmented understanding, further obscuring the core meaning of circularity (Blomsma & Brennan, 2017; Corvellec et al., 2022). Moreover, as circular economy regulations often center on carbon trading, broader environmental concerns are, to some extent, overlooked. While border carbon taxes are seen as environmentally beneficial, they are also criticized for potentially exacerbating global inequalities (Douenne & Fabre, 2022). Another major critique concerns the neglect of social dynamics and consumer behavior (Fellner et al., 2017). In this regard, when the circular economy is detached from everyday lifestyles and embedded solely in policy documents, it tends to offer

unfulfilled promises and result in policy packages that risk misleading industrial stakeholders and consumers by oversimplifying the principles of IE (Corvellec et al., 2022).

3. Industrial Ecology Applications and Adoption of Circularity in Turkey

When industrial zones and industrial policies in Turkey are examined from an environmental perspective, it becomes evident that global and European trends have influenced Turkey's environmental approach. The earliest initiatives related to circularity in Turkish industry were projects focused on IS. Following these projects, concepts such as green industry, symbiosis, and circularity began to appear in national policy documents. In this context, the first notable IS applications emerged around 2010. Over time, framework documents were developed, and especially after 2020, more comprehensive strategy documents focused on the circular economy began to be published (Figure 1).

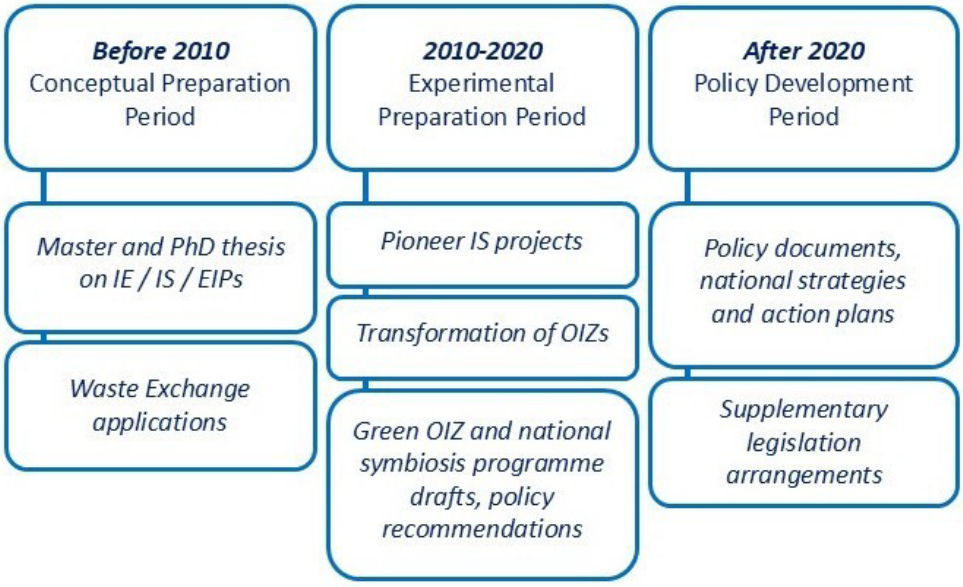

Figure 1 IS based industrial periods in Turkey (Prepared by the author)

The first IS example in Turkey was the BTC İskenderun Bay Industrial Symbiosis Project (2010–2014), developed as part of the Baku-Tbilisi-Ceyhan (BTC) Pipeline Project. The main partners of the symbiosis project were the BTC Company, the Ministry of Development, and TTGV (Technology Development Foundation of Turkey). The project was initiated in 2008–2009 with the support of UNDP and under the coordination of the Adana Chamber of Industry (ADASO). The Middle East Technical University and International Synergies also contributed to the implementation process. While the project primarily aimed to address soil pollution caused by the pipeline, it also identified a variety of industrial relationships, including interactions with agricultural and forested areas in the region (Figure 2).

Following the project, 420 potential synergies were identified within the IS network of 51 member companies from 28 sectors (Dolgen & Alpaslan, 2020). A significant environmental gain has been achieved through the IS process (Özkan et al., 2018). In addition to environmental benefits, the project also provided social and economic gains (Demircioğlu & Ever, 2020). As a result, it was calculated that the investment in IS was recovered within 1.1 years (Yıldız, 2019).

The experience gained from the İskenderun Bay IS project has contributed to building knowledge and capacity for other national-level projects. Realizing the potential identified in theoretical studies through concrete implementation paved the way for the design of new initiatives. This experience has been transferred to other projects through Development Agencies and TTGV; complementary academic publications have been produced, and new IS potentials have been

identified in existing industrial zones with the support of the Ministry of Industry and Technology (MoIT) (Yıldız, 2019). During this process, the transformation of existing OIZs into EIPs also came onto the agenda. IS projects in Turkey are designed at two main scales: (1) regional-scale IS projects coordinated by Development Agencies, and (2) local-scale projects focusing on transforming existing OIZs into EIPs.

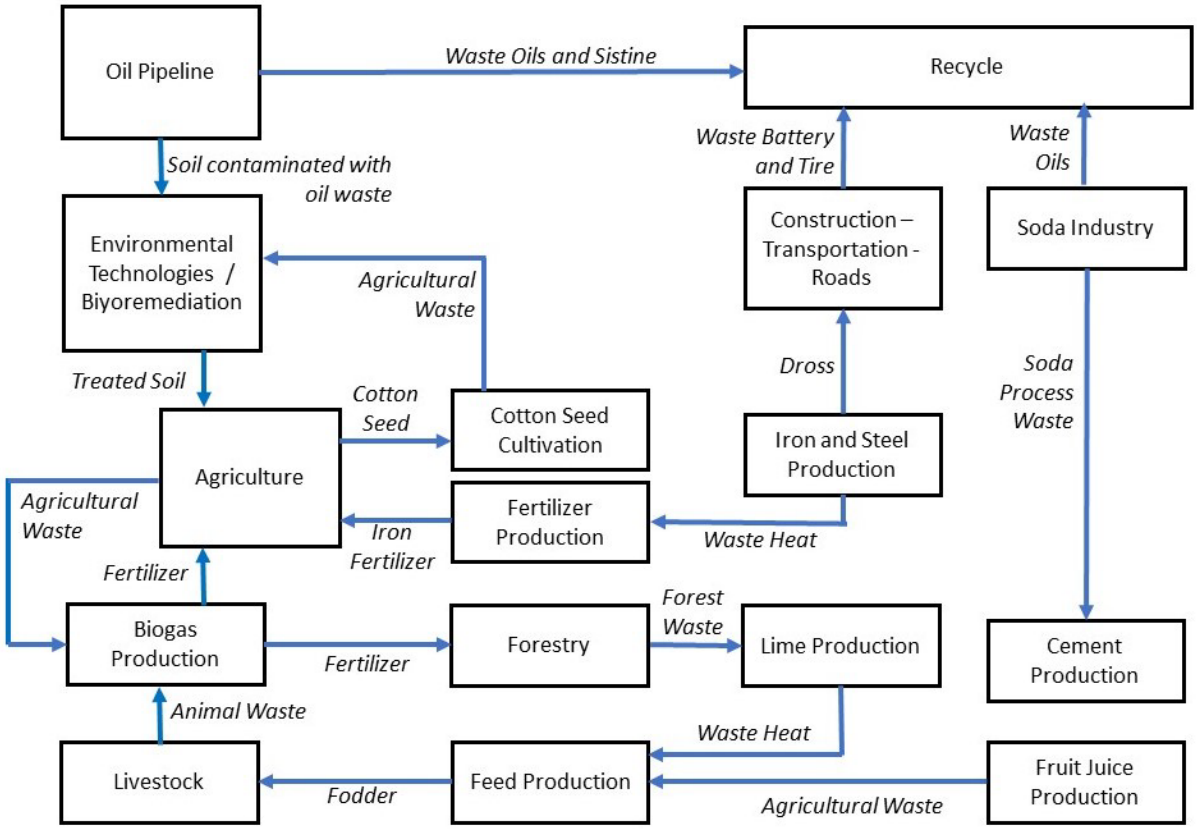

Figure 2 BTC İskenderun Bay IS scheme (Drawn by the author)

3.1. Regional IS Projects

The involvement of Development Agencies as the main actors in IS projects has ensured that these projects are positioned as part of regional development goals. The gains defined by the projects have revealed that economically efficient systems can be designed in addition to ecological benefits, and studies have begun for IS applications and cyclical systems in the economy (Genç et al., 2019; Genç et al., 2020).

The Bursa Eskişehir Bilecik Industrial Symbiosis Program was developed as a feasibility study for the TR41 Region. This initiative was launched in line with the regional policy objective under the heading 'Balanced Spatial Development and Sustainable Environment,' which called for the implementation of IS practices that deliver both environmental and economic benefits by enhancing cooperation among companies. According to the feasibility report, the program aimed to raise awareness of IS in the region, identify existing potential and strategic directions through regional and sectoral analyses, carry out feasibility assessments, conduct communication activities, and establish the infrastructure needed for the long-term implementation and dissemination of IS practices (BEBKA, 2014). The report focused on OIZs characterized by multi-sectoral structures and high manageability. As part of the program, each province in the region was evaluated separately. For instance, in the case of Eskişehir, potential transformation projects were identified at the company and sector levels within the Eskişehir OIZ (BEBKA, 2020).

One notable regional IS initiative is the Trakya Industrial Symbiosis Program (2014–2016), developed for the TR21 Region, which includes the provinces of Edirne, Kırklareli, and Tekirdağ, located in the European part of Turkey, west of Istanbul. The Trakya Regional Plan emphasized the

importance of integration and cooperation in production and expressed a commitment to implementing IS practices at the regional level. These studies revealed that OIZs with sectoral diversity hold significant potential for IS, and key focus areas for implementation were identified (Trakya KA, 2016).

Unlike other regional IS efforts, the Gaziantep Industrial Symbiosis Project (2015–2016) was initiated under the leadership of the Gaziantep Chamber of Industry, with the İpekyolu Development Agency acting as a project partner. The project explored IS opportunities within Gaziantep OIZ, analyzing 1,305 companies across 57 sectors and identifying 104 potential IS ties (Demirer, 2015; Dolgen & Alpaslan, 2020).

Another similar initiative is the Filyos Eco-Industrial Park Project, completed in 2016. This project was developed by the Western Black Sea Development Agency (BAKKA) in collaboration with TTGV. It aimed to leverage the regional development potential of the Filyos Port and its hinterland production zones by integrating them with the advantages of IS (Arslan & Öztürk, 2023).

As of the end of 2024, Development Agencies have issued their third-generation regional development plans for the 2024–2028 period. The visions articulated in these plans prominently feature concepts such as “green transformation,” “green economy,” “green growth,” “sustainable development,” “sustainable value,” and “sustainability.” An analysis of the strategic axes of the plans reveals that the Istanbul Regional Plan (TR10) integrates themes such as “IS,” “circular economy,” “green economy,” “sustainability,” and “digital transformation.” Similarly, the concept of “green transformation” is embedded within the strategic frameworks of other industrially significant regions, including TR31 (İzmir), TR41 (Bursa, Eskişehir, Bilecik), and TR42 (Kocaeli, Sakarya, Yalova, Bolu, Düzce). These developments indicate a continued institutional commitment by Development Agencies to support initiatives related to IS and the establishment of EIPs at the regional level in the near future.

3.2. Transformation of OIZs into EIPs

The second prominent model in Turkey’s IS practices involves enhancing the environmental standards of existing OIZs and integrating IS principles into their operations. OIZs have served as a foundational model for industrialization in Turkey since 1962. From the outset, the approach emphasized developing industry within designated zones while simultaneously implementing measures to prevent environmental pollution. As a result, numerous OIZs have been established, contributing to the spread of planned industrial areas across the country.

These zones incorporate a range of practices aligned with IE principles, such as controlled production, wastewater treatment facilities, energy generation from natural gas, rainwater harvesting, and green-certified buildings. Additionally, local Chambers of Industry have facilitated waste exchange programs that allow companies to reuse each other's by-products. Given these features, OIZs have increasingly been seen as viable starting points for ecological transformation in Turkish industry (Albayrak, 2000; Şenlier & Albayrak, 2011).

One notable initiative was the transformation project carried out in the Antalya OIZ under the title “Industrial Symbiosis and Eco-efficiency” (2015–2016). The project aimed to reduce resource consumption and enhance ecological production efficiency (Dolgen & Alpaslan, 2020). Other transformation efforts include pilot projects developed under the Green OIZ Framework Development for Turkey (2016–2018), launched at the national level. Technical analyses were conducted in four selected OIZs—İzmir Atatürk OIZ, Bursa OIZ, Adana Hacı Sabancı OIZ, and Ankara ASO I. OIZ—to assess their potential for conversion into EIPs. Among them, İzmir Atatürk OIZ has continued its transformation under the Eco-Industrial Park Transformation in İzmir: Green IAOSB project, in collaboration with the İzmir Development Agency (IZKA). Within this framework, action plans focusing on resource efficiency and green infrastructure were implemented, including

centralized wastewater treatment, enhanced water circularity, and industrial symbiosis applications. (Dolgen & Alpaslan, 2020).

These efforts have laid the groundwork for broader ecological and environmental priorities in Turkish industry. Starting from OIZs, initiatives that promote waste transformation and sustainable production practices are becoming increasingly widespread.

4. Industrial Ecology and Circularity in Policy Documents in Turkey

While feasibility studies and pilot projects are currently underway to support implementation, efforts have also commenced to develop a national policy framework aimed at promoting IS practices and EIPs. The concept of a “green industry” was first introduced in the Industrial Strategy Document published in 2013. A significant milestone in this regard was the “Green OIZ Framework Development for Turkey (2016–2018)” Project, initiated by the Ministry of Industry and Technology in collaboration with the World Bank and the International Finance Corporation. The project addressed key thematic areas such as eco-efficiency and cleaner production, green infrastructure (including renewable energy, wastewater treatment, and recycling systems), and circularity opportunities, particularly through IS (General Directorate of Industry and Productivity, 2019). Technical analyses were carried out in four selected OIZs to assess their potential for conversion into EIPs.

One of the key indicators demonstrating the national-level adoption of the IS approach is the inclusion of the statement in the 2019 Industrial Strategy Document–2023 that, “Within the framework of the Green OIZ Framework Development for Turkey Project, efforts to expand IS practices across the country will continue in collaboration with relevant stakeholders, including the Ministry of Environment and Urbanization, Organized Industrial Zones (OIZs), and industrial estates.” The strategy document further outlines commitments to green production, the modernization of OIZ infrastructure and enterprises through technology-intensive solutions, and the promotion of new investments aligned with cleaner production principles (MoIT, 2019, p. 49). These elements reflect a sustained policy direction and signal the initiation of systemic reforms designed to support the operationalization of circularity at the national level.

To draw upon international experiences for advancing applications at the national level, the document titled “A Roadmap for a National Industrial Symbiosis Programme for Turkey” was developed in 2019 in collaboration with the consultancy firm International Synergies. This document proposes a national framework inspired by the UK’s National Industrial Symbiosis Programme (NISP-UK) system, emphasizing the government's role as both a regulatory authority and a provider of financial resources. According to the project, TUBITAK-MAM is responsible for conducting scientific studies that will inform the implementation and coordination among the stakeholders involved. The framework suggests that an Organized Industrial Zone (OIZ) or a chamber of industry should serve as the nucleus of the regional IS system, with surrounding chambers, OIZs, and free zones forming an integrated network. Moreover, it recommends the establishment of a technological monitoring and reporting system alongside a program advisory group composed of representatives from various sectors to ensure the system’s effective operation.

Following the preparatory initiatives, a new phase in the incorporation of the “circular economy” into Turkey’s policy agenda was initiated with the announcement of the European Green Deal in 2019. The introduction of carbon trading regulations in Europe had significant implications not only for EU member states but also for countries with close trade relations with the Union, including Turkey. In response, Turkey launched its Green Deal Action Plan in 2021, coordinated by the Ministry of Trade, aiming to align its policies with Europe’s environmental objectives. This action plan, developed in accordance with the “Livable Cities, Sustainable Environment” priority of the 11th Development Plan, articulated the goal of transitioning towards a “green and circular economy.” The strategy seeks to simultaneously ensure trade compatibility with the EU and enhance the environmental sustainability of Turkey’s production structure. The 12th Development

Plan has further developed this approach in a more integrated manner. While it does not provide a detailed roadmap for the transformation of the existing industrial landscape, it does reaffirm the commitment to aligning with the European Green Deal and highlights the intention to establish the necessary infrastructure for green transformation. Under the main objective titled "Competitive Production with Green and Digital Transformation," sector-specific targets are outlined; however, no concrete benchmarks for green transformation are provided, with the focus primarily placed on raising awareness.

Thus, the process initiated through EIP transformation and IS projects in Turkey has evolved significantly under the influence of the EU. Although the term IE is rarely mentioned in policy documents, its key component, IS, has increasingly been included. Despite this, the term "EIP" has been largely avoided in policy discourse, with preference given instead to terms such as "green industry" and "green OIZ." In line with this thematic shift, the transformation of OIZs has been framed around the concept of "green," and Green OIZ Certification Standards have been developed collaboratively by the Turkish Standards Institute and the Ministry of Industry and Technology.

To qualify for certification, OIZs must first meet several preliminary criteria, including possession of TS EN ISO 14001 and TS EN ISO certifications, a "zero waste" certificate, the establishment of a dedicated unit for climate change and sustainability monitoring, the implementation of wastewater treatment within the OIZ, and the exclusion of coal usage. Once these prerequisites are fulfilled, OIZs are assessed according to economic, environmental, and social performance indicators. These include metrics such as the percentage of firms engaged in industrial symbiosis, reductions in energy and water consumption and waste generation, training initiatives, and geographic location. Based on their performance, OIZs may be awarded certification levels such as platinum, gold, silver, or bronze. As of 2025, it has been mandated that all newly established OIZs obtain a Green OIZ Design Certificate. Complementing this framework, the Türkiye Carbon Market Development Project was launched in 2024. With the finalization of operating rules for the carbon market, it is anticipated that the Turkish Environment Agency, established under Law No. 7261, will assume a more active and functional role in facilitating this transition.

Within the framework of the Technical Support Project for Assessing Turkey's Transition to a Circular Economy (2022–2025), supported by the EU, the National Circular Economy Strategy and Action Plan (UDESEP) was published in September 2024. The strategy outlines legislative measures aimed at ensuring product and economic circularity and identifies priority sectors in which product life cycles will be systematically addressed. These sectors include Packaging, Electronics and Information-Communication Technologies (ICT), Food and Biomass, Construction, Batteries and Vehicles, Plastics, and Textiles.

In parallel, the Climate Change Adaptation Strategy and Action Plan (2024–2030), published in 2024, incorporates circular economy considerations, albeit to a limited extent, under the thematic area of circular economy and industry. Among the listed actions, measures such as "strengthening the technical knowledge and capacity of industrial enterprises, particularly SMEs, for adaptation to climate change" and "disseminating information on the integration of adaptation elements into voluntary green procurement updates in the industrial sector" suggest an indirect connection to circular economy objectives.

By contrast, the Climate Law reflects a more explicit emphasis on the circular economy, although predominantly from the perspective of carbon market regulation. The legislation is largely structured around the establishment of an emissions trading system, indicating a shift away from the holistic perspective of IE toward a market-oriented regulatory framework. While the law devotes substantial attention to emissions trading mechanisms, it provides limited clarity regarding the implementation of adaptation strategies or the integration of Local Climate Change Action Plans into the existing planning framework. Nevertheless, amendments to zoning regulations have been initiated to enhance environmental standards and promote circularity.

5. Concluding Remarks

This study has examined the evolution of the concept of circularity, which has gained increasing prominence in Turkey's industrial policies and practices over the past 15 years, by addressing approaches shaped by both IE and circular economy perspectives (Figure 3). The initial efforts in Turkey were inspired by international examples of IE, with feasibility studies focusing on the transformation of OIZs into EIPs and the identification of potential IS schemes at the regional level. These early projects, launched in the absence of a formal legal framework, primarily aimed to map out possible collaboration opportunities, highlight circularity potential, and encourage producer participation in emerging IS systems.

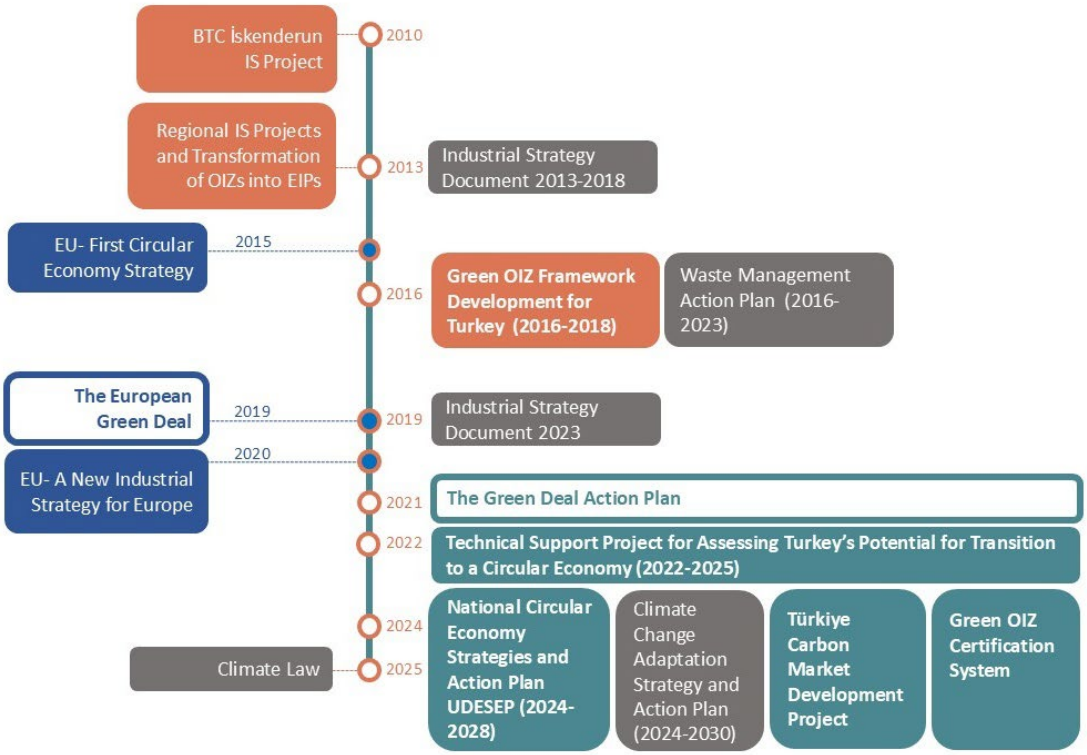

Figure 3 From industrial ecology practices to the circular economy: The evolution of policy frameworks in Turkey (Prepared by the author)

However, there remains no nationally recognized or standardized success criterion to evaluate the effectiveness or outcomes of these IS initiatives. Additionally, the fact that many of these regionally focused projects are limited to short-term (typically two-year) timelines and are designed through top-down approaches by centrally governed institutions may undermine their ability to accurately reflect local IS potential. The regional scale of these schemes, often encompassing multiple provinces and large geographic areas, also poses challenges to fostering the interaction and cooperation necessary for successful symbiosis. Since 2010, numerous initiatives aimed at assessing IS potential and facilitating the transformation of OIZs into EIPs have been launched. Nevertheless, no comprehensive evaluation has been conducted to assess the outcomes or effectiveness of these efforts. While the lack of systematic assessment limits broader conclusions, some academic studies, most notably those focusing on the İskenderun Bay Industrial Symbiosis Project, have reported significant realized or potential environmental benefits (Alkaya et al., 2014).

While the discourse of IE has gradually diminished in the formulation of policy documents, the concept of the circular economy has emerged as the dominant paradigm, particularly under the influence of the European Green Deal. This change, which has increased especially after 2020, can also be seen in Table 1.

Table 1 Concepts in Policy Documents (Prepared by the Author)

	Years	Policy Document	Main Concepts*					
			IE	EIP	IS	CE	GI	GOIZ
2010--2020	2013	Industrial Strategy Document					■	
	2016	Green OIZ Framework Development for Turkey (2016-2018)	■	■	■			■
	2019	Industrial Strategy Document -2023			■			■
	2019	A Roadmap for a National Industrial Symbiosis Programme for Turkey	■	■	■			
After 2020	2021	The Green Deal Action Plan 2021			■	■		
	2022	Technical Support Project for Assessing Turkey's Potential for Transition to a Circular Economy (2022-2025)			■	■		
	2024	National Circular Economy Strategies and Action Plan UDESEP (2024-2028)			■	■		
	2024	Türkiye Carbon Market Development Project			■	■		
	2024	Climate Change Adaptation Strategy and Action Plan (2024-2030)					■	
	2024	Green OIZ Certification System			■	■		■
	2025	Climate Law				■		

IE-Industrial Ecology, EIP-Eco-Industrial Park, IS-Industrial Symbiosis, CE-Circular Economy, GI-Green Industry, GOIZ-Green Organized Industry Zone

Within this emerging policy landscape shaped by themes such as "circularity," "circular economy," and "green industry," references to ecological foundations have progressively receded. As a result, the focus has narrowed to mechanisms such as "emissions trading" and "carbon markets," thereby reducing the holistic scope of earlier ecological frameworks. In this context, policy instruments such as the Industrial Strategy Documents, the National Circular Economy Strategy and Action Plan (UDESEP), and the Climate Law constitute the institutional and legal infrastructure grounded in the concept of the circular economy. However, within this emerging framework, the influence of IE appears to have been largely eclipsed.

At the core of the circular economy lies the objective of establishing business models that extend product life cycles through reuse and waste valorization. Although IS, a key component of IE, continues to be embedded within this model, EIPs have been increasingly sidelined. Instead, a market-driven approach has been proposed, in which symbiotic exchanges are monetized through instruments such as carbon and emissions trading systems (EMF, 2013). This situation has been the subject of criticism in terms of EU environmental policies (Corvellec et al., 2022) and has also been the starting point for research on improving and regulating the environmental contributions of the carbon trading system (Douenne & Fabre, 2022). Following the European Green Deal, this paradigm has become prominent not only in Turkey's national policy documents but also in certain regional plans reflecting the country's strong economic ties with the EU. While the circular economy has contributed to raising awareness of waste reuse and emission reduction, it also contains some weaknesses that require discussion.

Difficulties in Designing a Circular System:

Defining IS models based on the number of connections or the volume of waste exchanged can create rigid and difficult-to-manage systems. Consequently, such systems may guarantee waste production rather than reducing it. Quantitative criteria alone should not be taken as indicators of success, as they may offer a distorted view of system performance. However, within circular economy frameworks, prioritizing the recycling of economically valuable waste risks neglecting materials with little or no economic value but with significant environmental consequences. These wastes must be included in the system first.

Operational Challenges and Responsibilities:

Building production chains on the by-products of other firms is a fragile strategy under uncertain economic conditions. IS requires transparent rules, stable economic frameworks, and open communication among actors. While short-term cooperation may yield economic gains, sudden government decisions or an unstable business environment can easily undermine long-term sustainability. Furthermore, managing waste through top-down mechanisms may create bureaucratic obstacles, reducing the flexibility of companies in adapting to market dynamics. Another important challenge lies in clarifying legal responsibilities when waste in IS schemes fails to meet quality standards or cannot be utilized. Technical and legal capacities must be developed not only for system design and management but also for effective monitoring and enforcement.

Green Labeling and Greenwashing:

The widespread labeling of OIZs as "Green OIZs" risks concealing significant environmental deficiencies. Even with a tiered certification system (bronze, silver, gold), companies that neither participate meaningfully in waste cycles nor demonstrate progress in environmental practices may still benefit from the reputational advantages of certification. This raises questions about the fairness and credibility of such schemes. Additionally, the use of "green" tags may obscure environmental negligence. For instance, a zone causing harm in one area may still be labeled green due to limited positive practices elsewhere, misleading the public. Similarly, a company may improve circularity in some streams while continuing pollution in others, thus distorting the overall environmental picture. The certification and labeling mechanisms of OIZs therefore require critical reconsideration.

Governance:

At the regional scale, centralization and standardized approaches to IS schemes may restrict the development of innovative, locally adapted models. In Turkey, policy processes are typically hierarchical and top-down, whereas internationally recognized examples such as Kalundborg evolved through bottom-up initiatives shaped by local actors and their interactions. The technical complexity of the Emissions Trading System (ETS), combined with limited public engagement in its development, has hindered the identification of potential weaknesses in these mechanisms. While waste recycling is a visible indicator of circularity, the role of carbon markets and emissions trading in achieving actual emission reductions remains uncertain. Critical debates on the choice between emissions trading and carbon taxes, as well as the ethical implications of commodifying emissions, remain underexplored but warrant further study.

Spatial Dimension:

Circular systems should not be reduced to waste exchanges between companies but should be approached as comprehensive processes that also encompass urban functions. This requires linking industrial strategies with spatial planning. Recent regulatory changes in zoning laws, such as those related to waste recycling and rainwater use, represent positive steps toward integrating circularity into urban and industrial development. However, an economy cannot truly be considered circular if natural areas are not preserved, ecological systems are degraded, and mineral resources are extracted without adequate control. Protecting ecosystems and regulating resource extraction are therefore essential prerequisites for achieving genuine circularity.

This study provides a comprehensive assessment of current practices and highlights the conceptual shift in Türkiye's discourse, evolving from IE toward a circular economy. Future research is expected to focus more on the local and regional impacts of circularity-based industrial policies, as well as their implementation at the organizational level. Advancing this field requires further interdisciplinary studies. A more robust empirical discussion depends on the establishment of databases on circularity-oriented practices and the production of reliable regional and national statistics. In addition, the dissemination of case studies during this process would be highly beneficial for both policymakers and the industrial sector.

The circular economy should be regarded as a philosophical framework rather than reduced to a mere "commercial bureaucracy." Institutions need to internalize this perspective in a way similar to the mainstreaming of sustainability. At this stage, strengthening institutional capacity for monitoring legal regulations, managing carbon markets, and overseeing emission trading processes is essential to ensure environmental accountability. Although the circular economy has not yet fully met its environmental promises, its central role in Türkiye's industrial and regional development policies requires critical re-evaluation. Such a reassessment should be guided by participatory approaches that integrate spatial planning and place ecological priorities above superficial forms of "greenwashing." The future of circularity ultimately depends on embedding it not only in industrial strategies but also in broader urbanization policies.

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CRediT Authorship Contribution Statement

Ayşe Nur Albayrak: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Data curation, Conceptualization, Data visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Ethics Committee Approval

Ethics committee permission is not required.

Resume

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JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (491-509), 2025
DOI: 10.47818/DRArch.2025.v6i3179

A comparison of elements establishing the relationship between social memory and place in the cinema of the Turkish-Greek population exchange

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Abstract

In the age of mass migration, displacement, and the increasing number of refugees and migrants, more people are forced to leave their homelands every day. Refugees who are compelled to abandon their countries become disconnected from their homeland, history, and identity, losing their sense of belonging and often having no place to return to. One significant historical example of "displacement and place-making" is the population exchange between Anatolian Greeks and Turks in Greece, formalized by the "Convention and Protocol on the Exchange of Greek and Turkish Populations" signed on January 30, 1923. Those who were forced to leave their homelands struggled to establish a sense of belonging in their newly settled regions. The population exchange and the consequent forced displacement, as well as the efforts of individuals to construct a new sense of place and belonging, have been reflected in cinema. This study examines the Greek film Rembetiko, the Turkish film My Grandfather's People (Dedemin İnsanları), and the Turkish-Greek co-production Roza of Smyrna (İsmail ve Roza), all of which address the population exchange. The analysis focuses on the spatial representation of displacement in cinema, spatial memory, and the sense of belonging, particularly in relation to the places abandoned by those who experienced the exchange and their initial impressions of the new settlements. The study also examines the spatial factors influencing place-making and the post-memory transmission of the exchange experience to subsequent generations. This study aims to reveal how forced displacement—a critical, contemporary, social, and political crisis—is echoed in cinema, shedding light on the places that were abandoned and reconstructed by displaced individuals.

Keywords: cinema, place-making, population exchange, social memory, sense of belonging

1. Introduction

The number of displaced individuals, refugees, and migrants increases every day. Refugees forced to leave their countries are severed from their homelands, histories, and identities, losing their sense of belonging to a place and having no place to return to. Said (2015) explains the experience of exile and displacement through the concepts of "separation from home," "fragmented identity," and "divided self." During the 20th century, in the years of the First and Second World Wars, millions of people were forced to abandon the places where they were born, raised, and had lived for generations. These migrations, which caused spatial dislocation, also led to ruptures in both individual and collective memory. The population exchange examined in this study took place between Turkey and Greece following the signing of the "Convention Concerning the Exchange of Greek and Turkish Populations" on January 30, 1923. As a result of this agreement, 500.000 Muslim Turks living in Greece were relocated to Anatolia, while Orthodox Christian Greeks (referred to as Rums) who remained in Anatolia were resettled in Greece. Including those who had already fled to Greece during the War of Independence, the total number of Rums migrating from Anatolia to Greece reached 1.2 million.

Following the migration process, the displaced populations in Turkey came to be known as "mübadil" (exchangees), while in Greece they were referred to as refugees (Arı, 2000; Yıldırım,

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Article history: Received 26 February 2025, Revised 02 August 2025, Accepted 01 October 2025, Published 24 December 2025

2006). These groups struggled to adapt, establish a sense of belonging, and rebuild their lives in their new settlements. This struggle found reflection in artistic expressions.

In Greek literature, written works such as novels; for example, Numero 31328 (Venezis, 2015 [1931]) and Bloody Lands (Sotiriyu, 2013 [1962]); biographies, and books containing sketches of places left behind in Anatolia began to emerge shortly after the mass migration. At the Center of Asia Minor Studies, the memories, maps and sketches of refugees regarding the places they lived in Anatolia have been documented. However, due to factors such as the lower literacy rates among the Turks arriving in Anatolia compared to the Rums migrating from Anatolia, the theme of the population exchange did not find a place in Turkish literature until the 1980s (Kırtunç, 2005; Millas, 2005). While the Greeks referred to their forced departure from Anatolia following the War of Independence as the "Asia Minor Catastrophe", for the Turks, the relocation from Greece to Anatolia under the agreement was perceived as a victory. This divergence in perspectives on the population exchange, along with the distinct nature of their experiences of suffering, contributed to the delayed or earlier representation of the subject in the respective literatures of the two communities (Balta, 2005; Demirözü, 2005; Kırtunç, 2005; Kourtovik, 2005; Millas, 2005). In this study, three films which focus on population exchange are analyzed. The films are the 1983 Greek production "Rembetiko" (Ferris, 1983), the Turkish film "My Grandfather's People" (Dedemin İnsanları) (Irmak, 2011), and the 2016 Turkish-Greek co-production "Rosa of Smyrna" (Ismail ve Roza) (Kordellas, 2016). The research investigates the spatial memory, sense of belonging, and representations of space images—both of the abandoned and the newly settled villages, towns, and countries—of migrants from both nations who experienced spatial rupture due to the exchange. This is achieved through an analysis of films dealing with the population exchange.

2. The Reminders of Place: Spatial Memory, Displacement, and the Making of Identity

While memories build a bridge between the past and the future, they enable individuals and societies to perceive themselves as the same person or community over time. Remembering occurs through places and objects. Places, as significant instruments of memory, gain even greater importance when associated with unwanted but unavoidable events. Such compulsions undermine the belief in being the same person or society as yesterday and today. Memory is a process of remembering and forgetting. Both are crucial tools for individuals and societies to establish and sustain their existence, yet they are not neutral (Perouse, 2006).

Halbwachs' (2017) studies on memory emphasize that human beings exist within social relationships and that memory is constructed within society. Individuals build their memories through everyday interactions and recall as long as they remain within the framework of the group to which they belong. Collective memory emerges from the combination of individual recollections within the socially established boundaries of memory. Collective memory is socially constructed; social groups define what can be remembered and how it is remembered (Halbwachs, 2017). Unlike history, collective memory extends beyond mere recollection; it constitutes an active past shaped by lived experiences, fostering both individual and societal identity (Ricoeur, 2012).

Memories rely on the durability and continuity of the material world surrounding them, and place adds a dimension of continuity to collective memory (Halbwachs, 2017; Nora, 2006). The process of remembering is complex and closely tied to place. Spatial images act as the pillars of the bridge of memory and serve as the foundations of identity. Collective memory is linked to places where societies act collectively. It is through places that societies are reminded of who they are. Nora (2006) introduces the concept of "sites of memory," describing representations, indicators, and symbols that establish and reinforce the relationship between collective memory and place.

Concrete traces present in places that embody the characteristics of a collective past combine with individual, social, historical, and cultural values in the minds of their users, forming "spatial memory." In addition to representations, indicators, and symbols, the societal, political,

architectural, and cultural events of the era, along with traditions, habits, and neighborly relations, influence the creation of spatial memory. The “spatial memory” formed by spatial experiences in the mind reflects individuals’ emotional and meaningful experiences related to those places (Nora, 2006).

Identity is constructed through the continuity of memory, recollections, and narratives. Radical changes in places disrupt the connection between memory and identity, leading to the breakdown of intergenerational memory (Hareven, 1992). In some cases, rather than continuity, fragmentation, rupture, and separation become more significant in identity formation. While some choose to forget in the face of this fragmentation, many opt to remember. Such remembrance often results in the constant discussion of tragic events and the narration of memories through places. These narratives are so powerful that they embed themselves in the memories of subsequent generations who did not directly experience the events, a phenomenon termed post-memory (Hirsch, 1996, 2008, 2014).

The population exchange process examined in this study also led to fragmentation at both the individual and societal levels. The exchange was implemented following the signing of the “Convention Concerning the Exchange of Greek and Turkish Populations” on January 30, 1923. The agreement included provisions such as the prohibition of return for those subject to the exchange without government permission and the loss of citizenship of the emigrants in their countries of origin upon setting foot in their destination country, where they would automatically acquire new citizenship (Arı, 2000; Meray, 1969; Yıldırım, 2006). This study explores the spatial memory and sense of belonging formed by the exchangees regarding the places they were forced to leave and those where they resettled, as represented in films addressing the population exchange.

3. The Reflection of the Population Exchange in Cinema

The population exchange process, along with the social and personal dramas of the period, initially found expression in literature. In Greek literature, for Rum exchangees, the concept of what was left behind does not represent a country or land but is instead seen as a home and neighborhood (Demirözü, 2005; Millas, 2005). For people who lived without their own state or autonomy, the notions of homeland, country, or nation were not fully developed (Millas, 2005). Greek novels portray the population exchange not as a "national drama" but as an "individual and familial drama" (Demirözü, 2005; Millas, 2005). In contrast, Turkish novels depict the events within a broader national framework, often emphasizing a "we" versus "them" conflict. In Greek literature, the population exchange represents an "end" (Demirözü, 2005; Kourtovik, 2005; Millas, 2005). However, in Turkish literature, the conclusion of the War of Independence and the subsequent population exchange mark a "beginning" (Kırtunç, 2005). This beginning, tied to the establishment of a new political regime, is viewed as a hopeful and transformative event in Turkey, whereas in Greece, it is remembered as "The Asia Minor Catastrophe” (Millas, 2005).

Displacement, forced migration, spatial rupture, and place-making are significant layers of collective memory and spatial remembrance expressed through cinema. In Greek cinema, the film 1922 (Koundouros, 1978) offers direct and striking visual representations of the Asia Minor Catastrophe, revealing the relationship between memory and architectural destruction through images of fire, ruin, and abandonment. Rembetiko (Ferris, 1983) reflects the spatial memory of the past through the musical narrative of a Greek family who migrated from Asia Minor. Although Cloudy Sunday (Manousakis, 2015) does not explicitly focus on the population exchange, it indirectly addresses the theme by depicting the complex relationships among Jewish, Turkish, and Greek minorities in Thessaloniki formed after the exchange.

In Turkish cinema, Waiting for the Clouds (Bulutları Beklerken) (Ustaoğlu, 2004), exemplifies how the past persists in architecture through spatial traces and the character’s body language in the story of a Greek family forced to migrate from the Black Sea region. My Grandfather’s People (Dedemin İnsanları) (Irmak, 2011), conveys the spatial experiences of a family coming from Crete through the eyes of a child.

The Turkish-Greek co-production Rosa of Smyrna (İsmail ve Roza) (Kordellas, 2016), explores the confrontation of a family with their past after migrating to Greece following the Smyrna (İzmir) fire, focusing on the memory effects of abandoned places.

These films make visible not only physical spaces but also the transforming sense of belonging and spatial memory that accompanies migration. The population exchange and the Asia Minor Catastrophe represent a threshold at which spatial continuities are broken. Cinema serves as a powerful tool to trace these ruptures, reimagine lost places, and question how new senses of belonging are constructed. Within the scope of this study, the spatial reflections of the population exchange in cinema are examined through Rembetiko (Ferris, 1983), My Grandfather's People (Dedemin İnsanları) (Irmak, 2011) and Roza of Smyrna (İsmail ve Roza) (Kordellas, 2016).

4. Methodology

Cinema creates narratives and contexts that establish a discursive connection with the audience. There is no fundamental difference between texts, which derive meaning from the arrangement of words, and films, which are constructed through the combination of cinematographic codes (Ekinci, 2014, p.57). Cinema is approached as a text, with characters' discourses, notable phrases, and key words analyzed in alignment with the theoretical framework of the study (Uçar, 2021, p.58-59).

This study focused on the importance of the places within the cinematic narrative, the analysis of themes and events, and the contextual evaluation of opening scenes and other prominent sequences alongside the film's subject matter. The spatial analysis was conducted based on the assumption that cinema engages in a dialogue with the audience through places. The relationships characters establish with places within the cinematic narrative and significant sequences, as well as the spatial contexts of characters' pivotal discourses, were examined in the study.

This analysis was conducted as a qualitative data examination aimed at revealing the functions of the film in its spatial representation. Thematic analysis was employed as the primary method to systematically identify, analyze, and interpret patterns and themes within the film's spatial elements. This approach allowed for an in-depth exploration of how displacement, spatial memory, and belonging are expressed through cinematic places. Themes were derived inductively from spatial settings, providing a comprehensive understanding of the film's engagement with spatial memory, collective memory, identity construction and place-making.

5. Analysis of Population Exchange and Spatial Memory in Films

Rembetiko (1983) was written and directed by Costas Ferris, inspired by the life of Rembetiko artist Marika Ninou. The film takes its name from "Rembetiko", a genre of music that originated among the Greek populations of İzmir and Istanbul and was carried to Greece by population exchange refugees. This music, characterized by instruments like the bouzouki and baglama, often reflects the thoughts of the singer and critiques societal conditions, earning it a reputation as music of defiance against authority. The film introduces its subject through an on-screen text about Greek refugees and rembetiko music. The film narrates the life of Marika, a Rembetiko artist, from her birth to her death, encapsulating critical moments in Greek history, such as the Asia Minor catastrophe, the population exchange, and World War II.

The story begins in İzmir in 1919, with a Rembetiko performance in an Anatolian café and the simultaneous birth of Marika. The lyrics of the song reference Venizelos coming to İzmir, promising liberation from imperial rule. Shortly after Marika's birth, the audience sees smoke from the İzmir fire, followed by a transition to an image of the shoreline with the caption "İzmir, 1922" (Figure 1). The next scenes depict the plight of Greeks fleeing Anatolia, and archival footage shows people waiting to emigrate (Figure 2) and migration by sea (Figure 3) under the population exchange agreement. The film then transitions to Piraeus in 1925, showing the refugees' settlement.

Figure 1 The scene of the 1922 Izmir fire in the film Rembetiko at 7th minute (Ferris, 1983)

Figure 2 The scene of Greeks waiting on the shore to migrate following the exchange decision in the film Rembetiko at 7th minute (Ferris, 1983)

Figure 3 The scene of the migration locations by sea after the 1922 Izmir fire in the film Rembetiko at 7th minute (Ferris, 1983)

Figure 4 The scene of Greeks attempting to migrate by horse-drawn carriage after the 1922 Izmir fire in the film Rembetiko at 7th minute (Ferris, 1983)

Figure 5 The scene of the migration locations by train after the 1922 Izmir fire in the film Rembetiko at 7th minute (Ferris, 1983)

Figure 6 The scene of the entry of Turks into Izmir in the film Rembetiko at 30th minute (Ferris, 1983)

After the establishment of a “new home” in Piraeus, Marika's mother's death is depicted alongside the destruction of İzmir by fire. The connection between leaving the “motherland” and the loss of one’s mother is metaphorically significant. The devastation of İzmir, known for its catastrophic fire, parallels the internal burning grief of personal loss. Archival footage of the İzmir fire (Figure 1), the Turkish army entering İzmir (Figure 6), war scenes, population exchange negotiations led by İsmet İnönü at Lausanne, and real images of the migration process (Figure 2, 3, 4 and 5) punctuate the narrative. The film's transitions between events or years are marked by these historical depictions.

After scenes of İzmir's abandonment and the exchange, Marika sings a Rembetiko lyric: “I wish I could escape, far away, to the seas...” For those who had to leave their homes, neighborhoods, and lives behind on the other shore, the “sea” represents more than a physical barrier—it embodies being in limbo, caught between leaving and staying, a perpetual state of "purgatory" in the vast expanse of water.

The lemon market, located near their homes in Piraeus, is one of the recurring locations in the scenes filmed in the area. The scenes depicting the police suppressing a riot in the lemon market (Figure 7) culminate with an empty cage (Figure 8) in Marika’s home. This cage symbolizes the constraints in Marika’s life, a feeling of being unable to leave, and the oppression of having her future decisions made by state authorities, rather than herself.

Figure 7 The scene of the lemon market in the film Rembetiko at 53rd minute (Ferris, 1983)

Figure 8 The scene of the sense of rootlessness, the empty cage in Marika's house in the film Rembetiko at 53rd minute (Ferris, 1983)

Marika's Rembetiko songs are shaped by the context of war. In one of her songs, the lyrics "I'm burning, I'm burning, extinguish me with gas. I'm drowning, I'm drowning, throw me into the deep waters" reflect the story of the people in Piraeus, who, after experiencing the population exchange, are drawn to Rembetiko music. These people, like Marika, relate to the burning in Izmir. The fire in Izmir cannot be extinguished with gas—it only intensifies the flames. As they migrate from Izmir to Greece, they experience a psychological drowning, a sensation that physically manifests in the waters of the sea separating the two countries.

When Marika moves from Piraeus to Athens, her expression becomes numb from the unending displacement. The inability to belong anywhere, the futility of moving from one place to another, becomes meaningless for her. Before the Athens scenes begin, real footage of Hitler, war, and the burning of cities is shown, marking the beginning of yet another war period in Marika's life. The years 1937-1940 are conveyed to the audience through a backdrop of Rembetiko music and real footage. At the end of the Rembetiko song, Marika tells her daughter a story, which begins, "Once upon a time, there was a beautiful city called Izmir" (Figure 9). The story continues, "The most beautiful girl of Izmir, Adriana (the names of Marika's mother and daughter), was the queen of the city. Adriana had a daughter named Marika, and this beautiful kingdom is where the child grew up with everything she could ever wish for" (Figure 10). For Marika, who lost everything after coming to Piraeus at a young age, Izmir is imagined as a city that could provide a child with all the beauty one could wish for, had she stayed there. During the ongoing process of World War II, the line, "As for Izmir, as you said, someone else decides, and others pay the price," reminds the viewer of the escape from Izmir in 1922, emphasizing how decisions were made for people like Marika and others. "There is always a trap set before you. If you fall into it, no one will help you. You must find your way out on your own. This trap carries the names of those who hold great power. If you're lucky, you may have a chance to start anew." When Marika sings this song, there is no expression on her face. The decisions made by powerful figures in her life have led her into this trap—she has been forced to leave her homeland, with no one to help her escape. She has had no luck, failed to build a new life, and has always dreamed of escaping to distant places, to the sea, to begin anew. However, this dream no longer holds any meaning for her.

Figure 9 and 10 The scene of the story which Marika told her daughter in the film Rembetiko at 77th and 78th minute (Ferris, 1983)

Marika, along with her Rembetiko band, has set off to travel to Chicago. The lyrics of the Rembetiko playing at that moment are: "The dark storm in our hearts will take us nowhere. The terminal is dim and cold. The journey is like a wild snake; those with weak hearts cannot endure." No matter where they go, the sense of belonging in their hearts prevents them from reaching any destination. In fact, Marika's statement about being in America, "I've come to distant lands, and I'll stop singing," reflects her attempt to draw strength from this new beginning, but she, too, fails to find it. The words spoken to Marika, "America… America… When you come here, you say 'So what!'" highlight the continued theme of migration and exile. A Greek-American says, "The greatest disaster of Greece was not Izmir, it was migration. At the beginning of the century, a million people came, and those who remained, imagined Greece as a magnificent place." This emphasizes once again the theme of migration and exile, showing that no matter where they go, without a sense of

belonging, they remain disconnected (Figure 11). For the Greeks living in Anatolia, the end of the war, the entrance of the Turks into Izmir, and the idea of "America, America..." all led to a dream of Greece, but when they arrived, they realized the process was more of a disillusionment—"So what!" they said. The struggles and alienation they faced in Anatolia were carried over to Greece. Marika's response to this sense of alienation is: "Every morning, I look at the sun and beg, 'Burn me, Sun.'" This repetition of burning (Figure 12), which appears in scenes representing Marika's struggles, is reiterated here. As for the lemon market in America, the phrase "The same lemon market, it's just called Maxwell Street (Figure 13) here," underlines that the place itself is of no significance, and no matter where they go, the emotion felt remains the same—one of sameness and loss. Marika did not find the sense of belonging she was searching for in America, and when she returned to Athens in 1956, Athens, too, had changed. The interest in Rembetiko had diminished. After giving her final concert there, she converses with a friend about the profoundness of their statelessness. They are so displaced that this feeling overtakes any capacity for love, motherhood, or any other emotion. After her friend departs, Marika dies, and the film ends with Rembetiko music playing at her funeral, accompanied by dances.

Figure 11 and 12 The scene of the speech about the migration in the film Rembetiko at 125th minute (Ferris, 1983)

Figure 13 The scene of the Maxwell street in America in the film Rembetiko at 126 minute (Ferris, 1983)

The spatial findings of the film are summarized in Table 1.

Table 1 The Scenes About Spatial Memory, Sense of Belonging and Place-Making in the Rembetiko Film

	Themes	Scenes
Physical Spatial Datas Retained in Spatial Memory After Migration	The Last Memory of the Abandoned Place	• 1922 İzmir Fire (Figure 1) • Greeks Waiting on the Shore to Migrate Following the Exchange Decision (Figure 2) • Migration Locations by Sea After the 1922 Izmir Fire (Figure 3) • Migration Locations by horse-drawn carriage After the 1922 Izmir Fire (Figure 4) • Migration Locations by Train After the 1922 Izmir Fire (Figure 5)
	The Memory of the House and Neighbours in the Abandoned Place	None
	Depictions of Unforgettable Places in the Abandoned Place	• View of the 1922 Izmir Fire from the Shore (Figure 1)
	Spatial Image of the Moment When the Destination Country is First Seen	None
	The First Places Experienced in the Destination Country	None
	The Depiction of New Living Places in the Destination Country as Streets, Neighbourhoods, and Homes: Neighbourhood Relationships	• The House in Piraeus, the Resettled Neighbourhood, Neighbourhood Relationships, Lemon Market (Figure 7)
	Depiction of the Journey Process	• Greeks Attempting to Migrate by Sea After the 1922 Izmir Fire (Figure 3) • Greeks Waiting on the Shore to Migrate Following the Exchange Decision (Figure 2) • Greeks Attempting to Migrate by horse-drawn carriage After the 1922 Izmir Fire (Figure 4) • Greeks Attempting to Migrate by Train After the 1922 Izmir Fire and the Tents They Resided In (Figure 5)
	Aegean Sea	• Lives Separated by Two Countries, Lives Left Behind on the Opposite Shore, the Pain of Migration (Figure 1 and 3)
Sense of Belonging and Place-Making After Migration	Emphasis on House/ Neighbourhood/ Village/ Street Regarding the Abandoned Place	None
	The Reason for the Abandonment of the Living Place	• Greeks Waiting on the Shore to Migrate Following the Exchange Decision (Figure 2) • Migration Locations by Sea After the 1922 Izmir Fire (Figure 3) • Migration Locations by horse-drawn carriage After the 1922 Izmir Fire (Figure 4) • Migration Locations by Train After the 1922 Izmir Fire (Figure 5) • The Recapture of Izmir by the Turkish Army (Figure 6)
	Belonging in the New Living Places in the Destination Country	• The Empty Cage in Marika's House (Figure 8) • The Story Which Marika Told Her Daughter (Figure 9 and 10) • The Speech About The Migration (Figure 11 and 12) • The Lemon Market in Piraeus (Figure 7) • The Maxwell Street in America (Figure 13)

The film of “My Grandfather’s People” (Dedemin İnsanları), directed by Çağan Irmak, is based on the real story of his own grandfather, Mehmet Yavaş, a Greek immigrant. It was filmed in 2011. The film is viewed through the eyes of a ten-year-old boy, depicting Izmir in the 1980s (Figure 14), and the story of the 1923 population exchange period is conveyed through the grandfather's stories. The film continues in the form of a narration by Ozan, the young man of the 1980s, who recounts his childhood.

In 1980, when Ozan's family moves to their summer house, referred to as "the garden" (Figure 15) the film transitions from the local and migrant debates of the 1980s, where cries of "This is ours, go away!" are heard, to discussions of "foreignness" and "belonging" in the context of Ozan’s grandfather being called "Gavur" (infidel). The migrant, the "other," regardless of their place of origin, is labelled "Gavur" in the İzmir of that time. Despite the occasional conflicting phrases like "This is all of ours!" and "If we start calculating, everyone here is a migrant. Half of these people are 'Gavur,'" the continued discussions throughout the film suggest that this idea is not easily accepted. When school is out, the family heads to their summer house, and the question, "My home, my beautiful home. What did you do during the winter while we were gone?" reflects the emotional connection to the house, which is perceived as a living entity that can experience loneliness in the

absence of the family. The opening of the house's door is also a special ritual. The first step inside is marked by laughter, and the hope is that the time spent there will be filled with joy and laughter.

Figure 14 The scene of Mehmet Bey's relations with neighbors in the film My Grandfather's People at 4th minute (Irmak, 2011)

Figure 15 The scene of the garden in the film My Grandfather's People at 12th minute (Irmak, 2011)

Grandfather Mehmet leaves bottles in the sea. For the locals and tradespeople, Mehmet Bey is considered a "Gavur," and it is believed that he used those bottles to send intelligence reports to Greece. In response to his grandson Ozan's anger at the bottles, Mehmet Bey explains why he left them and shares his experience of the population exchange process. "Some things are unforgettable, like the place where you were born, even a place you grew up a little, or a place you vaguely remember…" he says, describing his childhood in Crete, Rethymno. He talks about his family's reaction to the exchange decision, their departure from their home, and the island. "I remember a house from afar, in Crete, in the village of Rethymno, the sound of the sea coming from afar, that sound is still in my ear, from back then. There was also a tavern, far away. I can hear its sound in the evenings, a young girl would sing. I don't know if that tavern still stands. Anyway… The rooms were whitewashed, everything smelled like the sea. The house was warm, oh, so warm. The cicadas never stopped chirping." As Mehmet Bey describes his village, the longing on his face is conveyed to the audience. Toward the end of his description, eight-year-old Mehmet is seen touching the walls of the houses in his village. As Mehmet enters the door of his house, the depiction of the village concludes. Together with him, as the inside of the house is shown (Figure 16), Grandfather Mehmet describes the family environment, calling the house and the family "What a celebration, what a turmoil!" The family speaks Greek. Grandfather Mehmet Bey talks about the last beautiful memory of Crete, a photo taken just before their departure. This photo, taken in the streets of Rethymno, became the photograph that says, "This is where we lived" (Figure 17). When they left Rethymno, in the haste, the photo was forgotten. "We were happy back then," says Mehmet Bey, reminiscing about the land where he was born and raised.

Figure 16 The scene of the house's inside in the village of Rethymno in the film My Grandfather's People at 31st minute (Irmak, 2011)

Figure 17 The scene of the family photo in Village street in the film My Grandfather's People at 31st minute (Irmak, 2011)

Mehmet Bey begins to tell the story of the population exchange, saying, "So many things were left behind in that house, so many." "It was 1923. Things started to heat up. Rumours started spreading. They said there was going to be an exchange. We had to leave there, leave our home. What could we do? Fate was like a castle... Everything was sold… We gathered our belongings. My mother cried, saying we'd leave our home and our neighbours. My mother took the last seedling from the lemon tree in the garden. You'd think that our house would come with it." After these words, they are seen closing their house and bidding farewell to their Greek neighbours. Mehmet says goodbye, touching the houses once more (Figure 18, 19 and 20). The Greeks of Rethymno have been divided into two. Some are sad about the departure of their Turkish neighbours, while others

emphasize that the Turks should, of course, leave (Figure 21 and 22). The Turks have travelled to the ports with wagons. Grandfather Mehmet Bey's oral narration ends, and the impact of the population exchange is seen through the eyes of Child Mehmet. At the port, people are gathered in a crowd, waiting (Figure 23). The "Gülcemal" ship is awaited. The conversations among the waiting crowd are like, "We're going to the homeland, what else? Don't cry." The name of the "Gülcemal" ship is the name of hope. They had waited at the shore for two days. During those two days, Mehmet's mother wanted to go back home to buy potatoes, as there was nothing left to eat. The father's response was, "That's no longer our home; they won't let you in." Like Mehmet's mother, others also took saplings from their gardens (Figure 24). They tried to take whatever they could from their homes, from the places they belonged to. The sound of the Gülcemal ship was heard first. After two days, they were still unsure whether what they had been waiting for had finally arrived. The first sighting of the Gülcemal ship (Figure 25) was the harbinger of starting a new life, a symbol of hope. With the arrival of the ship, the melancholy brought by farewell and waiting dissipated. The words, "Goodbye, my Crete!" are heard, but Crete is not shown once more. The sorrow on Mehmet's face is visible, and Grandfather Mehmet provides an explanation: "We were among the first to migrate. Then fifty ships carried two million souls. Both from there and from here. For a whole year." Following this, the journey on the Gülcemal is depicted for the audience.

Figure 18, 19 and 20 The scenes of the Mehmet's goodbye in the film My Grandfather's People at 33rd and 34th minute (Irmak, 2011)

Figure 21 and 22 The scene of the Greeks neighbours in Rethymno in the film My Grandfather's People at 33rd minute (Irmak, 2011)

Figure 23 The scene of the Turks gathered at the port in Rethymno, Crete in the film My Grandfather's People at 35th minute (Irmak, 2011)

Figure 24 The scene of people watering their saplings at the harbor in Rethymno, Crete in the film My Grandfather's People at 37th minute (Irmak, 2011)

Figure 25 The scene of the Turks gathered at the port in Rethymno, Crete in the film My Grandfather's People at 38th minute (Irmak, 2011)

Grandfather Mehmet says that they did not know how many days the journey lasted. In a scene where he says, "It was my first time seeing Izmir" (Figure 26), the same sorrow is again visible on Child Mehmet's face. Mehmet's first view of Izmir is early in the morning, and the image of the shore is not presented to the audience, emphasizing that it does not matter what Izmir looks like to Mehmet. What matters more to him than how Izmir appears is the home he lost, the life he had, the happy days, and the brother he had to leave behind—the sea, which is represented by a symbolic grave in the garden, is more significant than the visual appearance of Izmir. Izmir is seen for the first time from a great distance, in the middle of the sea. After the first view of Izmir, in Mehmet Bey's narration, the sea journey ends, and the population exchange process continues

with their life in Izmir before settling down. Mehmet Bey talks about how the place called Karantina (Quarantine) was given to them because of their arrival and mentions the first things he saw in Izmir after the ship journey. Quarantine, the hospital, and the bathhouse are the first places Child Mehmet experiences in Izmir (Figure 27). Everyone speaks Turkish, but those who came from Crete do not know Turkish. Mehmet Bey describes the sense of not belonging anywhere, saying, "There, they call us 'Turkish seed,' here they call us 'Gavur.'"

Figure 26 The scene of the first sight of Izmir in the film My Grandfather's People at 40th minute (Irmak, 2011)

Figure 27 The scene of the quarantine place in the film My Grandfather's People at 41st minute (Irmak, 2011)

Mehmet Bey continues, "That was the last time I saw Crete… I grew up early, aged early. But that house, my childhood, still stays there. I never became a child again. I always wondered, who lives there? Would a boy like me walk around that house? If someone found those bottles, and said they found us, I'd believe all this happened," concluding his narration of the population exchange. "Maybe one day, we'll all go together to see my home, to greet it," he hopes.

The narration of the population exchange ends. The film continues with scenes depicting Mehmet Bey's second attempt to go to Greece, which became impossible after the 1980 coup. After the coup, Mehmet Bey, dissatisfied with the country he lived in, prefers to die in the sea (Figure 28) where he left his brother, instead of being torn between the two countries, a place representing the indecision of leaving or staying. After Mehmet Bey's death, a letter arrives at their home. The message in the bottle that reached Crete found its recipient. A woman, who lives in the house described, has written the letter and is inviting them to her home/their home. The film then continues years later, with young Ozan visiting his grandfather's home, the house where Mehmet Bey was born and raised, but no one from the family is able to go. Ozan's question will be, "Was it these waters that separated us?"

When Ozan goes to his grandfather's house in Rethymno, Crete, the audience also greets the house from afar along with Ozan. The act of touching the walls, as Child Mehmet did when bidding farewell to his house and village, signals Ozan's arrival in the same house, the same village being bid farewell. Ozan learns that the forgotten photo from that house was kept. As he looks at the photo, the sound of the taverna can be heard from a distance. It is late afternoon. The place and its sounds have remained the same, but the people have changed. Ozan also says, "Everything is just as you left it, Grandpa, nothing has changed," and sends a message from 'the other side of the same sea' by leaving a letter in a bottle for his grandfather in the Aegean (Figure 29). The film ends with the sea (Figure 30).

Figure 28 The scene of the suicide in sea in the film My Grandfather's People at 96th minute (Irmak, 2011)

Figure 29 The scene of sending a message from the other side of the Egean Sea in the film My Grandfather's People at 114th minute (Irmak, 2011)

Figure 30 The last scene of the Egean Sea in the film My Grandfather's People at 114th minute (Irmak, 2011)

The spatial findings of the film are summarized in Table 2.

Table 2 The Scenes About Spatial Memory, Sense of Belonging and Place-Making in the Film "My Grandfather's People"

	Themes	Scenes
Physical Spatial Datas Retained in Spatial Memory After Migration	The Last Memory of the Abandoned Place	• The Memory of Young Mehmet's Home and His Farewell to It in Rethymno, Crete (Figure 16, 17, 18, 19 and 20) • Mehmet and His Family Taking a Photo in the Village Street of Rethymno, Crete (Figure 17)
	The Memory of the House and Neighbours in the Abandoned Place	• The Home and the Life Within It Are Depicted (Figure 16), and Farewells Are Said to Neighbors Upon Departure (Figure 21 and 22)
	Depictions of Unforgettable Places in the Abandoned Place	• The House, Village, and Streets in Rethymno (Figure 16, 17, 18, 19, 20, 21 and 22)
	Spatial Image of the Moment When the Destination Country is First Seen	• The Distant View of Izmir Dominated by the Sea (There Is No Image Indicating That It Is Izmir) (Figure 26)
	The First Places Experienced in the Destination Country	• The Quarantine and Bath Processes, Mentioned as the Reason for the Name of the Quarantine District in Izmir (Figure 27)
	The Depiction of New Living Places in the Destination Country as Streets, Neighbourhoods, and Homes: Neighbourhood Relationships	• The House in Izmir, the Neighbourhood Where Everyone Lives in Close Proximity, the House with a Garden and Its Surrounding Environment, Relationships with Non-Migrant Neighbours and Migrants (Figure 14)
	Depiction of the Journey Process	• The Process of Waiting for the Ship at the Shore (Figure 23) • People Watering Their Saplings at the Harbor in Rethymno, Crete (Figure 24) • The Journey Process with the Gülcemal Ship (Figure 25)
	Aegean Sea	• The Lives Separated by Two Countries, the Lives They Were Forced to Leave Behind on the Other Shore, the Pain of Migration (Figure 28, 29 and 30)
Sense of Belonging and Place-Making After Migration	Emphasis on House/ Neighbourhood/ Village/ Street Regarding the Abandoned Place	• The Home Is Depicted, and the Village and Street Locations Are Shown While Taking Photographs and Descending to the Shore for Migration (Figure 17, 18, 19, 20, 21 and 22)
	The Reason for the Abandonment of the Living Place	• Migration for Exchange: Departure from Crete, Rethymno to the Harbors by Ox-Carts (Figure 18, 19, 21 and 22.) • Gathering at the Harbor in Rethymno, Crete (Figure 23 and 24) • The First Sight of the Gülcemal Ship at the Harbor in Rethymno, Crete (Figure 25)
	Belonging in the New Living Places in the Destination Country	• The Process of Exclusion by the Local Population, the Sense of Belonging Developed Towards Izmir and Turkey (Figure 14) • Sence of Belonging to the summer house (Figure 15)

The film of "Roza of Smyrna" (İsmail ve Roza) directed by Giorgos Kordellas (2016) and written by Christina Lazaridi, is a Turkish-Greek co-production. While the film does not delve into the details of the population exchange process, it focuses on the lives that changed as a result of the exchange.

The film begins with a wedding in a church (Figure 31). Turkish soldiers entering the church with weapons, a gunfight, and the bride (Roza) being forcibly taken to a horse by a Turkish man are depicted. The historical context and location are not mentioned in the scenes, but it is understood that these events take place during the period when the city of Izmir, which was occupied by the Greeks in 1922, was reclaimed by the Turkish army.

Figure 31 The beginning scene of the church wedding in the film Roza of Smyrna at 1st minute (Kordellas, 2016)

The film continues in Athens in 1987. Dimitris, who works in a museum, is researching objects left behind by immigrants when they were forced to leave their homes during the population

exchange, for an exhibition on the subject. From a family photo taken in front of Hagia Sophia (Figure 32) it is understood that Dimitris is the son of a family that was forced to migrate from Istanbul after the population exchange. The term 'lost lands' is used for Asia Minor. Dimitris and his team will go to Izmir to find objects that Greek immigrants left behind in their homes and sacred places during the exchange. After Hagia Sophia, Izmir is the first location from Anatolia shown in the film (Figure 33).

Figure 32 The scene of Dimitris' family photo taken in front of Istanbul's Hagia Sophia in the film Roza of Smyrna at 6th minute (Kordellas, 2016)

Figure 33 The scene of Izmir in the film Roza of Smyrna at 9th minute (Kordellas, 2016)

Locations presented to the audience in Izmir (Figure 37) include the Atatürk Statue (Figure 34), Kemeraltı Bazaar (Figure 35), The Clock Tower (Figure 38 and 39) and an antique shop where items bearing traces of the immigrants are searched. A painting depicting the entry of the Turkish forces into Izmir (Figure 36) is a key item in the antique shop. The wedding dress, which belongs to the bride from the beginning of the film, is found in the antique shop. The details of what happened on the wedding day are learned from the shopkeeper. The wedding day in Izmir is described as the day the great fire, referred to as "the day the events began," occurred. The wedding dress was found by the father of the antique shop owner. The term "before Izmir became too chaotic" is used to describe that period. The family of the girl from Bornova intended to have the wedding and migrate to Greece. However, on the day of the wedding, Izmir descended into chaos. What happened during and after the wedding remains unknown. The family's house remained closed for years, with no one returning. The population exchange took place, and Turkish immigrants from Greece moved into the houses left behind by the Greeks.

Figure 34 The scene of the Atatürk Statue in Izmir in the film Roza of Smyrna at 11th minute (Kordellas, 2016)

Figure 35 The scene of Kemeraltı Bazaar in Izmir in the film Roza of Smyrna at 13th minute (Kordellas, 2016)

Figure 36 The scene of the painting depicting the entry of the Turks into Izmir in the antique shop in the film Roza of Smyrna at 15th minute (Kordellas, 2016)

Figure 37 The scene of Izmir in the film Roza of Smyrna at 52nd minute (Kordellas, 2016)

Figure 38 The scene of Izmir postcards in the film Roza of Smyrna at 52nd minute (Kordellas, 2016)

Figure 39 The scene of Izmir Clock Tower in the film Roza of Smyrna at 55th minute (Kordellas, 2016)

The process of discovering the owner of the wedding dress and what happened on that day forms the central plot of the film. The wedding dress's owner, the elderly woman Roza, refers to

Izmir as "hell." The reunion of Roza and İsmail, which gives the film its title, takes place years later in Istanbul. The first image of Istanbul shown in the film is of the Topkapı Palace in the Historical Peninsula (Figure 40). Later, significant historical buildings such as the Yeni Mosque (Figure 41) and Hagia Sophia (Figure 42) are emphasized, with Hagia Sophia highlighted as an important site for the Greeks in Istanbul.

Figure 40 The scene of Topkapı Palace in Istanbul in the film Roza of Smyrna at 70th minute (Kordellas, 2016)

Figure 41 The scene of Eminönü Yeni Mosque in Istanbul in the Film Roza of Smyrna at 70th minute (Kordellas, 2016)

Figure 42 The scene of Hagia Sophia in Istanbul in the film Roza of Smyrna at 75th minute (Kordellas, 2016)

The film nears its end with scenes showing Roza looking out at the sea across from the Süleymaniye Mosque, where she is later found dead the next morning (Figure 43). In his lecture on the love story of Roza and İsmail, Dimitris mentions the state of Izmir at the time. The first image on the slide showing the city depicts Izmir during the time when it was inhabited by Greeks (Figure 44 and 45). The film concludes with slides depicting the burning of Izmir (Figure 46 and 47).

Figure 43 The scene of the sea in Istanbul in the film Roza of Smyrna at 91st minute (Kordellas, 2016)

Figure 44 and 45 The scenes of early 20th century Izmir Images from Dimitris' conference in the film Roza of Smyrna at 91st minute (Kordellas, 2016)

Figure 46 and 47 The scenes of the 1922 Izmir fire ımages from Dimitris' conference in the film Roza of Smyrna at 91st minute (Kordellas, 2016)

The spatial findings of the film are summarized in Table 3.

Table 3 The Scenes About Spatial Memory, Sense of Belonging and Place-Making in the Film Roza of Symrna (İsmail ve Roza)

Topics of Population Exchange		Scenes
Physical Spatial Datas Retained in Spatial Memory After Migration	The Last Memory of the Abandoned Place	The Burning of İzmir (Figure 46 and 47)
	The Memory of the House and Neighbours in the Abandoned Place	None
	Depictions of Unforgettable Places in the Abandoned Place	• Historic Areas of İzmir Inhabited by Greeks (Figure 33, 34, 35, 36, 37 and 38) • Istanbul and Hagia Sophia, Topkapı Palace, Yeni Cami (Figure 32, 40, 41 and 42)
	Spatial Image of the Moment When the Destination Country is First Seen	None
	The First Places Experienced in the Destination Country	None
	The Depiction of New Living Places in the Destination Country as Streets, Neighbourhoods, and Homes: Neighbourhood Relationships	None
	Depiction of the Journey Process	None
	Aegean Sea	• The Lives Left Behind Across the Shores That Separate Two Nations: The Pain of Migration (Figure 43)
Sense of Belonging and Place-Making After Migration	Emphasis on House/Neighbourhood/Village/Street Regarding the Abandoned Place	Photographs Depicting İzmir During the Period of Greek Inhabitants (Figure 44 and 45)
	The Reason for the Abandonment of the Living Place	• The Recapture of İzmir by the Turkish Army (Figure 31)
	Belonging in the New Living Places in the Destination Country	• None

The Greek productions Rembetiko and Roza of Smyrna (İsmail ve Roza) (written and directed by Greek creators) share a common perspective, portraying the population exchange from the viewpoint of the Greek population. Rather than focusing on the migration that took place following the population exchange agreement, both films emphasize the events leading to the migration—specifically, the recapture of Izmir by the Turkish army from Greek occupation, which forced the Greeks to leave their cities. In both films, the final images of Izmir in the minds of the migrants are tied to the Great Fire of Izmir. The concepts of fire, hell, and burning are frequently highlighted throughout these films. Izmir and its destruction symbolize the lost homelands.

In contrast, the film of My Grandfather's People (Dedemin İnsanları) emphasizes the necessity of migration, leaving behind one's home, neighbours, and homeland. The final image of the homeland is that of Crete, remembered fondly as a beautiful and cherished place. In all three films, no spatial imagery is provided for the moment when the migrants first arrive in their new countries. In My Grandfather's People (Dedemin İnsanları), the depiction of the arrival in Izmir is vague; the scene showing the city from a distance gives no distinct sense of its identity as Izmir. This lack of focus on the new place suggests that the destination holds little importance for the migrants; it is the abandoned homeland that remains significant.

Rembetiko portrays life in Greece after leaving Anatolia, while My Grandfather's People (Dedemin İnsanları) depicts life in Anatolia following migration from Greece. In both films, a common theme emerges both groups of migrants are marginalized by the local population, struggle to gain acceptance, and find it difficult to feel a sense of belonging in their new locations. In Rembetiko, life in Piraeus is depicted as being no different from the marginalized and scorned existence in Anatolia. Similarly, My Grandfather's People (Dedemin İnsanları) highlights how the Turkish locals continuously refer to the migrants as "infidels," leading to the lament, "Over there, we are seeds of Turks; over here, we are infidels."

In Rembetiko, the characters' lack of belonging in their new places is conveyed through their constant desire to move elsewhere, coupled with their realization that no matter where they go, the result remains the same. This suggests that, along with the burning of Izmir, they lost their sense of identity and belonging. Conversely, My Grandfather's People (Dedemin İnsanları) demonstrates the establishment of a sense of belonging. The transformation of the house they "visited only to

stay for a short while" into a vibrant, living place indicates their sense of attachment. The emotional difficulty of leaving their former home in Crete, symbolized by the grandfather's musings about a young boy like himself roaming the house they left behind, conveys the deep connection between place and identity.

In Roza of Smyrna (İsmail ve Roza), the narrative does not centre on the lived experiences of those who directly witnessed the population exchange. Roza, a survivor of the exchange, describes Izmir as "hell". For her, the final image of Izmir is the violent conflict at the church. In the film, depictions of Izmir are presented through the perspective of those researching the period rather than through Roza's personal experience. The historical buildings of Izmir serve as spatial symbols for the displaced Greek population. Beyond Izmir, the film highlights the loss of Istanbul (referred to as Constantinople by the Greeks), the capital of the Byzantine Empire, and significant landmarks such as the Topkapı Palace and Hagia Sophia, which represent powerful spatial and cultural symbols of loss.

The recurring motif of the sea is significant in all three films. The protagonists of My Grandfather's People (Dedemin İnsanları) and Roza of Smyrna (İsmail ve Roza) both meet their ends while near the sea, symbolizing the dichotomy of departure and stasis, as well as the loss of identity and belonging. The sea is portrayed as a natural place that evokes memories of separation and displacement.

Table 4 summarizes the findings related to population exchange and spatial representation in Rembetiko, My Grandfather's People (Dedemin İnsanları), and Roza of Smyrna (İsmail ve Roza).

Table 4 Spatial Analyses of Population Exchange Films

	Themes	Scenes		
		Rembetiko	My Grandfather's People (Dedemin İnsanları)	Roza of Smyrna (İsmail ve Roza)
Physical Spatial Datas Retained in Spatial Memory After Migration	The Last Memory of the Abandoned Place	The Burning of İzmir	The Last Image of Their Homeland (Houses and Streets of Crete)	The Burning of İzmir
	The Memory of the House and Neighbours in the Abandoned Place	None	The house and the life within it are depicted, and farewell is said to the neighbors upon departure.	None
	Depictions of Unforgettable Places in the Abandoned Place	İzmir	The house, village, and streets in Rethymno	The historical areas in İzmir where the Greeks lived, as well as Istanbul, Hagia Sophia, and the Topkapı Palace
	Spatial Image of the Moment When the Destination Country is First Seen	None	A distant view of İzmir dominated by the sea (with no indication that it is İzmir).	None
	The First Places Experienced in the Destination Country	None	The quarantine and bathhouse processes.	None
	The Depiction of New Living Places in the Destination Country as Streets, Neighbourhoods, and Homes: Neighbourhood Relationships	The house in Piraeus, the immigrant neighborhood, neighborly relations, lemon market.	The house in İzmir, the neighborhood where everyone lives in close proximity, the house with a garden and its surrounding environment, and the relationships with both non-immigrant neighbors and fellow immigrants.	None
	Depiction of the Journey Process	Real images and the migration process.	Waiting for the ship on the shore and the journey by ship	None
	Aegean Sea	The lives left behind on the opposite shore, divided by two countries, and the pain of migration	The lives separated by two countries, left behind on the opposite shore, and the pain of migration.	The lives divided by two countries, the lives they were forced to leave on the other shore, and the sorrow of migration

Sense of Belonging and Place-Making After Migration	Emphasis on House/Neighbourhood/Village/Street Regarding the Abandoned Place	None	The house is depicted, and the village and streets are shown while photographs are being taken and as they descend to the shore for migration.	Photographs of İzmir during the time it was inhabited by Greeks."
	The Reason for the Abandonment of the Living Place	The Recapture of İzmir by the Turkish Army	Population Exchange	The Recapture of İzmir by the Turkish Army
	Belonging in the New Living Places in the Destination Country	"Exclusion by the local population and a sense of rootlessness	The process of exclusion by the local population, and the sense of belonging developed towards Izmir and Turkey.	None

6. Conclusion

This study has analyzed the relationship between spatial memory, collective memory, place-making, and belonging through the spatial representations in three films that address the population exchange. It reveals how forced migration, as exemplified by the population exchange, disrupted and transformed individuals' bonds with place. The films under examination demonstrate that the exchange was not merely a physical relocation but also a profound psychological and cultural rupture related to the reconstruction of spatial identity.

In Rembetiko and Roza of Smyrna (İsmail ve Roza), the destruction of İzmir's iconic places—ingrained in the spatial memory—during the great fire, and the traumatic spatial rupture associated with the departure of the Greek population, are depicted through powerful and affective images. In My Grandfather's People (Dedemin İnsanları), on the other hand, the narrative reflects a gradual reconstruction of belonging in the new settlement. Notably, even a summerhouse initially intended as a temporary shelter is transformed into a permanent home, emphasizing how a place can be embraced both physically and emotionally.

A shared feature across all three films is the ambiguous and indistinct representation of the new places to which the displaced populations migrated. This cinematic vagueness highlights that place is not merely a physical setting but a deeply emotional and identity-laden construct. For displaced individuals, it is often the place left behind—not the one reached—that holds lasting significance. From an architectural and spatial design perspective, this underscores that settlements are not only functional entities but are also imbued with historical and emotional meaning.

The recurring imagery of the sea in the films symbolically represents displacement. The sea emerges as a metaphor for both separation and rootlessness. In this sense, it transcends its physicality and becomes a symbol of the loss of spatial belonging and the perpetual feeling of dislocation.

This study demonstrates how the population exchange was perceived differently by the Turkish and Greek communities and how these perceptions are reflected in the spatial dimensions of cinema. The imagery of place, belonging, and rootedness changes in accordance with the events that forced people to leave their homelands and attempt to establish new lives elsewhere. Even a century after the exchange, the places that were once inhabited and the memories associated with them continue to be transmitted across generations, finding expression in the arts. The study highlights how a historical event leaves traces on the societies that experienced it, and how these traces are transmitted and reshaped through cultural production.

Through the lens of these films, the complex relationship between migration and place becomes legible from the perspective of the architectural discipline. The spatial memory shaped by the migration experience reveals that architecture is not only related to the built environment but also deeply intertwined with human memory, identity, and emotion. In this regard, spatial design should be understood not only as a physical process but also as one woven into social and cultural memory.

This study paves the way for further investigations into how forced migration experiences are spatially embodied as traumatic processes. Cultural productions such as films, documentaries, and

literary texts can be analyzed from an architectural perspective, particularly in terms of their spatial representations—architectural elements, spatial practices, and scenes of transition. Analyses focusing on the contrasts between pre- and post-migration places demonstrate that architectural narrative is nourished not only by physical structures but also by visual and narrative representations. Comparing migration-themed films from different geographies can yield insights into the spatial representation of migration across cultures. Such comparative analyses contribute to understanding both the cultural diversity of architectural production and the universal spatial effects of displacement. Documentaries, in particular, offer rich material on migrant living conditions, spatial confinement, and resettlement processes. These productions can be incorporated into architectural research and discussed alongside issues such as spatial justice, the right to housing, and housing crises.

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CRediT Authorship Contribution Statement

Elif Vurucular Kesimci: Writing – review & editing, Writing – original draft, Methodology, Analysis.

Declaration of Competing Interest

The author declares that there are no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Data Availability

All data are available within the paper.

Ethics Statement

An ethics committee approval was not required for this study.

Resume

Elif Vurucular Kesimci graduated from the Department of Architecture at Mimar Sinan Fine Arts University in 2010 and began her professional career in an architectural office in Bursa. Since 2015, she has been working as a faculty member in the Department of Architecture at Bursa Technical University, where she is currently an Assistant Professor. She completed her master's and PhD studies at Yıldız Technical University, focusing on public space analysis through Space Syntax in her master's thesis, and on public place, cultural heritage, and intergenerational spatial memory in her doctoral research. Her current academic work explores urban space, memory, and cultural continuity.

JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (510-525), 2025
DOI: 10.47818/DRArch.2025.v6i3180

Designing for experience: Exploring user-centered strategies in Selgascano's architecture

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Abstract

The production of space is a multidimensional and complex process that encompasses emotion, knowledge, intuition, foresight, and experience. When designing, architects consider interpersonal interactions and human-space relationships to create scenes suitable for the anticipated actions and experiences within a space. People, in turn, are the ones who experience spaces. Many researchers and architects focus on human-space interaction in architecture. Among these architects, the SelgasCano architecture office, founded in 1998 by Jose Selgas and Lucia Cano, places user experience at the center of its designs, aiming to create spaces that are not only functional but also places that users embrace and enjoy. Within this scope, the literature on human–space interaction was reviewed, and four key themes related to user experience in SelgasCano's architectural approach were identified. Four projects in which SelgasCano was considered to reflect these themes most clearly (Silicon House, SelgasCano Architecture Office, Second Home London Office, and Second Home Hollywood Office) were examined. The study reveals that SelgasCano systematically integrates context, biophilia, material, and color as core design components that frame and enrich user experience across their architectural projects. The findings reveal that SelgasCano's architecture positions user experience at the core of the design process, integrating sensory, emotional, and cognitive dimensions to create dynamic and engaging environments. The study concludes that user-centered and biophilic design strategies significantly contribute to enhancing spatial quality and human–space interaction. In this regard, examining and further developing design approaches that prioritize user experience is of critical importance for generating innovative and human-centered solutions in architectural practice.

Keywords: user experience, SelgasCano, context, biophilia, material, color

1. Introduction

From the views of Edmund Husserl, Martin Heidegger, Maurice Merleau-Ponty, Gaston Bachelard, and many contemporary authors, an experiential approach based on personal experiences in spaces can be read (Pallasmaa, 2018). Within this framework, the subject-object relationship is critically examined, emphasizing how individuals perceive, interpret, and engage with their surrounding environments. When the subject-object relationship is adapted to architecture, it is seen that studies are interpreted in a way that considers human-space interaction. The field is developed under the title of Environmental-Behavior Studies in architecture. The famous architect Rapoport, who worked on Environmental-Behavior Studies, states that all human-made environments contain human decisions; space is produced in such a way that relates people to other people and spaces (Rapoport, 1980, p. 10-11).

Buildings are scenes designed by taking into account the actions and experiences anticipated to take place within space. Individuals engage with these spaces through sensory perception, movement, and cognitive interpretation, which together shape their overall experience of the built environment. Action and experience occurring in space are in an inseparable relationship (Itterson et al., 1976). The built environment influences human thoughts and emotions (Rui & Firzan, 2024). Architectural experience, on the other hand, is the interpretation of aesthetic, social, environmental, or functional qualities by the inhabitant as a subject, within their own cultural

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Article history: Received 09 September 2025, Revised 10 October 2025, Accepted 03 December 2025, Published 24 December 2025

context and in a real time and space (Coelho, 2013). In a built environment, the experience of architecture is always individual and unique. Architecture comes into being with the meaning a person attributes to space. Otherwise, only the physical structure of environments can be spoken of. The artistic and mental essence of architecture emerges through individual experience (Pallasmaa, 2018). As can be understood, space cannot be reduced merely to a physical form, but gains meaning through the relationships established within it. The production of space is an act so complex that it encompasses emotion, knowledge, intuition, foresight, and experience, and cannot be clearly defined.

The space-human relationship has been taken into consideration by many architects from past to present, who incorporated user experience into both their discourses and works. For example, Peter Zumthor emphasized that architecture has its own reality that establishes a relationship with life (Zumthor, 1988, p. 1). Bernard Tschumi, on the other hand, claimed that the potential for unexpected actions to occur in space depends on the movements of users (Tschumi, 2000, p. 13, 226, 297). According to him, architectural space is constantly transformed by the events (user movements and resulting actions) that occur within and around it (Tschumi, 1994). This study aims to present an original approach that evaluates SelgasCano's architectural practice from different perspectives of user experience. The main research question of this study is to explore how user experience is shaped within the architectural practice of SelgasCano and through which conceptual and design components it is articulated. Accordingly, the study seeks to analyze the outcomes of SelgasCano's user-oriented approach within a conceptual framework. Within this scope, the literature on human–space interaction was examined, and four key themes related to user experience in SelgasCano's architectural approach were identified: context, biophilia, material, and color. Four buildings (Silicon House, SelgasCano Architecture Office, Second Home London Office, and Second Home Hollywood Office) considered to best reflect these themes were analyzed. The findings were evaluated through these four main themes, revealing how the architects approach user experience. In conclusion, the study demonstrates that user-centered design is not limited to physical form and functional arrangements but is also shaped by the ways in which spaces are perceived and experienced by their users.

2. Method

In this study, recent literature on human–space interaction was primarily reviewed. The architectural works of the firm SelgasCano, which constitute the focus of the study, were examined, and it was observed that context, biophilia, material, and color themes predominate in the firm's design approach to user experience. Accordingly, an additional literature review was conducted based on these themes to ensure a clear understanding and presentation of the conceptual framework.

In the case study section, which forms the original contribution of the research, Silicon House (2006), SelgasCano Architecture Office (2007), Second Home London Office (2014), and Second Home Hollywood Office (2019), four projects by SelgasCano, were selected as the sample, as they most clearly reflect the identified themes. The analysis of the architectural components shaping user experience in each building employed the four main themes (context, biophilia, material, and color) as the analytical framework. The findings were interpreted through a comparative analysis of visual and textual documents, and the architects' approaches to user experience were evaluated through these themes.

This study is limited to SelgasCano's projects in which the emphasis on user experience is explicitly expressed. The analysis is based on subjective interpretation and does not include user feedback or measurable performance assessments.

3. Literature Review: Exploring User Experience in SelgasCano's Architecture

To better understand how SelgasCano interprets user experience in their architectural practice, it is necessary to examine the firm's general design philosophy and approach to space. Founded in

1998 by José Selgas and Lucía Cano, the office frequently emphasizes its commitment to user-centered and experiential design principles:

- "We believe that human experience is the heart of architecture, and if we can bring people closer to each other and to nature, we can create better spaces for daily life" (Baldwin, 2019),
- "Architecture is about human experience" (Baldwin, 2019),
- "Architecture serves to solve problems and to make people feel better" (Domus, 2015),
- "We love designing for people" (Domus, 2015),
- "Our architecture is produced by reading the places and the lives of those who will live there" (Domus, 2015).

In an interview, SelgasCano stated that what makes their projects successful is that people enjoy using the building and make it a place of their own (SelgasCano, 2015). They expressed that environmental elements such as nature, context, climate, and history are among the main factors they take into account when creating an architectural product (SelgasCano, 2015). They further emphasized the importance of minimizing interventions on the construction site to preserve the integrity of the existing environment. Appropriate use of scale, efficient spending of the budget, and sustainability in transportation, manufacturing, and energy are among their design principles (Mundelsalle, 2019). Their simple forms, light materials, and transparency can be observed in their works as a product of the "less is more" understanding. Biophilia and the experience of color are among their priorities.

3.1. Themes Used by SelgasCano in User-Centered Design

3.1.1. Context in User Experience

Context is a concept with extensive literature in the field of design (Johnson, 1994). As it establishes a dialogue between new interventions and existing conditions, it inherently embodies a historicist perspective, emphasizing the continuity and integration of architectural elements across time. Therefore, it has a structure that sets standards, emphasizes rules, and is concrete and defensible. With its physical aspect, which mostly concerns the harmony of scale, proportion, ornamentation, color, material, and construction technique with the environment, it falls within the area of interest of architects. It is a concept that points to the physical texture of the environment in which the building is situated, as well as its social, cultural, and historical values (Johnson, 1994, p. 285-287). Moreover, context encompasses sociological dimensions, highlighting the ways in which architectural interventions interact with and influence the broader community. When context is addressed, in approaches that disregard the social values of the environment and focus on the physical dimensions of architectural space and form, the behavioral and experiential patterns that give meaning to buildings are in danger of being neglected (Sime, 1986). In this case, practices based on experience will not be included; as Auge points out, architecture will emerge where context, identity, and belonging are not utilized, and the relationship between place and human will be reorganized according to the new world. As a result, spaces that have no relationship with place and context, that encourage behaviors targeting consumption, that are suitable for rapid use, and that hinder the development of belonging will begin to proliferate (Augé, 2016, p. 7-9, 21). In this case, it is possible to say that people will only be present in space without becoming part of the place they experience and thus will not inhabit it or develop their spatial experiences (Heidegger, 1996). These approaches show that being situated within a context is necessary both for design and for human nature.

3.1.2. Biophilia in User Experience

An important element of context is the ecological diversity it contains. According to Beery and Wolf-Watz (2014), the relationship between nature and environmental behaviors has recently attracted attention in scientific practices. These approaches, using terms such as affinity, biophilia, attachment, ecological self, identity, and sensitivity, define the human–nature relationship in

emotional, cognitive, and/or physical forms (Bragg, 1996; Chawla, 1999; Clayton, 2003; Davis et al., 2009; Kals et al., 1999; Mayer & Frantz, 2004; Nisbet et al., 2009; Palmer, 1993; Schultz, 2001; Stedman, 2006; Sward & Marcinkowski, 2001; Wilson, 1984). In studies on nature and environmental behaviors, the emphasis is on the "experience" of nature, encounters with nature, and the possible emotional and/or cognitive relationships between nature and the individual that develop from these experiences. It is repeatedly assumed in these approaches that spending time in nature helps individuals see themselves as a part of nature, become more responsible for it, and ultimately contribute to its protection (Beery & Wolf-Watz, 2014).

According to Norberg-Schulz (1979), by addressing the interaction between nature and humans from a different perspective, human-made places are related to nature in three fundamental ways. First, it is based on the human desire to visualize his "understanding" of nature. To achieve this, one either constructs what is seen, or creates a work in areas where nature is "centralized" or marks a place. Second, nature is completed by adding the human being into it. Finally, it symbolizes the understanding of nature. For example, an element belonging to nature is reflected in a building that manifests it.

Designs inspired by nature have found their place throughout history in many fields, including industrial design, healthcare, medicine, materials science, nanotechnology, robotics, and engineering. The discipline of architecture also aims to contribute to the literature and develop new design solutions by approaching this subject from different perspectives. Understanding and analyzing nature by examining its forms, systems, materials, functions, processes, aesthetics, and ecosystems to discover new possibilities and solutions for related disciplines has become increasingly essential in contemporary architectural practice (Kahvecioğlu et al., 2024). According to Wijesooriya et al. (2025), the biophilia hypothesis suggests that humans have an innate affinity toward nature and natural systems (Wilson, 1984). The biophilic design approach pioneered by Stephen Kellert also aims to provide various psychological, behavioral, health, and well-being benefits by strengthening the human–nature connection. With biophilic design, elements of nature and the natural world are integrated into the built environment. It encompasses efforts in architecture and environmental psychology to produce healthier and more sustainable living spaces (Khanzadeh, 2024). In biophilic design, strategies that enable direct interaction with nature and the indirect simulation of nature through materials and design motifs support relaxation and a sense of belonging through organic forms, natural tones, and textures. Ecological materials, in turn, enhance emotional and sensory experience by emitting subtle natural scents (Ashour et al., 2025).

Research has shown that biophilic design provides psychological benefits such as stress reduction, improved attention, decreased anxiety, and enhanced mood. These effects can be recreated in interior spaces through the use of natural textures, colors, and materials such as wood, stone, and organic fibers. Such ecological materials offer sensory stimuli that reduce mental fatigue and increase awareness, effectively simulating the calming influence of nature (Ashour et al., 2025). Past studies have proven that experiences of nature reduce stress and facilitate recovery from mental fatigue (Hong et al., 2025), enhance users' cognitive performance, reduce stress, and promote overall well-being (Khanzadeh, 2024).

The understanding and application of natural formation and production processes are leading to revolutionary developments in architecture. Emerging through the collaboration of biology, architecture, and technology, these advancements hold the potential to bring significant changes to human life in the future. Interdisciplinary experts are conducting research in this field and developing theories that drive a paradigm shift in architectural thinking (Mutlu Avinç & Arslan Selçuk, 2019).

3.1.3. Material in User Experience

Comments on architectural form develop in line with the perception and evaluation criteria of the person observing the architectural work and are therefore important in both theoretical studies and practice (Jenks, 1997; Mozaikçi, 2010). The idea that the architect wants to convey to the user

is displayed through form. In architecture, the selection of materials is highly important, as it influences not only the appearance but also the character and experience of the built environment (Erdinç, 2023). The material and form that make up the architectural form have a decisive impact on the comprehension of the building (Mozaikçi, 2010).

The selection of appropriate building materials is a critical decision that influences multiple aspects of a project, including structural integrity, cost efficiency, aesthetics, health, and functionality (Makinde et al., 2024). While architects assess performance characteristics such as durability or compressive strength, they also consider sensory and experiential factors such as color and texture (Wastiels & Wouters, 2012). Research has shown that material properties such as color, brightness, and texture, affect visual experience, spatial perception, and emotional responses. Materials like wood and red brick promote relaxation, positive emotions, and creativity by stimulating the sympathetic nervous system, thereby creating a warm and natural atmosphere. In contrast, materials such as concrete and white paint enhance cognitive functions, improving attention and concentration (Zhou et al., 2025). Traditional sustainable materials such as bamboo, adobe, rammed earth, untreated wood, stone, clay, wool, and cork offer sensory experiences that foster calmness, clarity, and emotional resilience. Natural textures, earthy tones, and organic patterns encourage relaxation, while tactile experiences evoke deep psychological associations with nature, stability, and authenticity. When combined with natural light, vegetation, good ventilation, and acoustic comfort, these materials help reduce stress and promote mental well-being (Ashour et al., 2025).

Consequently, designers develop their projects not solely with considerations of function and utility in mind, but also to shape and enhance the experiential engagement of users with the space. Thus, choosing materials is not only about meeting technical requirements. It also involves elements concerning user experience or sensory stimulation such as the color or texture of the material (Wastiels & Wouters, 2009).

3.1.4. Color in User Experience

Color is a fundamental sensory perception and a key visual element that organizes space (Hong et al., 2025). It carries symbolic, associative, synesthetic, and emotional connotations, playing a critical role in shaping the user's overall impression of an environment (Mahnke, 2004). In architectural practice, color is not merely a surface treatment or decorative layer; it plays a decisive role in how space is perceived, understood, and experienced (Pinto & Fidalgo, 2025). Color is employed to emphasize the character of a building, to promote visual unity and harmony (Radwan, 2015), and to enhance the recognizability and identity of the structure. People's emotional and cognitive responses to a space can vary according to the colors used in its elements. Along with color, the functions and overall quality of the space also affect their experience. As a result, people may develop certain biases based on how they assume a place should be used. This shows the importance of creating design strategies that consider the specific qualities of each space (Noraslı, 2024).

Environmental psychology research has shown that different colors evoke distinct emotional responses. Warm colors (red, orange, yellow) create a sense of energy, warmth, and stimulation, though excessive use may cause discomfort. Cool colors (blue, green, purple) promote calmness, relaxation, and concentration, making them ideal for workplaces and healthcare environments. Neutral tones (white, gray, earth tones) provide balance and harmony and are often used to create timeless and elegant atmospheres. In addition, light or cool hues can make spaces feel more open and expansive, while dark or saturated tones can evoke a sense of enclosure, intimacy, or monumentality. Contrasting colors may be used to define circulation paths, emphasize entrances or focal points, and facilitate intuitive wayfinding. Understanding these psychological effects enables architects to make informed decisions when selecting colors for different building types, enhancing both functionality and user experience (Pinto & Fidalgo, 2025).

Colors, in addition to supporting the functions of buildings and urban spaces, can also carry symbolic, cultural, artistic, and aesthetic meanings. Color schemes planned according to users' emotional needs enhance the vibrancy of a space, intensify specific emotional and aesthetic experiences, and highlight the character of the environment (Jaglarz, 2023). However, it should be remembered that color perception may be influenced by physiological, cultural, age, gender, and other factors that create cognitive responses in users and affect their feelings and behaviors (Heller, 2017; Paschoarelli et al., 2024).

3.2. Case Studies on User Experience in SelgasCano's Architecture

In this study, examples are presented from the SelgasCano's buildings such as Silicon House (2006), SelgasCano Architecture Office (2007), Second Home London Office (2014), and Second Home Hollywood Office (2019) where the use of context, biophilia, material, and color are predominantly observed. Afterwards, it is discussed how the architects used these elements in the buildings as a tool to emphasize user experience.

3.2.1. Silicon House (2006)

Silicon House is located in an evergreen environment. The building is surrounded by oak, elm, acacia, prunus, and plane trees. It is said that the presence of Silicon House within a natural vegetation creates a contrast with nature (Figure 1). The house seeks to achieve harmony by opposing nature (ArchDaily, 2013). According to the designers, the building is "a design that departs from nature, occurring in a void left for them by nature, a void that only architecture can fill." Although it does not claim to be an organic structure, it is a house that respects nature and touches the natural landscape as little as possible. In another sense, it can be defined as an interface space reproduced within nature (Arkitektuel, n.d.).

Figure 1 Silicon House (Iwan, n.d.d)

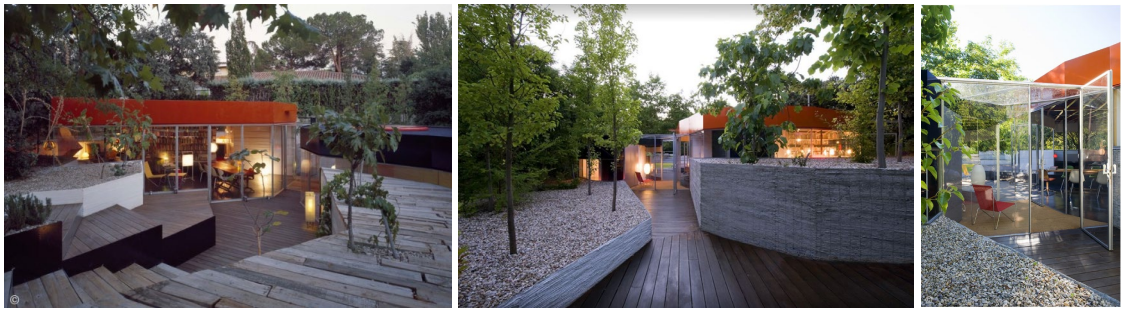

Figure 2 Silicon House's facades (ArchDaily, 2013)

The building reinforces the contrast it creates in a natural setting by vivid pastel colors. With its orange, white, light green, light blue, and navy tones, the building easily distinguishes itself from the exterior (Figure 2). Similarly, in the interior, red, yellow, orange, navy, and white colors are observed both in the use of furniture and in emphasizing the structural system of the building. The extensive use of glass in the building also allows the natural environment to be observed from the inside and enables the view of the contrast outside (Figure 3).

Figure 3 Silicon House's interiors (Iwan, n.d.d)

3.2.2. SelgasCano Architecture Office (2007)

The SelgasCano Architecture Office is one of the office buildings that provides a direct experience with nature. It is partially described as an aerodynamic tube embedded in the ground (Callaghan, 2015).

As an example of biophilic design, the linearly organized structure merges with the forested natural area through its transparent north façade (Figure 4). The transparent façade also allows the building to avoid the use of artificial lighting during the day. Natural ventilation is achieved through operable windows (Callaghan, 2015). Part of the façade is covered with an opaque material of fiberglass and polyester, which provides solar protection for the building.

Figure 4 SelgasCano Architecture Office (Iwan, n.d.c)

The building, situated in nature, was constructed without harming the trees in the forest. This has allowed users to interact with the animals and plants in the area (Callaghan, 2015). The work desks aligned with the transparent north façade of the building, along with a portion of the roof continuing with translucent elements, enable employees to experience nature both at eye level and when looking up at the sky (Figure 5). Thus, seasonal transitions in the forest, wildlife, and the landscape are incorporated into users' daily lives (Inhabitat, n.d.).

Figure 5 Selgascano Architecture Office and green space relationship (Selgas & Cano, 2011)

The vivid color preference observed in SelgasCano's works is also reflected in their own design office. Amid the dominant green and brown tones of nature, the building stands out with its white structural frame. In the interior spaces, they mostly employ a contrast between yellow, green, and white. The use of red and orange in the selected furniture further supports the designed colorful environment (Figure 6).

Figure 6 SelgasCano Architecture Office's interiors (Selgas & Cano, 2011; Iwan, n.d.c)

3.2.3. Second Home London Office (2014)

Second Home London Office is a shared workspace that accommodates approximately 30 companies. On the ground floors, there are meeting rooms, lounges, a café-bar, and spaces allocated for social activities such as yoga, pilates, concerts, parties, and film screenings (ArchDaily, 2015). The offices are spread over two floors on each façade of the building. In the offices, small working areas have been created with glass partitions arranged for four to five people (Figure 7). Sound insulation has been meticulously addressed in each office (Dezeen, 2014). For this reason, partition elements and furniture have mostly been made of materials with sound-absorbing properties such as plastic, acrylic, and drywall. The finishes have been completed with materials such as corrugated walls, epoxy paint, Oregon pine, wool carpet, and wood wool. The structural system of the building is composite, consisting of reinforced concrete and various frames (Divisare, n.d.).

SelgasCano stated that their clients wanted a very bright design (Architect Magazine, n.d.). This request was interpreted by SelgasCano mainly as a yellow floor, gray floor, orange furnishings, glass and flooring, white walls, and structural elements. Attention was intended to be drawn through interior furniture that creates similarity with one another.

Figure 7 Second Home London Office's interiors (Iwan, n.d.b)

Figure 8 Second Home London Office: The relationship between the building and the city (Iwan, n.d.b)

The building is located in the city center, in an environment without a direct relationship with nature (Figure 8). This situation led SelgasCano to design its own greenery. With the placement of 800 plants inside the building (Figure 9), it was aimed to create a place where users could be happier, more creative, and more productive (Dezeen, 2017). To heal unhealthy plants, a "plant hospital" was positioned in the courtyard (Dezeen, 2014).

After the design was completed, SelgasCano added a terrace to the roof of the building. The terrace features organically shaped seating areas and water pools filled with aquatic plants. In this design, it can be observed that a reflection of an element from nature was added to the building (Figure 10).

Figure 9 Green elements in the Second Home London Office interior (Dezeen, 2017; Iwan, n.d.b)

Figure 10 Second Home London Office terrace (Dezeen, 2017)

Second Home London Office was the subject of an article in The Guardian titled "Second Home review: a good day at the Office" (Moore, 2014). In the article, the environment that the building offers to its employees was presented as a successful spatial arrangement. By incorporating nature themes, it not only provides users with a calming and productivity-enhancing environment but also, with the spaces dedicated to social activities offered by the building, enables employees to use it not only for work but also for social interaction. With these qualities, the building is regarded as "a bold and admirable experiment in how creative arrangements in the spatial organization of small innovative businesses can influence commercial outcomes" (The Architectural Review, 2014).

3.2.4. Second Home Hollywood Office (2019)

Having previously worked with Second Home in London and Lisbon, SelgasCano transformed a former Hollywood parking lot into a campus hosting 250 companies (Dezeen, 2019c), consisting of 60 single-story oval units (Dezeen, 2019b) (Figure 11). The project was established on the site of the old Anne Banning Community House, completed in the 1960s and renovated for the project, as well as a former parking lot (Dezeen, 2019a). The existing building contains shared facilities such as offices, a café, a bar, a restaurant, spaces for events and conferences, lounges, and open terraces (ArchDaily, 2019). Circulation between the units takes place through landscaped winding pathways. The terraces defined in these outdoor areas encourage companies to socialize and employees to interact (Dezeen, 2019a). In addition to the offices within the campus, it also hosts cultural events. Local charities and neighborhood groups are able to use the campus's meeting rooms free of charge (Dezeen, 2019b). Second Home, in collaboration with the Natural History Museums of Los Angeles County (NHMLAC), has opened the campus to public use (Dezeen, 2019c).

Supporting their statement that "Our most creative work comes not so much from conflicting human geometries, but from natural forms and organic shapes" (Dezeen, 2019a), SelgasCano arranged the 60 units in the Second Home Hollywood Office with transparent curved walls to provide visual access to the outdoors. Among the units, they created an urban area with 6,500 plants and trees. The selected green elements consist of plants that require low amounts of water

(Dezeen, 2019a). In the design of the Second Home Hollywood Office, the rich sensory stimuli of nature are emphasized with trees, plants, and grasses moving with the breeze. The office space aims to establish a strong connection with natural processes and seasonal changes, offering users an environmentally harmonious experience (Figure 12).

Figure 11 Second Home Hollywood Office (Iwan, n.d.a)

Figure 12 Second Home Hollywood Office and green usage (Iwan, n.d.a)

Figure 13 Second Home Hollywood Office's interiors (Iwan, n.d.a)

The building's glass ceilings and windows create changing densities of light and shadow over time with daylight coming from multiple angles, while the diffuse lighting used on the walls and ceilings imitate the natural environment. Large windows, open-plan offices, and transparent partitions enhance the spaciousness of the space by providing uninterrupted sightlines. Verandas and tree canopies offer shelters that reinforce feelings of protection and rest. Since the pedestrian paths inside the office are designed in zigzag shapes surrounded by trees and plants, they add a sense of mystery and discovery to the space (Mutlu Avinç, 2024). Regarding the colors used in the building, an intensive use of yellow can be observed on the roof and the floor (Figure 13). In the interior furniture, dark red and orange textiles on desks and chairs stand out (Dezeen, 2019a). There are opinions that SelgasCano's design of Second Home Hollywood is an experiment on how the average office worker interacts with natural elements (ArchDaily, 2019).

4. Discussion of SelgasCano's User-Centered Approach

In this study, SelgasCano's works are examined through selected examples. Table 1 serves as an analytical framework that compares how the context, biophilia, material, and color shape user experience across the selected projects. These four themes, derived from the literature review, form the analytical framework used to evaluate the selected architectural projects. Each theme

represents a distinct dimension of user experience, addressing the relationship between spatial perception, emotional engagement, and environmental interaction. The discussion that follows interprets how the four conceptual themes presented in Table 1 are reflected in the selected projects and contribute to the understanding of user experience.

Table 1 Interpretation of SelgasCano's Structures in Terms of User Experience

Building		Context	Biophilia	Material and Color	User Experience
Silicon House (2006)		Creating contrast with the context to ensure that the structure is distinguished from the surroundings.	Building in an area where nature is central. Transforming the natural environment within the context into an object of spectacle.	Separation from the environment through the use of materials and colors. Emphasis on structure.	The user experiences the overwhelming contrast the architect has created between the natural and the artificial.
SelgasCano Architecture Office (2007)		Placement in context.	Completing nature by adding humans to it. Transforming nature into an object of spectacle.	Emphasis on connection through extensive use of glass. Representation of artificiality through smooth and colorful surfaces.	Benefit from the relaxing and productivity-boosting effects of working in nature. Feeling like a part of nature.
Second Home London Office (2014)		Creating contrast with the context to ensure that the structure is distinguished from the surroundings.	Creating a reflection of nature by adding a natural element to an interior space, independent of its context. Imitation of nature.	The use of dominant colors detaches from its context. The representation of artificiality through smooth and colorful surfaces.	Aiming to create a living space for employees. Increasing social interaction.
Second Home Hollywood Office (2019)		Creating context for the building.	Creating a reflection of nature by selectively adding a natural element independent of its context but according to its qualities that will adapt to the region.	The emphasis on context created by the extensive use of glass. The representation of artificiality through smooth and colorful surfaces.	Aiming to create a living space for employees. Increasing social interaction. Benefiting from the relaxing and productivity-boosting effects of working in nature.

In Silicon House (2006), it is observed that SelgasCano intervened in the natural void where the building is situated with colors that contradict nature and attempted to cover this intervention by using wood flooring, a material belonging to nature, on the ground. Seasonal transitions can be traced through the fallen leaves on this flooring, a man-made surface, via the wide transparent surfaces. It can be said that the architects created irony at this point. When the user observes the outside, rather than the natural environment itself, they watch the remains of nature within an artificial setting. The painting of the building's structural system in the interior can be read as an emphasis that the environment in which one is situated is man-made. Since epoxy coatings and plastic furniture offer the user a smooth experience that does not actually exist in nature, they can be seen as reinforcing the contrast between the natural and the artificial.

Looking at the design of SelgasCano Architecture Office (2007), it can be said that SelgasCano was an employer aware of the relationship between the connection to nature and work efficiency.

Here, users are provided with direct, immersive experiences of natural elements, reinforcing both well-being and productivity within the workspace. The building's very minimal intervention to the environment allows a pure observation of the natural setting. The completely transparent façade and the partially transparent roof eliminate the separation between inside and outside. Through these openings, the entire timeline of nature can easily be observed. The use of color, on the other hand, can be seen as a choice that adds dynamism to this simple design and revitalizes the employees. Through their selection of materials and colors, the architects create a contrast with nature, reminding users that the building is an interface between the natural and the artificial, and that the surrounding environment is man-made.

Second Home London Office (2014) can be seen as a design that aims to create a living space for employees, thereby enhancing their sense of belonging to the place. Given its central urban location, the building's connection to nature is expressed primarily through representational or imitative elements rather than direct interaction with natural surroundings. Many plants have been placed inside the building as elements of display in a context to which they do not belong, and an artificial pond has been created on the roof. Thus, nature has been reduced to an ornamental object. The use of color within the building creates a dynamic appearance in the space, ensuring that the building stands out. The orange tube located at the entrance caused the building to easily separate from its context. If this orange glass tube, symbolizing artificiality, and the incorporation of green elements into the building's interior using materials are interpreted as stemming from a longing for nature, then it can be discussed as a contradiction.

The inclusion of diverse uses and the presence of terraces open to employees in Second Home Hollywood Office (2019), similar to the building designed by SelgasCano for Second Home in London, can be considered as a practice aimed at increasing employees' connection to the place and thereby enhancing work efficiency. The fact that these areas are also open to the public is regarded as significant in ensuring that the intended user experiences in the space are not limited only to employees. Although the green environment created in the complex is organized with elements introduced by human intervention and not originally present there, the decision to use context-specific plants in the open spaces can be seen as one that has managed to partially reduce the sense of artificiality. However, the pastel colors and use of plastic in the space are thought to create a contradiction with nature, reminding users like other works that they are situated in a man-made environment.

As understood from the analysis, in SelgasCano's designs, context is used as a tool to create contrast with the ground so that the building attracts attention, utilized as an element that enriches the design by making use of its existing conditions, or alternatively, the building is placed within a new context created by the architects themselves. These different uses hinder making a definitive interpretation regarding SelgasCano's approach to context. However, in each case, the relationship established between context–building–user draws attention to the sociological dimension of context. The variability in the architects' interpretation of context also leaves debatable whether the building is a place that is inhabited and enables the development of spatial experiences, or whether it is a place that provides space for behaviors that target consumption. In the use of biophilia, SelgasCano refers to the three themes indicated by Norberg-Schulz: the human desire to visualize their "understanding" of nature, the aspiration to construct a work in areas where nature is "centralized" or points to a place, and the act of embedding the human into nature and symbolizing it. In each type of use, they emphasize the experience of nature and the cognitive relationship between nature and humans. They seek answers to the questions: How can nature be incorporated into design? How do people experience elements belonging to nature?

SelgasCano, on the other hand, employs material and color as tools that provide sensory stimulation for users and create impressions of the space. In this context, striking colors, surfaces with a smoothness not found in nature, and large transparent openings are indispensable elements in their works, serving to increase both the visibility of the building and the perception of its surroundings.

In summary, the comparative analysis demonstrates that SelgasCano's architectural works consistently prioritize user experience through an integration of contextual sensitivity, biophilic elements, material expression, and color dynamics. Each of these themes contributes to creating environments that are not only visually engaging but also emotionally and cognitively stimulating for users.

5. Conclusion

This study explores how user experience is interpreted in the architectural works of SelgasCano, focusing on the conceptual themes of context, biophilia, material, and color. Using a qualitative case study approach, four selected projects were analyzed to reveal how these design elements shape spatial perception and emotional engagement. The findings demonstrate that SelgasCano integrates sensory and experiential dimensions as core aspects of architectural design, offering a distinctive user-centered approach. Thus, the study has achieved its objective by revealing that user experience lies at the core of SelgasCano's architectural design process and by presenting an original approach to the experiential dimension of architecture.

From SelgasCano's style, it can be said that through the use of elements such as context, biophilia, material, and color, they aim to create touches that enrich people's daily lives, make them feel better, and ensure that they enjoy using the building. It is observed that SelgasCano's user-experience-oriented design approach makes significant contributions to enhancing spatial quality and strengthening human–space interaction within the discipline of architecture. However, user experience is a subject too deep, complex, and multi-component to be limited to these headings. The examination and development of design approaches centered on user experience are critically important for producing innovative and human-centered solutions in architectural practice. Understanding SelgasCano's interpretation may contribute to deepening a design approach that strengthens the emotional and physical bonds users establish with buildings.

This study contributes to treating user experience as a conceptual tool in architectural design. It provides significant practical insights into how an approach centered on user experience can be developed within the architectural design process. First, findings derived from SelgasCano's projects demonstrate that design decisions can be shaped not only at the formal or functional level but also through the ways users perceive, feel, and appropriate the space. This approach allows for a reconsideration of the criteria for experience-based design in architectural practice. The study also exemplifies how four conceptual themes can be employed as tools to enrich user experience. However, the scope of the study is limited to a specific architectural office. Since the review relies on qualitative evaluation, no direct user data on experiences (surveys, observations, interviews, etc.) were collected. The findings are based on the analysis of existing visual and textual documents; therefore, the results are interpretive in nature. Moreover, the selected themes (context, biophilia, materiality, color) represent specific dimensions of user experience. Other physical and social qualities of space could open different points of assessment in future studies. Comparative analyses involving different architects or offices could provide new depth to user experience–oriented architectural research. Future studies could also support user experiences in spaces with empirical methods such as surveys, observations, or interviews.

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CRediT Authorship Contribution Statement

Sena Işıklar Bengi: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Data curation, Conceptualization, Data visualization.

Declaration of Competing Interest

The author declare that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Ethics Committee Approval

Ethics committee permission is not required.

Resume

Dr. Sena Işıklar Bengi is a dedicated academic in the field of architecture a focus on user-centered design, urban design, post-occupancy evaluation and architectural education. She is currently working at Adana Alparslan Türkeş Science and Technology University, where she contributes to architectural education and research. With over ten years of teaching experience, she has been involved in a wide range of courses and scholarly projects. Her research explores the relationship between space and human behavior, aiming to enhance spatial quality through evidence-based design.

JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (526-537), 2025
DOI: 10.47818/DRArch.2025.vv6i3181

Analytical comparison of physical and virtual LEGO modules in architectural design education

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Abstract

The educational potential of games has increasingly attracted attention within architectural pedagogy, fostering investigations into game-based learning approaches. Among these, LEGO has gained prominence in both physical and digital formats, offering unique yet complementary contributions to design education. Physical LEGO sets strengthen students' manual dexterity, three-dimensional reasoning, and confidence by engaging them in tangible construction processes. Virtual LEGO platforms, in contrast, advance technological literacy, spatial visualization, and digital exploration, thereby preparing students for the demands of contemporary design environments. This study examines the role of both physical and virtual LEGO modules in architectural and interior design education through a comparative analysis. Student groups from different levels were tasked with reconstructing a pre-designed architectural plan using both formats. Upon completion, participants completed a structured questionnaire designed to evaluate their learning experiences, perceived challenges, and skill development. Data were analyzed using SPSS to identify statistical relationships between the two approaches. Findings revealed significant correlations between the modules, indicating their complementary nature in fostering spatial literacy and design skills. Physical LEGO modules were particularly effective in promoting hands-on engagement, efficiency, and confidence, while virtual modules enhanced creativity in digital environments and cultivated a sense of achievement. The comparison demonstrates that rather than competing, physical and digital formats enrich architectural pedagogy by addressing different dimensions of the design process. By situating LEGO within the broader discourse of game-based learning in architecture, this study underscores the importance of integrating traditional tactile methods with emerging digital tools. Such integration not only bridges the gap between physical and virtual realms but also provides a rational perspective on contemporary educational challenges in an increasingly digitized world. Ultimately, the results highlight the potential of LEGO to serve as a versatile pedagogical medium that cultivates both foundational design skills and adaptability to future technological contexts.

Keywords: architectural education, design education, educational materials, game-based education, LEGO

1. Introduction

Game-based learning is an innovative instructional approach designed to make the learning process more engaging and enjoyable for students (Gee, 2003). This method facilitates students' understanding and application of knowledge by incorporating active participation and problem-solving. In contemporary education, games have become central within frameworks where traditional learning environments intersect with digital-based education. Spatial literacy, defined as the ability to visualize and reason about spatial objects and their relationships, is a fundamental skill in architectural education (Strand & Nielsen, 2024). LEGO modules, both physical and virtual, serve as effective tools to foster these skills, bridging the gap between traditional and digital learning approaches.

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Article history: Received 06 November, Revised 01 December 2025, Accepted 09 December 2025, Published 24 December 2025

Previous research highlights the importance of direct architectural experiences in shaping students' problem-solving and conceptualization abilities (Ashrafganjouei & Nadimi, 2024). Games play a critical role in this process by actively engaging students and encouraging them to participate meaningfully in their own learning. Active learning emphasizes experiential engagement, where students learn by doing and apply their knowledge in practical contexts (Petty, 2014). Through gameplay, students develop skills such as rule-following, problem-solving, and collaborative thinking, resulting in deeper and more lasting learning outcomes (Squire, 2005). The evolution of LEGO itself from a purely physical construction toy to a sophisticated transmedia and digital ecosystem underscores its unique position as a pedagogical tool that can adapt to both tactile and digital learning paradigms. This dual nature of LEGO as a "materially digital medium" allows it to serve as a consistent variable for comparative studies in educational settings (Taylor & Ingraham, 2020).

Additionally, game-based learning captures students' attention, enhances motivation, and promotes sustained engagement (Prensky, 2007). This approach has been shown to be particularly effective for learners with diverse educational backgrounds, providing enriched learning experiences across various domains (Torun & Tatar, 2023). Studies have also emphasized the growing interest of the "digital generation" in using games as a learning medium, contrasting with traditional methods that may lack stimulation and decrease classroom motivation (Prensky, 2006; Squire & Jenkins, 2003). Furthermore, digital games have proven to be powerful tools for fostering engagement and motivation in the learning process (Machado et al., 2018). Educators widely recognize their potential to enhance both students' enthusiasm and learning outcomes (Huizenga et al., 2017). The transformative impact of digitalization on traditional industries, including toys, illustrates how digital tools can extend and enrich core competencies rather than replace them, a lesson exemplified by LEGO's strategic shift to smart specialization and digital-physical integration (Gürçaylılar Yenidoğan & Gül, 2021).

Game-based learning in architecture, the primary focus of this research, has been utilized to impart knowledge and skills in engineering and design, among various academic outcomes. This learning method aims to equip architecture students with skills related to real-world problems while providing an enjoyable and motivating activity. Consequently, it not only teaches students how structures are built and function but also fosters abilities in engineering and design (de Freitas et al., 2011). For instance, a game resembling "Minecraft" could demonstrate building and functioning structures, while a game similar to "SimCity" could impart knowledge and skills in city design and management. Furthermore, the advantage of game-based learning in the architectural context lies in the physical context, allowing students the opportunity to physically construct buildings and experience how components come together. This facilitates a more enduring impact on students' memories, aiding in a better understanding of the taught material. Innovative pedagogical approaches, such as Design Thinking integrated with physical tools like LEGO® Serious Play®, have demonstrated significant potential in unlocking student creativity, facilitating idea generation, and enhancing collaborative problem-solving in architectural education, particularly in contexts transitioning towards more interactive learning models (Holubchak, 2020).

Game materials that enrich gaming environments have been deemed as crucial as the games themselves by experts. These materials assist students in initiating and enhancing social interactions. Additionally, through these gaming tools, students interact with each other (Jalongo & Isenberg, 2013). Therefore, it is evident that the consideration of games and gaming materials, particularly in architecture education where social interaction is prominent, is essential.

Approaching the subject from a generational perspective, Carstens and Beck (2005) termed today's generation, who have grown up with digital computer games, as the "game generation." Traits such as competitiveness, the pursuit of alternatives, and ideals of heroism in this generation are a consequence of growing up with games. Traditional learning materials like books and notebooks are perceived as dull and ineffective for this generation. In this sense, comparing digital and physical games in relevant contexts becomes crucial for obtaining scientific data. This

generational shift aligns with observations in broader media studies, where adult engagement with LEGO transcends simple play, evolving into complex communities of practice that explore identity, craftsmanship, and materiality through both physical and digital extensions of the medium (Taylor & Ingraham, 2020).

This study undertakes research in the context of game-based learning in architecture, motivated by the aforementioned definitions and approaches, using both the physical and virtual modules of LEGO. A group of architecture and interior architecture students were tasked with creating models using LEGO's physical and virtual modules based on given plan schematics. Subsequently, their evaluations regarding the study were collected through a questionnaire. The study employed a diverse group of 55 students from various classes who had received architectural modeling and technical drawing education and some of whom had experience with digital games. The choice of LEGO as a comparative tool is further justified by its inherent computational logic; the modular, grid-based nature of LEGO systems, especially evident in advanced lines like LEGO® Technic, provides a tangible and virtual grammar for spatial reasoning and structural problem-solving that is highly relevant to architectural education (Xu et al., 2019).

The aim was to conduct a comparative analysis to uncover how the distinct affordances of physical and virtual LEGO modules differentially contribute to skill development and learning experience in architectural education. In this context, the following research questions and hypotheses were established to guide the comparative investigation:

- **Research Question 1:** How do physical LEGO modules affect architecture students' three-dimensional thinking skills?
- **Hypothesis 1:** Physical LEGO modules will yield significantly higher ratings in hands-on engagement, task efficiency, and tactile confidence compared to the virtual module.
- **Research Question 2:** How do virtual LEGO modules influence students' technological skills and spatial construction abilities?
- **Hypothesis 2:** Virtual LEGO modules will yield significantly higher ratings in digital tool fluency, perceived precision, and a sense of achievement compared to the physical module.

The study's findings are discussed in light of these research questions and hypotheses to provide insights into the complementary interplay of physical and digital tools in architectural education.

1.1. Methodological Approach and Tool Selection

To address these research questions and test the proposed hypotheses, a comparative experimental study was designed, employing LEGO modules in both physical and virtual formats as the primary pedagogical tool. LEGO is among the most recognized construction toys globally and is noted for its open-ended nature, which can transform into diverse shapes with each use, significantly contributing to students' development while providing entertainment (Güneş & Tuğrul, 2020; Kazez & Zülfü, 2016; Tuğrul, 2010). Its established integration into architectural education (Coşkun, 2019; Doma & Şener, 2022; Legény & Teixeira, 2019; Mohamed, 2017) and its parallel evolution into a "digital tool" with virtual modules make it an ideal and coherent comparative material. This coherence stems from LEGO's nature as a "materially digital medium," offering a consistent modular grammar across physical and digital platforms, which is ideal for comparative educational research (Taylor & Ingraham, 2020). This allows for a direct investigation into the physical and virtual dimensions of game-based learning in architecture, focusing on their complementary roles without the confounding variable of differing core mechanics. The choice of LEGO is further justified by its documented role in fostering innovation and specialization strategies, demonstrating its adaptability as a pedagogical tool aligned with contemporary digital transformation trends (Gürçaylılar Yenidoğan & Gül, 2021). The following sections detail the experimental procedure, participants, data collection instruments, and analysis methods used to implement this comparative approach.

2. Theoretical Background

This study situates itself within two converging research trajectories: the integration of game-based learning in architectural education and the pedagogical use of LEGO as a versatile spatial medium. Research on game-based learning has established foundational design frameworks, such as the model proposed by Shi and Shih (2015), which outlines eleven critical factors -including objectives, mechanics, and challenge- that structure effective educational games. Meta-analyses, like that of Toraman et al. (2018), consolidate empirical evidence, confirming the approach's positive impact on academic achievement while noting important contextual variations across studies. In architectural education specifically, this has evolved into tangible explorations of gamification strategies to structure the design process (Torun & Tatar, 2023) and the adoption of digital sandbox platforms like Minecraft, which share LEGO's modular logic, to create dynamic, student-centered learning environments (Coşkun, 2019). A parallel and significant trend involves the adoption of immersive technologies, such as Virtual Reality (VR), which are leveraged for complex spatial and historical education (Varinlioğlu, 2020) and for architectural design exercises utilizing virtual LEGO pieces, offering unique affordances like scalable user perspective (Doma & Şener, 2022). These pedagogical and technological developments are not isolated; they mirror the broader industrial process of digital transformation. This strategic paradigm involves the deliberate integration of digital layers with physical core products to create enhanced, hybrid value—a process clearly demonstrated in the LEGO Group's own innovation history and strategic recovery, which serves as a relevant case study in managing digital-physical synergy (Gürçaylılar Yenidoğan & Gül, 2021).

Concurrently, LEGO itself has been the focus of substantial and multi-faceted scholarly interest as a pedagogical tool. Its efficacy in enhancing spatial reasoning, structural understanding, and creativity in architecture and urban design contexts is well-argued (Legény & Teixeira, 2019) and discussed as a transferable, hands-on methodology for learning development (James, 2013). This application extends beyond simple modeling into sophisticated, facilitated methodologies like LEGO Serious Play, which is shown to unlock implicit knowledge, foster empathy, enhance collaborative ideation, and overcome conceptual blockages in educational settings (Holubchak, 2020). The cultural and material significance of LEGO transcends formal education, as richly evidenced by global adult enthusiast communities (AFOLs) where the tangible materiality of the brick, the precision of its clutch power, and the creative, iterative process of “LEGOfication” -translating concepts into the system's modular grammar- are central to practice, identity, and community building (Taylor & Ingraham, 2020). Furthermore, the technical and cognitive dimensions underpinning LEGO construction are formally analyzed in computational design research, which develops automated systems and algorithms to solve the complex combinatorial, geometric, and structural problems inherent in advanced LEGO models, thereby highlighting and formalizing the sophisticated spatial and logical reasoning its use can entail (Xu et al., 2019). Ongoing research also continues to explore hybrid physical-digital interfaces, such as Augmented Reality (AR) systems designed to guide and enhance the accuracy of physical LEGO assembly (Yan, 2019).

Thus, the literature presents two robust, interconnected strands: one concerning the theory and application of game-based and digitally-augmented pedagogical strategies in architecture, and another deeply examining LEGO as a consistent, multi-modal tool for spatial learning and creative expression. These strands are conceptually woven together by the overarching strategic principle of “smart specialization”—the focused enhancement of a core competency (in this context, spatial thinking and design logic through modular systems) with carefully selected and complementary digital capabilities, rather than through unrelated diversification (Gürçaylılar Yenidoğan & Gül, 2021). However, a direct, comparative empirical investigation of the physical and virtual instantiations of the same modular medium –LEGO- within a controlled, pedagogical setting remains an underexplored area. This study aims to address this specific gap, contributing

methodical empirical evidence and nuanced analysis to this integrated and evolving discourse on hybrid learning tools.

3. Experimental Study

This section details the implementation of the comparative methodology outlined in Section 1.1. It describes the participant profile, the specific materials and digital tools used, the experimental task, and the procedures for data collection and analysis.

3.1. Participants

The study comprised a diverse group of 55 students from different classes in the architecture and interior design departments of a single university. The participant demographics are summarized in Table 1. The group consisted of 40% architecture and 60% interior architecture students. Among these students, 27.3% were from the 1st year, 20% from the 2nd year, 25.5% from the 3rd year, 12.7% from the 4th year, and 14.5% were postgraduate students. All participants had prior education in architectural modeling and technical drawing, with some having additional experience with digital games.

Table 1 Participants' Demographic Characteristics

Variable	Group	n	%
Department	Architecture	22	40.0%
	İnt. Architecture	33	60.0%
Degree	D1	15	27.3%
	D2	11	20.0%
	D3	14	25.5%
	D4	8	14.5%
	MA	7	12.7%
	Total	**55**	**100**

3.2. Materials and Digital Tool

Physical LEGO Application: For the tangible construction task, a LEGO® Classic Medium Creative Brick Box (set number 10696) was used. This set provides an open-ended assortment of 484 pieces, including a variety of bricks in different shapes, sizes, and colors, suitable for architectural modeling without prescribing a specific outcome.

Virtual LEGO Application: The digital modeling task was performed using LEGO Digital Designer (LDD) software (version 4.3.11). LDD is an official, freeware computer-aided design (CAD) tool developed by the LEGO Group, allowing users to build models using a virtual library of LEGO pieces (Wikipedia, 2023). The software, accessible through the official LEGO service pages (LEGO, n.d.), features an intuitive graphical user interface. This interface enables users to select from a comprehensive digital inventory of bricks, manipulate them in a three-dimensional virtual workspace (through rotation, connection, and color change tools), and construct complex models without the physical limitations of piece availability. This tool was selected for its direct conceptual analogy to physical LEGO construction and its status as a recognized platform for digital brick-based design.

3.3. Task and Procedure

The experimental procedure followed a structured sequence:

- **Task Introduction:** All participants were provided with an identical architectural floor plan consisting of three interconnected volumes.
- **Physical Modeling Phase:** Participants were first asked to create a physical model accurately representing the given floor plan using the provided LEGO Classic bricks. The time taken to complete this model was recorded individually.

- **Virtual Modeling Phase:** Subsequently, participants were instructed to recreate the same floor plan digitally using the LEGO Digital Designer (LDD) software on a computer. Completion time for the virtual model was also recorded.
- **Survey Administration:** Upon completing both tasks, all participants filled out a structured questionnaire. The survey contained demographic questions, two Likert-type scales (5-point, from 1=Strongly Disagree to 5=Strongly Agree) designed to evaluate their learning experiences, perceived challenges, and skill development in each environment, and direct comparative questions about enjoyment, educational value, and perceived success.

Figure 1 presents the provided floor plan alongside representative samples of the resulting physical and virtual models.

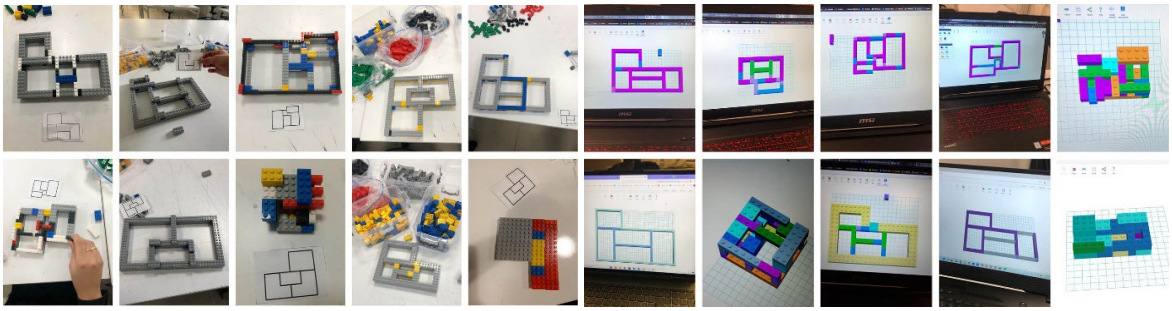

Figure 1 Sample images from the physical and virtual environment applications

3.4. Data Collection and Analysis

The structured questionnaire comprised three main sections: **(1)** Demographic information and prior experience with games; **(2)** Two identical 5-point Likert scales (1=Strongly Disagree, 5=Strongly Agree) assessing perceived skill development, engagement, and challenge for the physical and virtual modules separately. Scale items were designed around the constructs of manual dexterity, spatial reasoning, digital creativity, and self-efficacy; **(3)** Direct comparative questions forcing a choice between the two modules on enjoyment, educational value, and perceived success.

The Cronbach's Alpha reliability coefficient for the survey scales was calculated as 0.756, indicating acceptable internal consistency. All collected data were analyzed using SPSS 26 software.

The analyses employed both descriptive and inferential statistics:

- **Descriptive statistics** (arithmetic mean, median, standard deviation) were used to summarize participant responses and completion times.
- **The normality of distribution** was assessed using skewness and kurtosis values (accepted range: -1.5 to +1.5) (Tabachnick & Fidell, 2013).
- **An Independent Samples** T-Test was used to compare means between two independent groups (where applicable).
- **A one-way Analysis of Variance (ANOVA)** was conducted to detect significant differences among group means based on demographic variables (e.g., year of study).
- **Pearson Correlation Analysis** was employed to measure the strength and direction of linear relationships between continuous variables (e.g., computer skill level and virtual application success).

The analyses were conducted to answer the following key questions:

- How successful were the participants in each application based on their departments and classes?

- Did previous experience with physical/virtual games or computer skills influence their success?
- Were there significant correlations among participant responses?
- Which application did students find more enjoyable and educational?

3.5. Findings

Table 2 presents the sample size (N), minimum-maximum attitude scores (Min-Max), arithmetic mean (Mean), median (Median), standard deviation (SD), and skewness-kurtosis values for the research scale.

Table 2 Descriptive Data Regarding Participants' Responses and Completion Times

	N	Min	Max	Mean	Median	ss	Skewness	Kurtosis
Total values	55	2.56	10.00	6.7778	7.1111	1.71441	**-.595**	**.039**
Averages of completion times	55	1.50	25	7.5636	6.0000	4.90753	**.847**	**-.062**

The 'normality' distributions of the data from the normality test in Table 2 were examined, and Skewness/Kurtosis values were provided. According to the findings, the Skewness values are -.595 and .847, while the Kurtosis values are .039 and -.062, respectively. According to Tabachnick and Fidell, if these values fall within the range of -1.5 to +1.5, it can be assumed that the data follow a normal distribution (Tabachnick & Fidell, 2013).

Table 3 The Findings of the ANOVA Test Conducted to Detect Significant Differences Among the Survey Data

		Sum of s.	df	Mean Sq.	F	Sig. (p)
Time to complete physical app	Between Groups	270.566	4	67.641	1.815	.141
	Within Groups	1863.362	50	37.267		
	Total	2133.927	54			
Frequency of playing board games	Between Groups	46.135	4	11.534	1.388	.252
	Within Groups	415.611	50	8.312		
	Total	461.745	54			
How fun was the physical board app?	Between Groups	43.841	4	10.960	1.362	.260
	Within Groups	402.269	50	8.045		
	Total	446.109	54			
Self-assessment in terms of success in the board app	Between Groups	36.533	4	9.133	1.560	.200
	Within Groups	292.813	50	5.856		
	Total	329.345	54			
How educationally effective is the board app?	Between Groups	22.316	4	5.579	1.284	.289
	Within Groups	217.211	50	4.344		
	Total	239.527	54			
Time to complete virtual app	Between Groups	66.133	4	16.533	.703	.593
	Within Groups	1175.213	50	23.504		
	Total	1241.345	54			
Self-assessment of computer skill	Between Groups	39.276	4	9.819	1.960	.115
	Within Groups	250.470	50	5.009		
	Total	289.745	54			
Frequency of playing computer games	Between Groups	71.411	4	17.853	1.596	.190
	Within Groups	559.425	50	11.189		
	Total	630.836	54			
How fun was the virtual app?	Between Groups	79.877	4	19.969	3.659	.011
	Within Groups	272.851	50	5.457		
	Total	352.727	54			
Self-assessment of virtual application success	Between Groups	44.157	4	11.039	1.969	.114
	Within Groups	280.279	50	5.606		
	Total	324.436	54			
Self-assessment in terms of success in the virtual app	Between Groups	66.286	4	16.572	4.412	.004
	Within Groups	187.823	50	3.756		
	Total	254.109	54			

For the significance to be observed in the ANOVA test, the significance value should be p < .001. According to the data in Table 3, no significant differences were observed in terms of departmental values (p). Therefore, the analysis couldn't proceed to the "Post Hoc" tests to decipher the source of the differences.

To examine the correlation between the data, the research continued with the "Pearson Correlation Analysis." Since the compared values possessed an equal measurement level and also met the condition of a normal distribution, which indicates a "parametric" nature, the Pearson correlation coefficient was considered in this analysis. The findings obtained are presented in Table 4.

Table 4 To Determine the Significant Relationship Based on Correlation Between the Data, Findings of Pearson Correlation Analysis

		Department	Degree	Frequency of playing board games	How fun was the physical board app?	Self-assessment in terms of success in the board app	Time to complete physical app	How educationally effective is the board app?	Time to complete virtual app	Self-assessment of computer skill	Frequency of playing computer games	How fun was the virtual app?	Self-assessment in terms of success in the virtual app	How educationally effective is the virtual app?
Department	P.Cor.	1	-0.126	0.023	0.029	-0.158	-0.201	0.064	-0.050	-0.126	-0.173	-0.103	-0.113	-0.021
	Sig. (2 t.)		0.358	0.867	0.835	0.250	0.140	0.642	0.717	0.359	0.206	0.456	0.411	0.881
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
Degree	P. Cor.	-0.126	1	-0.198	-0.103	-0.019	-0.072	-0.192	0.022	0.086	0.110	-0.208	-0.069	-0.258
	Sig. (2 t.)	0.358		0.147	0.455	0.888	0.599	0.161	0.871	0.532	0.423	0.128	0.617	0.057
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
Frequency of playing board games	P. Cor.	0.023	-0.198	1	.311*	0.197	-0.126	0.157	-0.024	.323*	.287*	0.129	.330*	0.096
	Sig. (2 t.)	0.867	0.147		0.021	0.149	0.358	0.252	0.863	0.016	0.033	0.347	0.014	0.486
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
How fun was the physical board app?	P. Cor.	0.029	-0.103	.311*	1	.488**	0.131	.542**	0.016	.447**	.378**	.561**	.609**	.442**
	Sig. (2 t.)	0.835	0.455	0.021		0.000	0.341	0.000	0.907	0.001	0.004	0.000	0.000	0.001
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
Self-assessment in terms of success in the board app	P. Cor.	-0.158	-0.019	0.197	.488**	1	-0.037	.363**	-0.151	.408**	0.119	.381**	.617**	.362**
	Sig. (2 t.)	0.250	0.888	0.149	0.000		0.787	0.006	0.270	0.002	0.386	0.004	0.000	0.007
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
Time to complete physical app	P. Cor.	-0.201	-0.072	-0.126	0.131	-0.037	1	0.140	.561**	0.072	0.085	0.000	-0.043	0.123
	Sig. (2 t.)	0.140	0.599	0.358	0.341	0.787		0.307	0.000	0.603	0.539	0.998	0.757	0.373
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
How educationally effective is the board app?	P. Cor.	0.064	-0.192	0.157	.542**	.363**	0.140	1	0.144	0.204	0.251	.338*	.368**	.680**
	Sig. (2 t.)	0.642	0.161	0.252	0.000	0.006	0.307		0.294	0.135	0.065	0.012	0.006	0.000
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
Time to complete virtual app	P. Cor.	-0.050	0.022	-0.024	0.016	-0.151	.561**	0.144	1	0.172	0.160	0.088	0.003	0.112
	Sig. (2 t.)	0.717	0.871	0.863	0.907	0.270	0.000	0.294		0.210	0.242	0.523	0.981	0.415
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
Self-assessment of computer skill	P. Cor.	-0.126	0.086	.323*	.447**	.408**	0.072	0.204	0.172	1	.470**	.419**	.542**	.292*
	Sig. (2 t.)	0.359	0.532	0.016	0.001	0.002	0.603	0.135	0.210		0.000	0.001	0.000	0.031
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
Frequency of playing computer games	P. Cor.	-0.173	0.110	.287*	.378**	0.119	0.085	0.251	0.160	.470**	1	.325*	.314*	0.234
	Sig. (2 t.)	0.206	0.423	0.033	0.004	0.386	0.539	0.065	0.242	0.000		0.016	0.019	0.086
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
How fun was the virtual app?	P. Cor.	-0.103	-0.208	0.129	.561**	.381**	0.000	.338*	0.088	.419**	.325*	1	.627**	.553**
	Sig. (2 t.)	0.456	0.128	0.347	0.000	0.004	0.998	0.012	0.523	0.001	0.016		0.000	0.000
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
Self-assessment in terms of success in the virtual app	P. Cor.	-0.113	-0.069	.330*	.609**	.617**	-0.043	.368**	0.003	.542**	.314*	.627**	1	.325*
	Sig. (2 t.)	0.411	0.617	0.014	0.000	0.000	0.757	0.006	0.981	0.000	0.019	0.000		0.016
	N	55	55	55	55	55	55	55	55	55	55	55	55	55
How educationally effective is the virtual app?	P. Cor.	-0.021	-0.258	0.096	.442**	.362**	0.123	.680**	0.112	.292*	0.234	.553**	.325*	1
	Sig. (2 t.)	0.881	0.057	0.486	0.001	0.007	0.373	0.000	0.415	0.031	0.086	0.000	0.016	
	N	55	55	55	55	55	55	55	55	55	55	55	55	55

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The values marked with "*" in the Pearson Correlation row in Table 4 indicate significance at the .01 level, while values marked with "**" indicate significance at the 0.05 level. For all values below 0.05, a significant relationship can be considered. As this value drops below 0.05, it is inferred that the relationship between parameters increases (Cohen, 1988).

When interpreted according to this table, firstly, it was observed that neither the departments nor the classes had any statistically significant relationship with any other values. In other words, there was no impact of differences in completion times of applications, success levels, self-assessment in terms of entertainment and educational aspects based on classes and departments.

It was observed that those who play physical games also enjoyed the physical LEGO application (.311) and found themselves successful in the virtual LEGO application (.330). Moreover, this group was observed to also engage in playing virtual games (.287).

For those who play computer games, it was observed that they found enjoyment in both the virtual LEGO application (.325) and the physical LEGO application (.378). It was also determined that this group possessed high computer skills (.470). Hence, based on the results, a significant relationship can be deduced between students who play computer games and their computer-based skill levels. Furthermore, a correlation of 0.680 was found between those who found the virtual LEGO application educational and those who found the physical LEGO application educational.

A significant relationship was found only between completion times of the physical LEGO application and completion times of the virtual LEGO application (.561). Thus, no correlation was found between computer skills, entertainment, educational aspects, and the completion times of LEGO applications.

There was a significant correlation between students' computer skill levels and all other parameters related to the virtual application. This group also exhibited significant relationships with parameters related to the tabletop application. Hence, it can be stated that the participants' interest and skills in computers not only affect the values related to the virtual application but also influence other parameters related to the tabletop application in the same direction.

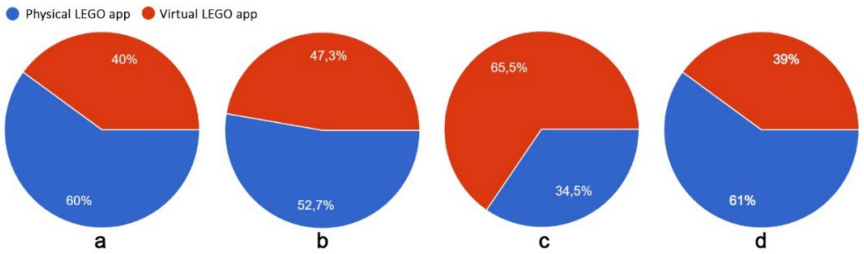

Figure 2 "The percentages of participant responses to questions '(a) Which application did you find more enjoyable?', '(b) Which application do you think is more beneficial in terms of education?' and '(c) In which application do you think you were more successful?' and '(d) mean percentages of completion times for the application'."

Participants were asked which application they found more educational or enjoyable and in which application they felt more successful. As depicted in Figure 2, 60% of the participants (Figure 2.a) found the physical LEGO application 'more enjoyable,' while 52.7% (Figure 2.b) evaluated the physical LEGO application as 'more beneficial' from a pedagogical perspective. In terms of skill-based comparison, 65.5% of students (Figure 2.c) mentioned that they were 'more successful' in the virtual LEGO application. In the comparison based on completion times (Figure 2.d), it is observed that 61% of participants completed the physical LEGO application 'later' compared to the virtual one.

4. Results and Discussion

This study employed a comparative framework to evaluate the distinct and complementary contributions of physical and virtual LEGO modules to spatial skill development in architectural education. The analysis of performance data and participant perceptions reveals a nuanced interplay between medium affordances, student profiles, and learning outcomes.

A foundational result was the lack of significant correlation between a student's academic year or department and their performance or perception in either medium. This suggests that the core spatial reasoning and modular logic engaged by LEGO are fundamental cognitive skills transcending standard curricular progression. The dominant influencing factors were instead individual digital affinity and prior experiential familiarity with games, reinforcing the profile of the contemporary "digital native" learner (Prensky, 2006; Carstens & Beck, 2005). This finding reflects a broader

cultural shift where engagement with modular, creative systems is often driven by personal interest and medium-specific literacy rather than formal training, a phenomenon well-documented in adult fan communities (Taylor & Ingraham, 2020).

Notably, computer proficiency correlated positively with enhanced enjoyment and perceived efficiency in both the physical and virtual tasks. This challenges a simplistic analogue-digital divide, indicating the development of a transferable spatial-digital intelligence. Students adept with digital tools appeared better equipped to parse the structural logic and spatial planning required in the physical assembly. This synergy exemplifies the core principle of effective digital transformation, where digital literacy acts not as a replacement for tangible skill but as a cognitive enhancer that deepens engagement with fundamental concepts (Gürçaylılar Yenidoğan & Gül, 2021).

The direct comparison between media yielded a clear, complementary pattern of strengths. Participants found the physical LEGO application more enjoyable (60%) and faster to complete (61%). Its tangible nature provided irreplaceable haptic feedback and an immediate, error-prone engagement with gravity, scale, and structure—key components of "direct architectural experience" (Ashrafganjouei & Nadimi, 2024). This aligns with its validated use in participatory, embodied methodologies like LEGO Serious Play, where the physical act of building is central to unlocking tacit knowledge, fostering empathy, and prototyping ideas (Holubchak, 2020).

Conversely, the virtual LEGO environment (LDD) generated a stronger sense of success (65.5%) while being rated equally educational. The digital interface likely reduced friction from manual dexterity, offered limitless undo/redo capability, and provided an infinite brick inventory. This allowed students to focus purely on spatial composition and intentionality, scaffolding the learning process. This finding resonates with the design logic of computational LEGO systems, which automate lower-level combinatorial and structural constraints to allow designers to focus on higher-level formal and functional goals (Xu et al., 2019). The virtual module's capacity to boost confidence is a significant pedagogical asset, particularly for students early in their design education.

The statistically equivalent rating for educational value is perhaps the most instructive outcome. It confirms that while the cognitive and experiential pathways differ—the physical being episodic and tactile, the virtual being more semantic and abstractive (Ashrafganjouei & Nadimi, 2024)—both are effective vehicles for cultivating spatial literacy. This duality is inherent to LEGO's identity as a "materially digital medium," where a consistent grammar of modularity and connection operates across physical and virtual realms, making it an ideal tool for comparative pedagogical study (Taylor & Ingraham, 2020).

These results strongly advocate for a strategically integrated, rather than dichotomous, approach in the curriculum. This mirrors the "smart specialization" strategy observed in successful organizational innovation, where new capabilities (digital tools) are woven into the fabric of core competencies (tactile spatial reasoning) to create a more resilient and adaptive whole (Gürçaylılar Yenidoğan & Gül, 2021). Pedagogically, this suggests sequencing or pairing activities: using physical LEGO for foundational concept generation, team-based exercises, and understanding material constraints, followed by virtual LEGO for iteration, precision drawing, and introduction to digital modeling workflows. Future research should explore hybrid interfaces (e.g., Augmented Reality for guided physical assembly) and the integration of simpler computational design principles to further bridge the tactile and digital dimensions of spatial thinking in architectural education.

Limitations and Future Research

The findings of this study should be interpreted considering its limitations, primarily the sample drawn from a single institution, which may affect the generalizability of the results. Future multi-institutional and longitudinal studies could validate and extend these findings. Additionally, while LEGO Digital Designer provided a coherent virtual counterpart, exploring more advanced or immersive digital platforms (e.g., VR-based LEGO modeling) represents a valuable direction for future comparative work.

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CRediT Authorship Contribution Statement

Erdem Köymen: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Data curation, Conceptualization, Data visualization. Mhd Feda Bouidani: Methodology, Investigation, Analysis, Data curation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethics Committee Approval

Document Number: E-20292139-050.04-2400042555 (İstanbul Sabahattin Zaim University).

Resume

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JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (538-563), 2025
DOI: 10.47818/DRArch.2025.v6i3182

Designing sustainable refugee settlements in Türkiye: A prioritized indicator framework and network-based scenario for Kilis

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Abstract

In response to the growing demand for sustainable and resilient refugee settlements, this study proposes a comprehensive framework that integrates prioritized design indicators with network-based spatial planning. Through a comparative evaluation of six international refugee camps and the application of the Analytic Hierarchy Process (AHP) to thirteen key design categories, the research identifies the most critical factors for developing inclusive, adaptive, and environmentally sustainable settlements. A customized network analysis is employed to visualize the systemic relationships between physical features and design priorities across global case studies. The proposed framework is applied to a design scenario for Kilis, a province in Turkey significantly affected by the 2023 Kahramanmaraş earthquake and home to a dense population of Syrian refugees. Informed by local architectural traditions and socio-cultural dynamics, the scenario incorporates modular housing, decentralized sanitation systems, solar energy infrastructure, and participatory planning processes. The resulting network diagram for Kilis demonstrates how priority indicators (such as safety, sustainability, and health) can be spatially embedded within the camp design. This integrative approach offers a replicable model for future refugee settlement planning, aligning humanitarian needs with long-term urban sustainability goals.

Keywords: sustainable refugee settlements, AHP, network analysis, modular housing, post-disaster planning, Kilis, Türkiye

1. Introduction

The global refugee crisis remains one of the most pressing humanitarian challenges of our time. Millions of people have been forced to abandon their homes due to conflicts, persecution, and environmental disasters. This has highlighted the urgent need for sustainable and inclusive living spaces more than ever. In addressing the refugee crisis, both the provision of immediate aid and the prioritization of long-term sustainability goals are essential. In this context, Shultz et. al. (2020) argues for the necessity of strong international cooperation, fair asylum policies, and the development of local solutions to facilitate the integration of refugees. They also emphasize the importance of more effective resource management in refugee assistance. Although various forms of post-disaster housing have been extensively studied in the context of natural catastrophes such as earthquakes and floods, this study adopts a more focused lens namely, the shelter responses to conflict-induced displacement (Kürüm Varolgüneş, 2021c). Unlike natural disasters, which often trigger immediate but time-bound interventions, refugee situations are prolonged, politically complex, and spatially embedded within contested geographies. Thus, they require a distinct analytical framework that goes beyond emergency relief to address long-term human settlement and spatial justice concerns. Strengthening international norms is critical to preventing crises and ensuring refugees can live under safer conditions. The implementation of sustainable innovations in refugee camps is identified as a vital means of balancing environmental impacts with humanitarian aid (Seifert et al., 2023). However, although temporary shelters are initially planned to last only a few years, they often evolve into slums, resulting in long-term adverse effects on urban fabric. This creates a mismatch with sustainable urban planning goals and can hinder long-

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Article history: Received 19 June 2025, Revised 01 October 2025, Accepted 11 December 2025, Published 24 December 2025

term recovery. When refugee camps transition into permanent settlements, urban planners and architects must play a crucial role, as these spaces require sustainable designs that integrate environmental, social, and economic dimensions beyond mere housing. Zetter and Deikun (2010) highlight the importance of urban interventions aimed at supporting the livelihoods of displaced individuals and creating humane spaces for them. While local integration of refugees is a sustainable solution, its success hinges on fostering social acceptance and establishing stable policies (Hovil & Maple, 2022). Additionally, the resilience and long-term stability of refugee communities depend not only on sustainable infrastructure but also on the provision of essential services such as water, sanitation, and hygiene (Yasmin et al., 2023). Al-Husban and Adams (2016) propose that the sustainability of refugee migrations requires viewing refugees not merely as individuals striving to survive but as people who can contribute to society. Creating sustainable living spaces for refugees must go beyond meeting immediate needs; it should include solutions that enhance resilience, promote social integration, and support refugees in achieving long-term stability (Wardeh & Marques, 2021). Holistic approaches play a key role in enabling refugees to become self-sufficient individuals who contribute value to their communities (Ismail, 2022).

1.1. Literature Review on the Refugee Crisis: Challenges, Approaches and Sustainable Solutions

The dimensions and impacts of refugee crises have increasingly been the subject of international debate in recent years. According to the mid-2024 report by the United Nations High Commissioner for Refugees (UNHCR), the number of forcibly displaced persons worldwide has reached 122.6 million. This highlights how factors such as war, persecution, violence, and human rights violations have driven millions to become refugees, asylum seekers, or internally displaced people. UNHCR's 2024 Global Trends Report underscores that this increase stems from both new conflicts and the protracted failure to resolve longstanding crises (UNHCR, 2024). The UNHCR report "Sustainable Development Goals and the Global Compact on Refugees" (UNHCR, 2020) emphasizes the alignment between the Sustainable Development Goals (SDGs) and the Global Compact on Refugees (GCR) in providing sustainable support to both refugees and host communities. It advocates that refugees should be viewed not merely as recipients of humanitarian aid but as part of the broader economic and social sustainability framework. The report further posits that refugees should be seen as actors capable of contributing to social and economic development. The topic has been addressed from various perspectives in literature (UNHCR, 2020). This study reviews specific works focusing on "architectural and spatial approaches," "sustainable and modular approaches," and "historical and sociopolitical perspectives." These studies provide diverse solutions and approaches at both local and international levels, offering a framework for the social, economic, and spatially sustainable support of refugees and displaced communities.

While post-disaster shelter literature often focuses on temporary housing solutions in the aftermath of natural disasters (e.g. earthquakes, floods, hurricanes), the context of refugee settlements arising from conflict-induced displacement presents a distinct set of challenges (Kürüm Varolgüneş, 2021a). These settlements are frequently characterized by political uncertainty, prolonged temporariness, and jurisdictional ambiguity (Kürüm Varolgüneş, 2021b). Unlike disaster recovery efforts that aim to restore pre-existing urban life, refugee camp design must address the creation of new urban forms under resource-scarce and administratively fragmented conditions. This study situates itself within this context, emphasizing the need for spatial solutions that respond to the protracted and hybrid nature of refugee urbanism. An important theme emerging from literature is the paradox of permanence within temporary refugee infrastructures. Although initially designed as short-term shelters, many camps undergo spatial, social, and infrastructural transformations that result in de facto urbanization. This shift from emergency habitat to semi-permanent urban settlement calls for a rethinking of architectural and planning approaches. Chaichian (2024) underscores that design solutions in such contexts must not only respond to basic needs, but also anticipate long-term integration, socio-economic participation, and environmental sustainability. The literature thus supports a move toward holistic and adaptable frameworks in the design of refugee settlements.

Abreek-Zubiedat (2023) examined the settlement processes of the Khan Younis refugee camp during the Cold War within the context of "militarized urbanization." The study analyses how military and political strategies shaped refugee settlements and their impact on social Dynamics. Almeniawi (2023) highlighted the importance of sustainable approaches by exploring the transformation of refugee settlements in northern Syria from temporary shelters into permanent living spaces. Siddiqi et al. (2024) examined Kenya's Dadaab Refugee Camps, situated on the Kenya-Somalia border, not as temporary settlements but as complex sites of historical, aesthetic, and architectural significance. The study challenges traditional perceptions by detailing the camps' long-term social and spatial impacts. The Irbid Refugee Camp and Al Za'atri Refugee Camp in Jordan serve as critical examples for examining the transformation of temporary shelters into permanent structures. Abu-Aridah and Ligler (2024) highlighted the importance of elements such as the use of local materials and community collaboration in the transformation processes of the Irbid Camp. Chaichian (2024) investigated the Al Za'atri Camp's evolution from a temporary shelter into an urban settlement, detailing the social, economic, and spatial implications of this transformation. Studies on refugee camps in Greece underscore the significance of participatory methods in designing shelter and living spaces. Jaradat and Beunders (2023) demonstrated that involving refugee communities in the design process fosters social cohesion and enhances the quality of living spaces. Wierzbicka et al. (2024) focused on the development of sustainable modular housing projects for individuals displaced by war. Their study highlights the potential of such structures to serve as both emergency shelters and long-term living spaces. Modular settlement projects offer flexible and scalable solutions based on principles of environmental sustainability and social cohesion. For instance, modular and energy-efficient housing solutions provide safe and cost-effective options (UNDP, 2021). In addition to contemporary refugee settlements, historical population movements also provide critical insights into the relationship between displacement, architecture, and identity. Akcan (2024) examined the 1923 population exchange between Türkiye and Greece within the context of architectural and national identity dynamics. The study discusses the role of population engineering and settlement policies in shaping national identities through architectural interventions.

Based on the reviewed literature, a set of multidimensional indicators was developed to evaluate refugee settlements in terms of spatial, environmental, and social sustainability. These indicators were derived from key themes repeatedly emphasized across prior studies—such as modularity, resilience, social inclusion, and efficient use of resources (Wierzbicka et al., 2024; Jaradat & Beunders, 2023; Almeniawi, 2023). Accordingly, the subsequent section (2.1) details the process through which these literature-based themes were operationalized into evaluation indicators used in the field analysis.

1.2. Syrian Refugees in Kilis and Türkiye: Sustainable Living Spaces and Social Integration

Türkiye plays a critical role in addressing the global humanitarian crisis by hosting a significant refugee population, with 2.933.205 individuals as of 31 December 2024 (UNHCR, 2024). The country faces multifaceted challenges, including providing shelter, integration, and well-being. The number of Syrian refugees in Türkiye and their distribution across provinces are presented in Figure 1 and Figure 2.

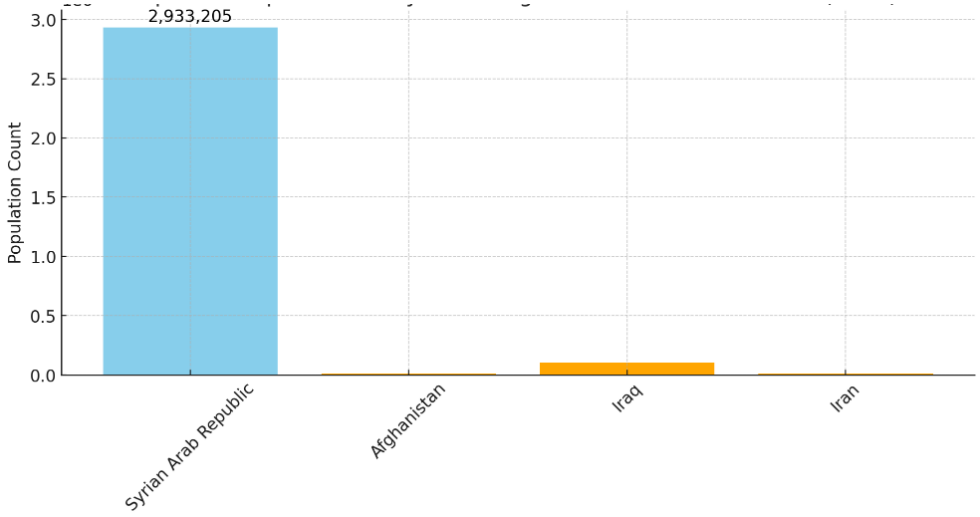

Figure 1 The number of Syrian refugees in Türkiye by the end of 2024 (UNHCR,2024)

Figure 2 Distribution of Syrian refugees by city in Türkiye (DGMM, 2024)

However, the fact that a large proportion of refugees live outside urban areas or in overcrowded settlements exacerbates these challenges (Tunç, 2015). In this context, sustainable solutions that support place attachment and social cohesion among refugees have become a critical necessity. Place attachment is defined as the sense of belonging and emotional connection individuals feel toward a specific place (Scannell & Gifford, 2010). For refugees, this concept is directly linked to feelings of safety, the formation of social networks, and processes of social integration (Altman & Low, 2012). In Türkiye, this dynamic is particularly evident in regions close to the Syrian border, such as Gaziantep, Hatay, Şanlıurfa, and Kilis. These areas, with their dense refugee populations, embody critical dynamics in terms of social cohesion, economic sharing, and cultural interaction (Haliloğlu Kahraman, 2022; Imrie-Kuzu & Özerdem, 2023; Şahin Mencütek et al., 2023). This study proposes a "sustainable living space" scenario for refugees residing in Kilis, particularly those affected by the 2023 Maraş earthquake. Figure 3 presents a timeline summarizing Türkiye's policies and practices concerning Syrian refugees between 2011 and 2022. Each period is associated with key regulations and practices addressing the refugee crisis. This timeline is not merely descriptive but analytical it highlights how shifts in Türkiye's refugee policy frameworks have progressively shaped the spatial, architectural, and social strategies that underpin the sustainable living space scenario proposed in this study.

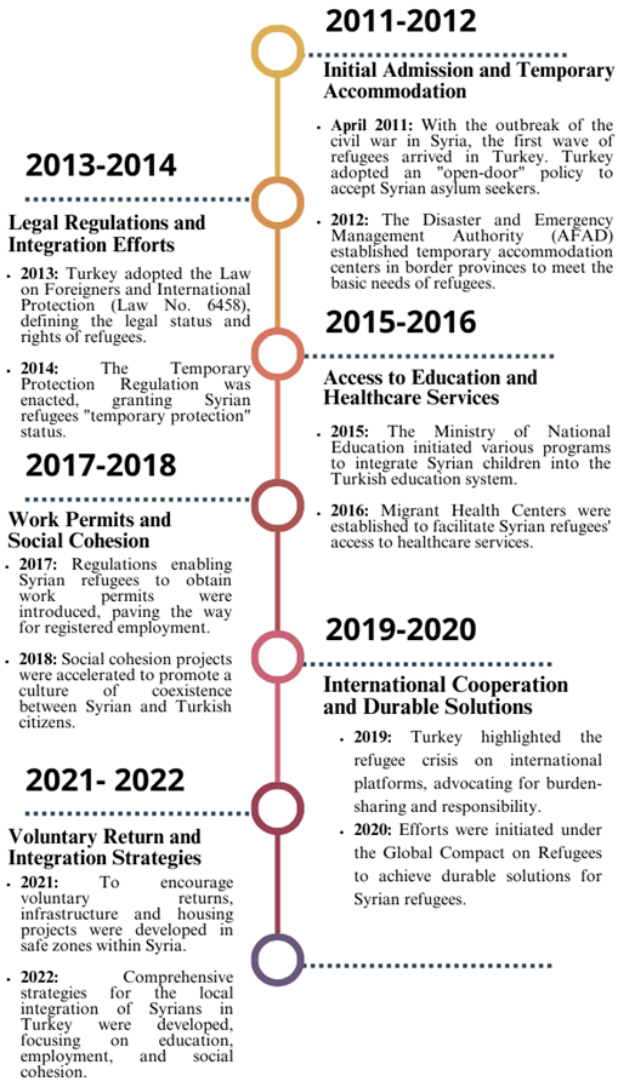

Figure 3 Timeline of efforts to address the issues faced by Syrian refugees (Aktaş, 2018; Eren, 2022)

In this context, the development of strategies to strengthen social cohesion and support environmental sustainability has become increasingly crucial, particularly in border regions like Kilis, where the refugee population has significantly impacted local demographics. Kilis, a key province along Türkiye's border with Syria, has experienced substantial demographic changes due to the influx of refugees. The refugee population in this region is noted to be very high relative to the local population, creating challenges in areas such as healthcare, the environment, and social integration (Achiri & Ibrahim, 2022). Additionally, the influx of refugees has led to environmental issues. The high concentration of refugees in Kilis has been reported to have adverse effects on waste management and environmental pollution (Aksoy & Tumen, 2021; Liszkowska, 2023). In this regard, it is evident that comprehensive strategic planning is required to improve healthcare services and enhance environmental sustainability in Kilis. Developing sustainable solutions to address the needs of both the local population and refugees is of critical importance for integration and environmental management. The 2023 Kahramanmaraş Earthquake adversely affected the living conditions of many people in the region, including Syrian refugees, and exposed the vulnerabilities in housing infrastructure (AFAD, 2023). This situation has once again underscored the importance of sustainable living spaces that adhere to modern urban planning principles, encourage community participation, and enhance local resilience (Asgary, 2018). The design of sustainable living spaces plays a vital role in strengthening refugees' place attachment and promoting social cohesion. Such spaces should not only meet the basic need for shelter but also provide environments where

refugees can engage in meaningful interactions with host communities (Mulvey, 2018). Projects involving community participation can support social solidarity and integration (Strang & Ager, 2010). In this context, a study aimed at enhancing the place attachment and well-being of Syrian refugees in Kilis could offer valuable theoretical and practical contributions. Furthermore, such an approach could directly support the United Nations' Sustainable Development Goal (SDG) 11, which focuses on making cities and human settlements inclusive, safe, resilient, and sustainable (UN, 2015).

2. Methodology

In this study, the qualitative dimension was derived from expert consultations and desk-based synthesis of best practices in refugee settlement design, while the quantitative dimension was based on Analytic Hierarchy Process (AHP) scoring. This integration ensured interpretive insight and analytical rigor without relying on direct personal data collection. The methodology consists of four integrated stages: indicator development, weighting and prioritization, case selection, and data collection and analysis. The framework combines qualitative insight with quantitative rigor, ensuring both theoretical depth and practical applicability.

2.1. Development and Prioritization of Evaluation Indicators

Building upon the theoretical and thematic foundations discussed in the literature review (Section 1.1), the development of evaluation indicators in this study was guided by recurring concepts identified across previous research on refugee settlements, post-disaster housing, and sustainable urbanism. Drawing on a systematic literature review and expert consultation, thirteen key design indicators were identified to assess the physical, environmental, and social dimensions of refugee settlements and post-disaster living environments. Specifically, physical indicators such as Accessibility, Shelter Flexibility, and Modularity reflect the spatial and architectural adaptability of settlements; environmental indicators including Resource Efficiency and Sustainability address ecological performance and resilience to environmental stress; while social indicators (Community Involvement, Cultural Sensitivity, Mental Wellbeing, Livelihood and Resilience, Social Spaces, Safety and Security, Health and Sanitation, and Monitoring and Feedback) capture the human-centered and participatory dimensions of settlement life. Although this study primarily focuses on conflict-induced displacement, these indicators were also informed by post-disaster recovery frameworks (Citaristi, 2022), which emphasize placemaking, community participation, and long-term resilience in reconstruction contexts. Hence, the proposed model aligns both with humanitarian shelter design principles and with the broader discourse on sustainable settlement development after disasters (Table 1).

Table 1 Statistical Comparison of Recognition Intensity

Category	Best Practices	References
Safety and Security (C1)	Ensure physical protection, adequate lighting, and community safety measures.	*(Aburamadan, 2023), (AlWaer et al., 2023), (Karsu et al., 2019), (Ernst et al., 2004)*
Cultural Sensitivity (C2)	Incorporate cultural and social practices offer culturally relevant services.	*(Wardeh & Marques, 2021), (Shohel, 2022), (Gladkikh et al., 2019)*
Accessibility and Inclusivity (C3)	Provide universal access, gender-specific facilities, and equitable services.	*(Wardeh & Marques, 2021), (Almeniawi, 2023), (Siddiqi et al., 2024)*
Efficient Use of Resources (C4)	Use local materials and efficient water management strategies.	*(Matthey-Junod et al., 2022), (Akcan, 2024)*
Sustainability (C5)	Utilize renewable energy and manage waste sustainably.	*(Matthey-Junod et al., 2022), (Abreek-Zubiedat, 2023)*
Modularity and Scalability (C6)	Develop modular systems adaptable to changing needs.	*(AlWaer et al., 2023), (Jaradat & Beunders, 2023)*
Community Involvement (C7)	Engage local communities and refugees in participatory design processes.	*(Ernst et al., 2004), (Karl & Scholz Karl, 2022)*

Health and Sanitation (C8)	Implement adequate water, sanitation, and hygiene (WASH) facilities.	*(Yasmin et al., 2023), (Karl & Scholz Karl, 2022; Karsu et al., 2019)*
Social and Community Spaces (C9)	Provide spaces that foster social interaction and community building.	*(Matthey-Junod et al., 2022), (Shohel, 2022)*
Livelihood and Resilience (C10)	Empower refugees through livelihood programs and resilience-building strategies.	*(Ernst et al., 2004), (Abu-Aridah & Ligler, 2024)*
Flexibility in Shelter Design (C11)	Ensure shelters are adaptable and meet varying environmental conditions.	*(Beeman et al., 2023), (Chaichian, 2024), (Antonsson, 2010)*
Mental Health and Wellbeing (C12)	Address psychological needs with spaces and services for mental well-being.	*(Beeman et al., 2023), (Gladkikh et al., 2019)*
Monitoring and Feedback (C13)	Integrate monitoring tools to gather feedback and improve design.	*(Matthey-Junod et al., 2022)*

2.2. Analytic Hierarchy Process (AHP)

A total of 13 domain experts (comprising professionals in architecture, urban planning, disaster management, and data analysis) were consulted to construct the pairwise comparison matrices used in AHP scoring (Kürüm Varolgüneş et al., 2023). These consultations were based on structured templates distributed via email and previously published evaluation criteria, thus avoiding any need for ethical review processes. Consistency ratios were verified (CR < 0.1) to ensure reliable prioritization and mitigate subjectivity in the weighting process. The resulting values informed subsequent visual and analytical modelling stages.

The Analytic Hierarchy Process (AHP) was adopted in this study as a multi-criteria decision-making tool due to its capacity to evaluate both objective (quantifiable) and subjective (intangible) criteria through a hierarchical structure (Abdel-Basset et al., 2018; Svahnberg et al., 2003), as well as its ability to conduct consistency analysis (Razavi et al., 2011). Its advantages include ease of application in both individual and group settings, rapid data processing (Deng, 1999), adaptability to various stages of the design process, and its flexible, scalable structure. Rather than prescribing a single correct solution, AHP supports decision-makers in identifying the most suitable alternative aligned with their goals and understanding of the problem (Petkov et al., 2007; Xi & Qin, 2013). Through pairwise comparison matrices informed by experiential knowledge, AHP calculates the relative priorities of alternatives, tests consistency, and produces overall performance scores—particularly useful for assessing building lifecycle performance (Han et al., 2023).

The Analytic Hierarchy Process (AHP) was employed to determine the relative priority of the thirteen design indicators identified through the literature review and expert input. Pairwise comparisons were conducted using expert judgments, and the resulting weights were normalized to derive a composite priority vector. To maintain clarity, only the key methodological steps and summary results are presented in this section, while detailed calculation matrices, consistency ratio (CR) tests, and intermediate weight derivations are provided in Appendix A. The AHP results informed the comparative framework used in subsequent analyses, ensuring that the prioritization of design indicators reflected both theoretical consistency and expert consensus.

2.3. A Case Selection

Six refugee settlements were selected as comparative case studies, representing diverse geographic and sociopolitical contexts: Zaatari (Jordan), Kalobeyei and Dadaab (Kenya), Bidi Bidi (Uganda), Cox's Bazar (Bangladesh), and Kahramanmaraş (Türkiye). The selection of these cases followed a set of analytical criteria derived from the literature review and the study's sustainability framework. Specifically, the camps were chosen based on:

- Design innovation: Showcasing unique architectural or spatial strategies that address environmental or social challenges,

- Relevance to sustainability goals: Integration of ecological efficiency, resilience, and community participation,
- Quality and availability of documentation: Access to verified data, plans, and research materials,
- Comparative applicability to the Turkish context: Allowing cross-reference between global practices and national post-disaster settlement strategies,
- Diversity in governance and management models: Including both internationally managed and nationally coordinated refugee settlements,

These criteria ensured that the selected cases collectively represent a comprehensive range of spatial typologies, climatic conditions, and governance approaches, thereby enabling the proposed framework to be evaluated against a broad spectrum of design strategies, operational systems, and contextual realities.

2.4. Network Analysis and Visualization

To examine the multidimensional relationships between physical features of refugee camps and the established design indicators, a network analysis was conducted using NetworkX and Matplotlib in Python. For each settlement, a relationship diagram was generated in which the thickness of connections represents the aggregated importance scores derived from expert-based assessments. This visual approach enabled the identification of design elements with high strategic impacts such as the linkage between modular shelters and resilience, or between solar energy systems and environmental sustainability. In the network visualizations presented in this study, the "Fruchterman-Reingold force-directed layout algorithm" was employed using the NetworkX and Matplotlib libraries in Python. This layout configuration was chosen for its ability to spatially distribute nodes in a manner that reflects the relative strength of their connections, thereby preserving the relational topology of the design indicators and camp features. While alternative layout methods such as "PCA (Principal Component Analysis)" or "Correspondence Analysis (CA)" could offer advantages in reducing dimensionality or emphasizing latent clusters, the force-directed layout was considered more suitable for capturing and visualizing interdependencies between spatial and social indicators. "Future studies may integrate PCA/CA layouts to complement the current visual analysis and enhance pattern recognition". By applying principles of graph theory, this method not only maps the relative centrality of each component within the system but also reveals patterns of co-dependency, enabling more informed spatial and infrastructural planning. In doing so, it transforms abstract design priorities into actionable configurations and supports evidence-based decision-making in settlement design.

2.5. Local Application: Kilis Design Scenario

Based on the results of the indicator framework and comparative case analysis, a localized design scenario was formulated for Kilis, a Turkish province significantly affected by the 2023 Kahramanmaraş earthquake and noted for its high refugee-to-host population ratio. The scenario development process involved the adaptation of the framework's components to socio-cultural and environmental conditions specific to Kilis. Field-based observations and informal consultations with NGO representatives and local coordinators were incorporated throughout the design process to ensure contextual relevance and responsiveness. Rather than formal user participation, which was not conducted due to ethical and procedural constraints, the study drew upon secondary reports, field documentation, and professional insights from organizations operating within the camps. These sources provided context-specific understanding of residents' needs, enabling iterative refinements in the proposed spatial organization and programmatic distribution. As such, the design reflects on-the-ground conditions and aligns with humanitarian practice, while adhering to ethical research boundaries. The resulting scenario provides a testable prototype for the practical implementation of the developed framework in a post-disaster and refugee-dense urban context.

The overall methodological process and the sequential steps followed in developing the sustainable design scenario are illustrated in Figure 4.

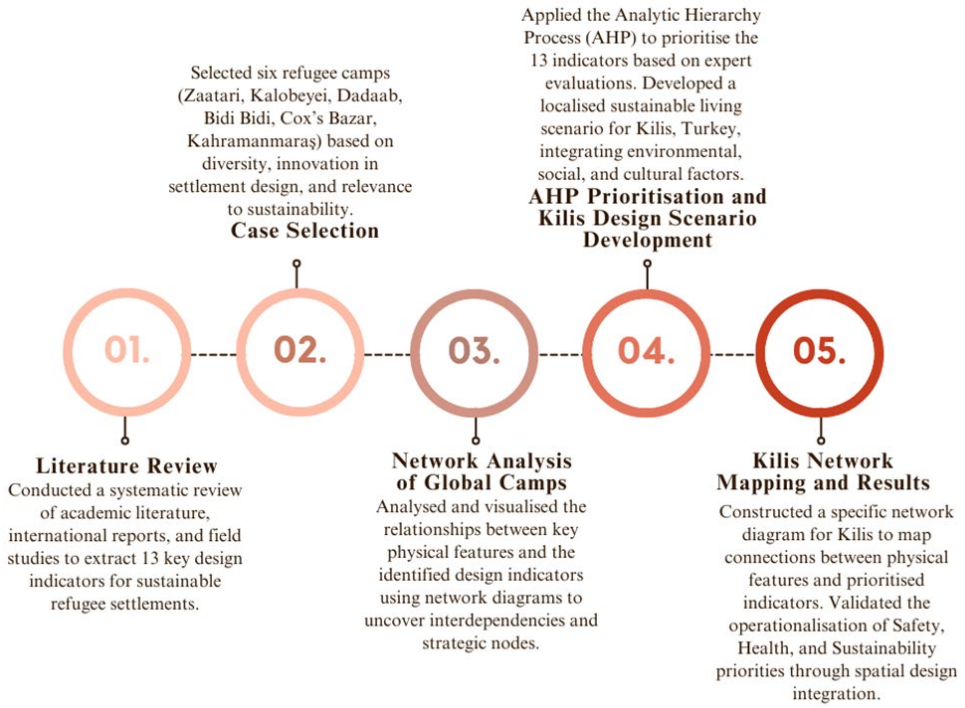

Figure 4 Process flowchart for developing a sustainable design scenario for refugee sites in Kilis, Türkiye

3. Results and Findings

3.1. Comparative Evaluation of Global Refugee Settlements

The comparative evaluation of global refugee settlements provides a foundation for understanding how diverse physical, environmental, and social design approaches shape living conditions in humanitarian contexts. Six refugee settlements (Zaatari (Jordan), Kalobeyei and Dadaab (Kenya), Bidi Bidi (Uganda), Cox's Bazar (Bangladesh), and Kahramanmaraş (Türkiye)) were selected based on their design innovation, relevance to sustainability, and contextual applicability. These case studies illuminate the best practices and critical challenges in establishing resilient and inclusive living environments. Zaatari Refugee Camp in Jordan exemplifies the evolution of humanitarian settlements from emergency responses to semi-permanent urban forms. Noted for its modular layout and market-oriented spaces, including the community-driven "Champs-Élysées" market, Zaatari promotes economic participation while integrating renewable energy and waste management systems (Carleen & Ying, 2015; Saidan et al., 2017). Despite these advancements, the camp faces structural overcrowding, limited long-term planning, and underdeveloped mental health services, which hinder sustainable integration (Pasha, 2021; Tomaszewski et al., 2016). Kalobeyei Settlement in Kenya represents an innovative model for socio-economic integration. Designed with a sustainability lens, the settlement incorporates renewable energy systems, water conservation, and shared infrastructure between refugee and host populations. Agricultural activities and small-scale trade support refugee self-reliance and community cohesion (Betts et al., 2020; Yarza Pérez, 2017). Kalobeyei's participatory and ecologically responsive planning exemplifies how refugee settlements can be positioned as long-term development projects (Fellesson & Mählck, 2024). Dadaab Refugee Camp, also in Kenya, is one of the world's largest and most long-standing refugee settlements. While it ensures access to education, health, and basic services through international humanitarian aid, it struggles with security risks and overdependence on external support (Chkam, 2016; De la Chaux & Haugh, 2020). Nevertheless, Dadaab serves as a case of resilience, highlighting the challenges of protracted displacement in unstable geopolitical

environments. In Uganda, Bidi Bidi Refugee Settlement showcases a culturally sensitive and environmentally adaptive design. Emphasis is placed on social cohesion through clustered village layouts, communal spaces, and the use of low-cost construction materials (Logie et al., 2021). Agricultural programs support food security and livelihoods, while social services such as health centers and child-friendly spaces contribute to well-being (Ssentongo et al., 2024). However, the settlement grapples with resource scarcity and gender-based vulnerabilities, reflecting the need for more inclusive and protective spatial strategies (Berke & Larsen, 2022). Cox's Bazar in Bangladesh (home to a vast Rohingya refugee population) is a densely populated and disaster-prone settlement. Its terraced shelters, bamboo-based design, and sanitation systems reflect context-sensitive approaches to environmental constraints (Islam et al., 2022). Nevertheless, the camp remains vulnerable to cyclones and flooding, with challenges in water access and social integration. The tension between refugees and host communities, driven by limited economic opportunities, underscores the complexity of implementing sustainable coexistence (Banerjee, 2024; Hoque et al., 2023; Khan, 2024). Kahramanmaraş Refugee Camp in Türkiye was established to house Syrian refugees displaced by conflict and natural disasters. Its design prioritized modular housing, social service accessibility, and GIS-informed spatial planning (Çetinkaya et al., 2016). Although the camp provides infrastructure that improves living standards, integration with the host community remains limited, and the vulnerability to seismic hazards has revealed gaps in emergency preparedness (Çavuş & Şahinöz, 2024; Kahraman, 2024).

Together, these case studies demonstrate a spectrum of strategies and outcomes in refugee settlement design. From market-based integration (Zaatari) to ecological self-reliance (Kalobeyei) and participatory planning (Bidi Bidi), each settlement reflects the tension between humanitarian urgency and long-term sustainability. The comparative analysis provides critical insights into how physical infrastructure, community involvement, and environmental responsiveness can be harnessed to improve refugee well-being and resilience.

3.2. Indicator-Based Relationship Mapping Through Network Analysis

To explore how physical and social components of refugee settlements relate to the core design indicators developed in this study, network analysis was employed for each of the six selected cases. These visualizations offered a layered understanding of how specific built elements—such as modular housing, renewable energy systems, or social space interact with broader conceptual goals like sustainability, flexibility, and community participation. Using NetworkX and Matplotlib in Python, relationship diagrams were generated in which nodes represent either a design category or a camp-specific physical feature, while the edges reflect the strength of the connections derived from expert-weighted evaluations. The diagram presented in Figure 5 analyses the Zaatari Refugee Camp (Jordan) and illustrates how modular shelters, solar energy systems, and market areas link to key design categories. The visual mapping shows strong connections between modular shelters and categories such as flexibility in shelter design (C11), health and sanitation (C8), and safety and security (C1), indicating that structural configurations can significantly influence both physical and psychosocial outcomes. Solar energy appears centrally connected to sustainability (C5), resource efficiency (C4), and community involvement (C7), highlighting its multifaceted impact. The market zones are similarly tied to economic resilience, community interaction, and cultural sensitivity, demonstrating that economic infrastructure plays a pivotal role in both integration and social cohesion (Abreek-Zubiedat, 2023; Ernst et al., 2004; Matthey-Junod et al., 2022).

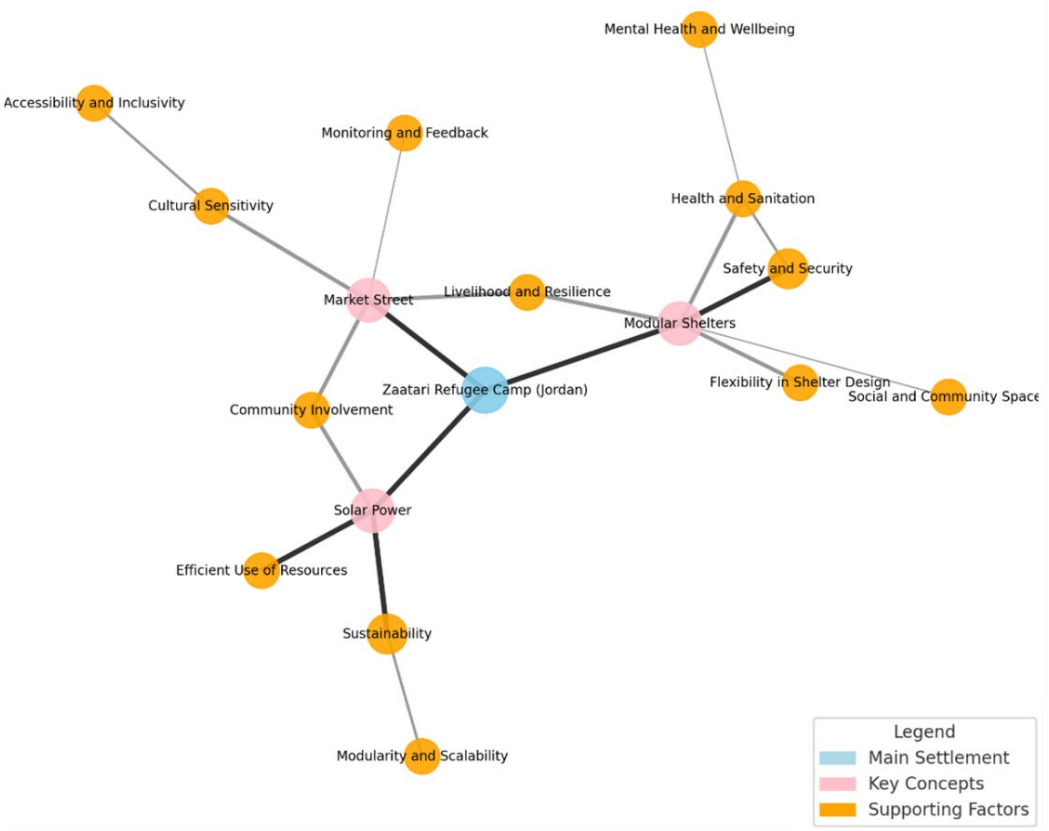

Figure 5 Relationship diagram of key design categories and features for Zaatari refugee camp

Figure 6 depicts the Kalobeyei Settlement (Kenya), where renewable energy, community integration, and permaculture practices form the core of the spatial and social strategy. The analysis shows that renewable energy systems are strongly linked to sustainability (C5), resource efficiency (C4), and community participation (C7). Community integration demonstrates ties to social spaces (C9), health (C8), and cultural sensitivity (C2), reinforcing Kalobeyei's commitment to participatory development. Permaculture links sustainability with food security, thus aligning environmental and social design goals (Yarza Pérez, 2017; Betts et al., 2020).

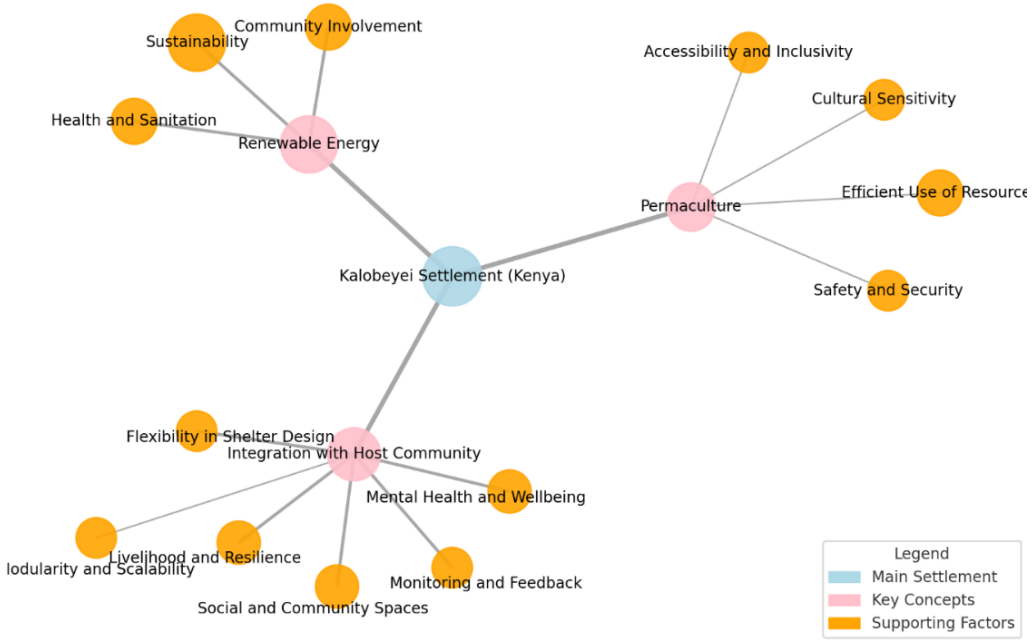

Figure 6 Relationship diagram of key design categories and features for Kalobeyei settlement area

Figure 7 focuses on Dadaab Refugee Camp (Kenya), a long-standing settlement with a strong emphasis on infrastructure provision. Key features such as water management, education, and healthcare services are central to its design. Water infrastructure connects to health and sanitation (C8), sustainability (C5), and resource efficiency (C4), while education facilities link to social spaces (C9), community participation (C7), and cultural sensitivity (C2). Healthcare access maps onto accessibility and inclusivity (C3) as well as safety (C1), showing that basic infrastructure, even when developed top-down, can have multi-dimensional social impacts (Chkam, 2016; De la Chaux & Haugh, 2020).

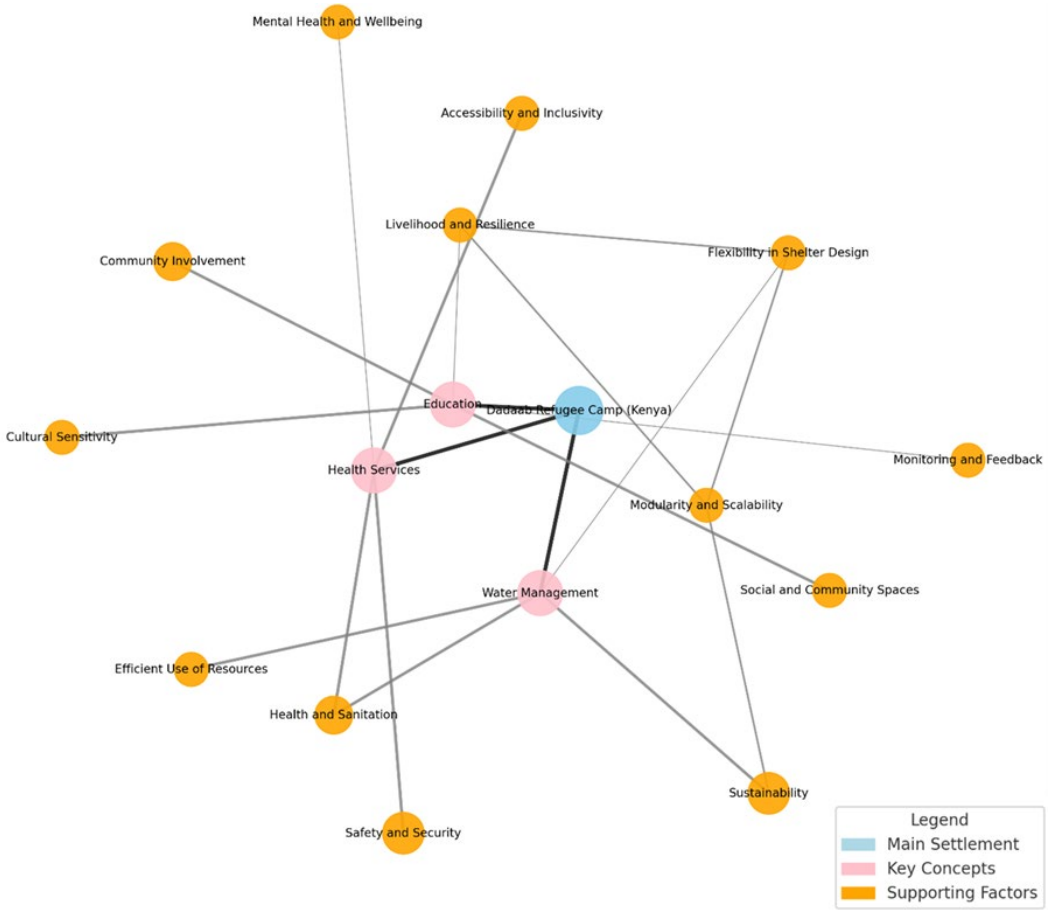

Figure 7

Relationship diagram of key design categories and features for Dadaab refugee camp

Figure 8 presents the network diagram for the Bidi Bidi Refugee Settlement (Uganda), which prioritizes clustered village structures, low-cost construction, and agricultural activities. These features are closely tied to sustainability (C5), modularity and scalability (C6), and economic resilience (C10). Agricultural areas also connect to health (C8) and food security, while community participation (C7) and cultural sensitivity (C2) are strongly present, indicating a design strategy rooted in local engagement and ecological adaptation (Logie et al., 2021; Berke & Larsen, 2022).

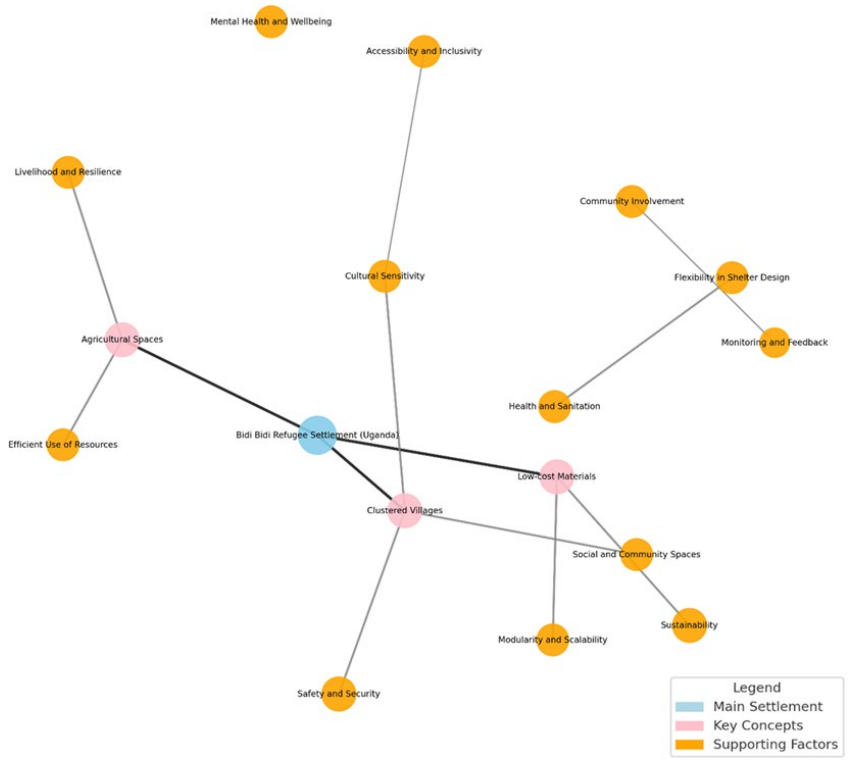

Figure 8 Relationship diagram of key design categories and features for Bidi Bidi refugee camp

Figure 9 illustrates the Cox's Bazar Camp (Bangladesh), where terraced shelters, bamboo-based construction, and sanitation systems dominate. Bamboo material is linked to sustainability (C5), resource efficiency (C4), and cultural sensitivity (C2), reflecting an environmentally attuned, culturally appropriate design strategy. Sanitation infrastructure shows strong ties to health (C8), community interaction (C9), and modularity (C6), illustrating how physical systems can support broader public health and governance goals (Islam et al., 2022; Hoque et al., 2023; Banerjee, 2024).

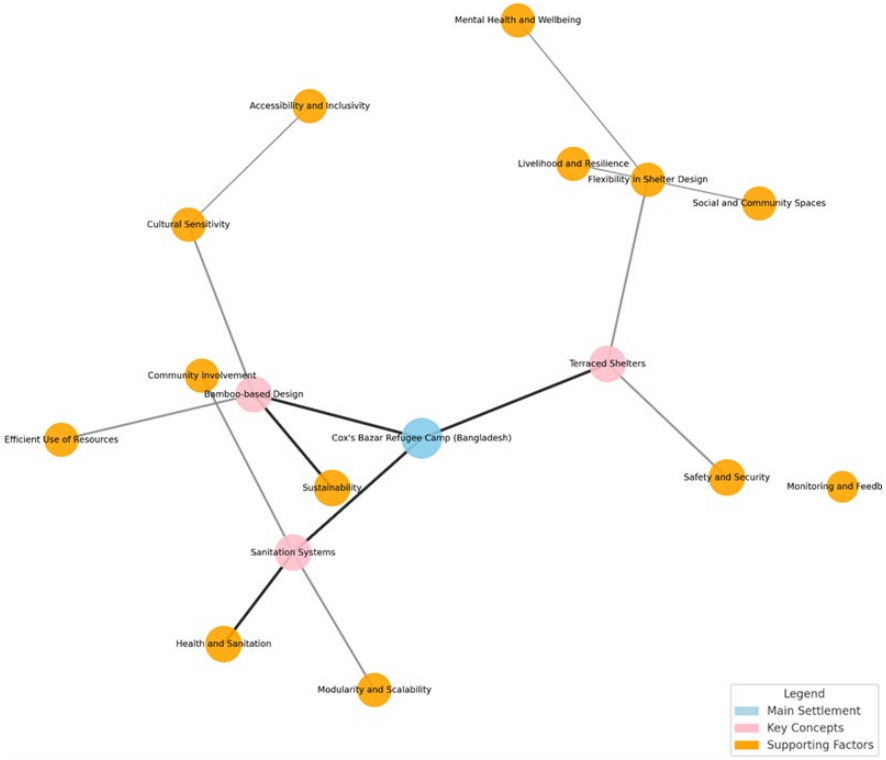

Figure 9 Relationship diagram of key design categories and features for Cox's Bazar refugee camp

Figure 10 provides an analytical view of the Kahramanmaraş Refugee Camp (Türkiye). Key elements (modular housing, social services, and urban-level infrastructure) are highly connected with flexibility (C11), safety (C1), health (C8), and accessibility (C3). Notably, social services play a bridging role by linking community participation (C7), mental well-being (C12), and social spaces (C9), suggesting that the quality and integration of service provision are central to resilience and dignity in refugee housing (Çetinkaya et al., 2016; Kahraman, 2024). These diagrams collectively reveal the complex interdependence between physical features and design goals in humanitarian contexts. The multidimensional nature of the visual models demonstrates that sustainable refugee camp design requires integrated thinking that spans infrastructure, culture, environment, and well-being. Comparative network structures across cases reinforce the need to tailor design strategies to local constraints and opportunities while maintaining fidelity to universal humanitarian standards.

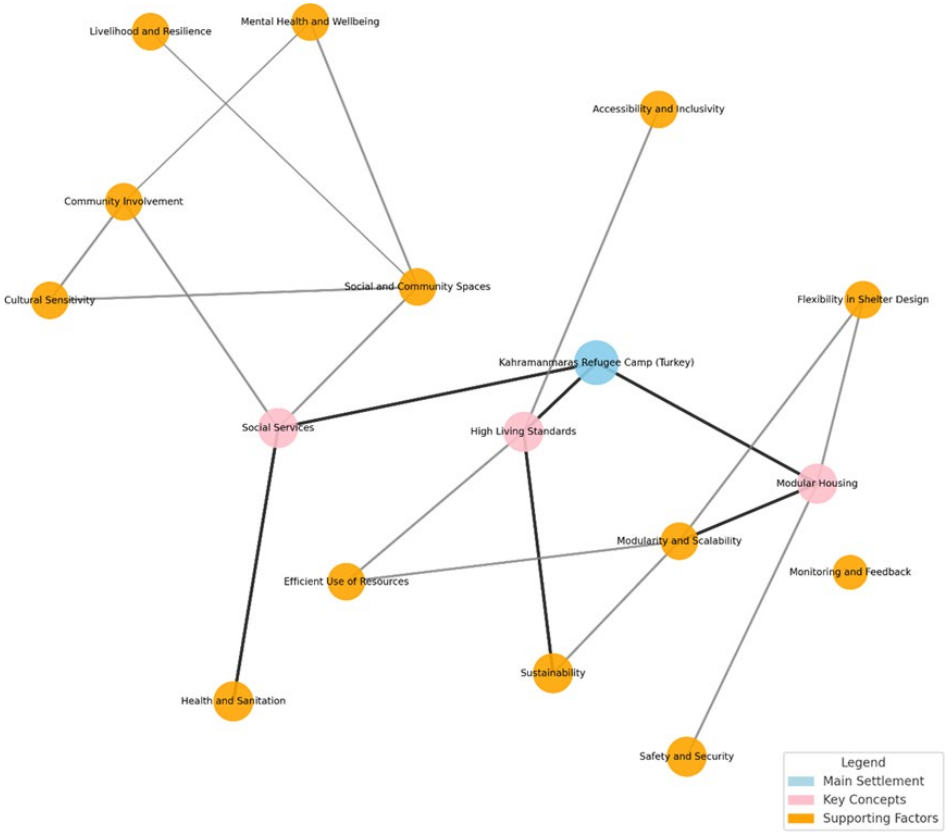

Figure 10 Relationship diagram of key design categories and features for Kahramanmaraş refugee camp

Table 2 summarizes the relative emphasis of each design indicator across the six refugee settlements analyzed in this study. The symbolic scale ((1) Very low ●○○○○, (2) Medium ●●○○○, (3) High ●●●○○, (4) Very high ●●●●○, (5) Exceptional/Dominant ●●●●●)) reflects the qualitative importance or degree of integration of each indicator within the respective settlement context. This comparative matrix allows for a holistic assessment of how sustainability, resilience, and social well-being dimensions vary between camps. It also provides an alternative to statistical correspondence analysis by visually consolidating all relationships in a single framework.

Table 2 Somparative Evaluation of Key Design Indicators Using Symbolic Rating Scale

Design Indicators	Zaatari (Jordan)	Kalobeyei (Kenya)	Dadaab (Kenya)	Bidi Bidi (Uganda)	Cox's Bazar (Bangladesh)	Kahramanmaraş (Türkiye)
Safety & Security	●●●○○	●●○○○	●●●●○	●●○○○	●●●●○	●●●○○
Cultural Sensitivity	●●○○○	●●●●○	●●○○○	●●●○○	●●○○○	●●●○○
Accessibility	●●●○○	●●○○○	●●●●○	●●○○○	●●●○○	●●●●○

Resource Efficiency	●●●●○	●●●○○	●●○○○	●●●●○	●●○○○	●●●●○
Sustainability	●●●●●	●●●●○	●●●○○	●●●●●	●●●○○	●●●●○
Modularity	●●●●○	●●●○○	●●○○○	●●●●○	●●○○○	●●●●●
Community Involvement	●●●○○	●●●●●	●●○○○	●●●●○	●●●○○	●●●○○
Health & Sanitation	●●●○○	●●●○○	●●●●●	●●●○○	●●●●●	●●●●○
Social Spaces	●●●●○	●●●○○	●●○○○	●●●○○	●●●○○	●●●●○
Livelihood & Resilience	●●●○○	●●●●●	●●●○○	●●●●○	●●●○○	●●●●○
Shelter Flexibility	●●●○○	●●○○○	●●○○○	●●○○○	●●●●○	●●●●●
Mental Wellbeing	●●●○○	●●●○○	●●●○○	●●●○○	●●●●○	●●●●○
Monitoring & Feedback	●●○○○	●●●○○	●●○○○	●●●○○	●●○○○	●●●●●

While the network analyses provided valuable insights into the relational structures among physical features and design categories in global refugee settlements, a context-specific prioritization of these indicators was necessary to guide the design framework for Kilis. Therefore, the following section employs the Analytic Hierarchy Process (AHP) to systematically determine the relative importance of each indicator.

3.3. Prioritization of Design Indicators via AHP

To quantify the relative importance of the thirteen design indicators, the Analytic Hierarchy Process (AHP) was applied, drawing on structured expert-based pairwise comparisons (Canan & Kürüm Varolgüneş, 2018; Eryürük et al., 2022). The resulting comparison matrix, shown in Figure 11, was constructed to assess the weight of each indicator in supporting sustainable refugee camp design. Each indicator was evaluated against all others using a 1–9 Saaty scale to determine comparative importance based on expert judgment. The results, as illustrated in the matrix, were processed to produce a normalized decision matrix and a vector of priority weights. The eigenvalue consistency ratio (CR) was calculated to verify the reliability of the input data. With a CR value of 0.098, which is less than the acceptable threshold of 0.1, the matrix was deemed consistent and analytically sound (Saaty, 1987; Kamaruzzaman et al., 2018).

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
C1	1.000	7.000	7.000	5.000	3.000	5.000	3.000	4.000	5.000	3.000	3.000	5.000	3.000
C2	0.143	1.000	1.000	1.000	0.333	0.333	0.333	1.000	1.000	0.333	0.333	1.000	0.500
C3	0.143	1.000	1.000	1.000	0.250	1.000	1.000	0.250	1.000	1.000	0.333	0.200	1.000
C4	0.200	1.000	1.000	1.000	1.000	0.200	1.000	0.200	1.000	0.333	0.333	0.333	0.333
C5	0.333	3.000	4.000	1.000	1.000	1.000	3.000	1.000	3.000	3.000	3.000	0.333	3.000
C6	0.200	3.000	1.000	5.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
C7	0.333	3.000	1.000	1.000	0.333	1.000	1.000	0.333	1.000	1.000	1.000	0.333	3.000
C8	0.250	1.000	4.000	5.000	1.000	1.000	3.000	1.000	5.000	3.000	4.000	1.000	5.000
C9	0.200	1.000	1.000	1.000	0.333	1.000	1.000	0.200	1.000	1.000	1.000	0.333	1.000
C10	0.333	3.000	1.000	3.000	0.333	1.000	1.000	0.333	1.000	1.000	1.000	0.333	1.000
C11	0.333	3.000	3.000	3.000	0.333	1.000	1.000	0.250	1.000	1.000	1.000	3.000	3.000
C12	0.200	1.000	5.000	3.000	3.000	1.000	3.000	1.000	3.000	3.000	0.333	1.000	3.000
C13	0.333	2.000	1.000	3.000	0.333	1.000	0.333	0.200	1.000	1.000	0.333	0.333	1.000
Total	4.002	30.000	31.000	33.000	12.250	15.533	19.667	10.767	25.000	19.667	16.667	14.200	25.833

λmax
3.443
0.546
0.499
0.477
1.494
1.019
0.786
1.851
0.580
0.762
1.191
1.559
0.622
14.828

n	RI
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49
11	1.51
12	1.48
13	1.56
14	1.57
15	1.59

n	13	Consistency
λ_{max}	14.828	λ_{max}:n eligible
CI	0.152	
RI	1.560	
CR	0.098	0.1 consistent

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	Row Averages
0.250	0.233	0.226	0.152	0.245	0.322	0.153	0.372	0.200	0.153	0.180	0.352	0.116	0.227
0.036	0.033	0.032	0.030	0.027	0.021	0.017	0.093	0.040	0.017	0.020	0.070	0.019	0.035
0.036	0.033	0.032	0.030	0.020	0.064	0.051	0.023	0.040	0.051	0.020	0.014	0.039	0.035
0.050	0.033	0.032	0.030	0.082	0.013	0.051	0.019	0.040	0.017	0.020	0.023	0.013	0.033
0.083	0.100	0.129	0.030	0.082	0.064	0.153	0.093	0.120	0.153	0.180	0.023	0.116	0.102
0.050	0.100	0.032	0.152	0.082	0.064	0.051	0.093	0.040	0.051	0.060	0.070	0.039	0.068
0.083	0.100	0.032	0.030	0.027	0.064	0.051	0.031	0.040	0.051	0.060	0.023	0.116	0.055
0.062	0.033	0.129	0.152	0.082	0.064	0.153	0.093	0.200	0.153	0.240	0.070	0.194	0.125
0.050	0.033	0.032	0.030	0.027	0.064	0.051	0.019	0.040	0.051	0.060	0.023	0.039	0.040
0.083	0.100	0.032	0.091	0.027	0.064	0.051	0.031	0.040	0.051	0.060	0.023	0.039	0.053
0.083	0.100	0.097	0.091	0.027	0.064	0.051	0.023	0.040	0.051	0.060	0.211	0.116	0.078
0.050	0.033	0.161	0.091	0.245	0.064	0.153	0.093	0.120	0.153	0.020	0.070	0.116	0.105
0.083	0.067	0.032	0.091	0.027	0.064	0.017	0.019	0.040	0.051	0.020	0.023	0.039	0.044
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

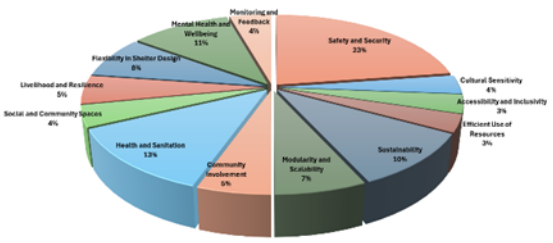

Figure 11 Relationship diagram of key AHP calculation matrices, weight values, and priority pie chart

The priority scores indicate that Safety and Security (C1) is the most influential design indicator, receiving a weight of 0.227 (23%), highlighting the foundational role of physical protection and risk reduction in camp environments. This is followed by Health and Sanitation (C8) at 0.125 (13%), underlining the centrality of hygiene, water infrastructure, and disease prevention in refugee well-being. Mental Health and Wellbeing (C12), with a priority weight of 0.116 (11%), emerges as a surprisingly strong priority, showing increasing awareness of psychological resilience in displacement settings (Beeman et al., 2023; Gladkikh et al., 2019). Sustainability (C5) ranks fourth (0.102 or 10%), showing the embeddedness of long-term environmental planning in modern camp design frameworks. Indicators such as Modularity and Scalability (C6) and Flexibility in Shelter Design (C11), which allow camps to adapt to population flux and environmental conditions, score 7% and 8% respectively. Meanwhile, Community Involvement (C7) and Livelihood and Resilience (C10) both hold 5%, reflecting the increasing but still secondary emphasis placed on participatory and empowerment-based strategies. Lower-weighted indicators, including Monitoring and Feedback (C13) (4%), Cultural Sensitivity (C2) (4%), and Accessibility and Inclusivity (C3) (3%), suggest either underrepresentation in existing design strategies or challenges in operationalizing these categories across diverse contexts (Wardeh & Marques, 2021; Shohel, 2022). Overall, the AHP results reinforce the idea that refugee camp design is still heavily guided by survival-driven metrics such as safety and hygiene, while social, participatory, and culturally adaptive dimensions are gradually gaining importance. The priority vector serves as a foundational input for the subsequent visualization (network analysis) and design adaptation phases, especially in the Kilis scenario. These results not only quantify expert preferences but also offer a structured basis for decision-making in complex humanitarian design environments.

3.4. Application of the Framework: Sustainable Living Scenario in Kilis

Kilis is a province located along Türkiye's border with Syria (see Figure 12) that has experienced significant demographic changes due to the influx of Syrian refugees. With one of the highest refugee-to-host population ratios in Türkiye, Kilis has witnessed intense pressures on housing, infrastructure, and community dynamics. These conditions necessitate an innovative, inclusive, and sustainable resettlement model. The sustainable living space project designed for Syrian refugees in Kilis offers a holistic and locally grounded approach. The project draws upon the city's spatial typologies, particularly its traditional courtyard houses—and the thirteen design indicators derived from global camp evaluations and prioritized through AHP. Each spatial decision has been developed by mapping these indicators onto the local architectural language, cultural expectations, and climatic conditions.

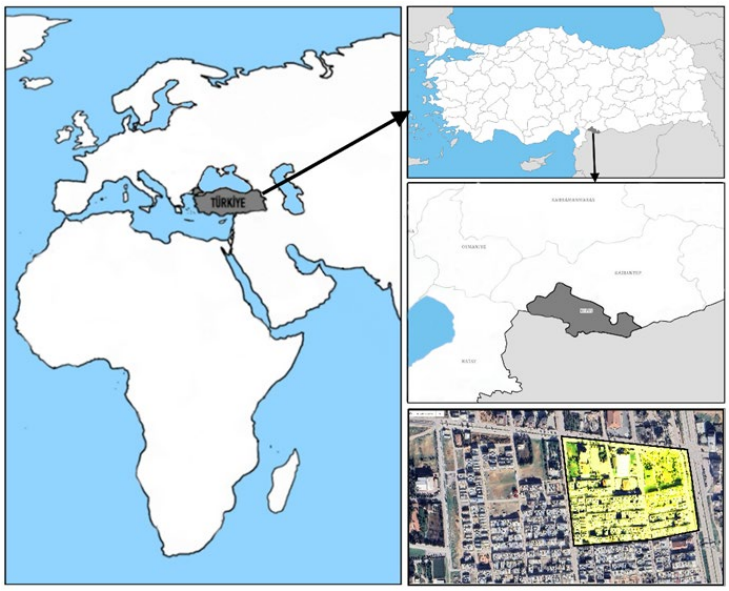

Figure 12 Location: From Türkiye to Kilis, Ekrem Çetin neighborhood

The design scenario prioritizes Safety and Security, implemented through low-rise modular units, open visual corridors, improved lighting, and designated safe spaces for women and children. Accessibility and Inclusivity are addressed via wide pathways, ramps, public transport access, and navigable zones for individuals with limited mobility. Cultural Sensitivity was a guiding principle, with Syrian family structures and Kilis's historic courtyard tradition merged in hybrid housing modules. Environmental and economic sustainability were embedded through solar panel integration, rainwater harvesting systems, greywater reuse, and urban agriculture zones. Vocational training centers and women-only workshop spaces support Livelihood and Resilience, while educational and recreational zones enhance Mental Wellbeing and Social Cohesion. To inform the design strategy, a word cloud was generated from expert consultations and participatory design sessions, highlighting recurring needs and priorities such as safety, sustainability, flexibility, and mental health (see Figure 13).

Figure 13 Word cloud from field studies and expert interviews informing the design process

The Kilis scenario offers a scalable model for post-disaster and high-density refugee settings. Its hybrid spatial layout, anchored by modular clusters and shared infrastructure, is visualized in the consolidated design representation shown in Figure 14, which maps all thirteen categories onto the master plan.

Figure 14 Kilis refugee sustainability center: An integrated and human-centered design scenario

3.5. Visualization of Local Design Integration: Network Diagram for Kilis

To validate and refine the Kilis design proposal, a customized network analysis was developed based on the same methodology applied to global camps. In this analysis, the Kilis Refugee

Sustainability Centre was placed at the core (Layer 1), with key physical features such as modular housing, social services, and living standards connected as intermediary nodes (Layer 2), and finally linked to the 13 design indicators (Layer 3) derived from AHP rankings and literature (see Figure 15).

The resulting diagram demonstrates strong, high-weight linkages between Modular Housing and indicators such as Safety and Security, Sustainability, and Shelter Flexibility. These align with the high priority weights assigned through AHP (C1: 23%, C5: 10%, C11: 8%). Likewise, Social Services connect directly to Health and Sanitation, Mental Wellbeing, and Community Involvement, confirming the centrality of service hubs in enhancing psychosocial and physical resilience. Interestingly, High Living Standards emerged as a bridging node—although not defined as a standalone indicator, it aggregates features like Resource Efficiency, Livelihood, Cultural Sensitivity, and Monitoring, suggesting a convergence of soft and hard design elements. The inclusion of this intermediary layer provides new insights into how design priorities coalesce at the neighborhood scale. This diagram reveals how the AHP-derived priorities were effectively operationalized within a spatial strategy. For instance, the centrality of Safety, Health, and Sustainability in both the network and the AHP analysis underscores their double validation as both expert-endorsed and structurally embedded elements.

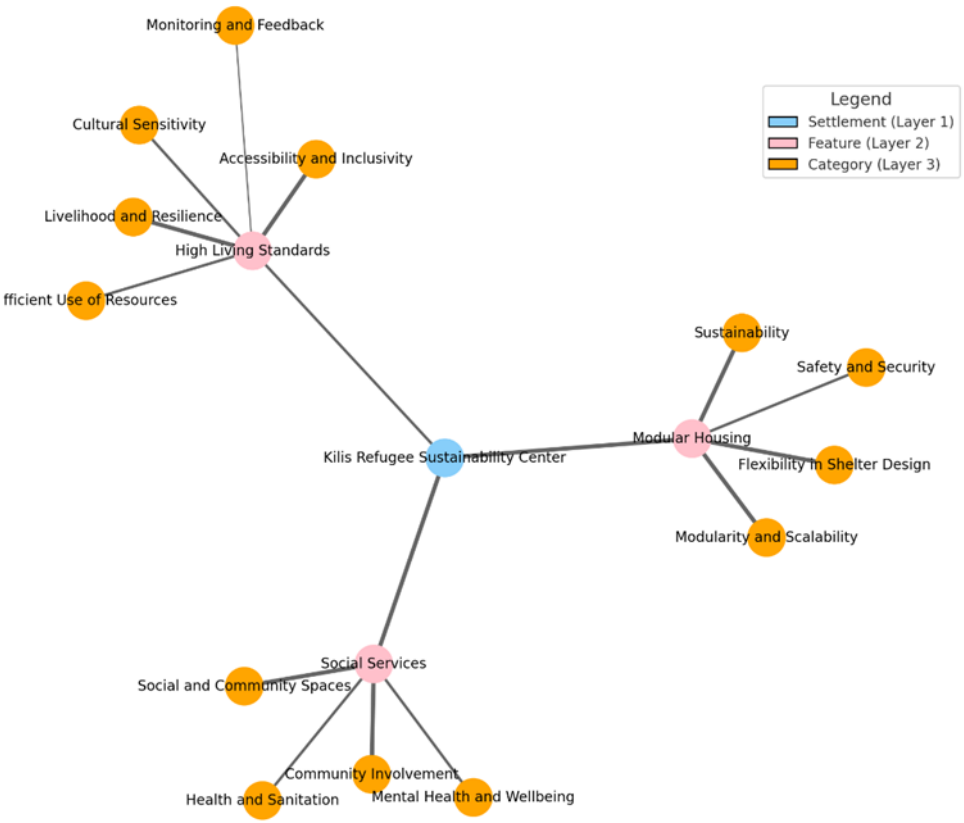

Figure 15 Relationship diagram of key design categories and features for Kilis refugee sustainability center

3.6. Design Implications and Policy Reflections

The findings of this study highlight the importance of integrating both global best practices and local contextual needs in refugee settlement design. The use of a prioritized indicator framework, grounded in expert assessments and visualized through network analysis, demonstrates how strategic design decisions can simultaneously address safety, sustainability, and community resilience. For policymakers and humanitarian planners, the Kilis scenario offers a replicable model that aligns architectural solutions with social policy goals. Emphasizing modularity, community participation, and environmental performance, the framework supports evidence-based planning for future refugee settlements in Türkiye and beyond. Moreover, the inclusion of feedback

mechanisms and participatory design processes ensures adaptability and long-term relevance critical factors for durable and inclusive urban integration.

4. Conclusions

This study proposed a comprehensive, context-sensitive framework for designing sustainable refugee settlements, integrating global design principles with local needs through a structured, indicator-based approach. By combining systematic literature analysis, expert-based prioritization via Analytic Hierarchy Process (AHP), and relationship mapping through network analysis, the research identified critical design priorities and revealed their interconnected roles in shaping effective settlement strategies. The comparative evaluation of global camps demonstrated the diversity of design responses to displacement, while the Kilis scenario showcased how such insights can be locally adapted. Key indicators—such as safety and security, health and sanitation, mental well-being, and sustainability—emerged as central nodes, both in expert ranking and network structures. Their translation into tangible spatial and infrastructural elements within the Kilis Refugee Sustainability Centre model validated the applicability of the framework in real-world settings. From a policy and planning perspective, the study highlights the necessity of integrating design thinking with humanitarian programming. The indicator-based approach enables prioritization of limited resources, supports community engagement, and strengthens resilience. As forced displacement becomes increasingly protracted and urbanized, the insights and tools developed here can guide future interventions toward more adaptive, inclusive, and sustainable refugee environments. Future research may expand on this framework by incorporating post-+occupancy evaluations, exploring dynamic spatial simulation tools, or extending the model to other at-risk regions. Ultimately, this research contributes not only to the academic discourse on refugee architecture but also to the actionable knowledge base required for equitable and future-oriented humanitarian design (Figure 16).

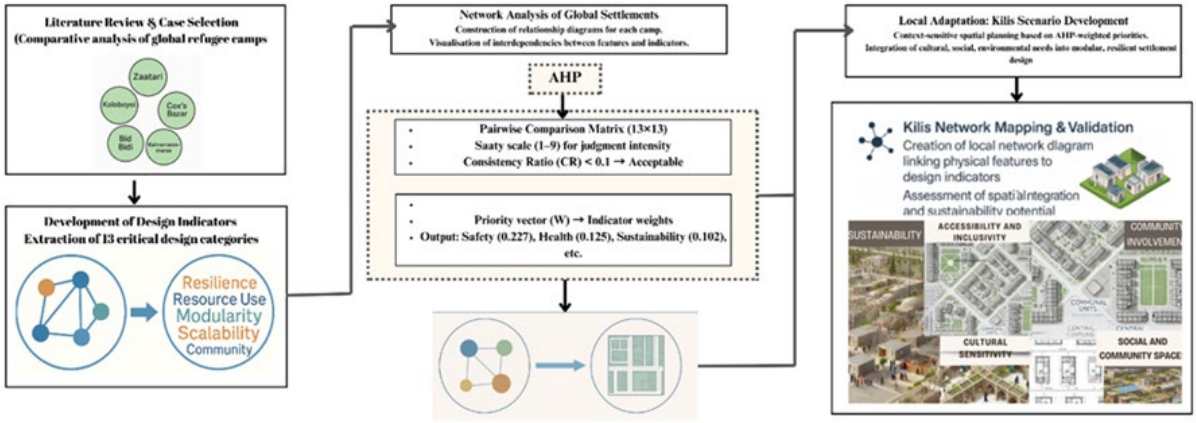

Figure 16 Graphical abstract

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Appendix A

Analytical Hierarchy Process (AHP)

In design contexts, it is widely used to compare alternatives and determine the most reliable option during problem-solving processes. The purpose of using AHP is to organize tangible or intangible factors in a systematic way and provide a simple solution to the decision-making process of problems. The pair-wise comparison matrix shows the importance levels of the criteria relative to each other within a certain logic (Gass & Rapcsák, 2004). With pair-wise comparisons, the criteria are transformed into a matrix. If aij gives the pair-wise comparison value of feature i and feature j, the pair-wise comparison matrix (Saaty, 1987; Saaty, 1990) is generally written as follows (Thanki et al., 2016):

Development of pair-wise comparison matrix (A) Building normalized matrix (A1)

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ a_{21} & \cdots & \cdots \\ \cdots & \cdots & \cdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \qquad A_1 = \begin{bmatrix} a'_{11} & \cdots & a'_{1n} \\ a'_{21} & \cdots & a'_{2n} \\ \cdots & \cdots & \cdots \\ a'_{n1} & \cdots & a'_{nn} \end{bmatrix} \quad (1)$$

and is calculated with the following formula:

$$a'_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \; for \; i, j = 1; 2; 3; \ldots; n \quad (2)$$

The pair-wise comparison matrix has a number of properties. These are listed below:

- All elements of the matrix are positive numbers, and it is a square matrix.
- If the matrix is fully consistent, the equality aij . ajk = aik is satisfied.
- If the matrix is fully consistent, all other factors of the matrix are obtained from any row.
- Expansions are made as many as 2 combinations of the number n.

- The eigenvector corresponding to the largest eigenvalue of the matrix is defined as the weight or relative importance vector in the AHP matrix.
- The diagonals of matrix A are equal to 1 (Saaty, 1987; Saaty, 1990).

In order to determine the importance of the criteria and alternatives relative to each other in the Analytic Hierarchy process, each alternative is scored by looking at its weight in the AHP pair-wise comparisons scale table with other alternatives. These weights are equally important (1), moderately important (3), strongly important (5), very strongly important (7), extremely important (9), intermediate weights. The relative importance vector to be obtained from the solution of the pair-wise comparison matrix is denoted by W = (w1, w2, ..., wn). The wj values here are defined as priorities or eigenvectors. The W* matrix is obtained from these values.

$$A_1 = \begin{bmatrix} \frac{w_1}{w_1} & \cdot\ \cdot & \frac{w_1}{w_n} \\ \cdot & \cdot\ \cdot & \cdot \\ \frac{w_n}{w_1} & \cdot\ \cdot & a'_{nn} \end{bmatrix} \quad \text{and} \quad w_i = \frac{\sum_{j=1}^{n} a'_{ij}}{n} \tag{3}$$

The largest eigenvalue of matrix A is known as λmax, and its corresponding eigenvector w consists solely of positive entries. The consistency of the matrix is defined as the ratio of CI to RI, or consistency index to random index. The random index table (Table 3) is employed for the RI calculation. To obtain the consistency ratio, use CI= λmax -n / n-1. A CR value less than 0.10 is considered consistent; however, if the consistency ratio surpasses 0.10, pair-wise comparisons should be reassessed (Kamaruzzaman et al., 2018; Razavi et al., 2011; Saaty, 1987).

Consistency Ratio is calculated as follows;

$$\text{Consistency Index } (CI) = \frac{\lambda_{max} - n}{n-1}, \tag{4}$$

$$\text{Consistency Ratio}(CR) = \frac{\text{Consistency Index(CI)}}{\text{Random consistency Index(RI)}} \tag{5}$$

Table 3 Random Consistency Index Values (Saaty, 1987)

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

CRediT Authorship Contribution Statement

Fatma Kürüm Varolgüneş: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Data curation, Conceptualization, Data visualization.

Declaration of Competing Interest

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Ethics Committee Approval

Ethics committee permission is not required.

Resume

Dr. Fatma Kürüm Varolgüneş is a Assoc. Professor of Architecture at Bingöl University, with a distinguished academic career focusing on architectural design and sustainability. She earned both her Bachelor of Architecture (B.Arch.) and PhD from Selçuk University, where her research centered on innovative approaches to architectural quality and energy-efficient design. Her scholarly interests encompass a broad range of topics, including architectural design education, ecological architecture, the integration of contemporary and traditional housing design, and the application of multi-criteria decision-making methods in architectural design. Dr. Kürüm Varolgüneş has contributed extensively to the field through numerous peer-reviewed articles, as well as presentations at both national and international conferences. Her publications address critical aspects of the built environment, with a particular emphasis on how sustainable building practices from the past can be adapted to future architectural design challenges. Through her research, she continues to explore how design strategies can balance sustainability, efficiency, and aesthetic quality in contemporary architectural practice.

JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (564-580), 2025
DOI: 10.47818/DRArch.2025.v6i3183

Growth and spatial distribution of art galleries in Istanbul between 2000 and 2022

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Abstract

In this paper, we illustrate the growth and spatial distribution of art galleries in Istanbul at the beginning of the 21st century. Previous studies have attributed the decentralization of urban activities from the old CBD to sub-centers as a result of population growth, economic and transportation development, and globalization in Istanbul. The present study begins by explaining the spatial distribution of Istanbul's cultural infrastructure within the urban macroform, followed by an investigation into the emergence and development of art galleries within the cultural ecosystem, providing a spatial focus as well as a historical context. We then analyze the growth and spatial distribution of art galleries from 2000 to 2022, with reference to the spatial characteristics of the cultural infrastructure and CBD in Istanbul's macroform. The results indicate that over two decades, the number of art galleries increased, with a tendency toward centralization in the historical CBD of the city, while decentralization also occurred at the borders of the historical CBD. Additionally, new clusters of art galleries emerged following the extension of the CBD and singular redevelopment projects specializing in cultural and artistic functions. This study contributes to the literature on Istanbul's urban growth and cultural studies by presenting a spatial assessment of the art galleries, which is a relatively underexplored component of cultural infrastructure. Additionally, by analyzing the relationships between the galleries and the urban macroform, specific revitalization and redevelopment projects, and cultural policies, the study highlights the role of art galleries within urban growth processes and the cultural infrastructure.

Keywords: art galleries, cultural infrastructure, Istanbul, urban structure, urban growth

1. Introduction

Culture and the arts are becoming important parts of the creative economy; while supporting cultural or artistic industries, cities can become more competitive in the global market. A significant body of research examines the role of artists and art museums in urban growth and regeneration in North America and Western Europe (Kim, 2007), while other studies trace these processes back to the 19th century examples in Paris and London (Lorente, 1995). However, there are not many studies in the geography of art galleries acting as intermediaries for the marketing of artworks. Thus, the present study examines the spatial distribution of art galleries in Istanbul, which form the main arteries of the city's cultural infrastructure, in the years 2000 and 2022. Within this context, the spatial distribution of art galleries is analyzed for these two time periods in relation to the urban macroform, existing cultural infrastructure, and urban regeneration projects.

During the postmodern era, the emergence of regions and new cities has created new horizons for the art markets. Although these organizational complexes were concentrated in large Western cities, such as New York and London, Istanbul's rank increased in this market due to the organization of international exhibitions, biennials, and the opening of new museums (Molho, 2014). Major

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Article history: Received 03 March 2025, Accepted 28 November 2025, Published 24 December 2025

industrialists of Turkey, by financially supporting these art events, not only provided benefits for themselves but also stimulated the local art markets.

At the international level, in the 1980s, as part of the postmodern culture, there was an increase in the number of art galleries due to economic development, spending more time on entertainment and consumption, and increasing importance of aesthetics. Furthermore, the development of art districts has consequently become a central focus of both policy initiatives and analytical efforts at the local and regional levels in the United States and Europe. Actors across different levels promote arts enclaves as catalysts for social and economic revitalization (Cameron & Coaffee, 2005). These studies demonstrate that the art and the neighborhood did not merely emerge simultaneously by coincidence but were fundamentally interconnected in their existence (Molotch & Treskon, 2009). Bain (2018) provides another example by analyzing the role of artists as urban developers through a critical examination of the relationships among artists, property ownership, and development in the mid-sized, post-industrial city of Hamilton, Ontario.

Adeli's (2011) more in-depth study shows that India, with its growing art scene, is one of the best examples of recent changes in its changing cultural and financial centers. The contemporary Indian art world is depicted as a 'new subsystem' of Indian society, emphasizing the structural transformations that have occurred over the past two decades. As another example from Asia, Kim (2007) describes urban art clusters and locational characteristics of art galleries in Seoul and their role in the creative industry in Korea. In Italy, Montalto (2010) explains that the Youth Ministry promotes contemporary arts and provides decentralization by encouraging responsible management of existing local projects. Some studies, drawing on the case of Athens and particularly Psiri, suggest that cultural clusters provide significant benefits for cultural facilities, including art galleries, by enhancing visibility, attracting visitors, and fostering shared audiences and networking opportunities (Karachalis & Deffner, 2012; Gospodini, 2006).

Despite the growing importance of art events at the international level, Anagnost's (2020) comprehensive study of New York's art world during the period 1960-2010 showed the end of affordable space for artists' studios, galleries, and community art centers in the urban centers of US cities due to rent increases. These results are also supported by Molotch and Treskon's (2009) paper on New York's Soho and Chelsea quarters for evidence of how art and place interact over time. They argue that the decline of New York's SoHo as a gallery district and the simultaneous rise of Chelsea cannot be explained solely by increasing property rents, as is often assumed, which are said to have displaced artistic activity. One of the reasons is that the city government has become a player in the effort to preserve Chelsea as an arts district. As a result, between 1990 and 2007, while the number of galleries increased from 16 to 303 in Chelsea, they decreased from 275 to 104 in SoHo. In another study, Zukin and Braslow (2011) conducted a comprehensive analysis on the life cycle of New York's creative districts, examining the unforeseen repercussions of unplanned cultural zones.

The paper by Molho (2014) explains the emergence of Istanbul's art market as a Middle Eastern art center with the financial and organizational support of the major industrialists of the country. At the same time, the spatial distribution of art galleries in Istanbul and their contribution to the value and revitalization of their neighborhoods are given. According to the results of this paper, the major concentration of art galleries was in a revitalized quarter, Beyoglu. Kahya and Ataöv (2019) examined clustered art organizations in Istanbul's contemporary art scene, revealing that these organizations promote complex social interactions among artist communities, despite inefficiencies in spreading this interactive networking across different social groups. Additionally, Polo (2015) claims that in the 2000s, contemporary art institutions in Istanbul flourished mainly due to the private initiatives of large industrial enterprises and wealthy families, frequently supported by political endorsement.

To further clarify these general dynamics identified across different countries, outlining the main factors influencing the location choices of art galleries will provide a clearer analytical framework.

The location choices of art galleries are a multidimensional urban process where various socioeconomic, cultural, and spatial factors converge. Art galleries may prefer to cluster in affluent neighborhoods and business-shopping districts. These areas are considered appealing because they allow galleries to establish close contact with potential buyers (Debroux, 2017; Molho & Sagot-Duvauroux, 2017). Another factor influencing the location of art galleries is the presence of cultural infrastructure. Areas with museums, art centers, and cultural institutions create a hub for galleries (Molho & Sagot-Duvauroux, 2017). From an economic perspective, affordable rents are also a determining factor in art galleries' location choices (Debroux, 2017; Molho & Sagot-Duvauroux, 2017). Old industrial areas with low property values and peripheral areas offer economic advantages for art galleries. Former industrial buildings, warehouses, or large empty buildings are preferred for such uses, as they offer spatial flexibility. Since these types of areas are also open to gentrification processes, they can become the focus of cultural production and exhibition areas in the long run (Molho & Sagot-Duvauroux, 2017).

Another critical factor in site selection is the need for collaborations and network structures among the actors in the art world. Galleries tend to be located close to each other for reasons such as access to shared resources, increased visibility, shared audience traffic, and the creation of opportunities for collaboration. These tendencies may facilitate the development of the natural clustering of art galleries in particular areas. Additionally, art galleries can use their location choices not only functionally but also as a means of strategic differentiation. Galleries may prefer to emphasize their aesthetic perspective or market positioning by placing themselves at unexpected locations (Molho & Sagot-Duvauroux, 2017). In conclusion, the concentration of art galleries in particular regions is shaped by the interplay of a range of factors, including cultural infrastructure, economic priorities, real estate market dynamics, social networks, and strategic location choices. This multi-layered structure paves the way for the emergence of art districts defined by galleries of different scales and characters within the city.

The review of the literature reveals that there are not many studies about the growth and location of art galleries in developing countries, and the present study investigates the spatial distribution of art galleries in Istanbul and compares their locational trends over the last two decades, from 2000 to 2022. Within the paper, background information about the city and its cultural infrastructure and earlier locational information about art galleries are given in the second section. A comparison of the growth and spatial distribution of art galleries during the last two decades was explained in the third section. This comparison is held at two levels. First, a general evaluation of the spatial distribution of art galleries in Istanbul's macroform is provided for the two different periods. Second, this evaluation is followed by an analysis of the growth and spatial location of art galleries at district levels. The final section of the paper is devoted to a conclusion.

2. Background: Art Galleries within the Cultural Infrastructure in Istanbul

Istanbul's cultural infrastructure comprises distinct components, each with unique cultural and artistic values and organizational and management structures. These include a broad range of establishments, such as historical and monumental works, museums, cultural centers, exhibition and concert halls, cinemas, and art galleries. Several studies concerning the spatial distribution of Istanbul's cultural infrastructure have revealed that cultural facilities form a cluster concentrated in the historical center of Istanbul, standing out and specializing in its economic value as well as its cultural and historical values (Aksoy & Enlil, 2011; Enlil et al., 2011; Koramaz & Kısar Koramaz, 2009). Enlil et al. (2011) introduced the term "cultural triangle" for Istanbul's historical center and its extension in the north direction, where the cultural infrastructure is spatially decentralized. The cultural triangle refers to the Fatih and Beyoğlu districts as the historical core of the city; the region within the borders of the Şişli-Beşiktaş and Sarıyer districts referring to the extension of the historical CBD; and the Kadıköy and Üsküdar districts on the Anatolian Side. Cultural centers, museums, and historical monuments with national and international importance are concentrated

in Beyoğlu and Fatih. Kadıköy, Üsküdar, and Şişli are regarded as second-degree sub-centers in terms of cultural infrastructure, as they have cultural facilities that serve the entire city as well as their immediate surroundings. Beşiktaş and Bakırköy are the other second-degree sub-center districts having a similar cultural infrastructure pattern (Kısar Koramaz & Koramaz, 2017; Koramaz & Kısar Koramaz, 2009). Another pillar of the cultural triangle is the Levent-Maslak axis, which lies within the borders of the Şişli, Beşiktaş, and Sarıyer districts (Figure 1). This area is significant, as it is home to enterprises that support cultural economies by providing services in creative industries such as printing, advertising, architecture, music, radio, and television (Aksoy & Enlil, 2011). Studies on Istanbul's spatial development have revealed that the city had a monocentric structure for a long time, with Beyoğlu and Fatih at its center. However, after the 1990s, the CBD, known as the first ring, began to expand outward from the center and displayed a polycentric development trend (Dökmeci & Berköz, 1994; Dökmeci & Çıracı, 1999). The spatial distribution of the cultural infrastructure and the enterprises in the creative industries also overlaps with the polycentric structure of Istanbul. On the other hand, Istanbul's cultural infrastructure also tends to spread along the coastline of the Golden Horn through the adaptive reuse of historical buildings and regeneration projects (Aksoy & Enlil, 2011).

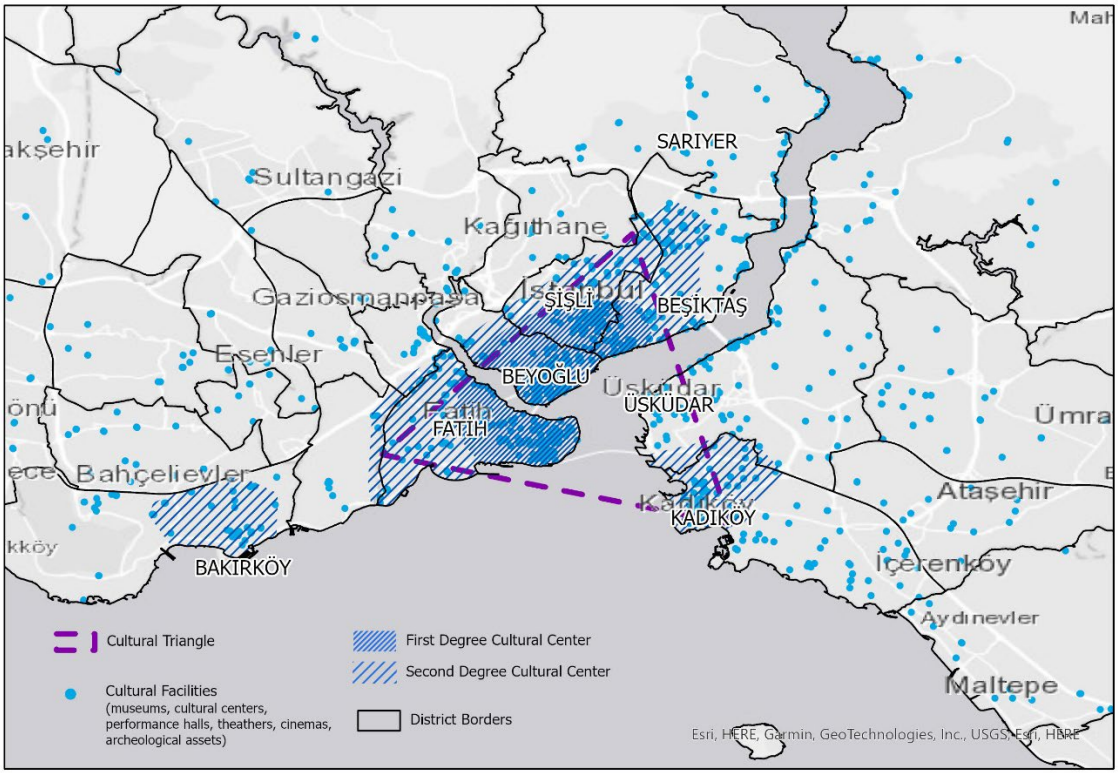

Figure 1 Centrality and spatial distribution of cultural infrastructure (First- & second-degree cultural centers are adapted from Koramaz & Kısar Koramaz, 2009; cultural triangle is adapted from Enlil et al., 2011)

Cultural centers, established and operated by local governments and increasingly common since the 2000s, have been effective in the decentralization of cultural infrastructure to the periphery of the city. The cultural infrastructure in the peripheral settlements is operated with people-oriented programs that appeal mostly to the local population residing in those settlements. In addition, cinemas in shopping malls constitute another component of the cultural infrastructure of peripheral settlements (Kısar Koramaz & Koramaz, 2017; Aksoy & Enlil, 2011; Enlil et al., 2011; Koramaz & Kısar Koramaz, 2009).

For a specific evaluation of the artistic production and the emergence of art galleries, it is beneficial to start with 19th-century Ottoman period Istanbul. During this time, interest in art among upper-class families grew due to the Westernization movement and visits from world-famous European painters, such as Melling in 1819, who came to admire Istanbul’s beautiful image.

In the Ottoman period, there were only a few painters due to Islamic religious constraints, and only a few Ottoman elite people were interested in painting. During this period, the establishment of Sanay-i Nefise Mektebi (School of Fine Arts) in 1882 marked the first step toward institutionalizing art education. The institution was located on the Historical Peninsula and became a hub for artistic and cultural production and exhibition. However, during the 19th century, İstiklal Street and its surroundings, known as Grand Rue de Pera, were the most prominent cultural and artistic centers in Beyoğlu. Grand Rue de Pera had been a popular destination where both local and foreign artists accommodated and established their art studios. The cafes, restaurants, entertainment venues, and shops located on Grand Rue de Pera had been places where works of art are exhibited in a spontaneous routine, while works of art and artists meet and interact with the art dealers, art buyers, and other interested audiences (Köksal & Sinanlar Uslu, 2023; Sinanlar Uslu, 2021).

During the Republican period, Sanayi-i Nefise Mektebi moved to Fındıklı in Beyoğlu and was transformed into a higher education institution under the name of "State Academy of Fine Arts." In 1937, Istanbul's first art museum was established under the name of "Museum of Painting and Sculpture" in Dolmabahçe, located within the borders of Beşiktaş. These had been significant establishments held by the state in terms of institutionalization of culture and arts education, artistic production, exhibiting of arts, and opening these processes to the public (Aliçavuşoğlu, 2010; Sanul & van Heur, 2018). During the Republican period, although the number of painters increased, there were only a few art galleries in the most modernized districts, such as Beyoğlu (Polo, 2015). The most critical development in terms of art galleries taking their place in art life in Turkey, as well as the involvement of non-state independent actors in this process, was the establishment of Maya Art Gallery in the 1950s. Maya Art Gallery, established on İstiklal Street, supported the artist through the exhibitions it organized between 1950 and 1955 and brought art to the audience (Köksal & Sinanlar Uslu, 2023; Savaş, 2008). After the 1950s, the number of art galleries started to increase in the most modern and higher-income districts, such as Beyoğlu and Şişli, due to economic and cultural development. After the 1970s, this trend continued in the organization of entertainment facilities and art activities, biennales, festivals, and the construction of modern art museums by prominent industrialists (Polo, 2015).

During the 1970s, the number of art galleries grew within the boundaries of the Şişli district in affluent historical neighborhoods such as Nişantaşı and Maçka. Parallel to the spatial flourishing of art galleries, the art market, led by the art galleries, also started to grow (Öz, 2013). In the 70s, banks and wealthy family-owned enterprises began to invest in and support culture and arts, with new cultural venues and organizations clustered in the city center. With its contributions to international cultural and artistic organizations and festivals, the founding of the Istanbul Foundation of Culture and Arts (İstanbul Kültür Sanat Vakfı IKSV / IFCA) in 1973 marked a significant turning point. This trend continued in the organization of entertainment facilities and art activities, biennales, festivals, and the construction of modern art museums by prominent enterprise owners (Mayer 2020; Polo, 2015). Another important event in terms of the development and internationalization of the culture and art world in Istanbul was the first Istanbul Art Biennale organized by IFCA in 1987. While the first biennial was held in historical places in the Historic Peninsula, in the following biennials, public spaces and art galleries in the Beşiktaş, Şişli, and Beyoğlu districts were also used as exhibition venues (Sanul, 2020; Mayer, 2020). Art galleries were crucial in providing support to artists and representing Turkish modern art in both national and international art arenas during the 1990s in Istanbul, as the city did not yet have a modern art museum (Üner Yılmaz, 2021).

The 2000s have significance as they brought about a shift in the way the city's art and cultural scene was organized, as well as the spatial organization of the related infrastructure. Istanbul strengthened its position in the international art market during the 2000s and gained a prominent position among global cities for its art market as well as the events it hosts. Especially in 2004, the sale of the Orientalist painter Osman Hamdi Bey's painting for $3.5 million increased the rank of

İstanbul's art market to the 10th level in the world (Molho, 2014). Another major milestone of 2004 was the foundation of the Istanbul Modern Museum, the city's first modern art museum, by the investment of one of the country's leading wealthy industrialist families. Private museums founded by banks and other industrialist families came after this. It can be stated that with the opening of new museums, the cultural infrastructure, which was formerly concentrated in the city center, was spread to various parts of the city, albeit with singular projects. Istanbul Modern Museum, located in Karaköy, triggered the spread of cultural facilities from their concentration on İstiklal Street to Karaköy. During this period, art galleries increased in derelict areas such as Cihangir, Galata, and Tophane on the outskirts of Beyoğlu. The role of the initiatives put forward by young artists and curators in structuring art galleries is also striking in terms of the diversification and independence of the art environment (Sanul 2020; Sanul & van Heur, 2018; Polo, 2015).

3. Art Galleries in Istanbul: An Analysis of the Years 2000 and 2022

In the following sections, the spatial distribution and the growth of the art galleries are analyzed and compared for years 2000 and 2022. Within the scope of this analysis, the general distribution of art galleries on Istanbul's macroform was first examined, and the areas where they were particularly concentrated and decentralized were evaluated comparatively for both periods. For this analysis, the address information of art galleries located in Istanbul in the years 2000 and 2022 was used and analyzed using the Kernel Density Analysis method. Subsequently, using the same database, an evaluation was made at the district level based on the number of art galleries, and comparisons were made for the years 2000 and 2022, revealing the change in the number of art galleries with figures and based on district boundaries.

One of the main challenges that research on Istanbul's cultural infrastructure currently faces is the absence of an extensive database that catalogues the city's culture and arts facilities based on their attributes, such as type, location, and organization and management structures, as well as a catalogue that keeps track of cultural events. It is much harder to analyze art galleries holistically due to their distinct organizational structures and operational characteristics resulting from their status as independent, privately owned enterprises and their spatial dispersion throughout the city. One of the main resources in Istanbul is the Istanbul Kültür Sanat Haritası - Istanbul Culture and Art Map which offers a calendar of events related to culture, arts, and entertainment in Istanbul as well as a list of relevant venues along with addresses and other details. The main reason for employing this resource is that, since this website began publishing in 1995, it has been a constantly updated source of information on cultural events and venues. This website was the main resource to compile the list of art galleries and the details of their addresses for both periods (Kültür Sanat Haritası, 2000; 2022). Similarly, the data for the art galleries in 2022 was gathered in December 2022 from Istanbul Kent Rehberi - Istanbul City Guide's website's cultural event venues—art galleries section (Istanbul.net.tr, 2022). Consequently, a comprehensive database containing the district and address details of art galleries for the years 2000 and 2022 has been created.

3.1. Spatial Distribution of Art Galleries in Istanbul

In order to understand the spatial distribution and concentration of art galleries in Istanbul, a Kernel Density Analysis is carried out using the ArcGIS program. Within the analysis, the address data of art galleries is used to generate spatial distribution maps for the years 2000 and 2022. The resulting maps provide insights into how the spatial distribution of art galleries has evolved and highlight significant areas of growth and spatial concentration (Figure 2 and Figure 3).

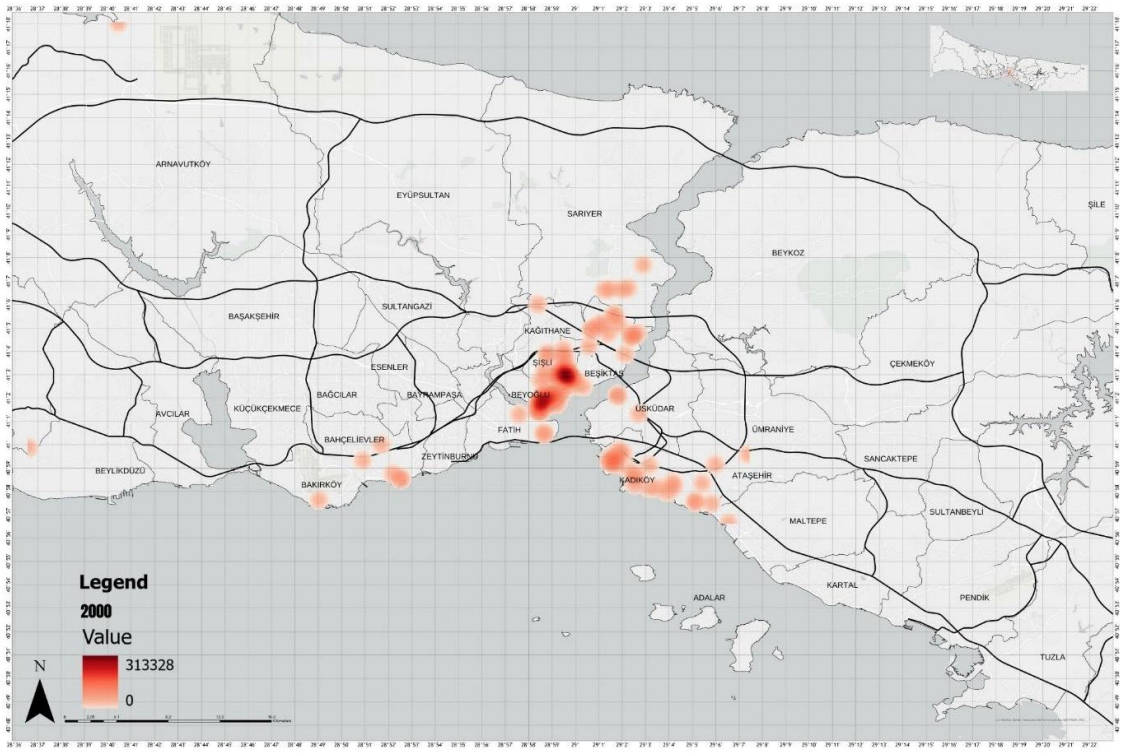

Figure 2 Spatial distribution of art galleries in Istanbul-Year 2000

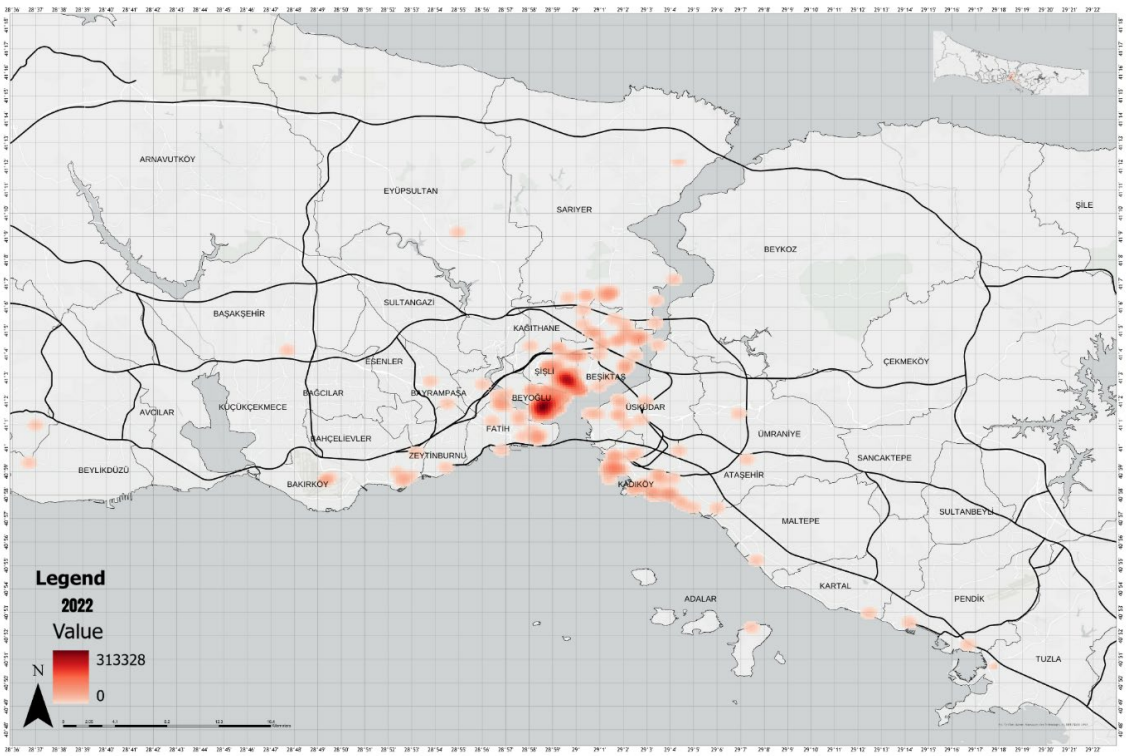

Figure 3 Spatial distribution of art galleries in Istanbul-Year 2022

The spatial distribution of art galleries in both 2000 and 2022 indicates a concentration within the city center, specifically in the Beyoğlu and Şişli districts. This area, where art galleries are concentrated, also coincides with the first-degree cultural center of the city, which refers to the area where cultural infrastructure and culture and arts events are concentrated. This area, located within the borders of Beyoğlu district and its extension in Şişli district, stands out in terms of accessibility and provides favorable conditions for the clustering of art galleries, especially due to

the continuity of pedestrian access. In the previous section, it was explained that since the 1990s, the new CBD of the city has expanded northwards along the Şişli-Maslak axis. The cultural infrastructure has followed this trend, particularly concentrating around Büyükdere Avenue and its surroundings. Similarly, the spatial distribution of art galleries in both periods indicates a spread from the center to the north along Büyükdere Avenue, apparently. The maps also indicate that the art galleries have been present in both periods along the coastline parallel to the Marmara Sea within the borders of the Kadıköy District on the Anatolian side. In other words, this region, which is one of the sub-centers of Istanbul's cultural infrastructure, maintained its continuity in terms of the presence of art galleries. Comparing the spatial distribution of the two periods, however, it can be stated that the growing number of art galleries from 2000 to 2022 decentralized both around the center within the Beyoğlu-Şişli borders and in other concentration areas (Figure 2 and Figure 3).

The spatial distribution of art galleries in 2000 shows that the concentration in the Beyoğlu district tended towards the Karaköy area, while the centralization in the Şişli district took place in the Nişantaşı area. However, based on the spatial distribution shown on the map, it can be stated that a concentration along Büyükdere Avenue within the borders of the Şişli, Beşiktaş, and Sarıyer districts also began during this period. Additionally, a cluster of art galleries is also observed along Nispetiye Street within the Beşiktaş district. On the Anatolian side, art galleries are located in the Kadıköy district's center and along the Marmara Sea coastline. Apart from these aforementioned areas where art galleries are concentrated, there are also various singular points where galleries are located, such as in the districts in Üsküdar and Ataşehir on the Anatolian side and Fatih and Bakırköy on the European side (Figure 2).

As the spatial distribution for 2022 is examined, it is observed that the centralization of art galleries within the borders of the Beyoğlu and Şişli districts still continues. However, a decentralization of art galleries around these centers is also observed. In addition, new areas of concentration for art galleries have also emerged throughout the city. The intensified and expanded area extending southwest from Beyoğlu's İstiklal Street towards the Karaköy region and along the Bosphorus coastline indicates that art galleries have spread into these areas. The centralization trend of art galleries in the Nişantaşı area within the Şişli district has shown a tendency to spread within the inner regions of Şişli. The map also indicates the spatial integration of galleries in the Şişli district with the ones in the Beşiktaş district through the corridor in the Maçka area, while advancing towards the Bosphorus coastline with increasing concentration (Figure 3).

Another finding revealed by the 2022 spatial distribution map is the presence of art galleries along the Bosphorus coastline, starting from Karaköy and continuing within the boundaries of the Beşiktaş and Sarıyer districts. In other words, by 2022, the results indicate that the European side of the Bosphorus has emerged as a new attraction zone for art galleries. Another finding revealed by the 2022 spatial distribution map is the concentration of art galleries along Büyükdere Avenue and the trend toward decentralization around this axis. This finding clearly indicates the importance of Büyükdere Avenue as a sub-region that has developed over the last 20 years and stands out in terms of the presence of art galleries and Istanbul's cultural infrastructure.

In the Fatih district, which is part of Istanbul's cultural infrastructure on the Historical Peninsula, the number of art galleries, which were few and scattered in 2000, increased by 2022 and shows a tendency to spread along the Golden Horn coastline. On the Anatolian side, the concentration of art galleries along the Sea of Marmara continues within the boundaries of the Kadıköy district. In addition, there is a noticeable concentration in the central neighborhoods of Kadıköy, especially towards the north in the Yeldeğirmeni region. In the Üsküdar district, the number of art galleries increased in 2022, with a tendency to be located both in the inner areas and along the Bosphorus. A general assessment of the spatial distribution for 2022 indicates that art galleries are densely located and form clusters in the above-mentioned areas, while they are scattered in other areas, where they are less numerous (Figure 3).

As a result, the maps created using the address information of art galleries in 2000 and 2022 reveal that art galleries in Istanbul are centralized in Beyoğlu-Şişli, where the cultural and artistic infrastructure is also concentrated. Over the past 22 years, this centralization has continued, but there has also been a clear tendency to expand around these centers. New areas of expansion and concentration have also emerged, such as Büyükdere Avenue, the coasts of the Bosphorus and Golden Horn, and the central area of Kadıköy. It is also observed that the sparse presence of art galleries continues in other parts of the city, where they are almost non-existent.

3.2. Presence and Growth of Art Galleries by District in Istanbul

The comprehensive database containing the district and address details of art galleries for the years 2000 and 2022 is used to analyze art gallery distribution in numbers and at the district level. In addition, art galleries' address information is used for an evaluation at the neighborhood scale to identify the possible clusters within the districts.

A descriptive evaluation of the number of art galleries indicates that the number of art galleries in Istanbul increased from 189 in 2000 to 331 in 2022. It is seen that 142 new art galleries were added to the total number of art galleries throughout the city between 2000 and 2022, and in other words, the number of art galleries increased approximately 3 times. The table and the map below show the distribution of art galleries by district (Figure 4, Table 1).

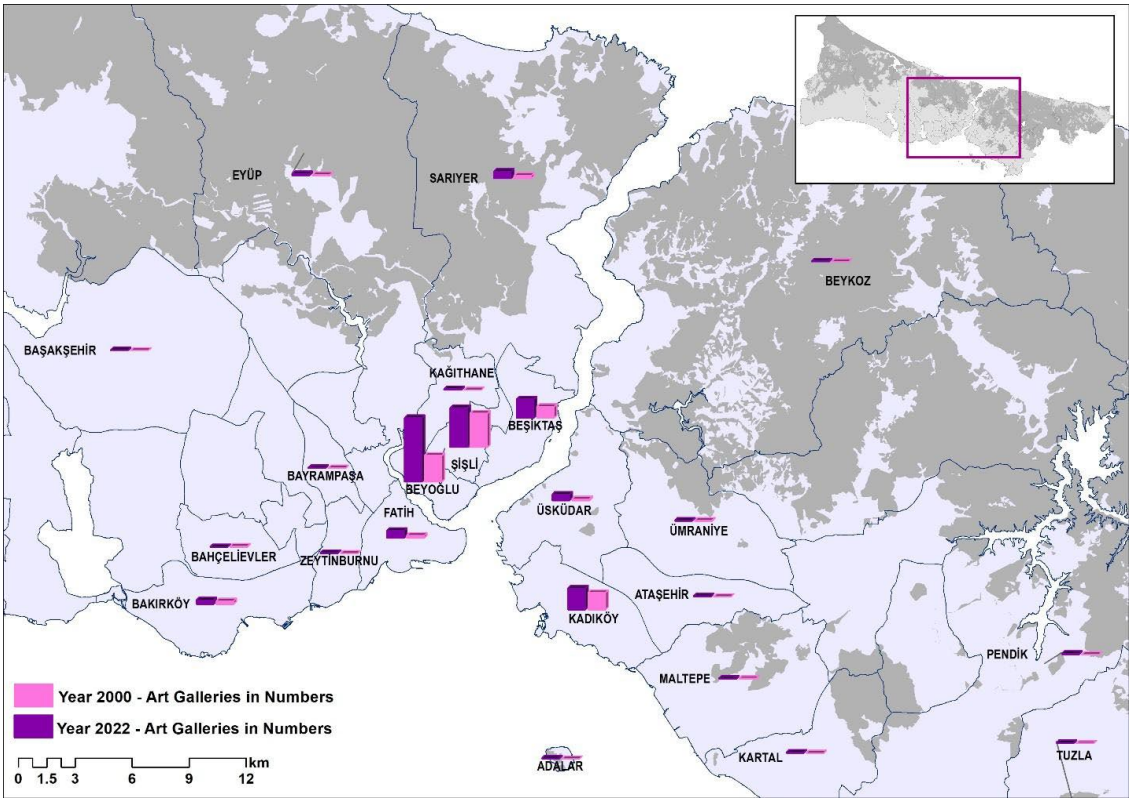

Figure 4 Number of art galleries in districts-2022 and 2000

In 2000, art galleries were located in the Beyoğlu, Şişli, Kadıköy, Beşiktaş, Fatih, Üsküdar, Sarıyer, Bakırköy, Eyüp, and Bahçelievler districts. The figures indicate the concentration of art galleries, especially in the Beyoğlu, Şişli, Beşiktaş, Kadıköy, Fatih, and Bakırköy districts, which fall in the region defined as the cultural triangle of Istanbul. Among these districts, Beyoğlu district, the first-degree center in terms of the city's cultural facilities, contains 25.9% of the art galleries. By 2022, the number of art galleries in Beyoğlu increased to 119, which constitutes 36% of the art galleries in Istanbul. The results indicate a significant increase in the number of art galleries in Beyoğlu, with a figure of 10%. In addition to these results, it is striking that almost half of the increase in the total number of galleries took place in Beyoğlu (49.3%) (Table 1).

Şişli, Beşiktaş, Kadıköy, Fatih, Sarıyer, and Üsküdar are the other districts that have a relatively higher share in the total increase in the number of art galleries in Istanbul. Almost 10% of the increase in the number of art galleries took place in Beşiktaş. The share within the total increase of art galleries in Istanbul for Şişli is 7%, and for the Fatih, Sarıyer, Kadıköy, and Üsküdar districts is almost 6%. These results indicate that, over the past 22 years, the concentration of cultural facilities within the cultural triangle has also been reflected in the distribution of art galleries. Nevertheless, Beyoğlu has become more centralized and distinct within this concentration due to the rise in the number of art galleries. Although art galleries are centralized in Beyoğlu, their address data shows that they are decentralizing within the Beyoğlu district borders. In 2000, art galleries were mostly concentrated along İstiklal Street and its surroundings. By 2022, galleries had expanded from central areas such as İstiklal Street, Galatasaray, and Tünel to the waterfront area of Karaköy. By 2022, the number of art galleries in Karaköy had significantly increased, extending to the Fındıklı region. The distribution of galleries from İstiklal Street to Karaköy is especially noteworthy. Neighborhoods such as Tomtom, Tophane, Firuzağa, Cihangir, and Çukurcuma have seen an increase in the number of art galleries. The Galataport project, which was developed on the Karaköy waterfront and was completed in 2022, has been one of the factors triggering the concentration of art galleries towards and around Karaköy. Additionally, Dolapdere has gained attention as a new hub for art galleries in Beyoğlu, which would have been triggered by various redevelopment projects, including a private university and a cultural center named as Arter.

Table 1 Number of Art Galleries in Istanbul, 2022 and 2000

Districts	Art Galleries / 2022		Art Galleries / 2000		Increase in art galleries from 2000 to 2022		Share within Total Increase
	N	%	N	%	N	%	%
Beyoğlu	119	*36.0*	49	*25,9*	70	*10.0*	***49.3%***
Beşiktaş	35	*10.6*	21	*11.1*	14	*-0.5*	***9.9%***
Şişli	73	*22.1*	63	*33.3*	10	*-11.3*	***7.0%***
Fatih	14	*4.2*	5	*2.6*	9	*1.6*	***6.3%***
Kadıköy	40	*12.1*	32	*16.9*	8	*-4.8*	***5.6%***
Üsküdar	11	*3.3*	3	*1.6*	8	*1.7*	***5.6%***
Sarıyer	13	*3.9*	5	*2.6*	8	*1.3*	***5.6%***
Bakırköy	8	*2.4*	6	*3.2*	2	*-0.8*	*1.4%*
Eyüp	3	*0.9*	1	*0.5*	2	*0.4*	*1.4%*
Kağıthane. Pendik *(2 districts)*	2	*0.6*	0	*0.0*	2	*0.6*	*1.4%*
Adalar, Ataşehir, Başakşehir, Bayrampaşa, Beykoz, Kartal, Tuzla, Zeytinburnu *(8 districts)*	1	*0.3*	0	*0.0*	1	*0.3*	*0.7%*
Büyükçekmece, Maltepe, Ümraniye *(3 districts)*	1	*0.3*	1	*0.5*	0	*-0.2*	*0.0%*
Bahçelievler	0	*0.0*	1	*0.5*	-1	*-0.5*	*-0.7%*
Arnavutköy, Avcılar, Bağcılar, Beylikdüzü, Çatalca, Çekmeköy, Esenler, Esenyurt, Gaziosmanpaşa, Güngören, Küçükçekmece, Sancaktepe, Silivri, Sultanbeyli, Sultangazi, Şile *(16 districts)*	0	*0.0*	0	*0.0*	0	*0.0*	*0.0%*
TOTAL	331	*100*	189	*100*	*142*	-	*100*

Şişli district is another important focal point for cultural facilities in Istanbul. Due to its locational and functional integration with Beyoğlu, Şişli serves as a cultural hub demonstrating historical continuity and also extends as part of the CBD to the north. Şişli maintains this characteristic with the number of art galleries in its borders. In 2000, the number of art galleries in Şişli was 63, constituting 33% of the city's art galleries. This number increased to 77 in 2022, but this number refers to 23% of the city's art galleries, indicating a decrease in percentage (-11.3%). Only 7% of the increase in the total number of art galleries during the past 22 years took place in Şişli. Still, the numbers indicate that Şişli has a unique position in terms of the existence of art galleries since it is

the district within whose boundaries the first art galleries of Istanbul were introduced to the cultural ecosystem of the city. In 2022, art galleries in the Şişli district are concentrated in the Teşvikiye and Harbiye neighborhoods, particularly on Vali Konağı, Abdi İpekçi, Hüsrev Gerede, Halaskargazi, and Maçka Streets. Examining the physical location choices of Istanbul's art galleries over time reveals that their continuing presence in these regions demonstrates the city's cultural ecosystem's historical continuity. Bomonti, a neighborhood in Şişli with a tiny cluster of art galleries, has become one of the city's important cultural venues through the adaptive reuse of an ancient beer factory. Furthermore, Büyükdere Avenue and its surroundings, going through Şişli and serving as an extension of the CBD since the 1990s, constitute another notable region with the presence of art galleries.

Beşiktaş is another prominent district that has experienced a rise in the number of art galleries from 2000 to 2022. The number of art galleries in the Beşiktaş district, which was 21 in 2000, increased to 35 in 2022. In 2022, Beşiktaş constitutes 10.6% of the total number of art galleries in Istanbul. The proportion of art galleries in Beşiktaş to the total number of galleries in Istanbul appears to have decreased at a negligible rate (-0.5%). When the address information of the art galleries in the Beşiktaş district in 2022 is examined, it is seen that there are generally clusters in several different regions. It is seen that an extension of the cluster in the Teşvikiye and Maçka regions within the borders of the Şişli district continues in the region that forms its neighborhood within the borders of Beşiktaş. Şair Nedim Street stands out in this region, and Akaretler is another area where art galleries are concentrated. Other prominent areas where art galleries in Beşiktaş are located are Büyükdere Avenue and its surroundings and Nispetiye Street in the Levent and Etiler neighborhoods. Finally, neighborhoods such as Bebek, Arnavutköy, and Kuruçeşme along the Bosphorus coastline appear as another cluster where art galleries are concentrated in the Beşiktaş district.

The number of art galleries in the Sarıyer district, which was 5 in 2000, increased to 13 in 2022. Art galleries in the Sarıyer district, which are spread over a wide geographical area, are concentrated in two different regions. According to address data, in 2022, art galleries in the Sarıyer district are concentrated on Büyükdere Avenue and in the Maslak region. There are also art galleries located along the Bosphorus coastline in Sarıyer, which is a continuation of the Bosphorus coastline in the Beşiktaş neighborhoods.

The increase in the number of art galleries from 2000 to 2022 in the Fatih district, which refers to the Historical Peninsula of Istanbul and forms the pillar of the cultural triangle in the historical center, is striking. There were only 5 art galleries in the Fatih district in 2000, and this number has increased to 14 in 2022. However, the art galleries in the Fatih district still account for only 4.2% of Istanbul's art galleries. According to the address data for 2022, art galleries in the Fatih district are clustered in the center of the Historical Peninsula, as well as in the Balat and Ayvansaray regions on the coastline of the Golden Horn.

The number of art galleries in the Kadıköy district, which represents the Anatolian side of the Istanbul culture triangle, increased from 32 in 2000 to 40 in 2022. Kadıköy, the Anatolian side pillar of Istanbul's cultural triangle, has the third highest number of art galleries in Istanbul. In 2022, the art galleries in Kadıköy constitute 12% of the art galleries in Istanbul. Despite the increase in the number of art galleries it hosts, it is seen that the proportion of Kadıköy district among the art galleries in Istanbul has also decreased (-4.8%). 2022 art gallery address data indicate that in Kadıköy, the Moda district, Kadıköy center and pier area, and Yeldeğirmeni neighborhood stand out as a region where art galleries are clustered. Another area where art galleries are concentrated is the Suadiye, Fenerbahçe, and Caddebostan neighborhoods and Bağdat Street. The Hasanpaşa neighborhood came to the agenda in 2022 as another region where art galleries are located.

Üsküdar, another district on the Anatolian side that stands out with its historical assets, is one of the sub-centers of the city in terms of spatial distribution and accessibility of the cultural facilities

it hosts. The number of art galleries in Üsküdar, which was 5 in 2000, increased to 11 in 2022. In 2022, the share of art galleries in the Üsküdar district in the total is 3.3%. The spatial location of art galleries in Üsküdar indicates that art galleries are concentrated in two different locations: the Altunizade neighborhood, which can be defined as a focal point for local cultural services, and neighborhoods along the Bosphorus, such as Kandilli and Kuzguncuk.

Bakırköy district is another sub-center serving its immediate surroundings in terms of spatial distribution and accessibility of cultural infrastructure. It is seen that the number of art galleries in the Bakırköy district did not change much from 2000 to 2022, increasing from 6 to 8. In the Bakırköy district, art galleries coexist with other cultural institutions in the settlement and are also located within large-scale fair and trade organizations that the district hosts.

The other districts, located on the periphery of the city, have fewer art galleries. In Kağıthane and Pendik there were no art galleries in 2000, and by 2022 there are 2 art galleries in each of these districts. In the Büyükçekmece, Maltepe, and Ümraniye districts, the number of art galleries has not changed since 2000, and still, there is 1 art gallery in each of these districts. In 8 districts of Istanbul—Adalar, Ataşehir, Başakşehir, Bayrampaşa, Beykoz, Kartal, Tuzla, and Zeytinburnu—there were no art galleries by 2000, and by 2022 there is 1 art gallery in each of these districts. According to the figures in the Bahçelievler district, there used to be 1 art gallery in Bahçelievler, but by 2022 there are no art galleries in this district. In 16 districts of Istanbul, there are no art galleries. These districts are mainly on the periphery of the city, with low integration into the cultural infrastructure both in terms of spatiality and accessibility.

4. Discussion

In this study, a comparison was made regarding the number of art galleries in Istanbul and their spatial distribution to districts between the years 2000 and 2022. Art galleries, a component of the cultural infrastructure with their unique organizational and management structures, play a crucial role in supporting artistic production and artists, facilitating the public's engagement with culture and art through exhibition practices, and ensuring the promotion of artists.

The literature on the spatial distribution of Istanbul's cultural infrastructure indicates that the cultural infrastructure and the culture-arts facilities are concentrated in the historical city center of Istanbul and on the CBD, which is an extension of the city center that developed in the 1990s. The region within the borders of Beyoğlu, Fatih, Şişli, Beşiktaş, Kadıköy, and Üsküdar districts, also known as the cultural triangle of Istanbul, includes cultural centers, theaters and performance halls, museums, historical monuments, and creative industries that support and nourish this entire cultural ecosystem.

Consistent with the research findings on the cultural infrastructure of Istanbul, the distribution of art galleries in 2000 revealed the spatial concentration in the Beyoğlu and Şişli districts. These two districts stand out in terms of the historical development of exhibition practices and the gallery sector in Turkey and Istanbul. Exhibition practices in Beyoğlu date back to the Ottoman Empire period, and the first art gallery of the Republican period was opened on İstiklal Street. In the latter half of the Republican period, art galleries began shifting from Beyoğlu to the Şişli district, where well-established galleries preferred to be located. Research results indicate that this historical trend continued into the year 2000. By 2022, it is seen that there is a significant increase in the number of art galleries in Istanbul, and this increase is particularly concentrated within the borders of the Beyoğlu district. However, while Beyoğlu is centralizing in terms of art galleries, it is noticeable that there is a decentralization within the district borders. Art galleries in Beyoğlu, on the one hand, maintain their presence around İstiklal Street; on the other hand, they are increasingly clustering in the Karaköy region. Additionally, between these two locations, new clusters have emerged in areas such as Tophane and Cihangir, situated on the hills of Beyoğlu. Several factors can be attributed to the decentralization of art galleries from İstiklal Street and its surroundings to Karaköy. The first of these is the opening of Istanbul's first modern museum, Istanbul Modern, in Karaköy in 2004. The Galataport project would be the other triggering factor, which was first brought to the

agenda in the 2000s and whose construction started in 2016 and was completed and inaugurated in 2021. Galataport is a controversial urban redevelopment project that brings together major cultural institutions such as Istanbul Modern and the Istanbul Museum of Painting and Sculpture, alongside other recreational, commercial, and touristic uses along the Karaköy waterfront. Since its initial proposal, the project has catalyzed significant functional and qualitative transformations in its immediate surroundings. Galataport and the Istanbul Modern Museum located within it are private-sector initiatives supported and facilitated by the state. This case provides a striking example of the prominent role played by the state and the private sector as key actors in shaping and directing Istanbul's cultural infrastructure. In addition, it is seen that art galleries have preferred areas in regions such as Tophane, which had been predominantly residential and were open to gentrification due to their lower use values compared to land values, and that functional and socio-cultural changes in these regions have been triggered by these new functions. This pattern in Tophane also overlaps with the tendency of art galleries to prefer areas open to gentrification as one of the factors influencing their location choices. In addition, it indicates a tendency for art galleries to position themselves in close proximity to other components of the cultural infrastructure—and to one another—thus forming clusters.

The capital-driven urban transformation that accelerated in İstiklal Street and its surroundings after the 2000s, characterized by gentrification, rising rents, and the replacement of cultural venues with more profitable commercial functions, began to transform the area's use and everyday life, leading to the loss of culture-related functions along İstiklal Street. Following the 2010s, the reconfiguration of the area for global tourism and international brands further accelerated this process (Kartal, 2021; Tekin & Akgün Gültekin, 2017; Erdi-Lelandais, 2015; Adanalı, 2011). Particular events such as the loss of the Emek Movie due to a shopping-mall-oriented redevelopment, the closure of the Atatürk Cultural Center for renewal, and the Gezi protests contributed to the deterioration and commercialization of cultural spaces in and around İstiklal Street. However, the research findings indicate that there has been a continued concentration of art galleries on İstiklal Street and in its surrounding neighborhoods in 2022, suggesting a gradual return of cultural activities to the area over time.

The findings indicate that art galleries are also spatially concentrated within the borders of Şişli and Beşiktaş, providing spatial integrity with Beyoğlu. Şişli holds a distinct position, as it is the primary central location where the art galleries sector, developed in the latter half of the Republican period, remains concentrated and continued to play its role in 2022. Within the borders of the Beşiktaş district, there is a concentration, especially in locations that have spatial integrity with Şişli. Additionally, the concentration of galleries in these areas can also be explained by the tendency, as highlighted in the literature, for galleries to locate in affluent neighborhoods. However, new clusters emerge in connection with adaptive reuse and regeneration projects in various locations in Beyoğlu, Şişli, and Beşiktaş. These clusters include the Dolapdere region, which experienced development concurrent with the inauguration of the Arter Cultural Center in Beyoğlu; the Bomonti region, which underwent gentrification following the opening of the Bomontiada Cultural Center, established through the adaptive reuse of the former brewery in Şişli; and the Akaretler region, which saw substantial growth subsequent to the renovation of its historic apartment buildings in the Beşiktaş district. These are private sector–led projects with specialized architectural and design features, and they contribute to the cultural infrastructure or support cultural activities.

Büyükdere Avenue and its surrounding areas also have a high concentration of art galleries. Since the 1990s, this area has been characterized by high-density vertical development as Istanbul's central business district, and it now includes mixed-use spaces such as modern office buildings, shopping malls, and residential projects. Büyükdere Avenue and its surroundings stand out as Istanbul's recently developed cultural hub, hosting national and international events through its cultural venues, theaters, concert halls, performance halls, and exhibition spaces. In 2022 Büyükdere Avenue and its surroundings have become one of the focal points of art galleries within

the borders of the Şişli, Beşiktaş, and Sarıyer districts. The findings also indicate that art galleries have also concentrated in the Bosphorus settlements of the Beşiktaş and Sarıyer districts on the European side of Istanbul. It can be stated that galleries' tendency to locate in these areas arises from both their tendency to cluster with other components of the cultural infrastructure and their preference to be within reach of other actors—like potential audiences and art-related investors—who are concentrated in these affluent neighborhoods.

On the Anatolian side of Istanbul, Kadıköy district and, more recently, Üsküdar district, stand out in terms of the presence of art galleries. Clusters with distinct characteristics are observed on this side of the city: one around the Kadıköy center, Moda, and Yeldeğirmeni neighborhoods, and another one along the Marmara Sea, particularly in affluent neighborhoods such as Suadiye, Fenerbahçe, and Caddebostan. In Üsküdar, art galleries are situated in the Altunizade neighborhood and along the Bosphorus coastline. In terms of the spatial distribution of art galleries, this pattern on the Anatolian side may be seen as an indicator that the Anatolian leg of the cultural triangle is expanding in various directions.

Despite these relatively central districts of the city with the briefly summarized spatial distribution characteristics, the presence of art galleries in other parts of the city is practically non-existent or very minimal. Undoubtedly, factors such as proximity to existing cultural infrastructure, accessibility, and affordable real estate values play a crucial role in the location choice of art galleries. Art galleries tend to prefer areas with existing cultural infrastructure that already offer these attributes. However, in peripheral areas that do not provide these features, collaborations with various stakeholders such as local governments, public institutions, artist initiatives, non-governmental organizations, and the private sector are crucial in the effort to bring art to the public. In addition to using the existing cultural infrastructure in these areas, implementing alternative exhibition practices that also utilize public spaces is crucial in introducing the arts to the public, increasing their interest and awareness, and integrating art into daily life. However, it is striking that the Bakırköy district, which in previous studies had been considered a cultural sub-center in Istanbul due to the cultural infrastructure it hosts, has remained quite overlooked in terms of the presence of art galleries. This finding points to the necessity of supporting sub-centers to ensure a balanced distribution of cultural and artistic activities, which often tend to be centralized in Istanbul.

5. Conclusion

As a result, this study has demonstrated an increase in the number of art galleries in Istanbul in 2000 and 2022, with a tendency for galleries to centralize their spatial location choices. This trend follows Istanbul's existing cultural infrastructure and aligns with the historical continuity of art gallery locations. This finding is consistent with the statement that art galleries tend to cluster in culturally and artistically vibrant cultural hubs to foster cultural engagement and interaction. In addition, research findings have revealed that new art gallery clusters have been formed in the peripheries of the central regions of Istanbul, triggered by the recently implemented adaptive reuse and redevelopment projects, which also demonstrate the influence of private-sector-led cultural investments on the reconfiguration of cultural spaces. This finding is consistent with the argument that art galleries tend to concentrate on areas revitalized through cultural and economic regeneration and redevelopment projects. The study also reveals that cultural production and consumption spaces in Istanbul are developing within a trend shaped and stimulated by large-scale cultural investments led by the private sector.

This study contributes to the urban planning and cultural studies literature by comparatively revealing the spatial transformation of art galleries in Istanbul between the years 2000 and 2022. The assessments regarding the overall distribution of art galleries across the city’s macroform and the locations where they tend to cluster provide initial insights into the factors influencing their location choices, offering a data-driven framework for developing a balanced and inclusive cultural strategy.

As this study focused on art galleries at the city scale, it was inevitably not possible to capture in detail the localized conditions that emerge at the cluster level. Future research focusing on smaller-scale clusters could more clearly reveal the relationships between urban dynamics, gallery location patterns, and the spatial, social, cultural, and economic impacts that galleries generate in their immediate surroundings. Examining galleries' organizational characteristics and the networks among relevant actors would also help explain their location choices and the specific dynamics of each cluster. Such studies could support the identification of how art galleries' roles within the cultural infrastructure and cultural ecosystem vary across clusters, thereby providing a basis for policies that enhance and support their activities. Furthermore, understanding the spatial, social, cultural, and economic impacts of art galleries within the clusters would make it possible to develop policies aimed at managing and guiding these effects.

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CRediT Authorship Contribution Statement

Elif Kısar Koramaz: Conceptualization, literature review and writing, methodology, data curation, analysis and results, writing, review and editing. Vedia Dökmeci: Conceptualization, literature review and writing, methodology, data curation. Numan Kılınç: Methodology, visualization and spatial analysis.

Declaration of Competing Interest

The authors declare that they have no known competing monetary interests or personal relationships that could have influenced the work reported in this paper.

Acknowledgement

The authors gratefully acknowledge Ekin Sanaç for providing support related to art galleries for the year 2000.

Data Availability

The data that support the findings of this work are available from the corresponding author upon reasonable request.

Ethics Committee Approval

Approval from an ethics committee was not required for this research.

Resume

Elif Kısar Koramaz graduated from the Department of City and Regional Planning at the Faculty of Architecture, Istanbul Technical University, in 2000. She completed her master's and doctoral studies at the Institute of Science, Istanbul Technical University, in the Master's Program in Landscape Planning and the PhD Program in City and Regional Planning, respectively. She completed her dissertation on topics of urban green areas and quality of life. Kısar Koramaz has been a member of the Landscape Architecture Department, ITU, since 2020. Her research areas, at the intersection of planning and urban design, include housing studies and urban renewal, public spaces, urban green areas and quality of life, cultural infrastructure and cultural policies, as well as environmental psychology.

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JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (581-601), 2025
DOI: 10.47818/DRArch.2025.v6i3184

The transformation of historical and spatial identity through adaptive reuse: The case of Cendere Art Museum

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Abstract

The adaptive reuse of industrial buildings is of great importance in terms of preserving industrial heritage and ensuring spatial continuity in the process of rapid urbanization. This study analyzes the conversion of the former Cendere Water Pumping Station, an important industrial building located in Sarıyer, Istanbul, and built in 1902, into the Cendere Art Museum. Following a comprehensive restoration and adaptive reuse process, the building reopened as a museum on October 24, 2022. The primary objective of this research is to critically analyze, through a single case study, the demonstrable impact of adaptive reuse on the spatial and functional character of a historic industrial building. The research specifically examines the interaction between the reuse process, spatial identity transformation, and cultural sustainability within the framework of the Cendere Art Museum. To address this, a unique evaluation framework integrating six key parameters derived from the literature was developed and applied. This holistic model is designed to systematically analyze the multi-layered transformation of spatial identity. The study employs a qualitative methodology. Primary data collection tools included site observations (conducted across three distinct dates in 2024), visual documentation analysis, and a SWOT analysis whose rigor was enhanced through data triangulation. The structure was assessed based on six main spatial parameters: structural features, functional compliance, lighting and air conditioning, historical and aesthetic values, contextual integration, and technological infrastructure. The collected data were analyzed under the themes of spatial identity, the adaptive reuse process, and cultural sustainability. The adaptive reuse process contributed to the continuity of spatial memory by preserving original industrial elements, such as the facade form and the load-bearing system. High ceilings and wide spans provided crucial spatial flexibility for exhibitions and events. However, modern additions, such as glass facade extensions and certain interior modifications, were found to have partially detracted from aesthetic coherence. The structure's conversion into a social gathering space (including a library and workshops) made a positive contribution to cultural sustainability by integrating historical heritage into public use scenarios. The developed six-parameter methodological model provided a strategic framework for the systematic identification of the building's strengths and weaknesses. The study demonstrates that adaptive reuse can transform historical buildings into a dynamic presence that meets contemporary needs while preserving their spatial identity. The proposed multi-dimensional analysis model is considered a valid tool for re-evaluating cultural heritage structures based on principles of spatial sustainability and contextual sensitivity. Future research is recommended to focus on collecting quantitative data on aspects such as user satisfaction, energy performance, and social dimensions to enable a more in-depth analysis of spatial identity.

Keywords: Cendere Art Museum, cultural sustainability, industrial buildings, adaptive reuse, spatial identity

1. Introduction

The adaptive reuse of industrial buildings forms an important bridge between sustainability and cultural heritage preservation within contemporary urbanization processes. Reusing disused or functionally obsolete industrial structures enables the regeneration of economic, social, and environmental values. This approach is defined in the literature as adaptive reuse and is particularly

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Article history: Received 17 December 2024, Revised 16 April 2025, Accepted 16 October 2025, Published 24 December 2025

noted for its successful examples that integrate contemporary requirements with historical contexts. Projects such as the Utopia Performing Arts Library in Belgium and the Roskilde Folk High School in Denmark are exemplary applications that combine aesthetics and functionality (Turkey Design Council, 2024). In Turkey, various projects have been developed in recent years focusing on the preservation and transformation of industrial buildings from the Ottoman and early Republican periods. The Feshane and Bomontiada examples in Istanbul represent successful local applications that have been transformed through cultural use scenarios (Saner, 2012; Güngör & Gökçen, 2022). This study was conducted specifically on the Cendere Art Museum, located in the Sarıyer district of Istanbul, aiming to evaluate its spatial transformation by addressing aspects of design, functionality, and sustainability in conjunction with the building's historical identity and environmental context. Accordingly, an evaluation model based on six key parameters highlighted in the adaptive reuse literature was developed. This integrated model differs from existing single-focused frameworks because it enables the systematic analysis of the simultaneous interaction of physical, functional, and perceptual (identity) dimensions, which are often fragmented or overlooked in traditional adaptive reuse assessments. Therefore, the model's originality lies in the synthesis of these multi-scale criteria, specifically adapted to the context of Industrial Heritage and Spatial Identity. This model was applied to the building using a qualitative research approach, employing methodological tools such as SWOT analysis and visual documentation. The application of this methodological framework specifically to the Cendere Art Museum case study fills a gap in the existing literature, as the case has not been studied in depth before, offering a unique methodological and case-based contribution.

1.1. Purpose

The primary aim of this study is to examine the relationship between the spatial transformation that occurs during the adaptive reuse of industrial buildings and the concepts of historical identity and cultural sustainability, using the case of the Cendere Art Museum. To achieve this objective, an evaluation model comprising six parameters related to the adaptive reuse process was developed and applied specifically to the building. The study also aims to discuss the potential methodological contributions of this model to the disciplines of interior architecture and architecture.

1.2. Problem

Industrial buildings constructed during the Industrial Revolution have become outdated over time due to technological changes and urbanization pressures, and today they are often abandoned. This situation has led to the deterioration of cultural heritage and spatial continuity. Adaptive reuse is a critical intervention strategy that facilitates the integration of historical structures into contemporary life while simultaneously securing the preservation of their inherent historical stratification. In this context, the Cendere Art Museum was selected and the transformation process was analyzed through a qualitative case study.

1.3. Questions

The study seeks to answer the following research questions:

RQ1: How has the adaptive reuse process transformed the spatial identity of the selected industrial building?

RQ2: What potential contributions does the Cendere Art Museum offer in terms of cultural sustainability, and how are these contributions related to the building's contextual characteristics?

RQ3: How can the methodological approaches used in this study serve as a reference for similar adaptive reuse projects?

1.4. Limitations

This study is limited to the case of the Cendere Art Museum and does not aim for statistical generalization. The analyses were primarily conducted through observations focusing on the

building's physical, functional, and contextual characteristics; however, data regarding social dimensions such as user behavior, spatial experience, and social attachment were unavailable for collection. The main reason for this limitation is that we have not been able to obtain the necessary ethical approvals to conduct interviews and surveys with users. As a result, the multidimensional structure of the concept of spatial identity has not been fully researched, and evaluations have remained limited to the selected physical model. The absence of findings related to user interaction and social dynamics is considered a significant gap that future studies should address to enable a more in-depth analysis of spatial identity and cultural sustainability.

2. Conceptual Framework

2.1. Concept and Reasons for Adaptive Reuse

Adaptive reuse refers to the adaptation of buildings to a new function by changing their existing characteristics. This process involves not only physical transformation but also a change in the cultural and social context. The main reasons why buildings lose their original functions are economic, socio-cultural and environmental factors (Gazi & Boduroğlu, 2015). Turanlı and Satıcı (2021) define adaptive reuse as bringing of buildings that have lost their usability to society with new functions while preserving their original identity. The adaptive reuse of buildings is of great importance in terms of preserving historical traces and transferring the past to future generations. Two key concepts frequently emphasized in this study -spatial identity and cultural sustainability- constitute the primary axes of the current research. Spatial identity is defined as a multilayered whole shaped not only by the physical form and material character of the building but also by its historical background, user experiences, representation in social memory, and perceptual impacts (Relph, 1976; Norberg-Schulz, 1980). Cultural sustainability, on the other hand, is understood as a holistic approach that seeks not only the physical preservation of buildings but also their revitalization through socio-cultural functions and the meaningful transmission of their significance to future generations (Soini & Birkeland, 2014). This process consequently supports the safeguarding of cultural values, provides a robust economic contribution, and actively fosters social interaction. Akadiri and Iliopoulos (2021) state that the conversion of existing buildings is a more economically viable approach than the construction of new buildings.

2.2. Choosing the Right Function and Interventions

In adaptive reuse processes, it is crucial to analyze the building's current condition and select the appropriate functions and intervention methods. Proper conservation and re-functionalization of historic buildings should be based on historical sources and international regulations. Yalçın (2024), in the case of the Historic Bitlis Municipality Building, stated that the correct interventions and function choices should focus on the preservation of aesthetic and historical identity. In determining the right function, it should be based on remaining faithful to the original identity, preventing structural damage, considering social benefit and preserving integrity. International documents such as the Carte Del Restoration Charter, the Venice Charter and the Amsterdam Declaration are used as guides in these processes.

2.3. Industrial Buildings and Repurposing Applications

Industrial buildings were shaped by social, cultural and economic influences after the industrial revolution. However, technological advances and urbanization processes have caused these buildings to become dysfunctional and idle over time. Tunçer and Ateş Can (2022) emphasize that the adaptive reuse of industrial buildings adds value to that part of the city while preventing the damage that the demolition of a large building would cause to the city. Among the preservation methods of industrial buildings, adaptive reuse stands out as an important approach. Höhmann (1992) categorized these methods under subheadings such as preservation as is, preservation close to the old function, preservation by giving museum function and preservation by giving new function. Ahunbay (2009) stated that these methods play a critical role in preserving the physical integrity of buildings and adapting them to contemporary life. In the international context, The Tate

Modern (London) project transformed a former power station into a contemporary art museum, establishing it as a cultural landmark (Figure 1). The building's industrial character has been preserved, and its vast interior spaces have been converted into exhibition and event areas, demonstrating structural integrity and fidelity in the transformation of an industrial power station into a contemporary art museum.

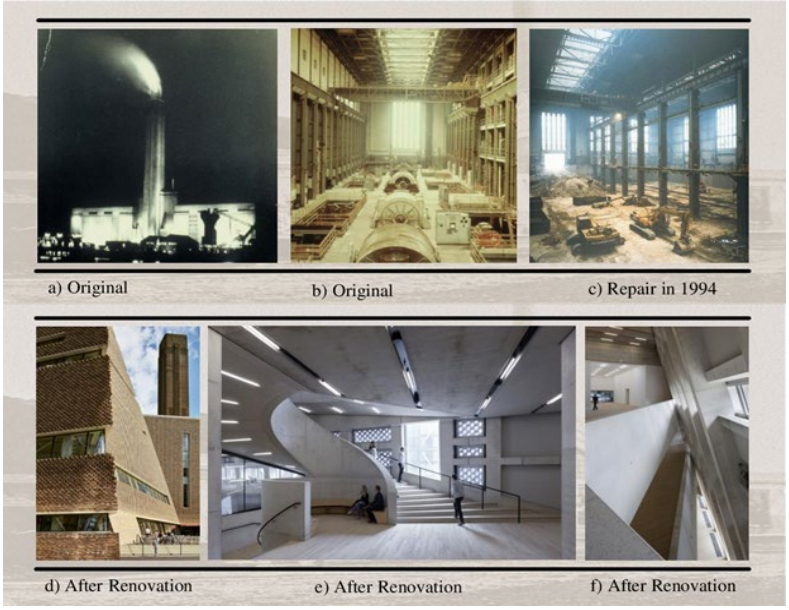

Figure 1 Tate Modern before and after its transformation (Herzog & de Meuron, n.d.)

De Hallen (Amsterdam) has become a focal point of social life through the transformation of a former tram depot into cultural and commercial spaces (Figure 2). It houses a library, cinema, and local designer shops, establishing a sustainable model for urban interior use by creating a multifunctional public space.

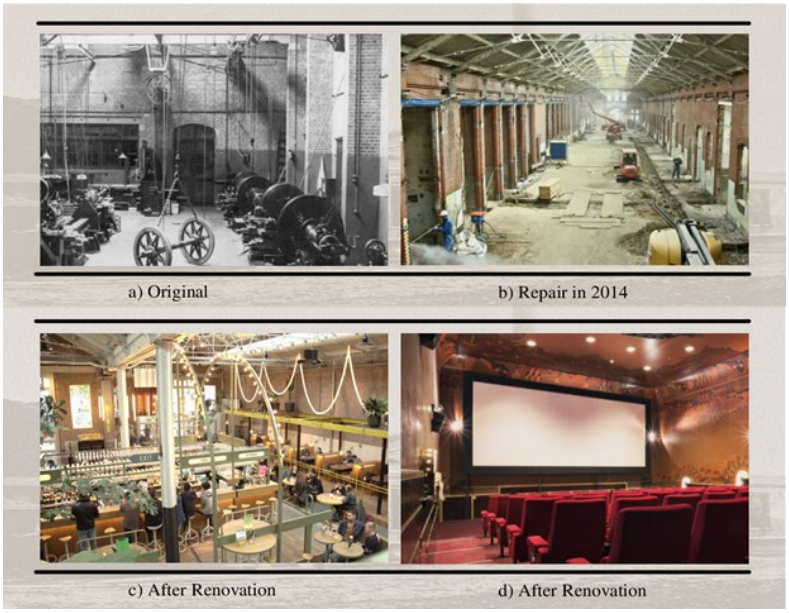

Figure 2 De Hallen interior use (De Hallen Amsterdam, n.d.)

El Born CCM (Barcelona) is an example of a protected market building that has been transformed into both a museum and a public event space by incorporating its archaeological remains into the exhibition (Figure 3). This transformation has revealed the site's historical layers, preserved them, integrated them into the spatial design, and strengthened the building's connection to its past.

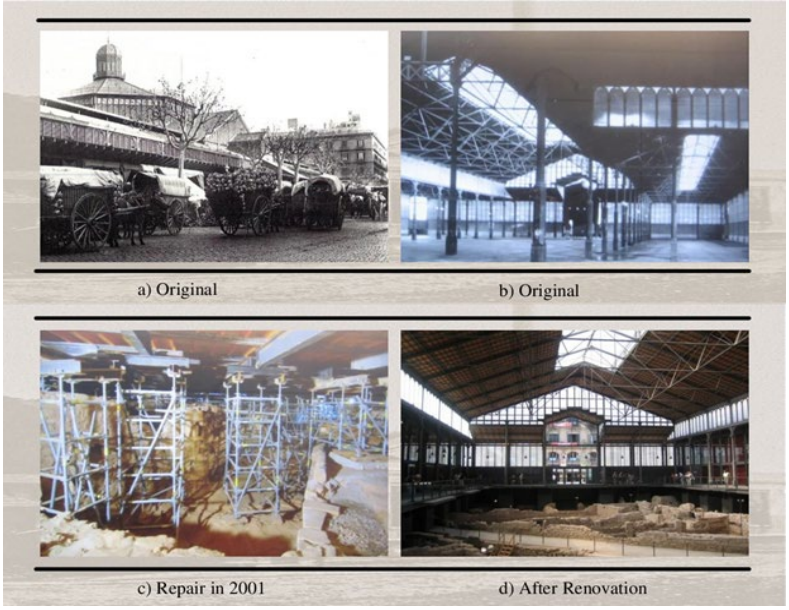

Figure 3 El Born CCM archaeological floor plan (Wikiarquitectura, n.d.)

In the context of Turkey, the new building of Istanbul Modern is part of the transformation process of the port structures in the Galataport area and hosts contemporary art galleries (Figure 4). The new function has strengthened the building's relationship with the waterfront, enhancing its aesthetic integrity.

Figure 4 Istanbul Modern facade detail (Istanbul Modern, n.d.)

CerModern (Ankara) has become one of Turkey's leading art centers through the repurposing of old train maintenance hangars for cultural and artistic functions (Figure 5). In terms of spatial design, it preserves industrial volumes while providing flexibility for exhibition spaces through wide spans and high ceilings, also enabling the creation of adaptable exhibition areas.

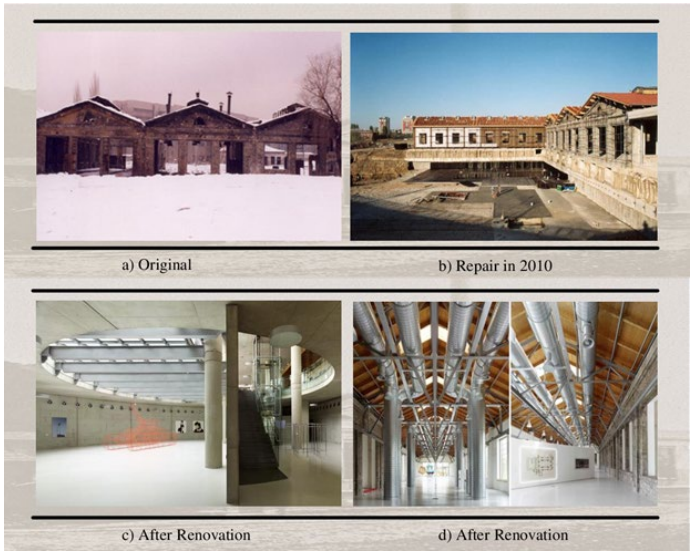

Figure 5 CerModern exhibition hall (Uygur Architects, n.d.)

The Cendere Art Valley (Istanbul) was developed as a public strategy for the transformation of underutilized industrial areas and was designed as a space focused on cultural production (Figure 6). The industrial identity of the area has been reinterpreted through contemporary architectural interventions, representing an adaptive reuse strategy at the urban scale.

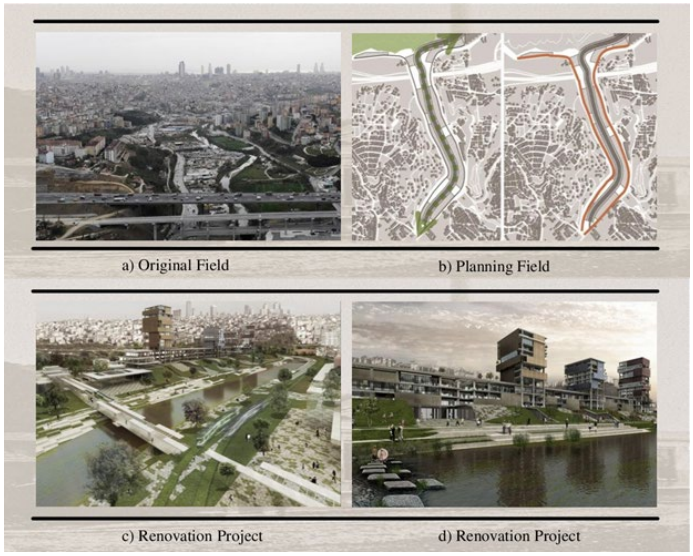

Figure 6 Cendere Art Valley master plan (Arolat, n.d.)

These projects are evaluated not only in terms of physical transformation but also through dimensions such as spatial identity, user interaction, and social engagement. The user experience is enhanced, the memory of the historical structure is preserved, and integration with contemporary urban life is achieved. Through these examples, approaches to the adaptive reuse of industrial buildings have been comparatively assessed in both local and international contexts. However, the vast majority of existing models for adaptive reuse feasibility and assessment in the literature tend to narrow the evaluation criteria down to a single axis. The prevailing approach determines the criteria by focusing either solely on technical feasibility or on a narrow environmental heritage perspective. A significant limitation of these single-focus frameworks is their inability to holistically analyze the multi-layered transformation in complex processes, such as the conversion of an industrial building into a museum. Existing frameworks fall short in examining how structural decisions simultaneously affect the perceived spatial identity and the relationship with the urban context. Therefore, the six-parameter framework presented in our study has an

original synthesizing structure. Our model integrates criteria derived from the literature by combining different scales and disciplines, serving the objective of Transforming Industrial Heritage and Spatial Identity. The original contribution of our model lies in its capacity to analyze the holistic sustainability and multi-dimensional interactions of the adaptive reuse process, unlike single-focus assessments.

3. Identification of Parameters for the Adaptive Reuse Process

3.1. Theoretical Foundations of the Evaluation Parameters

The primary objective of this study is to overcome the limitations of existing single-focused models and analyze the multidimensional interactions that influence Spatial Identity. Therefore, the six parameters selected for analysis were specifically designed to provide a unique synthesis of criteria drawn from various literature sources. The model's structural originality lies in its fusion of criteria, encompassing physical feasibility (such as Structural Features) with perceptual (Cultural Identity) and environmental (Contextual Relationship) criteria, all within one comprehensive framework. This methodological synthesis elevates the model beyond a mere technical assessment tool into a purpose-built methodology for measuring holistic sustainability in complex reuse projects. The evaluation parameters employed in this study were structured to comprehensively address the physical, functional, environmental, and historical dimensions of adaptive reuse processes. Each parameter was derived from criteria widely recognized in the adaptive reuse literature and was integrated for methodological purposes. The parameters not only serve as independent assessment criteria but also function interactively, providing a structural framework that enables a holistic analysis of the reuse process. Accordingly, the spatial transformation process of the Cendere Art Museum was analyzed using six key evaluation parameters developed through a literature-based approach: structural features, functional compatibility, lighting and climate control, historical and aesthetic values, contextual environmental relationship, and technological infrastructure (Table 1).

Table 1 Academic Literature (Created by the Authors)

Parameter	Academic References	Key Concepts	Method	Contribution Summary
Structural Characteristics	Conejos et al. (2013)	Sustainability, Adaptation, Building Physics	Modeling, Content Analysis	Presents sustainability criteria for building adaptation through the AdaptSTAR model.
Functional Compatibility	Shipley et al. (2006)	Economic Sustainability, Functionality	Survey, Quantitative Analysis	An empirical study evaluating the economic benefits of adaptive reuse.
Lighting and Climate Control	Cantizani Oliva et al. (2019)	Natural Lighting, Energy Efficiency	Energy Simulation, Physical Measurement	Proposes natural lighting strategies for cultural heritage buildings.
Historical and Aesthetic Values	Yung and Chan (2012)	Social Sustainability, Aesthetic Values	Field Study, Document Analysis	Provides an analysis focusing on the interaction of the historic building with the community and its social acceptance.
Contextual and Environmental Integration	Douglas (2006)	Contextuality, Environmental Compatibility, Intervention	Theoretical Synthesis, Literature Review	Offers a comprehensive presentation of fundamental theoretical and technical knowledge on building adaptation.
Technological Infrastructure	Kadeli et al. (2025)	Smart Building, Digital Transformation, Cultural Heritage	Case Study, Technological Application Analysis	Demonstrates the integration of smart building technologies into historic building adaptations.

Each parameter is based on widely accepted physical, environmental, and functional assessment criteria found in the literature. These parameters were evaluated in conjunction with the SWOT analysis and supported by visual documentation and field observations, enabling the analysis of not only physical attributes but also multi-layered aspects such as functional adequacy, user

interaction, and environmental integration. The model developed within this context is proposed as a context-sensitive and flexible evaluation tool for adaptive reuse processes.

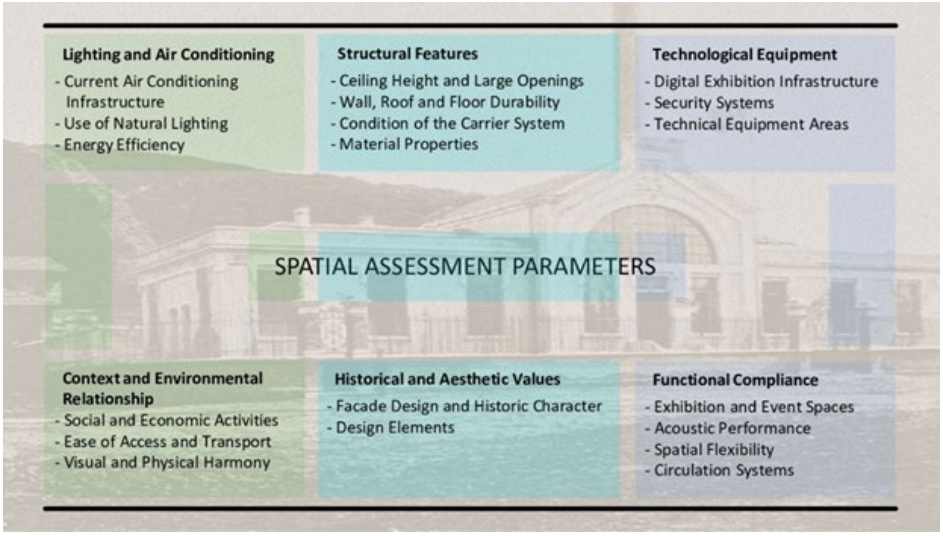

Figure 7 Cendere Art Museum, spatial assessment parameters (Created by the authors)

Figure 7 illustrates the analytical framework that applies the six parameters described above to the specific case of the Cendere Art Museum. The model is organized under the categories of the building, spatial identity, and cultural sustainability, with each parameter classified and linked through SWOT analysis.

3.2. Working Area

The study area is located along Cendere Street in the Ayazağa District of Sarıyer, Istanbul, Turkey. The subject of the research, the Cendere Art Museum -originally known as the Cendere Pumping Station- is one of the few surviving examples of industrial heritage structures in Istanbul. The building was constructed in 1902, during the reign of Sultan Abdulhamid II, to address the increasing demand on the city's main water supply system, the Taksim water facilities. Over time, the structure lost its 33-meter-high brick chimney and, despite these interventions, has largely preserved its original fabric to the present day (Figure 8).

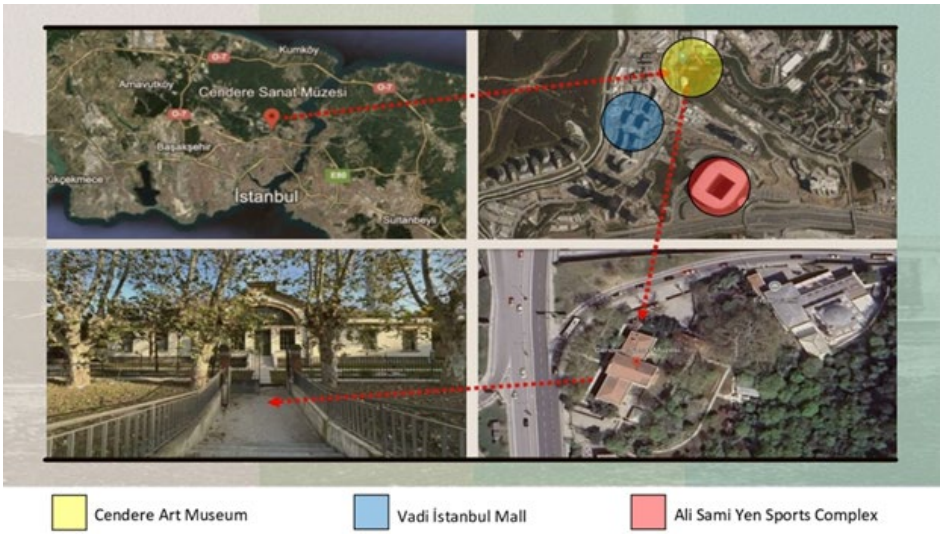

Figure 8 Environmental diagram for Cendere Art Museum (Google Earth, 2024; TKGM, 2024)

The spatial organization of the building consists of a central main volume accompanied by adjoining service areas. The main volume accommodates exhibition spaces, multipurpose activity areas, and circulation zones (Figure 9 & Figure 10).

Figure 9 Site plan and legend study of the Cendere Art Museum (Çınar, 2022. Edited by the authors)

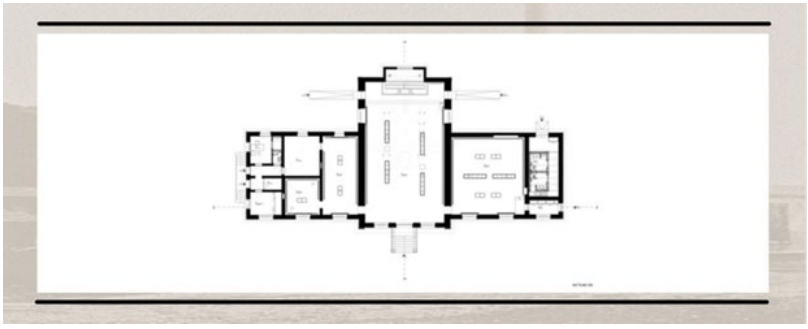

Figure 10 Ground floor plan of the Cendere Art Museum (Çınar, 2022)

The facade design features stone walls, large industrial window openings, and metal structural elements (Figure 11). In the longitudinal sections, roof skylights and spatial openings are evident (Figure 12).

Figure 11 Facade design of the Cendere Art Museum (Çınar, 2022)

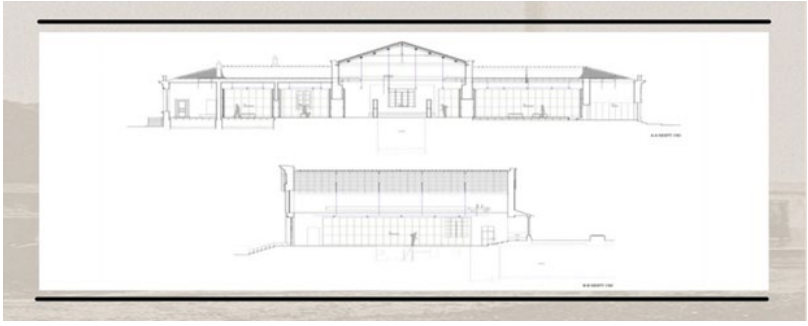

Figure 12 Sections of the Cendere Art Museum (Çınar, 2022)

On October 24, 2022, following a comprehensive restoration and adaptive reuse process, the building was reopened to the public as the Cendere Art Museum. During the restoration, previous interventions were removed, and the structure was repurposed while preserving its original identity. In the exhibition areas, only essential elements -such as backdrop walls, mechanical installations, and lighting fixtures- were added. The building was maintained as a neutral shell, distinct from newly added exhibition components. The ancillary structures were organized to accommodate workshop and administrative spaces. In the garden located at the front of the building, a layout was designed that preserved the natural boundaries defined by the existing trees. Circulation routes were established, guiding visitors from the entrance to the main historic building, the registered 400-year-old plane tree, the café, and the workshop areas. Along these routes, open-air exhibition plazas were created (Figure 13) (Çınar, 2022).

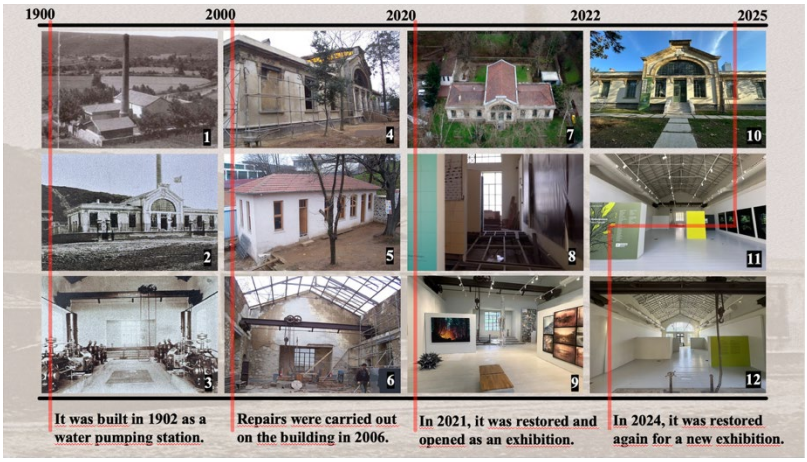

Figure 13 Historical process diagram of Cendere Art Museum (Kağıthane Municipality, n.d. [1], Cendere Art Museum, n.d. [2,3], Rena Construction, 2006 [4,5,6], Independent, n.d. [7], Youtube, 2022 [8], Artfullivingart, 2024 [9], Photographed by authors [10,11,12]. Edited by the authors)

3.3. Data Collection Tools

Only qualitative data collection methods were employed in this research. The tools used are as follows:

Visual Documentation Analysis: Archival photographs, architectural plans, drawings, and maps related to the restoration process were examined to analyze the building's physical and architectural features. These documents provided a valuable visual resource for understanding the historical transformation of the structure. Field Observations: On-site observations were conducted to directly examine the building's physical characteristics, spatial organization, and technical features. The observations were carried out on three different dates in 2024 (April, July, and November), each lasting approximately 2 to 4 hours. This series of three observation rounds followed a systematic data collection process. The observations were structured according to six key parameters defined in the study. Each observation was designed to document the physical, functional, and visual relationships between the building and its environmental context based on these parameters. Observation forms and note-taking techniques were employed during the process, and the same analytical template was applied in each round to ensure consistency. In the evaluation process, principles identified in the literature were used as references for analyzing the relationship between the historical structure and contemporary interventions. The findings were supported by visual documentation and integrated into the SWOT analysis.

SWOT Analysis: This method was employed to systematically assess the strengths, weaknesses, opportunities, and threats related to the adaptive reuse process of the Cendere Art Museum. The inherently limited interpretative capacity of the SWOT analysis was complemented by field observations and visual documentation, thereby creating a triangulated analytical framework. The validity and objectivity of each SWOT factor were systematically cross-checked against empirical

evidence from field observations and the six evaluation parameters, thereby significantly enhancing the reliability of the overall assessment.

3.4. Analyzing the Data

The collected data were evaluated using qualitative analysis methods, and the SWOT findings were thematically categorized through content analysis. In the analyses conducted under the themes of spatial identity, adaptive reuse process, and cultural sustainability, the limited interpretative depth of the SWOT analysis was complemented by field observations and visual documentation, enabling a more comprehensive and methodologically rigorous assessment. This systematic cross-validation process has ensured the internal consistency of the SWOT findings. This has strengthened the overall robustness and reliability of the analytical model.

4. Results and Discussion

The adaptive reuse process of the Cendere Art Museum was analyzed within the framework of six basic spatial evaluation parameters. These parameters are structural features, functional suitability, lighting and air conditioning, historical and aesthetic values, context and environmental relationship, and technological equipment, and are summarized as follows (Figure 14).

Figure 14 Cendere Art Museum restoration works (TAY Project, n.d. [13,14], Youtube, 2022 [15,18,19,20,21,22,23,24], mimdap, n.d. [16], Rena Construction, 2006 [17], Edited by the authors)

4.1. Structural Features

The structural system has been reinforced with steel supports, ensuring structural stability. High ceilings and spans provide spatial flexibility, although heat loss and surface deterioration have been noted in certain areas. The floor and roof systems are generally sound; however, localized risks of moisture-related deformation have been identified. Material selections largely reflect compatibility with the historical fabric, although some original surfaces have been covered (Figure 15, 16, 17 & Figure 18).

Figure 15 Cendere Art Museum structural systems (Rena Construction, 2006. Photographed by authors)

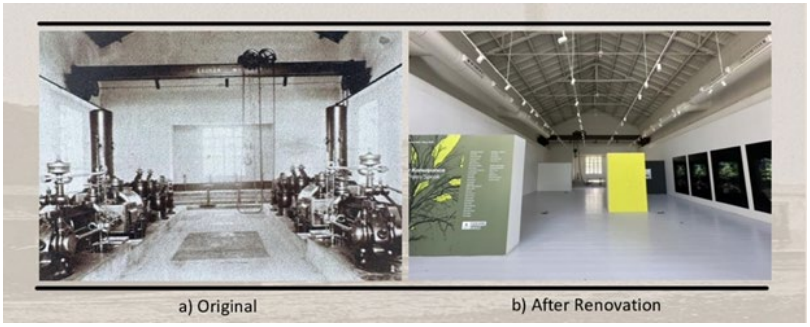

Figure 16 Cendere Art Museum ceiling and openings (Cendere Art Museum, n.d. Photographed by the authors)

Figure 17 Cendere Art Museum wall, roof and floor (Polat, 2022. Photographed by authors)

Figure 18 Cendere Art Museum material exchange (Polat, 2022. Photographed by the authors)

4.2. Functional Compliance

Spatial flexibility accommodates a variety of uses; however, in certain areas, fixed layouts limit adaptability. While the primary circulation routes are clear and facilitate wayfinding, narrow passageways may pose challenges during periods of heavy use. Exhibition and event spaces possess multipurpose potential, yet fixed arrangements restrict versatility. Acoustically, some spaces are suitable; however, sections with inadequate reverberation control were also identified (Figure 19, 20, 21 & Figure 22).

Figure 19 Cendere Art Museum functional additions (Photographed by the authors)

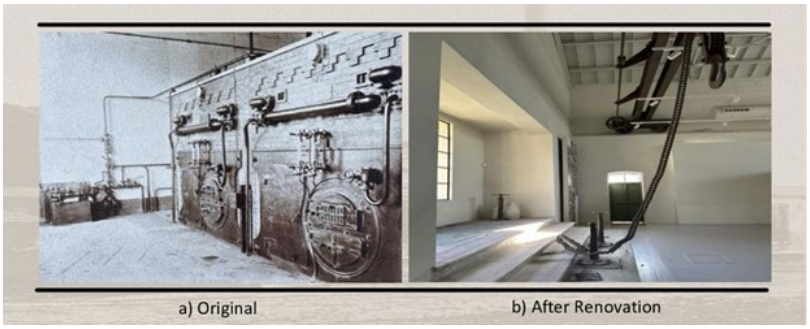

Figure 20 Cendere Art Museum circulation system (Cendere Art Museum, n.d. Photographed by the authors)

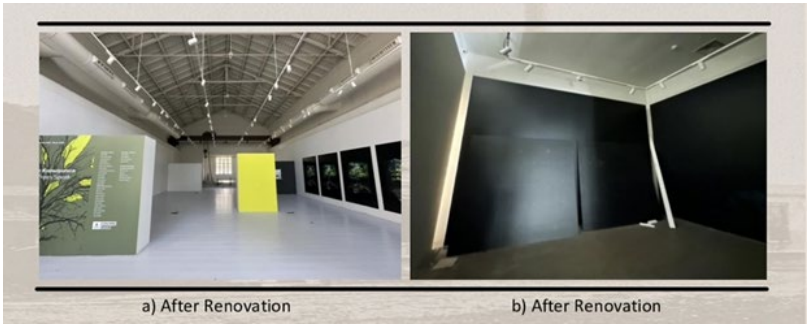

Figure 21 Cendere Art Museum exhibition and event spaces (Photographed by the authors)

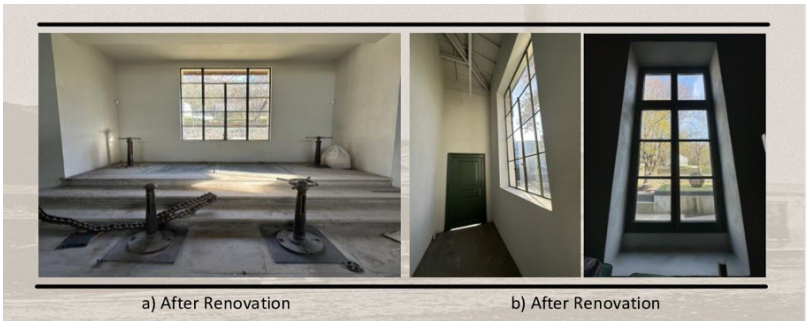

Figure 22 Openings creating acoustic problems at Cendere Art Museum (Photographed by the authors)

4.3. Lighting and Air Conditioning

Natural lighting is sufficient due to the positioning of the windows; however, inadequate lighting has been observed in certain interior spaces. Existing climate control systems have been integrated at a basic level, yet the placement of equipment disrupts visual continuity. Although passive heat gain is achieved in some areas in terms of energy efficiency, insufficient insulation has been identified as a cause of energy loss (Figure 23, 24 & Figure 25).

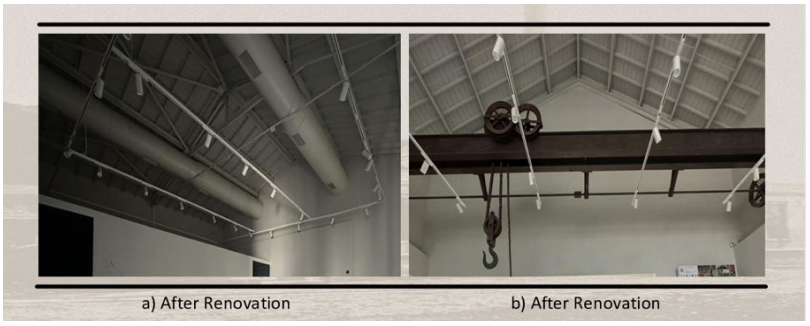

Figure 23 Cendere Art Museum lighting system (Photographed by the authors)

Figure 24 Natural light gaps in the Cendere Art Museum (Photographed by the authors)

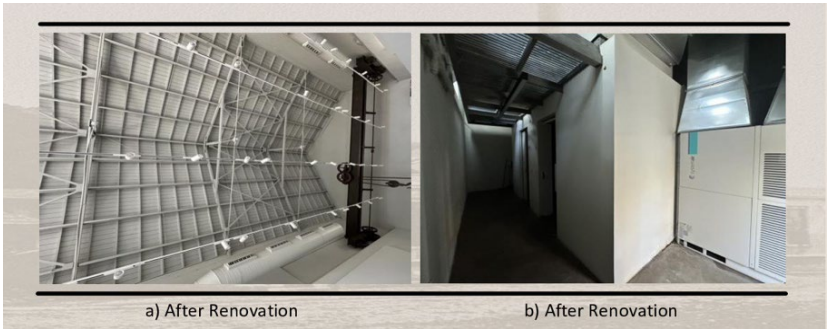

Figure 25 Cendere Art Museum air conditioning system (Photographed by the authors)

4.4. Historical and Aesthetic Values

A sense of coherence has been achieved between the new and historical design elements, and the facades have preserved their historical identity. However, certain modern additions - particularly material transitions on the facade- have been assessed as weakening aesthetic harmony. While an overall balance has been maintained in terms of visual integrity, restoration techniques could further enhance the aesthetic quality (Figure 26 & Figure 27).

Figure 26 Cendere Art Museum design old and new sections (Photographed by the authors)

Figure 27 Cendere Art Museum facade renovation (Rena Construction, 2006. Photographed by authors)

4.5. Context and Environmental Integration

The building is physically and visually integrated with the urban fabric. However, certain elements on the rear facades diminish contextual coherence. In terms of social functions, spaces such as the library and workshops support user interaction; nevertheless, it has been observed that access opportunities are not provided equally for all user profiles. While the central location offers a significant advantage, the lack of wayfinding systems imposes limitations on accessibility (Figure 28, 29 & Figure 30).

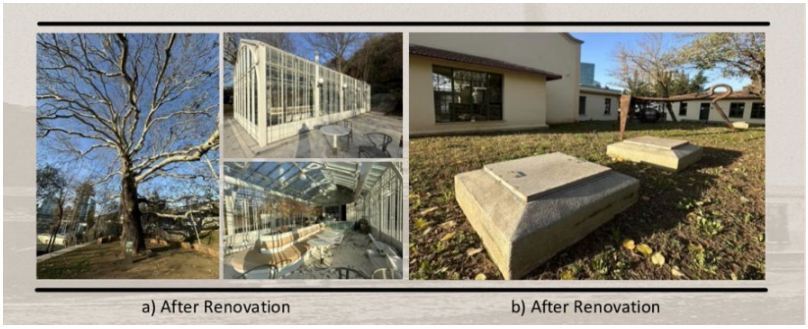

Figure 28 Cendere Art Museum landscape area renovation (Photographed by the authors)

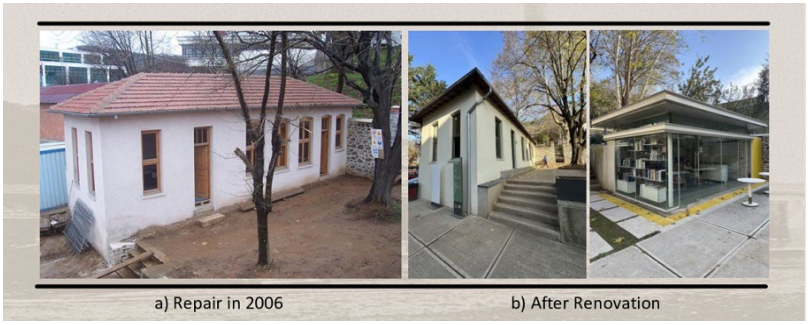

Figure 29 Cendere Art Museum administration and library buildings (Rena Construction, 2006. Photographed by authors)

Figure 30 Cendere Art Museum parking lot and direction signs (Photographed by the authors)

4.6. Technological Equipment

The building possesses a basic level of digital exhibition infrastructure; however, the system lacks up-to-date technology and integrated connectivity. Although security systems have been provided at a minimum standard, deficiencies have been identified in terms of emergency exits and monitoring systems. While the technical service areas fulfill essential functions, their physical capacity is deemed limited for the integration of new technological systems.

The findings obtained during the adaptive reuse process of the Cendere Art Museum reveal a complex relationship between the historical and spatial identity of the building and its cultural sustainability goals. The findings derived from the six-parameter evaluation model are subjected to a critical analysis, grounded in the study's conceptual framework and contextualized within relevant academic literature and comparative international case studies. The six-parameter analysis

presented above necessitates a holistic synthesis of the adaptive reuse process at the Cendere Art Museum, particularly focusing on the interplay among core parameters. A direct and mutually reinforcing interaction is observed among the parameters of structural features (4.1), functional compliance (4.2), and contextual environmental relationship (4.5). The successful reinforcement of the structural system and the preservation of high ceilings and wide spans (Structural) secured spatial flexibility, which proved crucial for facilitating multipurpose exhibitions and events (Functional). This functional adaptability preserves the building's industrial memory while also enabling the establishment of strong socio-cultural relationships with surrounding urban-scale developments such as Art Valley (Contextual). Consequently, the interplay among these core parameters reveals not only a successful physical transformation but also an interpretive coherence that fundamentally supports the continuity of the structure's spatial identity and its cultural sustainability.

The building's industrial character -particularly the spatial flexibility afforded by its high volumes and structural openness- constitutes the strongest aspect of its reuse. The reinforcement of the structural system and the preservation of the high ceilings (Structural) have been found to guarantee spatial flexibility, providing a multi-purpose potential for exhibitions and events (Functional). However, this physical success is accompanied by certain challenges in terms of aesthetic and perceptual identity (4.4 Historical and Aesthetic Values). In particular, modern glass façade extensions and incongruous interior interventions create a tension between the building's original industrial aesthetic and its new museum identity. This outcome demonstrates that the multi-layered identity of ‘place,’ encompassing physical form, cultural meaning, and perceptual experience, as advocated by academics such as Relph (1976) and Norberg-Schulz (1980), cannot be achieved in a uniform manner. Although the building's industrial memory has been preserved, weaknesses have been identified in terms of user experience and overall perceptual consistency. The building's conversion into a social gathering space (including a library and workshops) made a positive contribution to cultural sustainability by integrating historical heritage into public use scenarios. This approach is aligned with the broader definition of sustainability, encompassing the continuation of the building's social function beyond mere physical preservation. In this respect, the principle emphasized by Soini and Birkeland (2014) of viewing cultural sustainability as a 'dynamic process' has been successfully enacted through Cendere’s adoption of a dual role: not just as an 'exhibition space,' but also as a 'social gathering hub'. The strong points identified in the 4.5 (Contextual and Environmental Integration) parameter of the structure directly support the achievement of the cultural sustainability goal. The adaptive reuse approach at the Cendere Art Museum shows clear parallels with established international trends in industrial heritage conservation. Internationally, Tate Modern (London), exhibits a strong parallel with Cendere in the core philosophy of transforming high-volume, industrial architecture into an art venue. For example, the strategy of preserving the structural system to achieve spatial flexibility aligns with the approach seen in the Tate Modern in London, where both projects utilize the vast industrial volume as a neutral shell for new cultural programming. Both structures successfully translated the spatial flexibility -gained from the large spans and high ceilings covered in parameter 4.1 (Structural Features)- and translated it into functional efficiency (parameter 4.2 Functional Compliance). However, Tate Modern adopted a more restrained and consistent approach to preserving the building's original structural and aesthetic integrity. In contrast, Cendere’s explicit glass facade additions resulted in an outcome criticized for aesthetic consistency (4.4) and visual integrity (4.5), thus differentiating its intervention level from that of Tate's more minimalist adaptation.

Locally, Cendere offers a similar multipurpose potential to projects like Ankara's CerModern, which adaptively uses large spans for artistic events. Furthermore, international examples such as De Hallen (Amsterdam), converted from a former tram depot into a multi-functional public space with a library and commercial areas, and El Born CCM (Barcelona), converted from an old market hall, serve to reinforce the findings related to Cendere's significant role as a social gathering place (4.5) and its successful multi-functional capacity (4.2). These comparisons collectively suggest that

while the physical and functional aspects of Cendere's adaptive reuse process have been largely successful, the strategic integration of aesthetic interventions and contextual consistency remains an area where more meticulous consideration would have strengthened its spatial identity. This comparative assessment confirms that the successful application of the six-parameter model positions the Cendere case not merely as an isolated success but as a study highly relevant to the global and national discourse on functional and spatial identity in adaptive reuse.

Table 2 presents a systematic summary of the analyses conducted to evaluate the spatial transformation of the Cendere Art Museum during its adaptive reuse process. For each sub-parameter, strengths, weaknesses, opportunities, and threats were structured based on field observations, visual documentation, and literature-based principles. These analyses reveal the current condition and transformation processes of the building from a multidimensional perspective, offering a guiding framework for future spatial sustainability and functional adaptation strategies.

Table 2 Cendere Art Museum Spatial Evaluation Criteria (Created by the Authors)

	Sub-headings	Strengths	Weaknesses	Opportunities	Threats
Structural Features	Condition of the Load-Bearing System	The load-bearing system has been successfully reinforced with steel supports, ensuring structural stability.	Surface-level degradation has been observed at the connections of the load-bearing system in certain areas.	Structural reinforcement processes could be supported through further strengthening interventions.	Seismic risks and material fatigue may threaten long-term safety.
	Ceiling Height and Large Openings	High ceilings and wide openings offer flexibility in spatial use.	Wide openings cause heat loss; climate control is limited.	Ceiling spaces offer opportunities for modern lighting and acoustic solutions.	Inability to maintain thermal comfort may negatively affect user experience.
	Wall, Roof and Floor Durability	Roof and floor systems are largely intact and have adequate load-bearing capacity.	There is a risk of deformation caused by moisture on the floors.	Floor and roof layers can be upgraded with new coatings and insulation systems.	Moisture accumulation on the floors may lead to structural failure.
	Material Properties	Material choices are compatible with the historical character; surface homogeneity has been achieved.	Original material textures have been covered in some interior surfaces.	Exposing original material textures could emphasize the historical character.	Material deterioration in concealed surfaces may result in hidden damage.
Functional Compliance	Spatial Flexibility	The spatial layout is adaptable to different functions.	The plan organization does not offer flexible solutions for every area.	Flexibility can be increased through modular systems; new usage scenarios can be developed.	Unplanned interventions may weaken spatial integrity.
	Circulation Systems	Main circulation routes are clear, natural orientation supports accessibility.	Some secondary passage areas are narrow and may cause problems during heavy use.	New directional elements and circulation improvements can be implemented.	Narrow passage areas may pose safety risks under high occupancy.
	Exhibition and Event Spaces	Multi-purpose exhibition and event spaces can accommodate various programs.	Fixed exhibition layouts limit spatial diversity.	Flexibility can be achieved with temporary and portable exhibition solutions.	Insufficient programming may restrict the use of exhibition spaces.
	Acoustic Performance	Certain areas of the building have volumetric proportions that support natural sound distribution.	Not all areas are suitable in terms of acoustic reverberation and sound control.	Spatial comfort can be improved with acoustic panels and sound-absorbing surfaces.	High reverberation levels may cause functional discomfort.
Lighting and Air	Use of Natural Lighting	Window placement significantly supports natural lighting.	Natural light is insufficient in some interior spaces.	Lighting scenarios can be developed; daylight optimization can be achieved.	Inadequate lighting may compromise the exhibition experience.

	Current Air Conditioning	Basic air conditioning systems are integrated.	Placement of HVAC units negatively affects visual continuity.	User comfort and energy efficiency can be improved with updated HVAC systems.	Inadequate air conditioning may damage exhibition objects.
	Energy Efficiency	Passive heating/cooling potential exists in some areas.	Energy efficiency is reduced due to poorly insulated areas.	Performance can be improved through energy modeling and insulation upgrades.	Energy losses may increase operational costs.
Historical and Aesthetic Values	Design Elements	Visual coherence has been achieved between new and old design elements.	In some areas, modern additions conflict with historical elements.	Design interfaces can be revised to integrate contemporary aesthetics with historical language.	Visual inconsistencies may weaken the building's historical value.
	Facade Design and Historic Character	The facade retains original details and conveys a sense of historical identity.	Some new material additions on the facade are incompatible with the historical language.	Visibility can be enhanced through facade lighting and restoration techniques.	Deteriorations in facade integrity may negatively impact user perception.
Context and Environmental Relationship	Visual and Physical Harmony	The building maintains visual and physical harmony with its surroundings and has a strong connection to the urban fabric.	Elements on the rear facades hinder integration with the city.	Contextual improvements can be made based on environmental analyses.	Environmental incompatibility may weaken public acceptance.
	Social and Economic Activities	Facilities supporting social use, such as a library and workshop spaces, are available.	Social units do not provide equal access for all user groups.	New social use scenarios and cultural event programs can be developed.	Inadequate social programming may reduce user engagement.
	Ease of Access and Transport	Strong public transport connections and easy pedestrian access.	Inadequate orientation and accessibility at some entrance points.	Environmental wayfinding elements and accessibility infrastructure can be enhanced.	Accessibility shortcomings may limit user diversity.
Technological Equipment	Digital Exhibition Infrastructure	Basic digital infrastructure and presentation systems are available.	Current digital technologies are inadequate, and infrastructure integration is limited.	Digital presentation techniques, augmented reality, etc., can enhance user interaction.	Lack of technological infrastructure may alienate younger users.
	Security Systems	Minimum security equipment is provided for entrance control and monitoring.	Emergency exit signage and surveillance systems are lacking.	Modern security technologies can be integrated.	Security deficiencies may affect user confidence.
	Technical Equipment Areas	Technical service areas are defined and support current functions.	Technical equipment areas may be insufficient for new system integration.	Space use can be optimized with compact technical systems suited to the building.	Technical infrastructure deficiencies may limit system integration.

5. Conclusion

The primary aim of this study is to examine the impacts of the adaptive reuse process of industrial heritage buildings on spatial transformation, using the case of the Cendere Art Museum, and to assess the significance of this process in terms of spatial identity and cultural sustainability. The methodological model, developed based on six evaluation parameters derived from the literature, was applied using SWOT analysis and visual documentation tools, and supported by qualitative data.

The findings obtained in line with the research questions are summarized below:

RQ1: Impact of the Adaptive Reuse Process on Spatial Identity

In the adaptive reuse process implemented at the Cendere Art Museum, original industrial elements such as the facade form and the load-bearing system were preserved, contributing to the continuity of spatial memory. Conversely, additions such as glass facade extensions and certain interior modifications partially compromised aesthetic coherence, leading to visual discontinuities

from the user's perspective, highlighting the importance of adopting a balanced design approach between historical elements and contemporary interventions in adaptive reuse projects.

RQ2: Contribution to Cultural Sustainability

The adaptive reuse of the building, preserving its historical and architectural features, has facilitated a positive transformation in terms of cultural sustainability. The museum's emergence as a social gathering space demonstrates how historic heritage can be preserved and integrated into public use scenarios. Nonetheless, to ensure the long-term sustainability of the site, stronger alignment with local cultural policies is recommended.

RQ3: Transferability of the Methodological Approach to Other Projects

The methodological approach based on SWOT analysis and visual documentation systematically identified the strengths and weaknesses of the building, providing a strategic framework for evaluating the spatial transformation process. The developed model can be adapted to reuse projects in various contexts and provides a valid assessment framework that is particularly suitable for interior design and architectural fields. The limitations of the SWOT analysis were explicitly discussed, and the application of more comprehensive multi-criteria decision-making methods (e.g., Fuzzy AHP, Analytic Hierarchy Process) in future studies is recommended for future studies.

This study, through the findings obtained from the Cendere Art Museum, demonstrated how adaptive reuse processes can contribute to broader principles and established that a multi-layered assessment approach can facilitate a balanced relationship between historic structures and contemporary needs. The proposed model also offers practical recommendations that can contribute to the adaptive reuse policies of local administrations.

The recommendations developed based on the research findings are as follows:

- Balanced design strategies should be developed to ensure coherence between historical elements and contemporary design solutions.
- Cost/benefit analyses should be conducted for modern systems such as energy efficiency, ventilation infrastructure, and digital equipment.
- User experience should be considered in the early stages of the design process and supported through participatory approaches.
- The implementation of all presented design and technological recommendations should be planned not only according to technical requirements but also by considering project feasibility based on cost-benefit analysis results and conditions for long-term financial sustainability.

Suggestions for future research include:

- Collecting quantitative data on user satisfaction and spatial performance.
- Testing the model across different climatic and cultural contexts through comparative studies.
- Evaluating the impact of digital exhibition systems and smart technologies in adaptive reuse projects.
- Investigating spatial identity not only through its physical aspects but also perceptual and social dimensions, using user-based surveys, in-depth interviews, and experience-oriented ethnographic analyses.
- Measuring numerical data related to energy efficiency (e.g., heat loss, light levels, user comfort) using technical instrumentation.

This study proposes a multidimensional analysis model applicable in adaptive reuse processes, contributing both to theoretical discussions and design practices. The developed model is regarded as a valid tool for re-evaluating the transformation of cultural heritage buildings based on spatial sustainability and contextual sensitivity.

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CRediT Authorship Contribution Statement

Neslihan Yıldız: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Data curation, Conceptualization, Data visualization. Mert Kılıçaslan: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Data curation, Conceptualization, Data visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Ethics Committee Approval

Ethics committee permission is not required.

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JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (602-619), 2025
DOI: 10.47818/DRArch.2025.v6i3185

The intersection of history and nature: The transformation of Cebeci Asri Cemetery as urban open space

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Abstract

Today, cemeteries are gaining importance as potential open spaces due to the growth of cities and the increase in construction densities. Especially old cemeteries that have completed their function can be integrated into urban life as open-green spaces. Cebeci Asri Cemetery is an old cemetery that has completed its function as a burial space. As the first modern cemetery in the history of the Republic and an architectural competition project, it is an important area with cultural, social and historical value. Important bureaucrats of the Republican era, many poets, writers, journalists and artists who shaped society rest in this cemetery. It is also one of the limited number of green areas in the city. The purpose of this article is to develop a landscape-focused integration model that addresses spatial re-functionalization and digitally supported cultural route design at Cebeci Asri Cemetery. The cemetery area was evaluated as an open-air museum and a cultural route covering important figures of the history of the Republic was created. A mobile application was also developed for the culture route. Original structures such as ossuaries and namazgahs, which are inactive and vacant in the area, were also evaluated in this context and included in the usage scenario. As a result, this study presents an alternative approach for the urbanization of an old cemetery isolated from the city. Although they are early structures, solutions have been developed to preserve the namazgah and ossuary structures and transfer them to the future. It is envisaged that this study will create an idea/guide for urban administrations.

Keywords: cemetery, open space, urban green space, Cebeci Cemetery, urban integration

1. Introduction

Cemeteries have played an important role in urban planning from antiquity to the present day. In antiquity, the necropolis area where the dead would be buried is a determining element of urban planning. In necropolises, burial areas were generally located in areas outside the city center (Pérouse, 2017). For both religious beliefs and hygienic reasons, burial sites were preferred to be outside the city center. This planning approach has been in place since antiquity, and in modern urban planning, cemeteries are still located on the outskirts of cities. However, as cities have grown, cemeteries have become open spaces within the city (Mumford, 2007). For example, while Karacaahmet cemetery was located outside the city in Ottoman times, today it is located in the center of Üsküdar district. Similarly, the Père Lachaise Cemetery in Paris has become part of the center with the growth of the city. Beyond being a disadvantage, this situation creates an important opportunity for cities that are gradually losing their green texture. It is possible for cemeteries to take on the function of open-green areas in the city and make a great contribution to the urban ecosystem and green texture (Gönen, 1992). However, in order for cemeteries to take on such functions, planning, implementation and operational approaches need to be updated. In addition to their main functions, their meaning in urban life can be expanded by supporting them with potential functions. In many European and American cities, cemeteries are used for different functions in addition to their main function (Uslu, 2009). They are utilized as an extension of urban

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Article history: Received 03 February 2025, Revised 10 October 2025, Accepted 12 December 2025, Published 24 December 2025

green spaces and their urban use is expanded with functions such as education, sightseeing, meditation, exhibition and recreation areas.

The aim of this study is to investigate the importance of Cebeci Asri Cemetery as an urban open space and to develop solutions for its integration into the city. Cebeci Cemetery is of urban significance as it is both the first modern cemetery in the history of the Republic and a unique cemetery acquired through an international competition. There are unique structures such as ossuaries and namazgahs in the area, which are not found in other cemeteries. Since the cemetery has completed its burial function, it constitutes a potential area in the city for new functions. The study aims to expand its urban visibility and possibilities of use as an open space with new usage scenarios without harming the original use of the cemetery. In this context, it is aimed to bring the area to the city as an open-air museum with its cultural, social and historical values while maintaining its main function as a cemetery. The graves of important figures of the history of the Republic are located in the cemetery area. Therefore, this area is a place that sheds light on the history of the Republic. Important politicians, writers, bureaucrats and many artists of the period rest in this cemetery. However, the cemeteries are scattered throughout the area. Without the information of the name-parcel, it is difficult to find specific graves in the cemetery where approximately 250,000 bodies are buried. In line with this goal, a route covering the main graves in the cemetery is organized and the area is used for visiting and sightseeing purposes (Uslu, 2010). Visitors will be guided and informed with introductory signs containing information about the lives of important people and historical events in the area. A route will be created for students of various age groups to visit the area. In addition, there is currently an empty and inactive ossuary structure and a namazgah (open-air masjid) in the cemetery. These unique structures (ossuaries and namazgahs) will be utilized for various exhibition and promotional functions. The study, which is also supported by a mobile application, develops suggestions for a more active and interactive use of the area for users.

The study's original contribution to the literature is that it does not limit the cemetery area to merely a cultural route proposal. It proposes a landscape scenario that also includes unique heritage elements such as ossuaries and namazgahs located within the cemetery. The study contributes to the literature in terms of developing research outputs through instrumental design.

2. Conceptual Framework

2.1. Cemeteries

Grave literally means the place where the dead person is buried. The grave also refers to the covered dissolution rooms where the dead are buried in accordance with legal and religious rules in a way that does not harm environmental health. (Çalbayram, 2001). Cemeteries are places where many graves are located together. There is no standard measure for the dimensions of a grave, but it is generally appropriate for the length to be equal to the height of the dead and the width to be equal to half the height of the dead (Ragheb, 1996). The grave is separated from its surroundings by being raised with a slight mound so that it is higher than the soil. In Muslim graves, the grave is arranged with the grave head facing the qibla. A headstone, usually made of marble, is built at the head of the grave or at both the head and the foot of the grave. Flowers and plants are usually planted on the earthen top of the grave. Coniferous trees such as pine, juniper and cypress are also often planted around the graves. These trees are known to prevent the ammonia released as the body decomposes from accumulating in the soil. Thus, the residents and visitors around the cemetery are protected from the disturbing effects of gases released from the soil and bad smells (Çalbayram, 2001).

In all religions and societies, cemeteries are places that gain meaning under the influence of spiritual values and religious beliefs. In all beliefs, cemeteries are places that are respected and believed to have inner peace (Moda, 2019). Cemeteries remind human beings of the transience of their own life and the world. At the same time, cemeteries raise awareness of past memories and visits to these sites create an awareness of previous connections and relationships. In this respect,

cemeteries do not define a static texture, but form a cultural landscape that is always functioning and changing (Thomashow, 1995).

Turkish-Islamic cemeteries have a unique spirit, meaning and texture different from their counterparts in other societies. In Islamic cities, cemeteries are places that are almost lost among the greenery and integrated with the harmony of green and stones (Moda, 2019). However, the situation of cemeteries today is very different from the past, and they have been pushed out of urban life as places that give people fear and creeps (Tırnakçı, 2021). These areas are usually divided into parcels and separated from the cities by high, fenced walls. There are major differences in the way death and cemetery spaces are perceived today compared to the past. While cemeteries used to be a part of everyday life in the past, with modernization, they have lost the importance of being identified with the spiritual journey of the soul (Spellman, 2017). Thus, cemeteries, which used to be a part of daily life, have turned into urban spaces that cannot be integrated into daily life from this point of view and have moved away from urban areas. In fact, cemeteries are very rich areas in terms of green texture. In addition, due to religious ideas and prohibitions, the green tissue in cemeteries is considered untouchable compared to other green areas. Although urban open spaces can be easily transformed into buildings in short periods of time, cemeteries resist a different form of use for a long time because they are considered sacred areas (Uslu, 1997; Akten & Özkartal, 2016). Cemeteries are untouchable areas due to their function and sanctity. This to some extent guarantees that they are permanent open and green spaces (Sarı & Koçak, 2005). Therefore, if qualified solutions and design measures are taken within the scope of the integration of cemeteries into the city, they can make significant contributions to the city and play an active role in urban life.

2.2. Cemeteries as Urban Open Spaces

Urban open spaces are common use areas organized by city administrations in order for people to rest, walk, perform various recreational activities and approach nature (Keleş, 1984). Urban open spaces can be divided into two groups as active and passive according to their usage status. Active open spaces are areas such as parks, squares, gathering areas, all kinds of sports and playgrounds, zoological and botanical gardens, urban agricultural gardens, etc. that are used by the public. Passive open spaces are areas that are not suitable for active use due to reasons such as cemeteries, traffic islands, refuges, areas under ecological protection, topography and drainage (Çöteli, 2007). In urban life, open-green areas undertake many functions ranging from ensuring the long-term mental and physical recovery of the city dwellers to the protection and development of urban biodiversity, oxygen production, reducing heat islands, regulating air quality, reducing noise pollution, developing tourism, creating buffer zones between residential areas and industrial areas, and facilitating pedestrian and vehicle circulation (Tırnakçı, 2021). According to Kumru (2019), the benefits that urban open-green spaces provide to the city both aesthetically and functionally are listed as follows;

-lighten the monotonous and harsh texture of the city and bring vitality to the city,

-add physical and aesthetic value to the city with their structural and vegetal materials

-regulates the microclimate of the city, balances urban heat,

-regulates air quality by absorbing toxic dust and gases that pollute the air,

-eliminates the negative effects of wind,

-facilitate and organize transportation,

-meet the need for recreational space,

-take people away from the stress of the urban environment,

-reduce noise,

-increases the fertility of the soil,

-regulates building and population density,

-limits and directs the development of the city (Karaoğlu, 2007).

Today, open-green areas in urban centers are gradually decreasing both horizontally and vertically. The gradual decrease in open-green areas adversely affects individuals physically and mentally, monotonizes urban areas, and reduces the quality of life and environment. Development-oriented approaches in urban areas destroy the urban ecosystem and thus the need for alternative open-green areas arises, especially in urban areas. Cemeteries are potential areas that can be part of urban continuity when they are evaluated as recreational and open spaces (Tuna & Göker, 2018). Cemeteries are areas that cannot be changed in the zoning plan because they are protected both religiously and with a special protection law. Cemeteries, where burials are completed or still ongoing, are essential open-green areas for the urban fabric (Akten & Özkartal, 2016). Cemeteries constitute an important part of the open-green areas that are gradually decreasing in large cities. These areas, which used to be outside the city, have become intertwined with urban settlements and living spaces. Cemeteries within or close to the urban space constitute organic ties that connect the open-green areas and ecological corridors of the city (Uslu, 2009). Nowadays, cemeteries, which have been left among dense settlements, constitute an important component of cities with their potential within the urban texture. Cemeteries are among the rare open-green areas in cities where green areas are gradually decreasing (Karaoğlu, 2007). Today, as a result of rapid urbanisation, the interest and demand for open-green areas in cities has increased. Along with environmental problems, urbanites have started to better understand the importance of these areas. Cemeteries are the most important places that are candidates to replace the open green spaces lost as a result of urbanisation (Moda, 2019).

2.3. Examples from the World on the Use of Cemeteries as Urban Open Space

Today, the perspective of cemeteries in developed countries is quite different from our country. In the USA, cemeteries were used as recreation and promenade areas before the construction of urban parks in the 1850s. In England, cemeteries within the city were included in daily life as part of the urban open space and green space system (Çöteli, 2007). While the current situation of cemeteries in our country is not very good, European countries have a different approach to the issue and consider these areas as potential open-green areas. They also give importance to cemetery planning and reorganise unused cemetery areas to meet the recreational needs of the city (Güçlü et al., 1996). In this approach, it is primarily aimed to meet the passive recreation needs of the citizens. By prohibiting the burial of the dead in the cemeteries within the city limits, these areas are reserved for public recreation with well-maintained greenery and used as parks. In ecological terms, bridges are created between the city and cemeteries and the green texture of the city is planned as a whole. Thus, with the development and expansion of the city, cemeteries within the urban living space are no longer non-functional areas (Akten & Özkartal, 2016).

In most European and American countries, cemeteries are used as places of meditation or recreation. In fact, examples of cemeteries in the USA are places that offer passive recreation opportunities to the citizens. The main objective of the contemporary cemetery concept in these countries is to give cemeteries the function of a green buffer zone. For this purpose, cemeteries were integrated into the urban landscape with a trend that started in the 50s (Özkan & Küçükerbaş, 1996). In the 60s and 70s, the understanding of designing cemeteries as a natural park began to prevail. The amount of burial areas was reduced and burial areas were hidden by creating a dense green belt. Thus cemeteries became easily recognisable landmarks in the urban landscape and the concept of 'park cemetery' emerged (Kienast, 1990). The idea of relaxing with nature, which started with park cemeteries, has evolved towards forest cemeteries. Cemeteries are located in the forest and the ratio of burial areas has been reduced considerably. Thus, forest cemeteries also point to the new generation's interest in ecology and environmental concerns. These areas create quiet, peaceful and respected places of remembrance in the urban landscape with a new forest and habitat (Akten & Özkartal, 2016).

Some examples of cities in Europe and the Americas that have successfully integrated cemeteries into urban life are exemplified in this study (Image 1). The analysed examples formed a basis for the research. Accordingly, Novodevichy Cemetery in Russia (1898) has been opened to tourism by expanding its recreational use. This cemetery, which has turned into an open-air museum, can be visited by tourists for a certain fee. People use the Allegheny Cemetery (1844) in Pittsburgh, USA for visiting and sightseeing purposes. The habitat formed here attracts people's attention and people come here to observe animals such as eagles, owls, deer (Moda, 2019). Skogskykogarden Cemetery in Stockholm, Sweden is a cemetery dating from the early 20th century (1915-1920). The landscape is dominated by a forest of tall pine trees. The vegetation and architectural structures are in harmony and this area is also a UNESCO protected cemetery. Assistens Cemetery (1760) in Copenhagen, Denmark is another cemetery used as an urban green space. In this area, people organise recreational activities such as walking, jogging, resting on the grass and cultural events such as concerts and theatre. Mount Auburn Cemetery (1831), the first garden cemetery in America, serves both as an active cemetery and a museum. In the cemetery, which is considered one of the most important landscape areas in the country, there are more than 5500 trees, about 700 species and various shrubs and herbaceous plants (Kumru, 2019). Spring Grove Cemetery (1845) in Cincinnati, USA, is not only a burial site but also a permanent memorial. It continues to function as a cemetery and includes fine arts, architecture, educational programmes and activities for the public good. Ecologically, it shelters various forms of wildlife. Photographers, bird watchers, and students are frequent visitors to the cemetery as an arboretum and burial ground. Spring Grove is an important green space in the dense metropolitan fabric of Cincinati (Uslu, 2010).

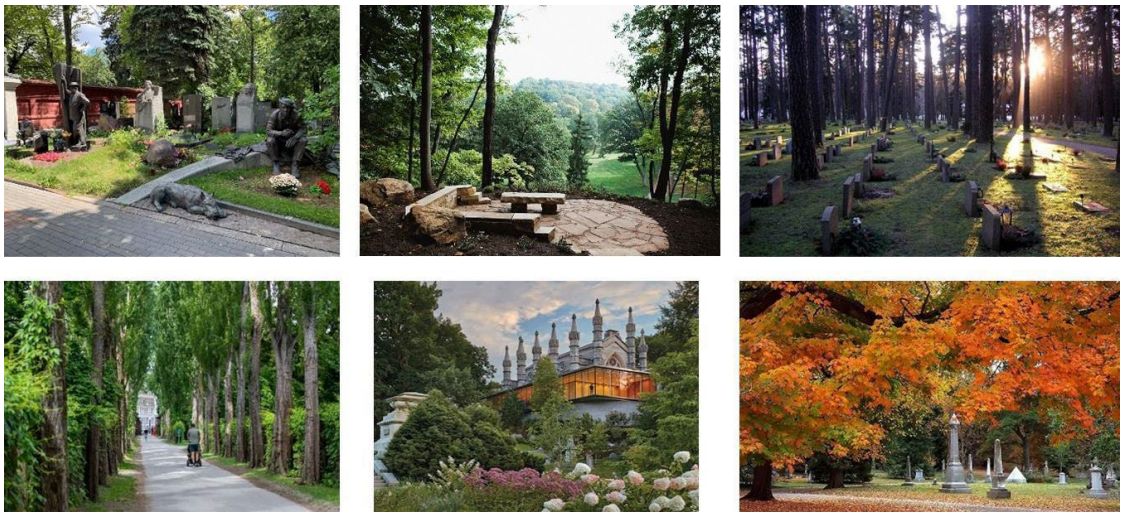


Image 1 From left to right; Novodevichy, Allegheny, Skogskykogarden, Assistens Cemetery, Mount Auburn, Spring Grove (Atlas Obscura, n.d.)

2.4. Literature Review

In the literature, there are studies that evaluate cemetery areas not only for their function as burial spaces but also for their different functions. In these studies, cemeteries are evaluated as components of public green infrastructure, elements of cultural landscape, or recreational areas (Rugg, 2000; Francis et al., 2005). Examples from Europe and America show that when cemeteries are incorporated into daily life as urban open spaces, they serve as places for walking, interacting with nature, and escaping urban chaos (Evensen et al., 2017; Skår et al., 2018; Rae, 2021). Studies examining the importance of cemeteries as green spaces in cities by acquiring different functions have also increased in recent years. These studies emphasize the ecological contributions of cemeteries to cities, such as shading, reducing the heat island effect, carbon storage, and ecosystem continuity (McClymont & Sinnett, 2021; Sallay et al., 2023). In our country, various studies have been conducted on cemeteries, particularly by landscape architects. Cemetery planning has been

evaluated based on fundamental criteria such as geology, topography, and accessibility. Criteria have been developed for afforestation, plant tissue, inventory, and maintenance processes. Case studies of historic cemeteries have clearly identified the problems encountered in implementation and maintenance (Uslu, 1997; Aksoy & Özkardaş, 2011). In this respect, the studies focus on the existing problems within the framework of the main function of cemeteries. More recent studies also highlight the importance of cemeteries as sustainable open green spaces and cultural and ecological resources. These studies evaluate cemeteries in terms of urban plant diversity (Yılmaz et al., 2018), cultural significance and recreational use (Tırnakçı, 2021), and urban air quality (Çobankaya & Akkurt, 2025). Consequently, the literature studies evaluate cemeteries as multifunctional urban green-open spaces beyond being distinct religious sites in cities. Based on this, the study examines Cebeci Asri Cemetery as a representative example with high representational power in terms of offering urban open space potential.

2.5. A Modern Cemetery in Ankara: Cebeci Asri Cemetery

The spatial development process of the city of Ankara covers a period of time extending from prehistoric times to the present day. The proclamation of the Republic is the most important event in the recent history of the city in terms of determining the form and direction of the spatial development of the city (Uslu, 1997). Ankara, which was chosen as the capital of the country with the proclamation of the Republic, entered into a rapid construction process. Many cemeteries in and around Ulus, which was the centre of the city at that time, were displaced for the need of construction. In order to transport the bones from these cemeteries and to meet the cemetery needs of the growing city, a new cemetery area was proposed in the zoning plans. This cemetery area, which can be seen first in the Lörcher plan dated 1924 and then in the Jansen Plan dated 1932, is located in the north of the city and in the region called Cebeci Village (Figure 1). Jansen defined this cemetery area as a part of the open green area of Ankara (Cengizkan, 2004).

Figure 1 Cebeci Asri Cemetery in the 1932 Jansen Plan (Cengizkan, 2004)

The cemetery is located north-east of the castle, which was the centre of the city at the time, and covers an area of 720,000 m2 . An international competition was launched in 1935 for the design of the cemetery and the project was designed by the German architect Martin Elsaesser. There are currently 90.000 tombstones in the cemetery and there are approximately 270.000 graves in total. There are 53 graves in the police memorial, 9 graves in the foreign affairs memorial and 70 graves in the aircraft memorial. In the non-Muslim cemetery, there are 1257 Christian, 515 Jewish and 22 Bahai graves.

The specifications of the competition organised for the cemetery and the selection criteria for the winning projects were published in the 1935 issue of Arkitekt magazine. A total of 12 projects were submitted to the international competition for the planning and design of Ankara's new city cemetery, and the project of Martin Elsaesser, who was also the architect of the Sümerbank Building, was selected as the winner. Elsaesser, a German architect, shaped his current design by applying the cemetery design principles already developed in Germany (Figure 2). The tomb sections are separated from the service spaces by small shrubs and grouped around grids. Between the grids are two squares connected to each other radially. Another characteristic feature of the design is the high perimeter walls between the plots. The cemetery design does not express a hierarchical order, but rather a homogeneous and balanced distribution. The hierarchical order is only noticeable in the composition of plants and roads. In order to green the cemetery and emphasise the main axis, the main roads are heavily planted under the control of the administration. The secondary roads and paths are left to the control of both the management and the grave owners. Thus, grave owners were also allowed to honour their loved ones (Kor, 2013).

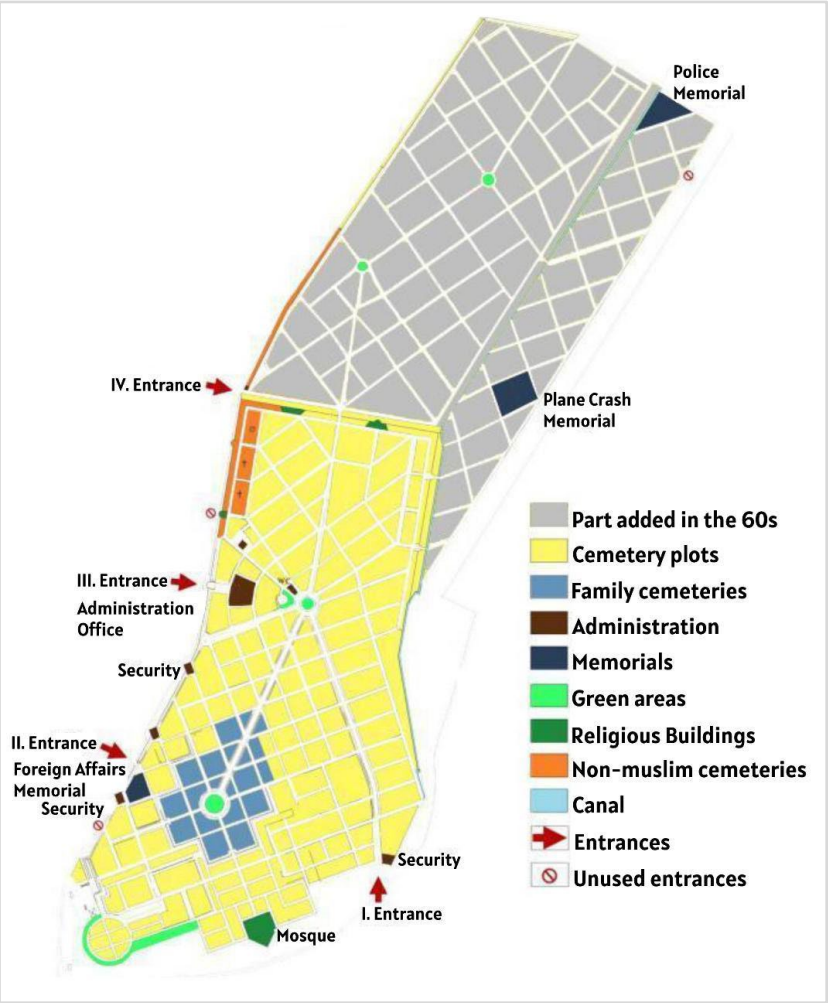


Figure 2 Cebeci Asri Cemetery spatial organisation (Adapted from Kor's 2013 study)

Towards the end of the 1950s, Cebeci Cemetery could not meet the demand for burial. From 1958 onwards, the cemetery boundaries were extended to the north of today's Siteler neighbourhood. This expansion was implemented without reference to Elsaesser's design principles. This extension to the north of the Cebeci Cemetery is incompatible with the original plan. Elsaesser's design principles of small blocks and squares have been replaced by a randomised grid plan with larger grave blocks. Only the grave blocks and streets were repeated to avoid any loss of burial space and to allow for more burials. By 1974, Cebeci Asri Cemetery was closed for new burials except for special requests with reference to the cemetery directorate (Kor, 2013).

3. Material and Method

Cebeci Asri Cemetery is located north of Ulus, the old city center of Ankara, and is a cemetery that has largely completed its burial function today. The study covers the evaluation of the cemetery as an urban open-green space. The research employed literature review, field observation, and architectural documentation methods. Feasible design proposals were presented for the integration of the area into the urban open space system.

The field survey was conducted on different days throughout January 2024, covering various periods of the day. This allowed for the observation of the cemetery's usage intensity, the current state of the graves, and circulation areas. As part of the on-site observation method, interviews were conducted with personnel responsible for managing the site. Qualitative information was obtained regarding the cemetery's maintenance and operation routines, usage intensity, and problematic issues. Photographs were taken and field notes were kept throughout the process. Original architectural structures in the area were documented as part of the architectural documentation method. The prayer area, ossuary, and mortuary structures were documented by measuring them on site according to survey principles and verifying them with photographic records. Based on the data obtained, a cultural route proposal has been presented. The route was created using observation and rule-based prioritization based on field data. A draft route was created on the map, taking into account entry and exit areas, shortest distances, vehicle parking areas, graves of important figures, and historical heritage elements. The route's functionality was analyzed through on-site walks. After necessary revisions in terms of walking time, comfort, and safety conditions, the final route was determined. Simultaneously, the current conditions of the area were analyzed within the scope of the criteria, and a table containing solution proposals was presented (Table 1). The review criteria include urban connections, entrances, security conditions, heritage elements, urban furniture, landscaping, flower greenhouses, the condition of gravestones, parking areas, and circulation. Along with the route proposal, solutions to the area's existing problems have also been suggested. This study is also supported by a mobile application to promote the effective use of the area.

4. Results

Cebeci Asri Cemetery has an important place in urban memory as it is both the first modern cemetery in the history of the Republic and was acquired through an international competition. Documenting, preserving and evaluating the architecture of the Republican period is necessary for the sustainability of urban memory (Kayın, 2007). Cebeci Cemetery is an area that has a documentary quality because it reflects the social, economic and cultural life of the society to the space; has identity value as a part of urban memory; has architectural value in terms of reflecting the design and architectural understanding of the period in which it was built; and has original artistic and regional value. In addition to the importance of preserving this area as a cultural carrier of the Republican period, increasing its urban sustainability and visibility with new scenarios will make significant contributions to urban life. Cebeci Cemetery constitutes a large open space in the city with an area of 720,000 m2 . According to the 2018 data of Ankara Metropolitan Municipality, the total green area size in Altındağ district, where the cemetery is located, is 9,880,800 m2 (Ankara Metropolitan Municipality, 2018). Cebeci Cemetery constitutes an important green area by covering 6.38% of the total amount of green area in the district. Therefore, by developing new

usage scenarios without harming the original function of the cemetery, it will be possible to both increase the contact of the citizens with the area and to keep the area alive with active use (Figure 3).

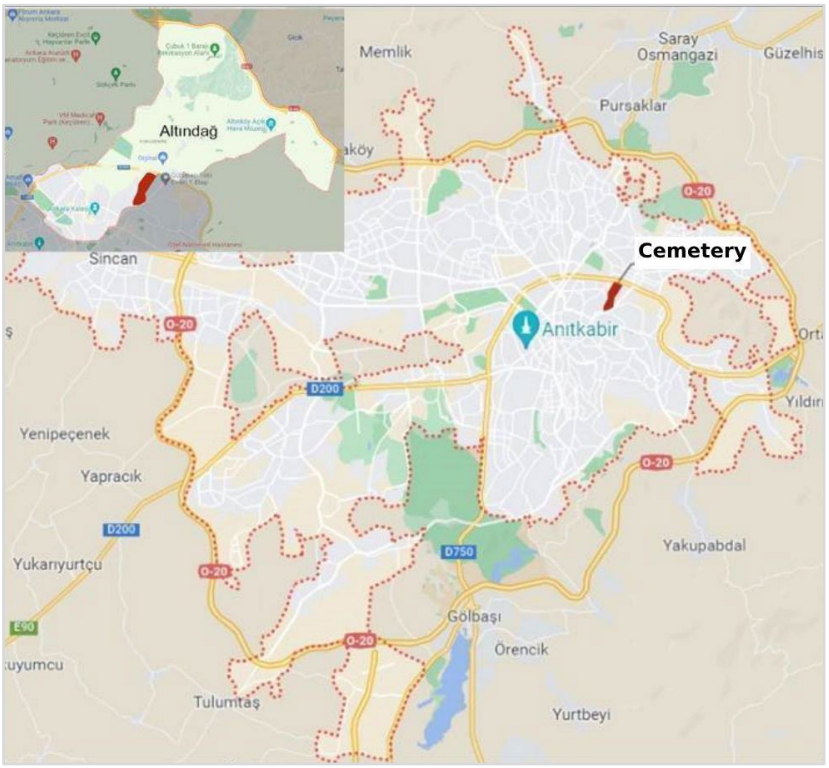


Figure 3 Location of Cebeci Asri Cemetery in Ankara and Altındağ district (https://earth.google.com)

Cebeci Asri Cemetery offers a rich source of social, cultural and archaeological artefacts since the foundation of the Republic of Turkey (Cengizkan, 2004). As it witnessed the Republican period, it is the final resting place of important personalities of the period. Many important politicians, writers, bureaucrats, poets and artists were buried in this cemetery. Afet İnan (historian), Ahmed Arif (poet), Cahit Sıtkı Tarancı (poet), Mevhibe İnönü (wife of İsmet İnönü, 2nd President and first Prime Minister), Makbule Atadan (sister of Atatürk), Mehmet Emin Resulzade (one of the founders of the Democratic Republic of Azerbaijan), Uğur Mumcu (journalist), Nasuh Akar (national sportsman), Refik Saydam (fourth Prime Minister) and Hasan Ali Yücel (founder of the Village Institutes) are some of the important people buried in Cebeci Cemetery. In addition to the graves of important personalities, the tombstones used in the cemetery also attract attention with their different forms, designs and use of materials (Image 2).

Image 2 Some of the well-known figures buried in Cebeci Cemetery (Author archive)

In addition to Muslim graves, there are also Christian and Jewish sections in the cemetery. Apart from the Abrahamic religions, there are a few graves of different religions and beliefs such as Baha'ism (Çiçek, 2017). The Christian, Jewish and Muslim graves in the area face in the same direction (south). The direction of the Baha'i graves in the area is orientated to the east. It was observed that there are differences in the directions of Muslim graves built at different times (Image 3).

Image 3 Graves of different faiths in the cemetery (Author archives)

From the 1940s, when the cemetery was first used, until the 1960s, Ankara stone (andesite) was widely used for gravestones. At that time, the graves were first approved by the municipality and then constructed. Therefore, while the cemetery had a regular, uniform and controlled construction until the 1960s, a disorganised and irregular construction started to develop from the 60s onwards. With the introduction of marble in grave structures and new legal regulations after this period, polyphony and irregularity began to occur in grave structures (Kor, 2013). Today, although marble graves with different designs are the majority in the cemetery, there are also a few graves where Ankara stone is used (Image 4).

Image 4 Andesite old graves before 1960, marble grave examples after 1960 (Author archive)

When the accessibility characteristics of the cemetery were evaluated, it was determined that there were four main entrance gates and all of them were located in the old part of the cemetery (Figure 2). Although the additional section built later covers a larger area, these graves can only be accessed from the old section. The third gate, located in the west of the cemetery, serves as the main entrance with security, reception and administration building. There is no car parking area in the cemetery. However, vehicles can be parked on the road close to the visited cemetery. In the outer part of the cemetery, many places are reserved for car parking areas. Therefore, there is no shortage of space for car parking in the area. However, there is no car parking area inside the cemetery, and vehicles temporarily stop on the main roads. The secondary roads are only wide enough for a single vehicle to pass.

When the spatial organisation within the cemetery area is evaluated, it is seen that there is a security office at each entrance gate. There is a mosque (İsmet Oğultürk Mosque) near gate I and an administration building opposite gate III. In addition to these, there is a gasilhane (where the

dead are washed), which is not in use today, and an ossuary (osteophilac) as an original space near gate IV. An ossuary is a place where the bones of the dead whose grave money is not paid within 10 years after burial are stacked. It is not a practice seen in Muslim cemeteries, but it is more common among Zoroastrians, Jews and Greeks. Although they had different purposes of use at the time, they are places where the bones of the people who were buried in the past are taken out and stacked when the existing grave areas are filled. Although there are few ossuary structures in our country, they can be seen in non-Muslim cemeteries and churches (Coşkun, 2009). Therefore, the ossuary structure in Cebeci Cemetery is one of the unique places that can rarely be seen in cemeteries. There are also 6 namazgahs (open-air masjids) in the area. 2 of these namazgahs were used as burial grounds to meet the burial demand of non-Muslims. The other 4 continue to exist as empty-open spaces. There are also 3 gasilhane structures in Cebeci Asri Cemetery to wash the dead. These structures are located inside the retaining walls (Image 5) (Figure 4).

Image 5 Respectively; ossuary, namazgahs, gasilhane (Author archive)

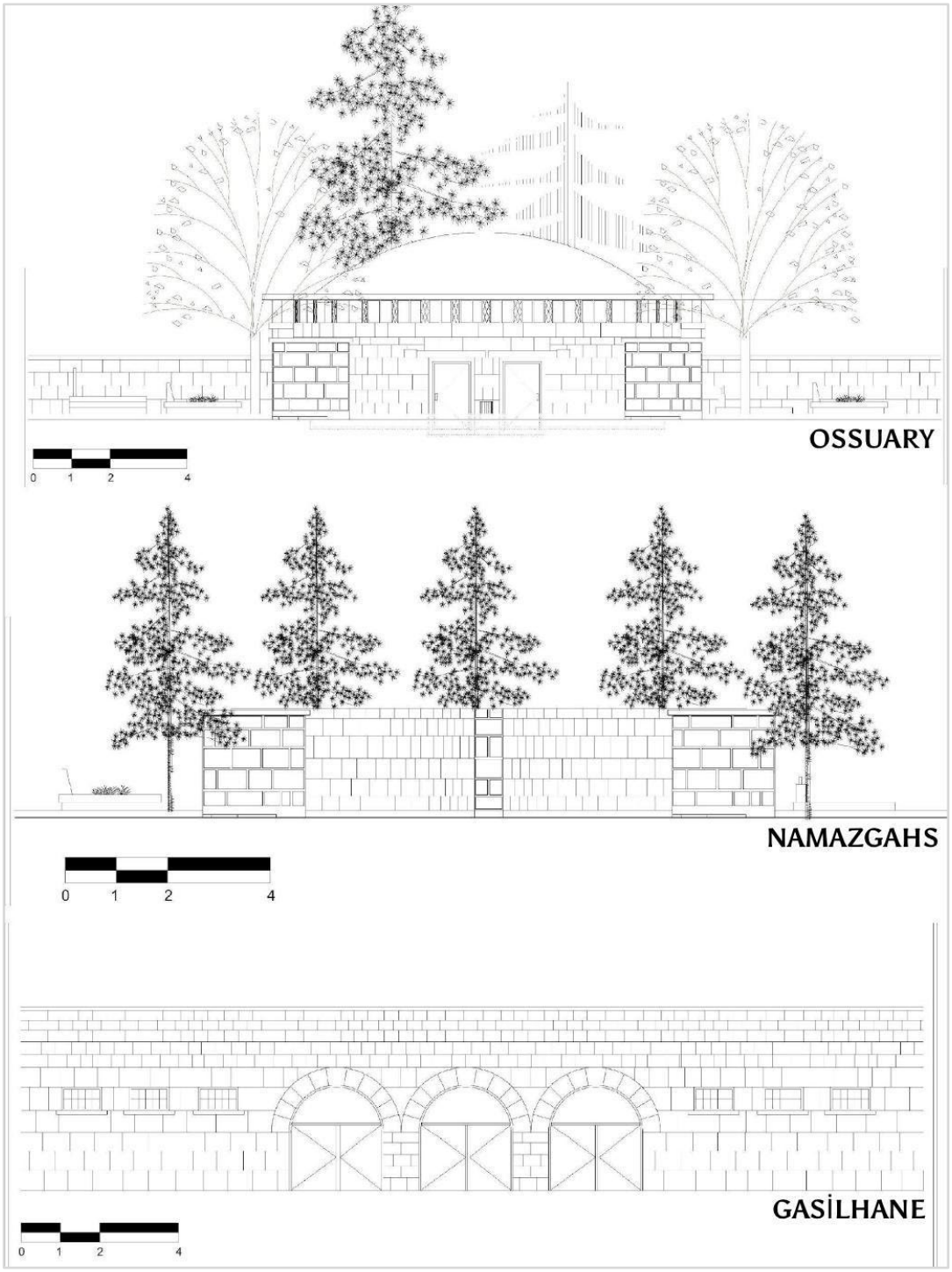


Figure 4 Respectively; front views of ossuary, namazgahs, gasilhane (Author archive)

Cebeci Asri Cemetery is the first modern cemetery in the history of the Republic. With its features such as being an international competition project and being the resting place of important figures of the Republic, it is not only a burial site but also a cultural monument. In this respect, it forms a part of the national memory. At the same time, the cemetery serves as an important buffer as a green area in the region. In Altındağ, which has a low density of green areas, Cebeci Asri Cemetery creates an ecological resource for the sustainability of urban life. Documenting, preserving and evaluating the architecture of the Republican period is also important for the sustainability of national memory. In order to ensure this continuity, the value of Cebeci Asri Cemetery should be understood and brought to the society. In line with this goal, a cultural route was designed in the study, which allows visiting the graves of important personalities in Cebeci Asri Cemetery. On this route, there will be panels giving information about the people and their works

in the cemetery. For this route, the entrance gate on Plevne Street, which is not used today, is proposed to be reused. The ossuary and namazgah structures specific to the cemetery have been functionalised as exhibition areas and added to the sightseeing route. The non-Muslim graves, police, foreign affairs and aircraft memorials in the cemetery are also included in the proposed route. In Figure 5, the proposed sightseeing route is shown on the cemetery plan. Accordingly, the route is designed so that it can be entered from two different gates on Plevne Street, and both roads converge at the area (9) where Uğur Mumcu's grave is located. From here, two branches divide to the left and right. By following these branches, graves of different faiths, namazgahs and ossuary structures can be visited. Since the area to the north of the grave plan was added in the 60s, the route is limited to the original planing area.

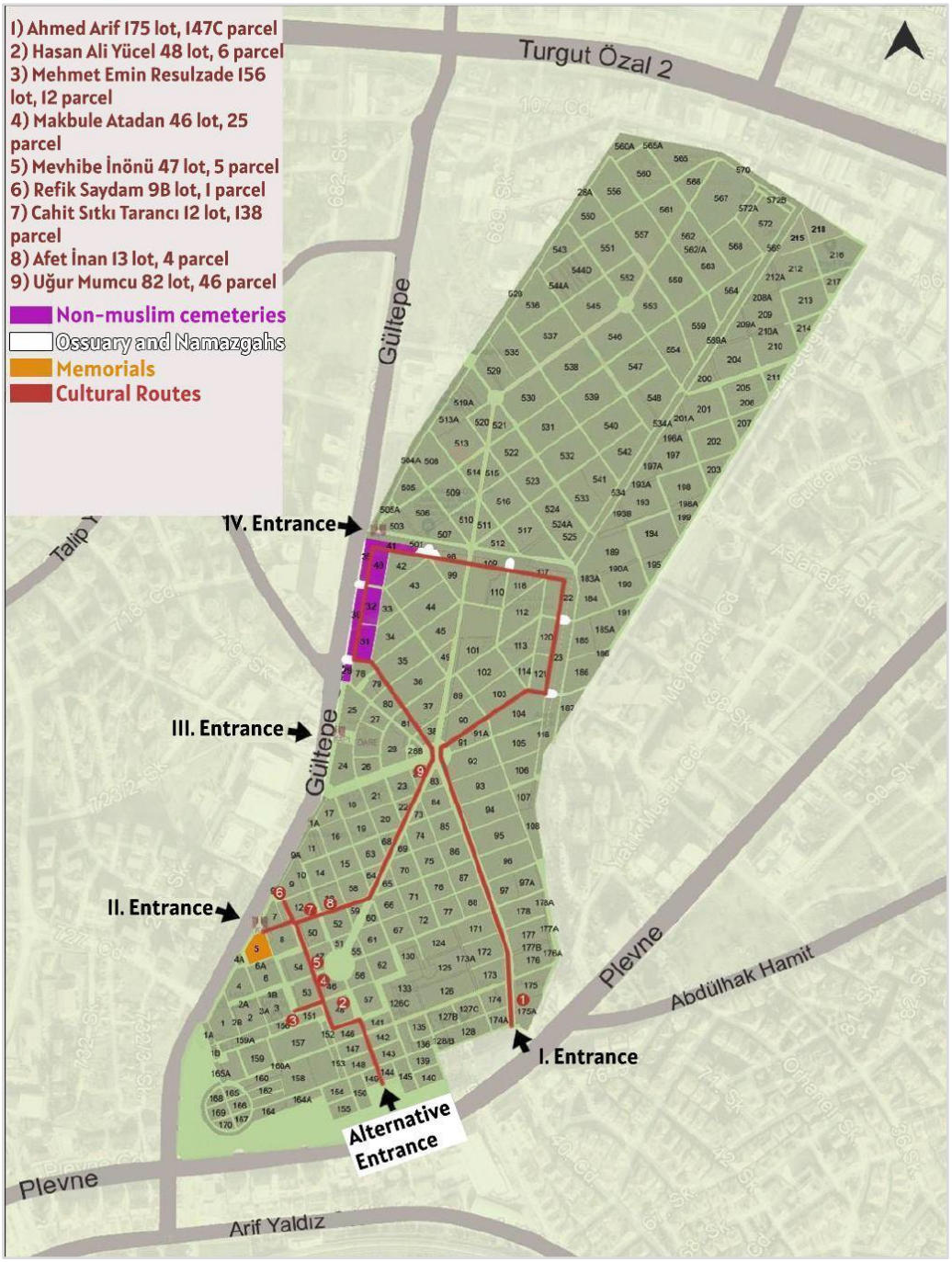
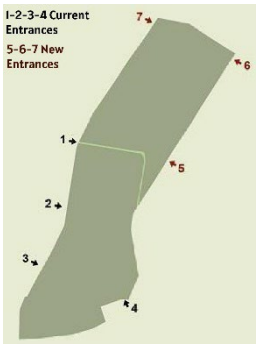
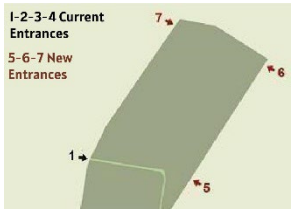
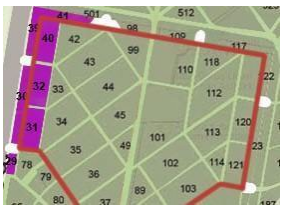
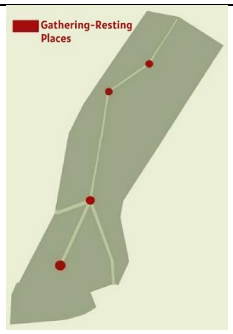
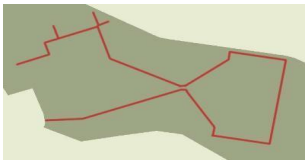
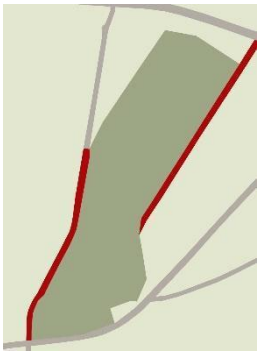


Figure 5 Cebeci Cemetery sightseeing route

Although a new function is proposed for the cemetery area, the current situation has been analysed and suggestions have been developed to use the area more efficiently and in accordance with the new function. In addition to the main function of the cemetery area, environmental connections, entrances, securities, cemetery units, urban furnishings (seating units, garbage bins, direction-information signs, lighting elements), plants, greenhouse-planting areas, tombstones, car parks and circulation-pedestrian roads are analysed and solution suggestions are presented in the table.

Table 1 Evaluation of Cebeci Cemetery in the Context of Criteria

Assessment Criteria	Current Condition	Images from the Cemetery	Solutions
Urban Connections	The cemetery is physically isolated from its surroundings. The cemetery is separated from its surroundings by masonry stone walls of varying heights and iron railings.		A separate entrance area was created for the sightseeing route in the southern part of the cemetery (Plevne Street). Thus, both the visibility of the area can be increased and the green area can be utilised in a more defined way.
Entrances	The cemetery has 3 entrances from the west and 1 entrance from the south via Plevne Street. There is no entrance gate to the second part of the cemetery, which was added to the cemetery in the 1960s, but this area can be accessed from the first part.		In order to have direct access to the second cemetery section, which was added in the 1960s, entrance areas should be created from suitable places in the cemetery. Necessary control and security measures should also be taken at the entrance areas.
Security	Within the cemetery, there are security areas only at the entrance gates (4 in total). In the additional part of the cemetery, there is no alternative entrance and no security point.		The homogeneity and holistic use of the cemetery should be increased by adding both entrance and security areas to access the additional section.
Cemetery units	Within the cemetery, there is an abandoned ossuary structure and unused namazgah areas.		The ossuary should be utilized as a closed exhibition area and the namazgahs as open exhibition areas and promotional functions.

Urban furnishings	There are no resting areas within the cemetery. The direction signs are insufficient and it is difficult to find the cemeteries. Since garbage bins are insufficient, garbage accumulates on the roadsides. There is no homogeneous lighting in the area.		The cemetery area is insufficient in terms of urban facilities both for the sustainability of the cemetery function and for new functions. Considering the whole area, a homogeneous distribution of urban furnishings elements should be ensured.
Vegetation and plantation	The cemetery area is planted with broad-leaved species to camouflage the grave sites.		Isolation of the burial sites from the walking paths for the cultural route should be ensured by planting.
Greenhouse area	There are no greenhouses or flower shops in the area for visitors to the cemetery.		A greenhouse should be created in the undefined park area south of the cemetery.
Grave stones	Within the cemetery, destroyed or neglected graves are found.		The graves should be routinely maintained and any damage should be repaired.
Parkings	Outside the cemetery area, there are parking areas only on the west side and the other parts of the area are not accessible by vehicle.		It is not possible to create a parking area inside the cemetery due to the density of graves. However, areas can be created outside the cemetery (outside the west wing) where vehicles can park. In addition to car parking areas, bicycle and motorcycle parking areas and areas for the disabled should also be organized.
Circulation-pedestrian routes	Pedestrian paths have been damaged due to the density of graves in the cemetery.		Pedestrian paths should be redesigned and improved considering the proposed sightseeing route. Broken paving and curb stones should be repaired. Vehicle entrances and exits should be restricted with barriers. The walking route should be pedestrianized.

In this study, a mobile application proposal for the cultural route was also developed (Figure 6). The application includes a GPS-supported map that allows users to find important points in the cemetery. Users can follow the route through the cemetery on the map or create customized routes according to their interests. For example, a route that includes only the graves of poets. The mobile app also includes an audio guide that informs users about the history and significance of the graves. For each stop on the route, there is audio and written information about the biography of the

people buried in the cemetery, historical events and structures. This application, where users can share their experiences and opinions, also includes a module that provides information about plant species and ecological values in the cemetery. These components bring together wayfinding, information, and participant feedback processes under a comprehensive digital tool. The mobile app makes the cemetery more active and dynamic while also ensuring integration with modern communication methods.

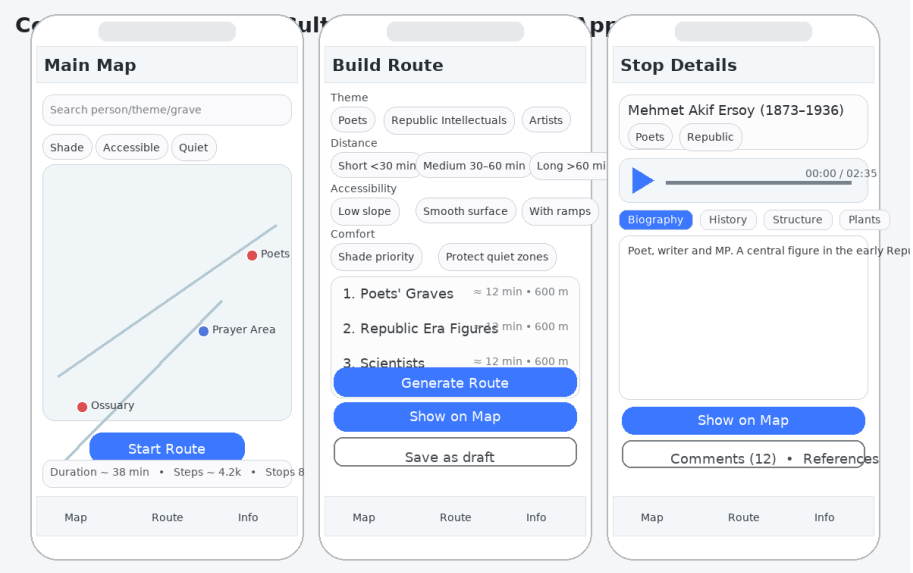


Figure 6 Mobile application ınterface

5. Discussion and Conclusion

Today, the perspective on cemeteries is gradually changing. In European countries and the United States, a movement started in the 1950s to integrate cemeteries into landscapes. Until today, this understanding has evolved towards the concepts of 'park cemetery' in the 1970s and 'forest cemetery' in the 2000s. In our country, the situation works in the opposite direction. While in ancient Turkish cemeteries and in the Ottoman period, graveyards were used as parks and green areas where daily activities were carried out, cemeteries have been isolated from urban life with modernization. Today, most cemeteries have become frightening, and insecure places that are rarely visited only during burials and religious days.

In this study, Cebeci Asri Cemetery, a socially, culturally and historically important cemetery in Ankara, is analyzed. With reference to examples of cemeteries in Europe and America, it is aimed to increase the urban visibility of Cebeci cemetery and its integration with the city as a green space. In line with this goal, a usage scenario has been developed based on the analysis and observations made in the area. The original burial function of the cemetery was preserved and the area was revitalized with new functions. Cebeci Asri Cemetery is a site with positive impacts on the urban ecosystem. Coniferous and broad-leaved trees are common throughout the cemetery and are beneficial in improving the air quality of the environment and reducing carbon emissions. The dense green space in the cemetery positively affects the microclimate, absorbs noise and reduces the urban heat island effect. At the same time, the cemetery plays an important role in the urban ecosystem by providing a habitat for birds, insects and other animals. Therefore, the integration of Cebeci Asri Cemetery with the city, like the cemeteries in Europe and the United States, will provide significant gains to the city both culturally and environmentally. The cultural route created within the cemetery area offers the opportunity to discover the graves of historical figures from the Republican era. It also reveals monumental structures such as the namazgah, ossuary, and mortuary within the site. Thus, it provides visitors with a sequential and thematic route that offers a historically rich, accessible experience while respecting the site's current function.

It is aimed that such approaches will both provide an idea for urban administrations in the evaluation of cemetery areas and provide guidance for the development of similar approaches in different cemetery areas. In our cities where urban open spaces and green texture are gradually disappearing, it is an inevitable necessity to use the existing open spaces in the most accurate and effective way. Future studies may examine the impact of route suggestions on parameters such as legibility, comfort, and safety through user experience surveys and field interviews. Accessibility within the area can be tested with disabled users and independent expert supervision.

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CRediT Authorship Contribution Statement

Aslı Taş: Writing-review & editing, Writing-original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. Mazlum Kalak: Writing-review & editing, Writing-original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Ethics Committee Approval

Ethics committee permission is not required.

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JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (620-631), 2025
DOI: 10.47818/DRArch.2025.v6i3186

Adapting historic sites: Konya-Sille's approach to climate resilience

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Abstract

Climate change represents an increasingly significant threat worldwide, particularly affecting cities, with historic urban areas encountering this issue on a more profound and complex scale. Although contemporary cities are susceptible to natural calamities due to rapid urban growth and rising population density, historic urban structures, marked by their historical legacy, show a unique vulnerability to the effects of climate change. This is especially pertinent considering their distinctive construction materials and settlement layouts. In this regard, the Sille Neighborhood in Konya, boasting a 5000-year-old history and abundant cultural heritage, emerges as an essential example. It demands detailed scrutiny in the face of environmental challenges like the urban heat island phenomenon, sudden flooding, and drought conditions. The traditional construction materials in Sille, such as wood and adobe, exacerbate this vulnerability, emphasizing the vital need to balance the preservation of historic heritage with climate adaptation strategies.

Keywords: adaptation/resilience, climate change, urban heat island, Sille, historic city

1. Introduction

Climate change is presently one of the gravest threats on a global scale. Cities are particularly vulnerable to this danger due to their high levels of urbanization and growing populations. As major contributors to global greenhouse gas emissions, urban centers face the risk of natural disasters if sufficient measures are not implemented. This issue affects not only contemporary cities but also urban heritage sites of significant historical and cultural importance. These historic urban areas, which reflect the identity of societies, are at great risk from extreme temperatures, sudden heavy rainfall, floods, and droughts resulting from climate change.

In this regard, the Sille Neighborhood, situated in the Selçuklu district of Konya, is a noteworthy urban area for examination. This is due to its rich historical and cultural heritage as well as its susceptibility to climate change impacts. With a history spanning approximately 5,000 years, Sille bears the imprints of the Hittite, Phrygian, Roman, Byzantine, Seljuk, Ottoman, and Republican eras. Recognized as a significant bishopric centre during the Byzantine period, Sille houses monumental structures such as the Hagia Eleni Church, constructed in 327 AD. It also thrived as a hub for culture, education, and handicrafts during the Seljuk and Ottoman times. In 1995, Sille was designated as an urban heritage site to ensure its preservation (Özyurt & Dişli, 2021).

Clearly, an ancient city like Sille, with its extensive history showcasing the legacy of numerous civilizations, inherently possesses a delicate structure that necessitates protection. However, it is also unavoidable that this historic city, given its long history and unique material choices (such as timber and adobe), is particularly susceptible to the effects of climate change, including the urban heat island effect, floods, and droughts. These factors heighten the delicate balance between preserving historical heritage and adapting to climate change to a more critical level. While modern adaptation solutions might compromise the qualities of historic structures or fabric, neglecting climate adaptation would equally jeopardize the heritage itself. Traditional conservation methods often aim to maintain a structure in a static, time-specific condition, but as climate change is a

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Article history: Received 17 June 2025, Revised 19 August 2025, Accepted 01 October 2025, Published 24 December 2025

dynamic and continuously evolving threat, static conservation approaches are proving inadequate. This also raises the question of how conservation laws and practices can be integrated with current climate change considerations.

This article seeks to propose policies for enhancing the climate adaptation and resilience of historic areas, specifically focusing on Konya-Sille. To achieve this objective, the study adopts a holistic case study approach based on a qualitative research design. The analytical framework of the study relies on a multi-layered data synthesis: in this context, the theoretical background was established through an academic literature review, while Sille's current condition and vulnerabilities were identified by examining local government documents, such as the Conservation-Oriented Development Plan and existing data, as well as reports from institutions like the Turkish State Meteorological Service (TSMS) and the General Directorate of State Hydraulic Works (DSI). This data was further enriched and supported by on-site observations in the area. The core finding from these analyses is that Sille's traditional architecture and settlement fabric embodies time-tested passive design principles and resilience strategies that should not be overlooked in combating climate change. Accordingly, the article's main contribution to the literature is its presentation of a holistic planning framework that integrates this traditional knowledge with innovative adaptation strategies, such as green and blue infrastructure, thereby both preserving cultural heritage and enhancing climate resilience.

2. Geographical and Architectural Characteristics of Konya-Sille

Situated to the west of Konya, Sille is a distinctive settlement with a history spanning around five thousand years. The area's rugged landscape has played a major role in shaping Sille's settlement characteristics. Buildings are arranged in terraces on the steep slopes flanking the stream that runs through the centre (Figure 1). This terraced layout enables cubic, flat-roofed structures to enjoy clear views and ample sunlight, which also enhances privacy. Streets running perpendicular to the slope feature staircase pathways, and most buildings are constructed directly adjacent to the street, lacking front gardens.

Figure 1 Photographs of Sille's general building layout (From personal archive, June 1, 2025)

The distinctive settlement pattern of Sille clearly demonstrates the successful application of passive climate control in traditional architecture. The houses, arranged like an amphitheater on the area's rugged terrain, are tiered to ensure they do not obstruct each other's views, sunlight, or wind. This clever arrangement not only provided privacy but also enabled the optimization of natural ventilation and solar exposure. Unlike the dense and unplanned concrete developments in Konya's city centers, Sille's organic fabric has the potential to naturally mitigate the Urban Heat Island (UHI) effect, owing to its lower building density and higher proportion of natural surfaces. Although no direct comparative study exists between Sille and central Konya, it has been established in the literature that such organic fabrics in traditional settlements create cooler microclimates compared to modern cities (Gago et al., 2013). Indeed, Waseem et al. (2021) also highlight the influence of urban fabric on microclimates and the role of green spaces in mitigating the UHI effect. These findings offer valuable insights into how topography and architectural formations can be leveraged as fundamental elements for climate adaptation in contemporary

urban planning. However, the current decline in population and the abandonment of streets, particularly in the upper parts of Dere Caddesi (Stream Street), pose a threat to this natural resilience. Therefore, preserving and enhancing Sille's existing topographical advantages should be central to climate interventions in its urban development plans.

Most buildings in Sille are one or two storeys high, with earthen roofs. Although only a few are built from adobe, the vast majority are constructed using stone. The primary building material is a unique type of rock sourced from the volcanic area to the south of the region (granite, syenite, and andesite), known as "Sille Stone." This stone has been extensively used in many old buildings, churches, and mosques across the region, particularly in Seljuk-era structures in Konya (Aklanoğlu, 2009; Kuyrukçu & Yıldız Kuyrukçu, 2015).

In addition to Sille Stone, timber (pine, juniper, poplar) was used as horizontal reinforcement within stone walls, as the main material in Baghdadi construction, and for interior and exterior door and window frames, room flooring, cabinets, shelves, beams, braces, eaves, and stairs. Earthen roofs were constructed with timber beams covered with matting and earth, made durable against snow and rain by a layer of 'çorak', a mixture of salt and ash, and compacted with stone rollers (Közoğlu et al., 2022, p.19).

Beyond being merely a building material, Sille Stone's compatibility with the region's climatic conditions makes it a critical material for climate resilience. Research shows that volcanic stones of andesitic origin, like Sille Stone, have a thermal conductivity coefficient in the average range of 1.7–2.5 W/mK (Ekinci & Aydin, 2016). Although this value is higher than that of modern insulation materials, the stone's primary climatic advantage stems from its high thermal mass (heat storage capacity). This property allows the thick stone walls to slowly absorb heat during the day and gradually release it at night, helping to keep buildings cool in summer and warm in winter. This is one of the main reasons why the energy efficiency of traditional buildings exhibits results comparable to those of modern buildings (Közoğlu et al., 2022, p.17). However, the extent to which this unique material is used in current restorations, and the thermal performance implications of its replacement with modern materials, require further investigation. These attributes of Sille Stone highlight the importance of the "local material use" strategy, which integrates cultural heritage preservation with climate adaptation, serving as an exemplary model for modern sustainable architecture.

Sille is home to significant historical structures such as the Hagia Eleni Church, Çarşı Hammam, and Sille Museum. Main streets with dense settlement, like Karataş Street and Hacı Ali Ağa Street, define the urban fabric alongside the bazaar that has developed on both sides of Sille Stream. The streets are generally narrow; as is common in traditional Turkish-Islamic urban fabric, their widths typically range from 3 to 5 meters, wide enough for a pack animal to pass (Günay, 2013). This narrowness creates a cooler environment, particularly during hot summer months, by ensuring the streets remain shaded for longer periods. The streets are stone-paved and equipped with central gutters to channel runoff water; neighborhood fountains are located at corners where multiple streets converge. Although some old streets have been abandoned due to population decline, the architectural elements of old Sille residences hold the potential for revitalization through future renovation projects (Konya Metropolitan Municipality, n.d.).

Sille was registered as an urban heritage site by the Konya Cultural and Natural Heritage Preservation Board in 1995. These registration and protection decisions aim to prevent new construction from diminishing the town's authenticity and integrity. Selçuklu Municipality and Konya Metropolitan Municipality are actively engaged in restoration efforts in Sille, aiming to transform it into a major attraction through facade improvements and street revitalization. Restoration and reconstruction projects are ongoing in line with the Conservation-Oriented Development Plan, prepared in 2001 and revised in 2024. Notably, extensive rock stabilization works have been undertaken to mitigate disaster risks posed by natural rock formations impacting

parts of Sille's historic settlement area. These efforts aim to both preserve Sille's cultural heritage and enhance its resilience to natural disasters (Selçuklu Municipality, n.d.).

In summary, Sille's geographical location, topography, settlement fabric, and traditional building materials do not merely present a historical and cultural identity, but also constitute a holistic system of passive climate control and natural resilience formed through centuries of experience. Each element, from the terraced settlement to the high thermal mass stone walls, is part of a local adaptation strategy developed in response to the region's climatic challenges. This section has described Sille's deep-rooted legacy of resilience. However, the critical question is the extent to which these traditional strategies remain adequate in the face of today's increasing and intensifying climate change threats, such as extreme heat, flash floods, and prolonged droughts. Therefore, the following section will analyze in detail Sille's current vulnerabilities to these modern climatic pressures.

3. Climate Change Impacts and Vulnerability Analysis in Sille

Although Sille shares similar climatic traits with Konya, it benefits from a unique microclimate due to its valley position, sparse population, and rural nature. The nearby mountains, such as Takkeli, Gevenli, and Büyük Gevele, help Sille to have milder winters and cooler summers, shielding its vineyards and gardens from frost damage. Konya's climate statistics show average temperatures of -0.2 °C in January and 23.6 °C in July, with recorded extremes of 40.9 °C and -28.2 °C. Additionally, with an annual rainfall average of 327.6 mm, Konya is one of the driest provinces in Turkey (Turkish State Meteorological Service (TSMS), n.d.).

The valley location and mountainous terrain provide Sille with a natural microclimatic benefit, crucial to the climate-responsive nature of its traditional settlement. However, the unregulated expansion and fragmented design from Konya city centre towards Sille threaten this microclimatic benefit and its inherent resilience. The increase in concrete construction significantly worsens the Urban Heat Island (UHI) effect. Maintaining this microclimate not only offers environmental advantages but also is integral to Sille's cultural identity and quality of life. The traditional settlement's low population density and rural character support this microclimate, yet unchecked urban sprawl disrupts this fragile equilibrium. This highlights the necessity of restricting urban development in historic areas and implementing comprehensive planning strategies to protect existing microclimatic benefits (Aklanoğlu & Erdoğan, 2011).

3.1. Urban Heat Island Effect and Local Observations

The Urban Heat Island (UHI) effect refers to the situation where urban areas experience higher temperatures than their rural surroundings. This temperature difference is especially noticeable at night and during times of low wind (Oke, 1982). Key factors contributing to UHI include urban materials like concrete and asphalt, which absorb and store more solar energy. Additionally, urban structures such as tall buildings and narrow streets enhance heat retention, while a lack of green spaces and human-generated heat further amplify this effect (Oke, 1982; Voogt & Oke, 2003). As a result, UHI is a significant concept affecting environmental quality, public health, and the sustainability of cities.

The extensive use of concrete and asphalt, along with dark-coloured materials, heightens the UHI effect by increasing solar energy absorption and heat release. With fewer natural surfaces, urban temperatures can surpass those in rural areas by several degrees (Oke, 1982; Voogt & Oke, 2003).

In the specific case of Sille, no direct measurement data or detailed local observations on the Urban Heat Island (UHI) effect are available. However, the settlement's unique physical structure directly influences this risk. The earthen roofs in the traditional fabric help to mitigate thermal stress, thanks to their high thermal mass, by storing daytime heat and releasing it slowly at night, and by providing evaporative cooling through their retained moisture. In contrast, coating these roofs with synthetic materials like membranes for waterproofing during modern restorations could

eliminate this natural cooling effect. Similarly, while the narrow, shaded streets help maintain cooler conditions during the day, paving them with modern asphalt could lead to higher night-time temperatures by causing greater heat absorption compared to traditional stone paving.

To validate these qualitative observations, conducting a Land Surface Temperature (LST) analysis based on satellite data for Sille and its surrounding urban areas would clearly reveal the extent of the UHI effect and identify high-risk zones. Such a visualization would provide strong evidence for policy-making processes, particularly by illustrating the temperature differentials between the historic fabric and newly developed areas.

3.2. Flood and Flash Flood Risks: Sille Stream and Infrastructure Deficiencies

Climate change, by increasing atmospheric water vapor, modifies precipitation patterns, resulting in more frequent sudden and intense flooding in certain areas (IPCC, 2021). Sille Stream, located in the Konya Closed Basin, was once an essential water supply, irrigating local vineyards and gardens. However, after the Sille Dam was constructed between 1953 and 1960, coupled with a decline in rainfall, the stream bed dried up, a situation mirrored by many smaller streams and rivers in the vicinity (Aklanoğlu, 2009, p.83).

In urban areas, especially in historic settlements, existing drainage systems often struggle to cope with sudden, intense rainfall. The prevalence of impermeable surfaces like asphalt and concrete prevents water from being absorbed into the ground, leading to flooding in streets, underpasses, and residential zones (Grimm et al., 2008). Sille's architectural and planning characteristics directly influence this risk. Within the terraced fabric of the settlement, the narrow, stone-paved streets with their central gutters have historically functioned as a drainage system, channeling rainwater to the stream bed in a controlled manner. However, the sudden and severe downpours associated with climate change have the potential to exceed the capacity of this traditional system. Surface runoff, flowing rapidly due to the increase of impermeable surfaces at higher elevations, can turn these narrow streets into channels, thereby increasing the risk of flooding in flat areas near the stream bed and in building basements.

Sille employs a combined sewage system, where both wastewater and stormwater are discharged together. Although detailed records of past flood events in Sille are scarce, this setup suggests that the drainage systems may become overwhelmed during sudden downpours (Aklanoğlu, 2009, p.83). A flood risk map, developed by considering the topography of the Sille Stream bed and its surroundings, would be a critical tool for identifying potential flood zones and the most vulnerable structures (e.g., historic residences with basements).

The Sille Stream, once a crucial water source, has turned into a dry riverbed due to dam construction and reduced rainfall. While the dam aimed to prevent floods and aid irrigation, the drying of the stream bed has significantly altered the local ecosystem and water cycle. This arid stream bed, while worsening drought conditions, also increases the risk of flooding by obstructing the natural flow of water during sudden and severe rainfall, a result of climate change. Dry beds may be inadequate for handling sudden water surges, a problem further exacerbated by the combined sewage system. This situation highlights a 'water management paradox,' where both drought and flood risks are heightened. It emphasizes that relying solely on one-dimensional water management solutions, such as dam construction, may not be sufficient to address the complex challenges posed by climate change (Ministry of Agriculture and Forestry, General Directorate of Water Management, Department of Flood and Drought Management, 2023). Therefore, integrated water management strategies and 'blue infrastructure' solutions are crucial for building resilience against both water scarcity and excessive rainfall.

3.3. Drought Impacts and Water Resources Management Issues

Konya is acknowledged as one of Turkey's driest provinces, having faced its most intense drought period, especially over the past ten years (Şarış & Gedik, 2021). The shortage of water, mainly due to inadequate rainfall, presents significant social and economic difficulties, potentially resulting in reduced agricultural output, nutritional shortfalls, and even cases of famine and deaths.

The water reserves in the Konya Basin have greatly decreased. For example, figures from the State Hydraulic Works (DSI) reveal that the water levels in Altınapa Dam have dropped to 37%, and in Bağbaşı Dam to just 15% (General Directorate of State Hydraulic Works [DSI], n.d.). This critical situation threatens not only the supply of drinking water but also agricultural irrigation, which is the region's economic cornerstone. In addition to current dam occupancy rates, long-term quantitative data showing changes in regional groundwater levels and precipitation trend analyses based on updated climate projections for Konya are necessary to understand the future extent of the drought risk.

The Konya Basin Drought Management Plan highlights Sille Stream as a major surface water source, noting that the Sille Dam, built in 1960, was primarily designed for irrigation and flood control, although it clearly states that the dam does not provide drinking water (DSI, 2019). At the same time, the irregular and excessive use of groundwater resources in the area emerges as a key factor in water scarcity. Despite having only about 2% of Turkey's total surface water resources, the Konya Basin accounts for 17% of the country's groundwater potential (DSI, 2019). This imbalance clearly demonstrates the region's heavy reliance on groundwater for its water management, along with the inherent risks of such dependency.

3.4. Current Infrastructure's State Against Climate Change

Sille's existing sewage system functions as a combined network, handling both wastewater and stormwater. This setup can place significant pressure on drainage capacities during sudden, heavy rainfalls, resulting in increased incidents of waterlogging and flooding (Aklanoğlu & Erdoğan, 2011). More generally, poor infrastructure, the dominance of impermeable surfaces, and a lack of green spaces make urban areas susceptible to climate-related disasters (UN-Habitat, 2011). To address these vulnerabilities, Selçuklu Municipality is undertaking several projects in Sille to reduce disaster risks. These efforts include rock stabilization, extensive infrastructure upgrades, and improvements to superstructures, all aimed at boosting Sille's overall resilience to climate change (Selçuklu Municipality, n.d.). (Figure 2). The primary vulnerabilities of Sille to climate change and their relationship with the current infrastructure status are summarized in Table 1.

Figure 2 Photographs of rockfall mitigation measures, including stone walls and wire mesh applications, implemented in Sille to reduce rockfall hazard (From personal archive, June 1, 2025)

Table 1 Sille's Climate Change Vulnerabilities and Impacts

Vulnerability Area	Situation/Observation in Sille	Current Infrastructure Status	Expected/Observed Impacts
Urban Heat Island Effect	Risk of urbanization from Konya despite microclimate, narrow streets, stone structures	Presence of impermeable surfaces, lack of green spaces	Increased temperatures, negative impacts on human health, increased energy consumption
Floods and Flash Floods	Dry bed of Sille Stream, past floods	Combined sewage system, inadequate drainage, impermeable surfaces	Waterlogging during sudden and intense rainfall, infrastructure damage, risk to life and property
Drought and Water Scarcity	Konya is one of the driest regions, most severe drought in the last 10 years	Decreased water levels in dams, overuse of groundwater	Reduction in water resources, decline in agricultural production, negative impacts on ecosystems and human health

4. Traditional Architecture and Settlement Fabric's Climate-Adaptive Features

Over the centuries, Sille's traditional architecture and settlement patterns have developed in response to the area's climatic conditions and geographical features. These buildings display notable elements that reflect passive design principles, providing important insights for modern strategies aimed at adapting to climate change.

4.1. Passive Design Principles (Orientation, Form, Building Envelope)

The architecture of Sille homes is characterized by a compact design that adapts to the sloping landscape, with the aim of reducing heat loss. Buildings are generally located on south-facing slopes to optimize the use of solar energy. Larger windows on the southern sides of the buildings allow for effective capture of sunlight. This arrangement ensures that no house blocks another's access to sunlight, views, or wind, thereby maintaining a harmonious integration with the natural environment. While these strategies build resilience against energy costs by reducing the fuel consumption required for heating in winter, they work in conjunction with other passive cooling strategies to prevent overheating during the summer months.

4.2. Natural Ventilation and Shading Strategies

Sille's traditional settlement, with its terraced design on sloping land, provides significant benefits for passive climate strategies. This configuration ensures that buildings are positioned to prevent obstructing each other's exposure to wind, allowing cool breezes to flow freely. As Knowles (2006) discusses in 'The Solar Village: Living for the Future,' such tiered layouts and the strategic positioning of structures on inclined terrain are essential for optimizing environmental advantages, including natural ventilation and sunlight exposure. These principles align with the adaptive techniques seen in traditional settlements like Sille. This natural ventilation enhances thermal comfort and reduces the need for mechanical cooling by helping to cool the buildings, especially during hot, still summer nights when the urban heat island effect is most intense. Givoni (1969) also noted that the intentional arrangement of trees and walls around buildings creates a windbreak, promoting a more temperate microclimate and thereby lowering the need for heating energy. It is suggested that these environmental modifications play a vital role in enhancing the energy efficiency of homes in Sille.

The windows in Sille homes are generally small, narrow, and tall, featuring wooden shutters. Arnaoutakis and Katsaprakakis (2021) pointed out that such small windows and their wooden shutters help manage solar gain in summer while offering protection from wind and cold in winter. These simple yet effective architectural elements directly contribute to maintaining liveable indoor temperatures during extreme heatwaves, one of today's most significant climate vulnerabilities. Additionally, the open-air areas in front of the main living spaces, known as 'ön damlar' act as eaves over the entrance doors, connecting with the outdoors and aiding in solar control. Research by Hyde (2000) on comparable traditional structures supports the effectiveness of such open or semi-open spaces in improving solar management and regulating the local microclimate.

4.3. Thermal Performance of Sille Stone and Earthen Roofs

The walls of Sille houses were built with notable thickness, using a masonry method that primarily utilized Sille Stone. This high thermal mass plays a critical role in stabilizing the building's interior temperatures, acting as a natural buffer against contemporary challenges such as extreme temperature increases and heatwaves. Studies on similar traditional structures confirm that wall thickness greatly enhances thermal performance (Asadi et al., 2012). Additionally, Sille Stone's low thermal conductivity and natural air-filtering capabilities help maintain comfortable indoor conditions, consistent with the climate control advantages seen in other natural stone materials (Asadi et al., 2012). The flat earthen roofs, constructed with timber beams overlaid with matting and earth, also served functional purposes such as drying food for winter. These roofs significantly contribute to indoor comfort due to their high thermal mass effect. Additionally, they function as a primitive form of green roof; by absorbing a portion of the water during sudden, intense rainfall and providing evaporative cooling, they help to both reduce flood risk and mitigate the urban heat island effect. The thermal mass effect of earthen roofs is recognized as a crucial passive climate control strategy in traditional architecture (Terman, 1985).

4.4. Climatic Benefits of Courtyard and Terraced Structures

Sille homes are constructed following a plan that includes courtyards and terraces. Most of these residences feature courtyards with large seating spaces and rooms that open directly to them. Courtyards, particularly in arid and hot climates, create shaded and cooler microclimates, which reduces the building's cooling load and offers sheltered outdoor living spaces against extreme heat. The tiered terrace design helps to channel cool breezes into the buildings and ensures that airflow is not blocked by neighbouring structures.

These climate-adaptive lessons from traditional Sille architecture offer a rich source of inspiration for contemporary quests in sustainable and bioclimatic design. Each feature examined—in areas such as high thermal mass materials, passive cooling and heating strategies, natural ventilation, and water management, which are detailed in Table 2—demonstrates that effective solutions can be achieved without relying on modern technology. This body of local knowledge serves as a model for designing structures that are highly energy-efficient, have a low carbon footprint, and are more resilient to climatic shocks.

Table 2 Climate Adaptation Features of Traditional Sille Architecture

Architectural Feature	Climate Adaptation Benefit
Terraced and Tiered Settlement	Natural ventilation, solar control, windbreak effect, privacy, and microclimate creation
Sille Stone Walls	Thermal insulation with high thermal mass, protection against heat and cold, air filtration
Flat Earthen Roofs	Indoor comfort via thermal mass effect, water retention potential, functional use (drying)
Small, South-Facing Windows	Passive heating, natural lighting, reduction of energy losses
Wooden Shutters	Solar control, protection from wind and cold
Courtyard House Types	Microclimate creation, natural ventilation, spacious living areas
Narrow Streets	Windbreak effect, shading, reduction of urban heat island effect

However, realizing this potential requires more than individual architectural applications; it demands a holistic planning approach that integrates these principles into conservation and development processes. Therefore, building upon the traditional experience analyzed in this section, the following section will detail the modern, climate-adaptive conservation and planning strategies that can be developed for Sille.

5. Planning Approach: Climate-Adaptive Conservation Strategies

Enhancing the climate change resilience of areas with historical and cultural importance, such as Sille, can be achieved through a holistic and integrated planning approach that goes beyond traditional conservation methods. While numerous solutions can be proposed, their effectiveness depends on their implementation through an integrated strategy, prioritized according to Sille's specific vulnerabilities. Therefore, this section presents an action framework for Sille, ranging from the most urgent and highly feasible interventions to medium- and long-term strategies, which are detailed in Table 3.

Priority 1: Urgent and Foundational Interventions (Water Management and Flood Risk Reduction)

Considering Sille's geographical location and the climatic realities of the Konya Basin, water management is the most urgent area for intervention. Strategies in this area must address both drought and flash flood risks simultaneously.

- **Expansion of Permeable Surfaces:** As a direct intervention against the risk of flash floods in Sille Stream and the potential for narrow streets to rapidly channel water, it is vital to use permeable materials instead of impermeable surfaces like asphalt and concrete, especially in areas near the stream and in large spaces like car parks. This practice will allow rainwater to infiltrate the soil, replenishing groundwater and alleviating the load on the sewage system during sudden downpours, thereby reducing flood risk. This is a highly feasible priority with low costs and high impact.
- **Rainwater Harvesting and Greywater Systems:** To combat drought, the most fundamental vulnerability of the Konya Basin, the integration of rainwater harvesting systems into the historic fabric should be encouraged. Traditional earthen roofs and courtyards, combined with modern filtration and storage (cistern) systems, can create a valuable water source for uses such as garden irrigation. Integrating these systems with greywater recycling systems is one of the most urgent and strategic steps towards reducing the pressure on potable water supplies and increasing resilience against water scarcity.
- **Ecological Restoration of Sille Stream:** The dry state of the stream bed both reinforces the perception of drought and poses a risk during flash floods. The ecological revitalisation of the stream—by planting vegetation that acts as a water retainer and natural filter and creating small pools to slow water flow—will both reduce flood risk and positively affect the area's microclimate. This is a medium-term yet fundamental improvement step.

Priority 2: Medium-Term Strategies (Combating the Urban Heat Island Effect and Architectural Adaptation)

Once water management is addressed, the priority shifts to combating extreme temperatures and the Urban Heat Island (UHI) effect, which directly impact the quality of life in Sille.

- **Promoting Green Roofs and Vertical Gardens:** As a direct solution to mitigate the UHI effect, green roof applications should be encouraged, especially in new or restored buildings. The tradition of earthen roofs can facilitate the cultural adoption of this modern practice. Green roofs using drought-resistant native plants will lower building cooling costs while helping to balance Sille's overall temperature.
- **Preserving Traditional Materials and Passive Design Principles:** To maintain the natural protection offered by Sille's traditional architecture against extreme heat, the use of local materials with high thermal mass, such as Sille Stone, should be mandated in restorations. Preserving architectural elements that provide passive cooling, such as thick walls, small windows, and courtyards, is the most effective and sustainable method for reducing dependency on mechanical cooling and increasing energy efficiency.

- **Increasing Urban Green Spaces:** Protecting existing vineyards and gardens and converting abandoned streets and plots into temporary or permanent small "pocket parks" or community gardens, will break the UHI effect on a local scale and protect public health by creating shaded, cool recreational areas.

Priority 3: Long-Term Strategic Framework (Holistic Governance and Legal Integration)

The success and sustainability of physical interventions depend on a strong governance and legal framework.

- **Disaster Risk Management Plans and Early Warning Systems:** A Disaster Risk Management Plan that integrates the interventions mentioned above should be prepared, including detailed flood, drought, and rockfall risk maps specific to Sille. Establishing an early warning system, particularly for flash floods, is a critical long-term investment to prevent the loss of life and property.
- **Participatory Planning and Awareness-Raising:** The success of all implemented strategies depends on the participation and knowledge of the local community. Education and awareness programmes should be organised in collaboration with the public, NGOs, and local authorities on topics such as water conservation, the maintenance of traditional buildings, and the protection of green spaces.
- **Legislative Integration:** Updating cultural heritage conservation legislation (e.g., the Conservation-Oriented Development Plan) to include climate change adaptation goals will ensure that all these efforts are legally grounded. Incentivising or mandatory clauses should be added to planning regulations concerning the use of permeable surfaces, the requirement for local materials, and rainwater harvesting systems.

Table 3 Prioritised Climate Adaptation Strategies for Sille

Priority Level	Strategic Area	Implementation Proposals	Targeted Benefit / Associated Vulnerability
Priority 1: Urgent and Foundational	Water Management and Flood Risk Reduction	• Expansion of permeable surfaces (car parks, stream banks). • Integration of rainwater harvesting and greywater systems. • Ecological restoration of Sille Stream	• Benefit: Water efficiency, reduced flood risk, groundwater replenishment. • Vulnerability: Flash floods and flooding, drought and water scarcity.
Priority 2: Medium-Term	Combating the Urban Heat Island (UHI) Effect and Architectural Adaptation	• Promoting green roofs and vertical gardens. • Preserving traditional materials (Sille Stone) and passive design principles. • Increasing urban green spaces (pocket parks, gardens).	• Benefit: Reduced UHI effect, energy savings, improved quality of life. • Vulnerability: Urban Heat Island, extreme temperatures.
Priority 3: Long-Term	Holistic Governance and Legal Integration	• Preparation of detailed disaster (flood, drought, rockfall) risk plans. • Establishment of early warning systems. • Participatory planning and awareness programmes. • Updating conservation legislation with climate objectives.	• Benefit: Disaster preparedness, community participation, sustainable conservation. • Vulnerability: Institutional and legal unpreparedness for all risks.

6. Conclusion

Konya Sille, with its rich 5000-year heritage, now stands at a critical crossroads in the face of threats from climate change, such as drought, floods, and extreme heat. The fundamental dilemma in this process is twofold: on one hand, the inadequacy of static conservation approaches, which aim to preserve the cultural fabric as if frozen in time, against dynamic climate threats; and on the other, the risk that modern adaptation solutions, which disregard historical identity, could

irreversibly damage this heritage. At this delicate balance point, this study centers on the understanding that conservation must not only preserve the past but also be able to adapt to the conditions of the future.

The core argument of this article and its original contribution to the literature is its reinterpretation of Sille's traditional architectural fabric not merely as a passive heritage to be preserved, but as an active and living set of strategies for climate resilience. High thermal mass local materials, terraced settlements adapted to the terrain, and architectural elements providing passive climate control embody a time-tested experience offering low-carbon, energy-efficient solutions to modern challenges. Accordingly, the study presents a concrete planning framework that integrates this local knowledge with innovative solutions like green and blue infrastructure, prioritized according to Sille's specific vulnerabilities.

In conclusion, the case of Konya Sille transcends the limits of a local case study to offer a paradigm for other historic cities worldwide facing similar climatic and cultural pressures. This study demonstrates that the sustainable future of historic cities is profoundly linked to our capacity to use the architectural heritage of the past as a laboratory to design and conserve the resilient and identity-rich spaces of the future. Placing cultural heritage at the centre of climate action is to protect not only structures, but also our collective memory and a liveable future.

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CRediT Authorship Contribution Statement

Murat KİTİR: Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft, Writing – Review & Editing.

Declaration of Competing Interest

The author declares no known competing financial or personal interests that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Ethics Committee Approval

An ethics committee decision is not required.

Resume

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JOURNAL OF DESIGN FOR RESILIENCE IN ARCHITECTURE & PLANNING

Research Article
Online: www.drarch.org
Volume 6, Issue 3 (632-647), 2025
DOI: 10.47818/DRArch.2025.v6i3187

Tectonic character in Tadao Ando's Church of the Light: Structure, space, and form

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Abstract

Tadao Ando is one of the most important figures in modern architecture, combining minimalist design with traditional Japanese aesthetics, and is known for the use of light in spatial and spiritual contexts. The Church of the Light is one of his well-known projects, reflecting his architectural philosophy and design approach. This paper primarily examines the relationship between the structural form, architectural space, tectonic character, materiality, and detailing in the Church of the Light. Particularly, the paper analyzes the use of materials and the interplay between structure and architectural space in Ando's design. This analysis is based on the taxonomy proposed by Chad Schwartz in his book "Introducing Architectural Tectonics: Exploring the Intersection of Design and Construction", which includes Place, Precedent, Space, Anatomy, Stereotomic, Tectonic, Representation, and Detail as the primary principles constituting the concept of tectonics. The analysis sections and the findings discuss how Ando's tectonic sensibility transforms raw materials and the use of light into an experiential and spiritual architectural space. Additionally, the study offers a deeper understanding of Ando's architectural approach by examining the Church of the Light.

Keywords: architectural space, Church of the Light, concept of tectonics, structural form, Tadao Ando

1. Introduction

Tadao Ando is one of the most important figures in the history of modern architecture, who benefits from a minimalist approach and Japanese aesthetics in his buildings. His architectural design language emphasizes elements such as the use of light, structural integrity, and the emotional impact of space. Through his use of raw concrete and glass (mass and light), Ando attempts to create architectural spaces that foster communication between humans and nature, rather than constructing a shell that isolates people from nature. The key distinction between his work and Western architecture lies in this different approach to nature. According to Ando, three fundamental elements define architecture: material, simple geometry, and nature (Şahbaz, 2010, p. 31). The Church of the Light, one of the clearest examples of Ando's tectonic approach, embodies this architectural philosophy. In this building, Ando utilizes the play of light and shadow to transform spatial perception through the use of simple geometric forms.

Although numerous studies exist in the architectural literature on the spatial and aesthetic qualities, as well as the phenomenological and philosophical dimensions of Tadao Ando's buildings, there has been limited in-depth analysis of Ando's specific buildings, particularly in relation to tectonic principles. Particularly in buildings like the Church of the Light, which demonstrate how light, material, and structural elements interact in the creation of space, the evaluation of these relationships from a tectonic viewpoint has not been extensively explored.

This paper aims to fill this gap in the literature and reveals Ando's distinctive approach to spatial design by employing the tectonic analysis framework proposed by Chad Schwartz (2016).

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Article history: Received 31 July 2025, Revised 22 October, Accepted 17 December 2025, Published 24 December 2025

Methodologically, the paper adopts a qualitative approach grounded in Schwartz's taxonomy, including place, precedent, space, anatomy, stereotomic, tectonic, representation, and detail. Unlike Frampton's general tectonic culture analysis, this study is the first in-depth case study to apply Schwartz's eight-fold taxonomy in a detailed and systematic manner to Tadao Ando's Church of the Light. These categories are individually analyzed to interpret the contextual, spatial, structural, tectonic, and material characteristics of the Church of the Light.

To achieve this aim, the paper begins with a literature review on the concept of tectonics in architectural theory, followed by a brief discussion of Ando's architectural philosophy and basic information about the Church of the Light. Then, the building was analyzed thoroughly using Chad Schwartz's tectonic framework. Finally, the results obtained from the analyses are listed and discussed.

2. Literature Review

2.1. Concept of Tectonics

The concept of tectonics is the totality of lines, masses, and volumes encompassing a work of art (Armağan, 2011). The term has been used since Ancient Greece, meaning "to build" or "to establish"; but it has gained different meanings over time (Schwartz, 2016). Tectonics, as a fundamental concept in architectural history, is based on a perspective that encompasses the components of a building from both technical and aesthetic perspectives.

The concept of tectonics, explored by various philosophers, architects, and theorists across different periods, has evolved in new dimensions and meanings over time. Immanuel Kant (1724-1804) indirectly contributed to architectural theory through his theories on aesthetic judgments and beauty. According to Kant, beauty contains "purposeless purposiveness," a notion that raises the question of how aesthetic values can be balanced with functionality in architecture (McCoy, 2009). Arthur Schopenhauer (1788-1860) expanded upon Kant's ideas, arguing that buildings, beyond their structural functions, leave a profound aesthetic impact on humans. For Schopenhauer, tectonics extends beyond a building's physical stability to encompass an internal order and perceptual effect (Schwartz, 2017).

Friedrich Wilhelm Joseph Schelling (1775-1854) argued that forms and structures in nature carry an inherent "spirit", suggesting that in architecture, aesthetic and structural form should be integrated. Karl Friedrich Schinkel (1781-1841), who saw tectonics not only as a structural necessity but also as a representation of idealism, is one of the important architects who brought all these ideas to life. Schinkel's work can be cited as an example in emphasizing the importance of aesthetic value in load-bearing structural systems. Karl Bötticher presented an important theory regarding integrating structural logic and aesthetic elements in tectonic architecture. Bötticher defined tectonics as the understanding that a building's structural elements and aesthetic values must coexist and be in harmony, and presented this approach as a significant contribution to architectural theory (Jodidio, 2012; Rasmussen, 1992). Karl Bötticher (1806-1889) divided the building into two main categories: Core-form (Kernform) and Art-form (Kunstform). Core-form represents the functional and technical aspects of the building, while Art-form encompasses the building's artistic and aesthetic values (Bötticher, 1992). Bötticher says that a successful architectural work results from the harmonious combination of these two forms. These two distinctions constitute one of the important fundamental elements of tectonic discussions in architectural history (Akgün et al., 2022).

Gottfried Semper (1803-1879) considered architectural elements not only as structural components but also as forms of cultural and aesthetic expression. Semper proposed that a building consists of structural-technical components, which include elements related to its static and durability aspects, and structural-symbolic components, which express its cultural and aesthetic meanings. Semper stated that the elements that make up the building's surfaces originate from textile arts, arguing that traditional techniques, such as those used in carpets, curtains, and knots,

were important sources of inspiration in façade design. He noted that the knot motif, in particular, is one of the most fundamental details used in architecture. (Schwartz, 2017).

Gottfried Semper explained the origins of architecture with four basic elements: the hearth, the earthwork, the frame, and the surrounding membrane. The heart represents the central element of the building and the focal point of social life. The earthwork anchors the building to the ground and forms its foundation. The frame provides the load-bearing structural system, and the surrounding membrane forms the building's surface, defining its aesthetic and symbolic identity (Semper, 1989). In Semper's theory, these components correspond to the functional and cultural dimensions of the architectural form. From the end of the 19th century onwards, modern architecture was influenced by Semper's theory, which significantly enhanced the expressive power of façade design and architectural elements.

Otto Wagner (1841-1918) emphasized that modern materials (steel, concrete, glass) introduced new tectonic understandings in architecture, asserting that these materials should not only be functional but also carry an aesthetic language. Adolf Loos (1870-1933), in his manifesto "Ornament and Crime", argued that ornamentation was unnecessary and that modern architecture should be simple and functional. Loos' views encouraged a minimalist and functional approach to tectonics (Loos, 1982). Eduard Sekler (1910-2007) considered tectonics not only as a structural issue but also as a concept based on the observer's perception. According to Sekler, tectonics goes beyond the accuracy of a building's structural system; it also concerns how this system is visually and experientially perceived (Sekler, 1965).

Kenneth Frampton (1930-) is one of the leading figures who has addressed the concept of tectonics in architectural theory from both ontological and representational perspectives. Frampton views architecture not only as a functional and structural discipline but also as a cultural form of expression with its own unique meaning inherent in the act of construction. In his work "Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture" (1995), Frampton examines the tectonic practices in architectural history in detail, presenting his thoughts on how tectonics should be reinterpreted in modern architecture. In his book, while addressing the evolution of tectonic understanding in 19th- and 20th-century architecture, he discusses tectonics under two main categories: As the first category, ontological tectonics focuses on how the being of a building, through its materials and structural systems, is not only functional but also sensually and experientially perceived. For Frampton, building components are not merely structural elements but serve as fundamental components of architecture. The second category, representational tectonics, refers to the idea that a building must have cultural meaning(s) related to materials and the construction process. Frampton examines how modernist architects used materials not only for technical requirements, but also as aesthetic and symbolic elements. For instance, Le Corbusier's use of concrete as a plastic form of expression, or Mies van der Rohe's use of steel and glass as a narrative of purity in architecture, can serve as good examples in this context (Frampton, 1995).

Frampton's concept of tectonics highlights the honest use of materials and the clear expression of structure in architecture. He believes that good architecture should reveal its construction, with structural elements also contributing to the design narrative. Architects like Louis Kahn, Carlo Scarpa, and Alvar Aalto are key examples for him. Kahn gives meaning to materials, Scarpa focuses on detailed craftsmanship, and Aalto organically utilizes natural materials. Frampton argues that after the mid-20th century, industrial production weakened this tectonic quality. He criticizes how early modernism's material honesty gave way to postmodernism's decorative and superficial style (Frampton, 1995).

2.2. Tadao Ando's Architectural Philosophy

Tadao Ando, born in 1941 in Osaka, Japan, is an architect whose work blends traditional Japanese aesthetics, phenomenology, and modernist principles. Although Ando received no formal architectural training, he developed his design talent, perspective, and philosophy through

extensive self-education (Nazik, 2020). Tadao Ando's architectural approach is shaped by three basic elements: material, simple geometry, and nature (Güzer et al., 2000). His curiosity about natural elements, such as light, shadow, and wind, has formed the basis of his architectural approach, enabling him to create spaces that enhance sensory awareness and invite thought (Yıldız, 1995). Ando was internationally recognized for his ability to create immersive spaces using powerful design strategies, alongside his minimalist approach, and received the Pritzker Architecture Prize in 1995 (Jodidio, 2012).

Ando's refined use of raw concrete in his architectural approach echoes Japan's carpentry traditions, transforming spaces into smooth, tactile surfaces (Gündüz, 2019). Ando, with his attention to detail, transforms concrete into more than just a functional material, making it a tool of expression. (Baek, 2017). His interactive use of concrete, glass, and wood in his buildings combines tradition and modernity, enriching the spatial experience. The balance between enclosure and openness is fundamental to his architectural philosophy. His thick concrete walls define and separate spaces while emphasizing the inner world (Rasmussen, 1992). In his designs, Ando goes beyond functionality, aiming to create spaces that stimulate the senses and enhance awareness of one's surroundings (Haristianti & Murdowo, 2019).

Influenced by Le Corbusier's architectural approach, which is evident in his works, Tadao Ando designs dynamic spaces that transform perception by blending geometric forms with organic elements (Schwartz, 2016). One of the techniques that stands out in Ando's architectural philosophy is his use of natural light not only as a means of illumination but also as a transformative element of space (Cengiz, 2022). Through the carefully placed voids, openings, and slits in the structure, he utilizes the movement of light and shadow throughout the day to create constantly changing and transforming spaces (Erzen, 2004). Ando considers space not merely a space to be lived in, but a reality to be experienced. He does not separate nature from the design process, preserving its interaction with nature and the environment in his designs. In this way, he transcends time as an abstract concept and transforms it into an element that can be experienced, felt, and perceived (Seçer, 2016).

2.3. Project Brief of the Church of the Light

Located in Ibaraki, Japan, the Church of the Light, designed by Tadao Ando in 1989, has become one of the most important buildings in the history of modern architecture. This concrete building, designed to refurbish a Christian complex, reflects Ando's architectural style and philosophy of duality. A cross-shaped opening on its east façade skillfully admits light, creating a unique experience for the user. The predominantly concrete structure is designed with a minimalist, unadorned style. Establishing a strong interaction between nature and architecture, the building strengthens the spatial experience by incorporating contrasts such as fullness and emptiness, light and darkness, simplicity and serenity (Çeşmeli, 2019). Concrete walls and wooden seating elements are harmonized in the building (Furayama, 1996).

Devoid of ornamentation, the raw concrete surfaces foster a contemplative and serene ambiance, imbuing the space with spiritual depth. This building can be seen as a living example of the phrase “less is more” (Şimşek, 2011). The flawless finish of the concrete surfaces reflects the precision and craftsmanship inherent in the Japanese carpentry tradition. This meticulous attention to detail is particularly evident in the seamless integration of the cross-shaped void with the concrete joints. Natural light entering through the void from the east gradually illuminates the dim interior from the early hours of the day, softening the rigid concrete surfaces and transforming the space into a luminous volume. The interaction between the use of light and the material in the building alters the perception of concrete, transforming it from a solid form into a spiritual entity, thereby increasing the building's spiritual and spatial significance. The only religious symbol in the building is a cross-shaped opening, indicating that the building was designed with a minimalist perspective, devoid of ornamentation.

3. Methodology

The Church of the Light is selected as a case study building in this paper to investigate the relationship between architectural space and structural form in Ando's architecture. The analysis is based on the taxonomy proposed by Schwartz (2016). In his book, Schwartz presents a novel and systematic approach to analyzing buildings, detailing spatial experience, aesthetic elements, and structural features. This systematic approach can be categorized into eight areas: Place, precedent, space, anatomy, stereotomy, tectonics, representation, and detail. Beyond the fundamental concepts of the building, this paper also addresses elements such as material selection, building-specific components, use of light, integration into the context, and user experience. As Schwartz argues, understanding the tectonic character of a building requires much more than simply analyzing its physical components.

3.1. Place

The principle of "Place" focuses on the relationship between a structure and its surrounding context, as well as how it adapts to the environmental setting. As seen in Figure 1, the Church of the Light is situated in the Ibaraki district of Osaka, close to a dense urban fabric but almost completely isolated from its surroundings. This location reflects Ando's core design philosophy for space. In contrast to the urban environment, the building aims to provide a tranquil and spiritual atmosphere. The separation from the surrounding dense urban development and social life transforms the church into a space that invites an inner journey (Metalocus, n.d.). Ando avoids direct entrances to highlight nature in his architectural and design approach, routing routes in rural projects that must be passed before reaching the building. By doing so, he detaches users from the urban context to evoke the power of nature and make it perceivable (Çeşmeli, 2019). Upon entering the church, the user's connection to the outside world is severed. The church, situated away from the noise and chaos of its surroundings, offers a deeper, more meditative experience within its interior. The physical presence of the external urban environment diminishes once inside, and upon stepping into the space, the outside world virtually disappears, allowing an atmosphere of inner peace to prevail. This creates a tension between the environment and the building, which plays a significant role in the architectural design. As the user enters the space, they detach from the surrounding context, further deepening the spiritual experience intended within the space. The atmosphere inside the church serves Ando's goal of creating an "internal landscape." Here, the environment is not merely a backdrop but an element that reinforces the spiritual atmosphere created within the interior (Kroll, 2011).

Figure 1 Ground floor plan of the building (Reproduced from ArchEyes (n.d.) by the first author)

The most fundamental elements shaping the interior geometry in this building are the planes and minimalist concrete walls. The deliberate use of these walls represents a critical stance against the prevailing principles and approaches of contemporary architecture. While many modernist architects such as Le Corbusier and Mies van der Rohe embraced the idea of creating fluid spaces

between walls, Tadao Ando emphasizes the significance of the wall itself, thereby positioning his work in opposition to many longstanding modernist ideals. As seen in Figure 2, for Ando, the concrete wall is not merely a structural component but a philosophical medium through which the relationship between architecture and nature is questioned.

Figure 2 Environment of the building (Photographs: Nobuyoshi Araki, Hiromitsu Morimoto) (ArchEyes, n.d.)

In the design of the church, light also plays a crucial role in interacting with the surrounding context. Ando expresses existence in the art of creating surfaces by using light not only as a tool but also as a means in itself. He makes light an indispensable element of the spatial atmosphere (Üçüncü, 1995). As seen in Figure 3, light, as it enters from the outside, becomes an integral part of the space and is used as an element that conveys the spirit of the place. The cuts and angled forms in the building's walls allow natural light to penetrate the space. This light reflects off the walls, creating shifting shadows over time that produce an effect that makes the user unaware of the passage of time. This interaction erases the contextual connection, deepening the spiritual silence within the space. In its relationship with the environment, Ando's intervention in response to the surrounding context aligns with the minimalist form and simplicity of the structure. The harsh concrete material and geometric forms create a distinct contrast with the surroundings. This design isolates the space from the external hustle and bustle, allowing the user to embark on an inner journey. The Church of the Light does not merely relate to the environment; instead, it acknowledges environmental interactions and remains unaffected by them. This design choice represents a unique approach to the surrounding context and social structure. Every detail within the structure is thoughtfully designed to balance this tension with the profound sense of calm found within. As a result, the Church of the Light not only reinforces the physical and spiritual experience but also reshapes the environmental context, centering the user's experience within the space. All these elements demonstrate how Ando's architectural philosophy manifests in the relationship between the Church of the Light and its environment. The building is not just a physical space, but an atmosphere that leads the individual on a spiritual journey through its relationship with the environment, light, and time.

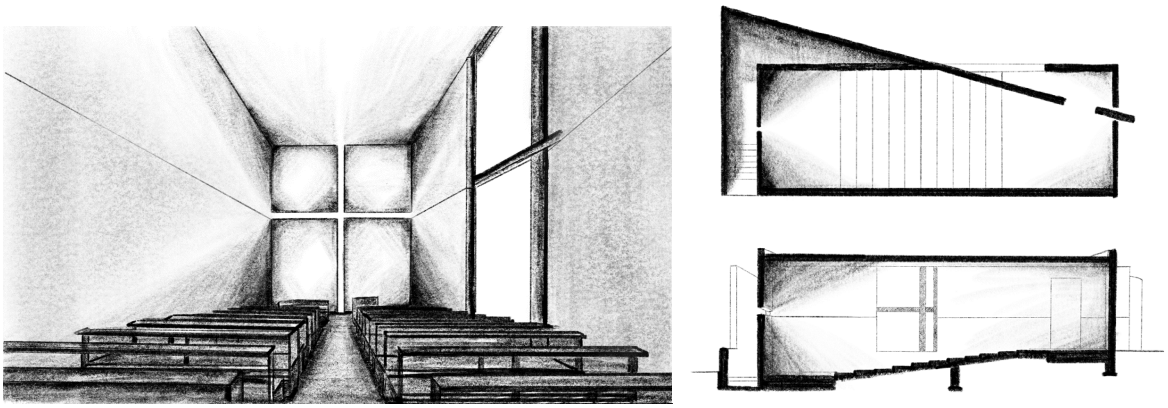

Figure 3 Interior view of the building (Drawn by the first author)

The orientation of the building and its relationship with the sun's movement constitute fundamental elements that enrich the spatial experience of the building. Ando meticulously considered the entry and distribution of sunlight when determining the building's positioning. The building is situated in a way that isolates it from the noise of the urban fabric, creating a tranquil atmosphere while ensuring maximum utilization of natural light. The openings and incisions in the main walls are strategically designed to direct sunlight into the interior at different times of the day. The varying effects of light at different times of day create distinct atmospheres within a space, influencing the perception of that space. The sunlight entering through the openings designed in the building plays a crucial role in altering the perception of space. Sunlight strikes concrete surfaces, creating shadows that depend on the angle, and enhances both the architectural expression and the interaction between the user and the space. The constant fluctuation of daylight prevents the space from remaining stagnant, offering users a different spatial experience. Through this transformation, visitors perceive the flow of time and its emotional impact, in addition to the physical aspects of the space. The way sunlight shapes the space allows users to experience it, inviting them on a journey through the space. As a result, the building is not just an isolated architectural entity, but a dynamic environment engaged in an ongoing dialogue with its surroundings. The interplay of light and time elevates the building beyond a mere physical structure, transforming it into a space that embodies both temporal and spiritual dimensions.

3.2. Precedent

The principle of "Precedent" refers to the influence of previous buildings and ideas on a design. In the case of the Church of the Light, the building draws inspiration from Le Corbusier's Chapelle Notre-Dame-du-Haut in Ronchamp, a significant modernist work. It bears a resemblance in that it creates a space of separation between the two elements through the use of light. As seen in Figure 4, the light band created on the ceilings of both buildings makes the roof appear to float, reversing the familiar load-bearing principle of the structure and eliminating the structural elements at the corners. This surprises and makes the clean structural transition, which has persisted since the Renaissance materialism, even more surprising. As seen in Figure 5, when viewed cross-sectionally, light filters into the space through the slit created in the ceiling in both buildings, freeing the roof from gravity and creating a floating impression. In Ronchamp, this visually lightens the mass and obscures the perception of the structural system. Similarly, in the Church of the Light, light enters through the line formed by the intersection of the load-bearing wall and the partition wall that enters the space, creating a guiding axis toward the center of the building.

Figure 4 Interior views of the Chapelle Notre-Dame-du-Haut (ArchEyes, n.d.) and Church of the Light (Schoof, 2021)

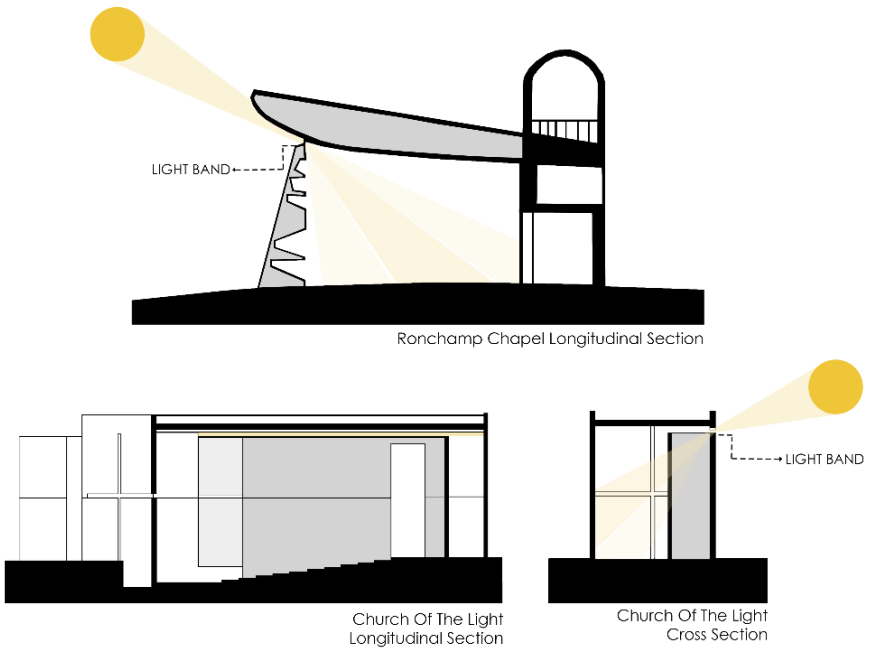

Figure 5 Sections of the Chapelle Notre-Dame-du-Haut and Church of the Light (Drawn by the first author)

However, while Ando was inspired by the relationship between light and space seen in Ronchamp, he diverged significantly from Le Corbusier's design language. Le Corbusier's Chapelle Notre-Dame-du-Haut features organic, flowing forms, with its curved rooflines and sculptural volume that seem to blend with the landscape. In contrast, Church of the Light utilizes a geometric, minimalist approach. Instead of the soft curves and sweeping shapes found at Ronchamp, Ando opts for rigid concrete prisms and sharp angles. The clean, unadorned surfaces of the concrete structure in the Church of the Light stand in stark contrast to the organic, expressive forms at Ronchamp. Furthermore, while Ronchamp allows light to filter freely through irregular openings, creating a dynamic and somewhat unpredictable play of light and shadow, the Church of the Light constrains the entry of light through a cross-shaped slit in the concrete wall. This controlled entry of light serves as a subtle yet powerful architectural element, transforming the space with an almost meditative quality. The impact of light in Ando's design is far more restrained than in Ronchamp, where light floods the interior in varying, unplanned ways. The effect of light in the Church of the Light is deliberately planned to enhance the spiritual experience, making the interaction between light and shadow an integral part of the building's spatial identity.

The Church of the Light bears a resemblance to the Pantheon, another historical precursor, in that light dematerializes the environment, defining an atmospheric space entirely outside of material constraints. As seen in Figure 6, light filtered through the oculus in the Pantheon's dome moves throughout the day, creating a dynamic perception of time and space within the space. This movement alters the atmosphere of the space, revealing the building's geometric and structural essence. This temporal and spatial trace left by the light on the dome surface strengthens both the structural and symbolic essence of the architectural form. Similarly, the light filtering through the openings on the Church of the Light's surface enhances the perception of spatial boundaries through its movement on the reinforced concrete walls, making the structure's tectonic character visible. In Ando's words, the aim is not to reveal the nature of the material, but to use it to "create the purpose of the space"; by drawing light into the space, a serene and translucent atmosphere transcends the material's boundaries (Ando, 1990, p. 458). Thus, in both the Pantheon and the Church of the Light, light is not merely an atmospheric element; it transforms materiality, revealing the spirit of the building and reinforcing its tectonic character. Just as light entering through the oculus at the top of the Pantheon traces the sun's movement throughout the day, leaving a temporal trace in the space, so too does natural light in Ando's building create a planimetric transformation within the interior. This transformation, through the interplay of light and shadow,

intuitively contributes to the tectonic nature of the structural order. Thus, both structures utilize light as a tool for constructive meaning and spatial experience, transcending its mere visual element.

Figure 6 Light in the Pantheon, Rome (Gajewski,2017)

3.3. Space

The principle of "Space" concerns the interior of a building and the atmosphere it creates within. In the case of the Church of the Light, the interior is characterized by simplicity and minimalism, with a focus on creating a profound and contemplative environment for its users. The space itself is not merely a physical volume but an experiential realm that deeply affects the individual's spiritual and emotional state. The dimensions and orientation of the interior space are meticulously planned to enhance the user's spiritual journey. The space is not expansive in the traditional sense, but its proportions and directional focus direct the user's attention inward, drawing them into a deeper engagement with the environment. The use of materials also contributes significantly to the character of the interior. As seen in Figure 7, the interaction resulting from the combined use of concrete and wood creates a natural balance within the space, blending the hardness of the concrete with the warmth of the wood. This combination softens the industrial feel of the concrete and adds a tactile dimension to the interior. This allows users to establish a more intimate and human connection with the designed structure. The combined use of materials such as concrete, wood, and glass in the structure deepens the atmosphere of the space. Additionally, the interior design plays a crucial role in enhancing the overall spatial experience. The transition from smaller, intimate spaces to larger, more open spaces occurs in a balanced manner. Passing through narrow corridors or small rooms before entering a larger, more spacious space offers a layered experience of exploring the space.

Figure 7 Church of the Light Sunday School (Photograph: Hiromitsu Morimoto) (ArchEyes, n.d.)

Eduard Sekler not only views tectonics as a structural concept but also defines it as a phenomenon based on the observer's perception of it. Tectonics extends beyond the clarity of a building's structural system, focusing on its visual and experiential perception (Sekler, 1965). In this context, Ando's spatial design reinforces Eduard Sekler's concept of tectonics in relation to visual and experiential perception. Leaving the structural system open and visible alters perception through the play of light and shadow created within the building, creating spatial richness. The sharp shadows cast on the surfaces by the movement of light throughout the day give new meaning to the space. The stark clarity of the reinforced concrete surfaces and the influential band of light filtering through the narrow vertical opening transform the building's structural accuracy into the observer's temporal experience (See Figure 8).

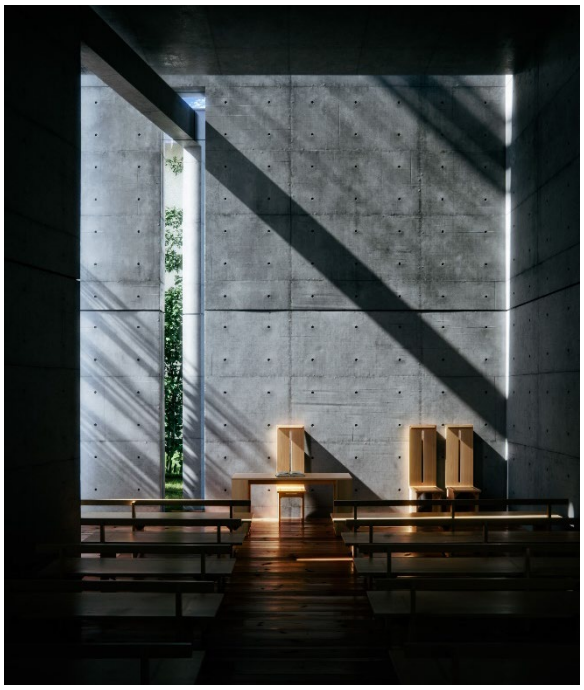

Figure 8 Church of the Light-Tadao Ando architecture (Photograph: Adrian Iliescu) (Iliescu, 2023)

The building's spatial design encourages introspection and spiritual reflection, allowing individuals to detach from the outside world and retreat into their inner selves. For example, the gently sloping floor, designed with guidance, gently guides the user toward the altar, emphasizing the ritualistic and ceremonial nature of the space. On the other hand, light plays a crucial role in shaping the space. The cross-shaped opening in the concrete wall serves as the primary conduit for light to enter the interior, casting dynamic, shifting patterns of light and shadow throughout the day. This interplay of light and shadow not only alters the appearance of the space continuously but also evokes an ethereal, almost mystical atmosphere. As seen in Figure 9, the changing qualities of light reflected on the building throughout the day create a sense of movement and transformation within the space, contributing to a fluid experience where each moment feels different from the previous. This interplay between light and space fosters a deeper connection between the user and the space, creating a meditative and ever-evolving experience.

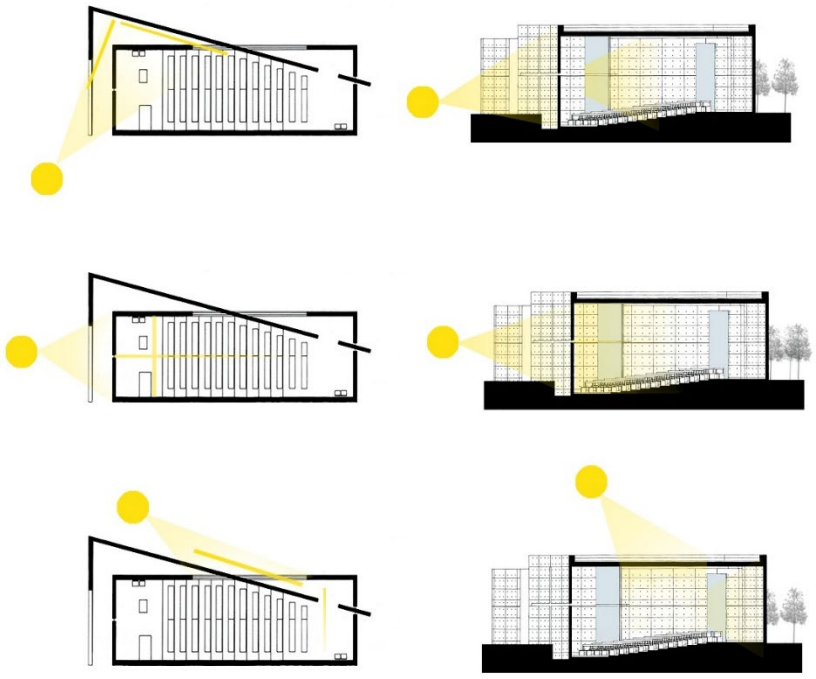

Figure 9 Distribution of light from different angles on plan and section (Reproduced from ArchEyes (n.d.) by the first author)

3.4. Anatomy

The principle of "anatomy" examines how the physical and structural components of a building are organized into a coherent architectural whole. Semper (1989) defines the four fundamental elements of architecture as the hearth, the earthwork, the framework, and the cladding. Ando's architecture considers these elements, identified by Semper, not only as structural elements but also as components that shape the psychological, perceptual, and phenomenological character of the space. In the example of the Church of the Light, this anatomical logic is clearly revealed through the sequential arrangement of building layers and tectonic openings, as visualized in Figure 10. The design develops in six distinct stages, from excavation (earthworks) to the final cladding, with each stage contributing to the creation of a systematic material and spatial composition. The "earthwork" explains the relationship between the reinforced concrete base surface and the structure's topography. The weight of the concrete symbolizes the structure's foundation in the ground and its anchorage in space. The concept of the "hearth" is associated with the symbolic and functional center that constitutes the structure's essence. In the Church of the Light, the hearth is the center of the altar, accompanied by the light reflected from the cross-shaped opening, which forms the spatial and spiritual heart of the structure, the focal point around which people gather and give meaning to their lives. This is consistent with Schwartz's definition of architectural anatomy as the internal order that gives a building its identity. In Ando's buildings, the "framework" is a combination of structural simplicity and geometry. The Church of the Light's load-bearing system is defined by reinforced concrete walls. The use of load-bearing reinforced concrete walls instead of the traditional column-beam system is the fundamental tectonic decision that defines the structure's anatomy. These constructional decisions shape the building's identity. The reinforced concrete used in the structure's framework provides a powerful tectonic expression of mass, weight, and permanence, while the load-bearing and partition walls serve as both the structural framework and spatial definition. The roof, a monolithic concrete slab that appears to float as the partition walls penetrate the space, unifies the volume and intensifies the sense of enclosure. "Cladding" is redefined in Ando's design by the simple concrete surfaces that clad the structure. Concrete, in addition to being a cladding material, becomes a "light curtain" that reflects light, defines shadow, and dissolves the concreteness of the surface. Overall, the anatomy of the church demonstrates Ando's transformation of a limited number of fundamental elements (solid concrete walls, light, and geometric precision) into a spatial organism that conveys both structural

integrity and metaphysical depth. Through its concise material logic and experiential openness, the structure exemplifies how architectural anatomy can be the basis for meaning, order, and emotion.

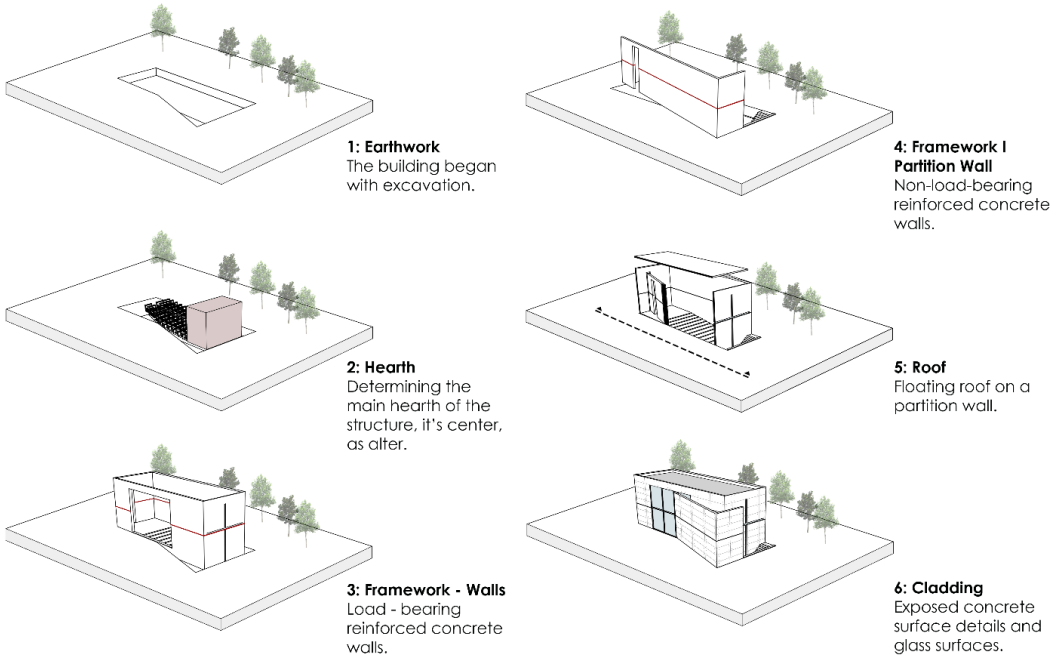

Figure 10 Anatomy of the Church of the Light (Drawn by the first author)

3.5. Stereotomic

The “stereotomic” explains how the structure is constructed and how it relates to Frampton's principle of "material integrity." The heavy and solid nature of concrete reveals how the Church of the Light is firmly anchored in the ground, creating a sense of rootedness. The structure establishes a strong connection with the ground through its concrete walls and mass elements. Concrete symbolizes the solid and uninterrupted foundation on which the structure rests. These mass structures not only ensure the structural security of the space but also strengthen the building's subterranean connection to nature. The heavy and solid nature of concrete, combined with the depth of the space, creates a spiritual atmosphere. Through this strong connection to the earth, the structure's stereotomic structure becomes a symbol representing the continuity of nature and the permanence of the building (Schwartz, 2016; Erzen, 2004).

3.6. Tectonic

“Tectonic” refers to the integration of structural elements in a building in both aesthetic and functional terms. In the Church of the Light, the tectonic principle is manifested in the combination of concrete walls and the cross-shaped light incision. As seen in Figure 11, the concrete walls are designed in a functional way to ensure both structural integrity and the passage of light into the interior. The effect created by the light falling onto the concrete surfaces and the changing shadows over time strengthens the experiential dimension of the space. The tectonic principle is embodied in the harmony of all the building's elements, combining both aesthetic and functional aspects (Schwartz, 2016; Erzen, 2004). In this structure, the use of planar elements such as reinforced concrete walls and slab-free floors instead of column-beam systems adds a unique character to the building. These elements come together without the need for traditional vertical supports, creating a sense of openness and fluidity within the space. The geometry plays a crucial role in this interaction, where the precise alignment and positioning of walls and slabs contribute to the overall harmony of the structure. Some of the walls appear to be disposed in a way that enhances the sense of simplicity and clarity in the architectural composition, offering a serene, meditative quality to the space (Schwartz, 2016; Gündüz, 2019).

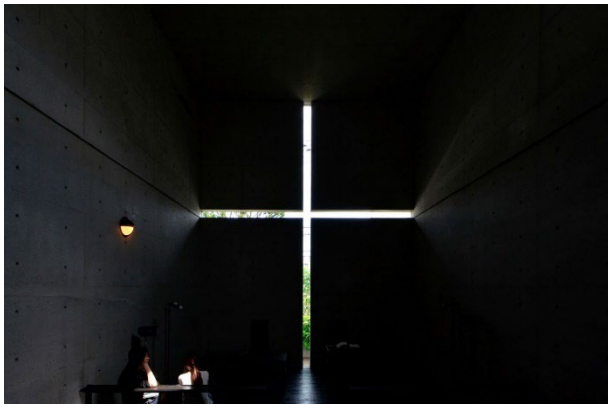

Figure 11 Church of the Light interior (Photograph: Nobuyoshi Araki, Hiromitsu Morimoto) (ArchEyes, n.d.)

3.7. Representation

In the "Representation" section, the mold traces and holes left clearly visible on the structure are not merely decorative elements, but indicators of the construction process and a representation of the concrete's ontological significance. This aesthetically expresses the tectonic character. The dynamic nature of the Church of the Light's surfaces is revealed by the constant changes induced by light. The concrete surfaces, especially features such as formwork marks and holes, reveal the marks of the production process, thereby enhancing the connection between the user and the space. These elements visually capture the building's attention and symbolize its identity and essence. As seen in Figure 12, the cold, hard texture of the concrete, interacting with light, undergoes a continuous transformation as shadows and signs change. This process highlights the building's dynamic and ever-changing character, gradually shaping the viewer's spatial experience. The shadows cast by light at different times of day, along with the changing appearance of the formwork marks and holes, emphasize the transformation of the space. The interplay between light and shadow significantly transforms the Church of the Light into a multi-layered and spatially complex structure. While the traces left by the concrete formwork on these changing surfaces, which also influence the ornamentation and create an aesthetic texture, are not only a decorative element but also a reflection of the building's production process. The formwork marks and holes, as part of the building's identity, carry not just a visual but an ontological meaning. These marks represent the process of formation and the material nature of the structure, while also suggesting that the building communicates through an aesthetic language. These traces within the structure imply that the Church of the Light is not only a physical but also a symbolic entity. Therefore, these elements are not intended as ornamentation, but rather as representations of the building's essence (Schwartz, 2016; Erzen, 2004).

Figure 12 Church of the Light interior (Photographs: Nobuyoshi Araki, Hiromitsu Morimoto) (ArchEyes, n.d.)

3.8. Detail

"Detail" refers to the small yet significant elements where a building's structural and aesthetic components converge. Frampton's tectonic concept emphasizes the fair use of materials and the

clear expression of structure in architecture, dictating that the construction of a building should be demonstrated. According to this understanding, structural elements should be a visible part of the design narrative (Frampton, 1995). The mold marks and holes clearly visible in the building reinforce this narrative and its tectonic character. As seen in Figures 13 and 14, the reinforced concrete surfaces forming the building's walls were cast in two pieces, leaving a clear trace of plaster running through the center of the structure. In the Church of the Light, details play a decisive role in shaping the aesthetic perception of the building. The subtle imprint marks on the cast concrete surfaces reveal the meticulousness with which the structural elements have been designed. The use of wood, both on the walls and in the flooring, creates a contrast between the coldness of concrete and the warmth of the natural material, adding a sense of intimacy to the space. These details, found in the combination of concrete and wood, not only provide the user with a sense of unity but also deepen the architectural language of the building. In the interplay of these details, the space offers not only aesthetic pleasure but also an atmospheric experience that enriches the user's interaction with the environment.

Figure 13 Church of the Light details (Photographs: Nobuyoshi Araki, Hiromitsu Morimoto) (ArchEyes, n.d.), Church of the Light-Tadao Ando architecture (Photograph: Adrian Iliescu) (Iliescu, 2023)

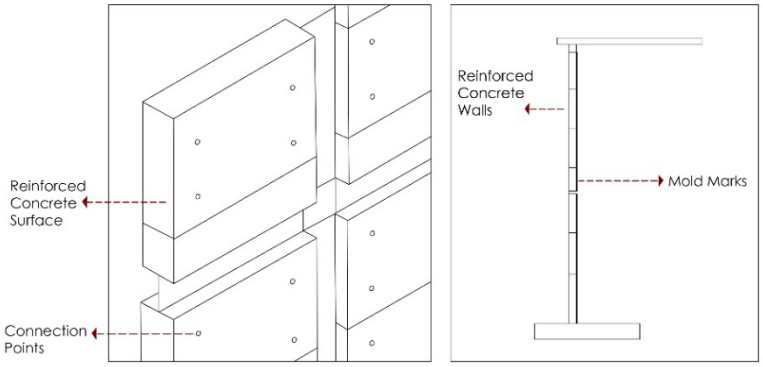

Figure 14 Details from Church of the Light (Drawn by the first author)

4. Conclusion

This study analyzes Tadao Ando's Church of the Light comprehensively by exploring how tectonic principles shape the relationship between architectural space and structural form. By systematically applying Schwartz's tectonic framework, this study offers a more in-depth analysis than previous phenomenological approaches, revealing the precise mechanisms that define how Ando's architecture achieves spiritual depth. The Church of the Light demonstrates how tectonic principles can combine expressive power with technical execution. The building's commitment to material permanence, structural clarity, and the creation of an introspective spatial landscape demonstrates a timeless architectural approach: conceptual resilience through simplicity and focus. The Church of the Light reflects Ando's architectural philosophy, combining the solid, heavy presence of concrete with the delicate play of natural light. The concrete elements serve as structural elements and tools for shaping the architectural space, creating a sense of order and calm. Each element of the building contributes to function and atmosphere, emphasizing the connection between material and meaning.

The interior's spiritual quality stems from the way light enters and interacts with the building's simple geometries and materials, offering visitors a powerful emotional experience. The shifting light and shadow change the space throughout the day, deepening its spiritual atmosphere. This creates an environment where the user's experience extends beyond mere function, fostering a deeper emotional and sensory connection with the space. The Church of the Light demonstrates how tectonic principles can guide both the technical and expressive aspects of architecture. As such, it is a notable example of modern architecture that effectively integrates structure, aesthetics, and human experience.

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CRediT Authorship Contribution Statement

Helin Bağcıvan: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Data curation, Conceptualization, Data visualization. Yenal Akgün: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Data curation, Conceptualization, Data visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Ethics Committee Approval

Ethics committee permission is not required.

Resume

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